Significance of morphology in the systematics of Mesembryanthemaceae: interactive database and illustrated atlas for identification

By

Pascale C.M.H. Chesselet

Submitted in partial fulfilment of the requirements for the degree

PHILOSOPHIAE DOCTOR

In the faculty of Biological and Agricultural Sciences
(Department of Botany)

UNIVERSITY OF PRETORIA
PRETORIA

2004

Promoter: Prof. Dr. A.E. van Wyk
Co-promoter: Hon. Prof. Dr. G.F. Smith

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021



'.....their actual limits and essential characteristics
.....lie veiled in difficulties, which escape development
and defy research. They will not be fettered.'

Adrian Haworth 1821
Revisiones Plantarum Succulentarum
Commenting on *Mesembryanthemum sensu lato*
(206 spp.)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

ABSTRACT

Significance of morphology in the systematics of Mesembryanthemaceae: interactive database and illustrated atlas for identification

By

PASCALE C.M.H. CHESSELET

Submitted in partial fulfilment of the requirements for the degree
PHILOSOPHIAE DOCTOR
In the Faculty of Natural and Agricultural Sciences
(Department of Botany)
University of Pretoria
Pretoria
2004

Promoter: Prof. A.E. van Wyk, Co-promoter: Hon. Prof. G.F. Smith

An overview and interpretation of morphological characters is provided for the Mesembryanthemaceae. Characters useful for identification are separated from those of phylogenetic significance. A new tribal classification that relies primarily on characters of the floral nectary is proposed for subfamily Ruschioideae. Apatesieae is characterized by a broad, flat holonectary, Dorotheantheae by the broad, flat meronectary, Drosanthemeae by the lophomorphic meronectary and Ruschieae by the lophomorphic meronectary (pleisiomorphic state) and lophomorphic holonectary. Ruschieae is defined by the morphological synapomorphy: leaves basally fused. The lack of stable phylogenetic characters and extreme variation in morphological characters give the mesembs an inherent flexibility that may have predisposed this family to great adaptability, and may well have contributed to their explosive speciation in the Succulent Karoo of southern Africa.

A web-based interactive key to mesemb genera was constructed. Species identification is enabled through an iterative search facility and illustrations of types. The 'Interactive Mesembs' site is available at http://www.mesembs.org. Mesembs comprise 1666 species, 4 hybrids and 112 subspecies in 126 genera. New biogeographic data showed mesembs to have extremely high levels of endemism at species level in Fynbos (93%), Albany Thicket (91%), Succulent Karoo (89%), and

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Grassland (84%). At genus level, endemism is highest in Succulent Karoo (45%) and then Fynbos (24%). Most shared genera are between Succulent Karoo and Fynbos (12 genera). The most primitive extant tribe in subfamily Ruschioideae, the Apatesieae, is almost entirely confined to the southwestern Cape. Data supports the hypothesis that the Fynbos Biome is older than the Succulent Karoo Biome, and that the former biome may have acted as a mesic refuge. The number of shared genera between Fynbos and Succulent Karoo supports the recognition of the Greater Cape Mediterranean Region.

Keywords: Aizoaceae, character analysis, congruence, diversity, endemism, floral nectaries, Fynbos, hygrochastic fruit, interactive key, Mesembryanthemaceae, mesembs, molecular data, morphology, phylogeny, refugia, Succulent Karoo, systematics, taxonomy.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

LIST OF ABBREVIATIONS

ACRO	*Acrodon*
AETH	*Aethephyllum*
ALOI	*Aloinopsis*
AMPH	*Amphibolia*
ANTE	*Antegibbaeum*
ANTI	*Antimima*
APAT	*Apatesia*
APG	Angiosperm Phylogeny Group
APTE	*Aptenia*
AREN	*Arenifera*
ARGY	*Argyroderma*
ARID	*Aridaria*
ASPA	*Aspazoma*
ASTR	*Astridia*
BERG	*Bergeranthus*
BIJL	*Bijlia*
BRAU	*Braunsia*
BRIA	*Brianhuntleya*
BROW	*Brownanthus*
CALA	*Calamophyllum*
CAM	Crassulacean Acid Metabolism
CARR	*Carruanthus*
CARY	*Caryotophora*
CAUL	*Caulipsolon*
CEPH	*Cephalophyllum*
CERO	*Cerochlamys*
CHAS	*Chasmatophyllum*
CHEI	*Cheiridopsis*
CIRC	*Circandra*
CLER	*Cleretum*
CONI	*Conicosia*
CONO	*Conophytum*
CORP	*Corpuscularia*
CRPA	*Carpanthea*
CRPO	*Carpobrotus*
CYLI	*Cylindrophyllum*
DACT	*Dactylopsis*
DEIL	*Deilanthe*
DELO	*Delosperma*
DESC	refers to a descriptive character
DICR	*Dicrocaulon*
DIDY	*Didymaotus*
DINT	*Dinteranthus*
DIPL	*Diplosoma*
DISP	*Disphyma*
DORO	*Dorotheanthus*
DRAC	*Dracophilus*
DROS	*Drosanthemum*
EBER	*Eberlanzia*
EBRA	*Ebracteola*
ECTO	*Ectotropis*
ENAR	*Enarganthe*
EREP	*Erepsia*
ESTE	*Esterhuysenia*
FAUC	*Faucaria*
FENE	*Fenestraria*
FRIT	*Frithia*
GIBB	*Gibbaeum*
GLOT	*Glottiphyllum*
HALL	*Hallianthus*
HAMM	*Hammeria*
HART	*Hartmanthus*
HERE	*Hereroa*
HYME	*Hymenogyne*
IHLE	*Ihlenfeldtia*
JACO	*Jacobsenia*
JENS	*Jensenobotrya*
JORD	*Jordaaniella*
JUTT	*Juttadinteria*
KEY	refers to a character useful for identification
KHAD	*Khadia*
LAMP	*Lampranthus*
LAPI	*Lapidaria*
LEIP	*Leipoldtia*
LITH	*Lithops*
MACH	*Machairophyllum*
MALE	*Malephora*
MARL	*Marlothistella*
MESE	*Mesembryanthemum*
MEST	*Mestoklema*
MEYE	*Meyerophytum*
MITR	*Mitrophyllum*
MONI	*Monilaria*
MOSS	*Mossia*
MUIR	*Muiria*
NAMA	*Namaquanthus*
NAMI	*Namibia*
NANA	*Nananthus*
NELI	*Nelia*
NEOH	*Neohenricia*
OCTO	*Octopoma*
ODON	*Odontophorus*
OOPH	*Oophytum*
ORTH	*Orthopterum*
OSCU	*Oscularia*
OTTO	*Ottosonderia*
PEER	*Peersia*
PHIA	*Phiambolia*
PHYL	*Phyllobolus*

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

PHYLO	refers to a character of phylogenetic significance
PLEI	*Pleiospilos*
POLY	*Polymita*
PREN	*Prenia*
PREP	*Prepodesma*
PSAM	*Psammophora*
PSIL	*Psilocaulon*
RABI	*Rabiea*
RHIN	*Rhinephyllum*
RHOM	*Rhombophyllum*
RUSC	*Ruschia*
RUSU	*Ruschianthus*
SAPH	*Saphesia*
SARC	*Sarcozona*
SCEL	*Sceletium*
SCHL	*Schlechteranthus*
SCHW	*Schwantesia*
SCOP	*Scopelogena*
SKIA	*Skiatophytum*
SMIC	*Smicrostigma*
STAY	*Stayneria*
STOE	*Stoeberia*
STOM	*Stomatium*
SYNA	*Synaptophyllum*
TANQ	*Tanquana*
TITA	*Titanopsis*
TRIC	*Trichodiadema*
UM	Unordered Multistate
VANH	*Vanheerdea*
VANZ	*Vanzijlia*
VLOK	*Vlokia*
WOOL	*Wooleya*
ZEUK	*Zeuktophyllum*

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

TABLE OF CONTENTS

ABSTRACT iii
LIST OF ABBREVIATIONS v
TABLE OF CONTENTS vii
CHAPTER 1 1
INTRODUCTION 1
1.1. Background 1
1.2 Historical background 3
1.3 Rationale 6
1.4 Research Approach 7
1.4.1 Conduct morphological analyses 7
1.4.2 Compile sets of taxonomic and biogeographic species data for rapid information retrieval 8
1.5 Objectives 9
1.6 Hypotheses 9
1.7 Layout of thesis 10
1.8 Publications relevant to this chapter 12
CHAPTER 2 13
METHODOLOGY AND ELECTRONIC PRODUCTS 13
2.1 Sources of information 13
2.1.1 Descriptive data 13
2.1.2 Visual information 13
2.2 Character analysis 14
2.2.1 Character list and discussion of characters 14
2.2.2 Characters and software used for identification 14
2.2.3 Assessment of characters for their phylogenetic significance 15
2.3 Illustrated atlas for identification of mesemb genera 16
2.4 Database and internet site 16
2.4.1 Enriched nomenclatural database 16
2.4.2 The Internet site 19

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

2.5 Publications relevant to this chapter 19
CHAPTER 3 21
CLASSIFICATION OF MESEMBRYANTHEMACEAE 21
3.1 Position in angiosperm phylogeny 21
3.2 Family delimitation and subfamilies included 22
3.3 Supra-generic classification 24
3.4 The genera of Mesembryanthemaceae 28
3.5 Publications relevant to this chapter 34
CHAPTER 4 35
PATTERNS OF FLORISTIC DIVERSITY IN
MESEMBRYANTHEMACEAE 35
4.1 Publication relevant to this chapter 35
CHAPTER 5 42
CHARACTER ANALYSIS 42
5.1 Approach 42
5.2 Character list and discussion of characters 47
5.2.1 Vegetative character set: Life cycle and growth form 47
5.2.2 Vegetative character set: Leaves 54
5.2.3 Vegetative character set: Stems and branches 74
5.2.4 Reproductive character set: Flowering, inflorescence & flowers ... 79
5.2.5 Reproductive character set: Fruit 99
5.2.5.1 Introduction 99
5.2.5.2 Classification of mesemb fruit 99
5.2.5.3 Hypothesis of evolution of fruit types in
Mesembryanthemaceae 100
5.2.5.4 Seed dispersal in Mesembryanthemaceae 104
5.2.5.5 Fruit characters 107
5.2.6 Geographic character Set: Broad distribution data 116
5.3 Publications relevant to this chapter 117
CHAPTER 6 119
ILLUSTRATED ATLAS FOR IDENTIFICATION OF MESEMB GENERA 119

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

6.1 Index of plates 119
6.2 Concise character list 123
CHAPTER 7 257
GENERAL DISCUSSION 257
CHAPTER 8 266
CONCLUSIONS 266
REFERENCES 270
ACKNOWLEDGEMENTS 287
SUMMARY 289
CURRICULUM VITAE 292
APPENDICES 296
Appendix 1: Research priorities in mesembs 299
Appendix 2: Genera of Mesembryanthemaceae 313
Appendix 3: Systematic and evolutionary significance of morphology 358
Appendix 4: New tribal classification based on nectaries 365
Appendix 5: New tribe and adjustments to classification 380
Appendix 6: List of species names 386
Appendix 7: Rediscovery of *Ruschia acutangula* 551
Appendix 8: New tribal classification (popular) 558
Appendix 9: *Ottosonderia monticola* 563
Appendix 10: *Antimima aristulata* comb. nov. 567
Appendix 11: Mesembs with schizocarpic fruit, *Ruschianthemum* 571
Appendix 12: *Dorotheanthus rourkei* 576
Appendix 13: *Brianhuntleya*, a new mesemb genus 581
Appendix 14: *Antimima insidens* 587
Appendix 15: Taxon x character state matrix for identification of mesemb genera 589

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

CHAPTER 1

INTRODUCTION

1.1 Background

A major and unique component of southern Africa's arid-land flora belongs to, depending on the classification adopted, the succulent plant family Mesembryanthemaceae Fenzl, or succulent members of Aizoaceae Martynov in a broad sense, colloquially known as vygies, ice plants, mesembs, or 'ficoïdes crystallines' to the French. Mesembryanthemaceae has diversified explosively, particularly so in the Succulent Karoo Region. This winter-rainfall desert constitutes the world's only arid biodiversity 'hotspot' (Cowling & Cowling 1999) among the 25 recognized globally on the basis of their diversity, endemism, and the apparent threat of extinctions (Myers *et al.* 2000). Mesembs are also well represented in the Cape Floristic Region where Fynbos dominates, as well as in the in summer-rainfall areas of southern Africa. The family is almost entirely endemic to southern Africa with only about 20 species occurring naturally elsewhere. Southern Africa is here defined as Botswana, Lesotho, Namibia, South Africa and Swaziland.

Exceptional diversification and speciation is reflected in a taxonomy that recognizes 1666 species grouped into 126 genera. Mesembs comprise 63% of southern Africa's succulent flora, and 10% of South Africa's Flora (Smith *et al.* 1993). The family Mesembryanthemaceae is comparable in size to the New World Cactaceae (Barthlott & Hunt 1993), also an arid area specialist group.

The uniqueness and evolutionary success of Mesembryanthemaceae (as reflected by high species diversity and ability to colonize apparently environmentally harsh habitats) are attributable to combinations of specialized morphological features

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

that enable survival in arid and in semi-arid conditions. The mostly hygrochastic fruit capsules with rain-dispersed seed are diverse in form and serve taxonomically to distinguish among genera. Succulence and innovative water storage and saving mechanisms contribute to their resilience to drought. In contrast to their close relatives in Aizoaceae here treated in a narrow sense, mesemb flowers are characterized by whorls of bright-coloured petals originating through a 'dedoublement' of staminodial primordia (Ihlenfeldt 1960). Flowers are mostly adapted to insect pollinators.

Succulence is an adaptation to survive seasonal drought in arid environments. Mesembs show a wide array of succulent morphologies, and different strategies are evident (Smith *et al.* 1993). In succulent plants, water relations are optimized and prioritized against other factors such as carbon gain. Many utilize Crassulacean Acid Metabolism [CAM] photosynthesis, or are able to switch to CAM (Von Willert *et al.* 1992). Besides low and sporadic rainfall, other ecologically important factors in the life strategies of mesembs include high irradiation, high temperatures, exposure to sandblasting and soil salinity. Low temperatures are thought to be a limiting factor in the distribution of most mesembs in the colder interior of southern Africa (Rutherford & Westfall 1986; Van Wyk & Smith 2001) above the climatically severe great escarpment.

Cultural and economic importance of mesembs include traditional uses in soap making, preserves, poultices and preparations with psychoactive medicinal properties (Van Wyk & Gericke 2000). Mesembs are the subjects of a huge trade in 'curiosity plants' among succulent collectors. They display features not seen elsewhere in the plant kingdom—the combination of minutism, mimicry and extreme succulence accounts for much of the variation in form and bizarre shapes that add to their appeal.

Botanists have been and largely still are baffled by the tremendous diversity of mesembs, and consequently their taxonomy lags well behind that of many other groups (Chesselet *et al.* 1995). The systematics of the mesembs is emergent: family concepts are debatable, a comprehensive supra-generic classification is lacking, generic delineation is often unclear, and many species are difficult to name

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

unambiguously. The informal supra-generic classification proposed by Hartmann (1991, 1993, 1998) provides a baseline for modern research in the field (Klak *et al.* 2003a; Landrum; 2001; the present study).

Identifications at genus- and species-level are difficult for a number of reasons including paucity of taxonomic work in the group—less than a third of species have been revised since their original description; difficulty finding distinct morphological characters; ill-defined circumscriptions in a number of genera and species (Chesselet *et al.* 1995). Knowledge of species distribution is often restricted to the locality of the type specimen only (Chesselet *et al.* 1995; Hartmann 2001a, b; Chapter 4 of this study). The unresolved state of mesemb taxonomy and systematics affects many levels of biodiversity research, especially in the arid winter rainfall region of southern Africa.

1.2 Historical background

Botanical exploration of southern Africa by Europeans began in 1652 with the arrival of Jan van Riebeek at the Cape of Good Hope. The first known illustration of a mesemb is of *Conicosia elongata*, originally collected on Robben Island, drawn in 1678 and finally published in Jacob Breyne's *Exoticarium plantarum centuria prima.* For a detailed overview of historical aspects of mesemb research refer to Herre's (1971) *Genera of the Mesembryanthemaceae.*

Taxonomic research of mesembs started off conservatively in 1753 when Carl Linnaeus listed 35 species under the single genus *Mesembryanthemum* in *Species Plantarum.* This number increased with the introduction of large numbers of novel southern African mesembs to European botanical collections during the late 18th century. Although *Mesembryanthemum* L. became increasingly heterogeneous and unwieldy, it was accepted as a highly variable genus made up of several hundred species and divisible into sections primarily on leaf-form and habit of growth (Stearn 1939).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

The English naturalist Adrian Hardy Haworth (1768–1833) studied mesembs from live material brought to the Royal Botanic Gardens at Kew. By 1824, Haworth had no less than 362 mesembs in cultivation, amongst other succulents such as aloes and crassulas. He named two mesemb genera: *Gibbaeum* Haw. and *Hymenogyne* Haw., and proposed the name *Glottiphyllum* (Haw.) N.E.Br. but made no further subdivision of *Mesembryanthemum sensu lato*. He did, however, describe a number of species.

It was not until 172 years after Carl Linnaeus's original description that N. E. Brown, Haworth's successor at Kew, began dismantling *Mesembryanthemum*. Brown made the fundamental distinction between species with axile placentation and those with basal or parietal placentation (Brown 1925), which now forms the primary division of Mesembryanthemaceae into two subfamilies, Mesembryanthemoideae and Ruschioideae Schwantes in Ihlenf., Schwantes & Straka emend. Bittrich & H.E.K.Hartmann. Brown's discovery initiated intense interest in the supra-specific taxonomy of mesembs, and many new genera were subsequently described. The main players in the ensuing race to establish genera and describe new species were based in England and Germany and, to a lesser extent, in South Africa.

In 1947, Gustav Schwantes proposed the first formal classification of mesemb genera into tribes and subtribes (Schwantes 1947). This scheme, revised and completed by H. Straka and H.-D. Ihlenfeldt, was published in Hans Herre's (1971) *Genera of the Mesembryanthemaceae*. Six tribes were recognized for the entire group. Although some of the groupings are still maintained today, others are considered to be artificial as they depend largely on superficial morphological similarities. Schwantes also provided a typification of mesemb fruit capsules (1952) and described a number of genera.

Mrs H.M.L. Bolus described several genera and numerous 'new' species—a total of 1 445 between 1928 and 1958! Although sometimes described as the ultimate splitter, Bolus's descriptions of geographical variants are valuable to modern taxonomy. Botanical paintings by Mary Page and Beatrice Carter accompanied Bolus'

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

descriptions (Smith & Walker 2001). These are very useful in the identification of taxa, particularly of live material as succulent plants generally do not make satisfactory herbarium specimens (Burgoyne & Smith 1998).

Table 1. Historical overview of mesemb classification. Brown's work on the hygrochastic fruit led to the establishment of many genera and Bolus described more than a thousand new species. By 1971, the Linnaean genus *Mesembryanthemum* was effectively raised to family in the taxonomic hierarchy, with 125 genera and 2411 species.

Year	*Author*	*Publication*	*No. Genera*	*No. Species*
1753	Carl Linnaeus	Species Plantarum	1	35
1821	Haworth	Observations on the genus Mesembryanthemum	2 (+2)	206
1862	Sonder	Flora Capensis	1	293
1920's	Brown	Mesembryanthemum and some new genera separated from it Gardener's Chronicle	±150	?
1920–1958	Bolus	Notes on Mesembryanthemum and allied genera	?	±1445
1971	Herre	The genera of the Mesembryanthemaceae	125	2411
1998	Smith *et al.*	Mesembs of the world	123	±1680
2001	Hartmann	Illustrated handbook of succulent plants. Aizoaceae (Mesembryanthemoideae, Ruschioideae as well as subfamilies Sesuvioideae, Tetragonioideae, Aizooideae are included)	136	?
this study	Chesselet	'Interactive Mesembs' database	126	1666

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

1.3 Rationale

- The mesembs are an important and unwieldy family. A 'bottom up' approach has been used in this study. Data is provided from species level (species-level inventory and database). Observations at species level were used together with a treatment of genera (Appendix 2) to provide a character list describing genera, which in turn served to resolve systematic affinities at supra-generic level.
- To present the information generated in this study several components are included: a hardcopy thesis that includes a comprehensive discusson of morphological characters, an illustrated atlas of genera and a number of published papers, a nomenclatural database and an interactive key (under construction on the Internet). The Internet site, Interactive Mesembs is available at <http://www. mesembs.org>. This site is accessible through the South African National Biodiversity Institute's website at <http://www.sanbi.org>.
- Systematic groupings and affinities of genera in Mesembryanthemaceae are not fully resolved. This study aims to find morphological characters of systematic significance that provide resolution to the relationships among genera, contrasts this data with recent molecular work, and provides a new classification drawing on the congruence of these comprehensive character sets.
- Global availability of biodiversity data on the Internet and the unwieldiness and sheer size of Mesembryanthemaceae justify a computer-based approach to its documentation, inventory and interpretation.
- 'Interactive Mesembs', a comprehensive nomenclatural database for the entire family, is an integral part of this project. The dataset contains additional taxonomic and biogeogeographic information and is intended to contribute to the global enhancement and rapid expansion of biological information, research and resource management. The utility of a site carrying the Interactive Mesembs dataset is requisite considering the high demand for plant

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

identification and advanced taxonomic and distribution data. It will also stimulate and facilitate further basic and taxonomic work on the mesembs.

- An interactive key to genera using easily accessible macro-morphological characters was initially constructed using LucID (Appendix 15) as a tool for character analysis. It is being adapted for the Internet to enable specialists and non-specialists to identify mesembs to genus level. Interactive Mesembs will enable rapid assessment of field research and observations in a visually stimulating way through the inclusion of accurate and supporting botanical art. The global availability of this comprehensive information set on the mesembs will strongly support the needs of the users of botanical information including nature conservationists, academics (educational tool), researchers (scientific tool), non-government organizations, consultants, private sector practitioners, specialists and non-specialists, non-governmental organizations, amateurs, collectors and farmers, all of whom require empowerment to better understand the current classification and biology of this large succulent plant family.

1.4 Research Approach

1.4.1 Conduct morphological analyses

- Assess the entire family morphologically at genus level from information sourced primarily from published data synthesized in a genus-level treatment of the Mesembryanthemaceae (Chesselet *et al.* 2000a), field and herbarium observations, and as well a visual study of the Bolus Herbarium's collection of botanical paintings of live mesemb material.
- Compile and test sets of morphological characters useful for identification, at genus level, using LucID Professional (1999).
- Compile a comprehensive character list, use character illustrations and explanations of their adaptive and/or phylogenetic significance, and/or usefulness in identification in an illustrated morphological atlas of the mesembs (Chapter 6).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

- Search and test for characters useful in supra-generic classification and constructing phylogenetic hypotheses of relationships among higher-level groups within Mesembryanthemaceae.
- Use 'Dahlgrenograms' or 'bubble diagrams' *sensu* Dahlgren *et al.* (1985) to visually assess taxonomic patterns of character distribution.
- Code selected characters according to cladistic principles for phylogenetic analyses and construct a taxon-character matrix for future analyses using cladistic software (Hennig86 and PAUP).
- Discuss hypotheses of evolution for characters and present probable transformation series where possible.
- Test congruence of morphological characters using a published molecular phylogeny.
- Synthesize data and propose models of evolution in the family.

1.4.2 Compile sets of taxonomic and biogeographic species data for rapid information retrieval.

- Compile a database from own research and observations, herbarium collections, taxonomic literature, vegetation and distribution maps and a collection of accurate botanical paintings of (mostly) type material.
- Provide a species level checklist of currently accepted species names linked to synonyms with a nomenclature that reflects latest revisions and interpretations, and covers the entire family.
- Analyze distribution data at species and genus level for biomes to establish patterns of diversity, geographic distribution and endemism in the family.
- Digitize a collection of botanical illustrations that depict live (mostly) type plants and floral details for ±1 980 plates held at Bolus Herbarium (University of Cape Town) for the facilitation of correct species identification, as well as the visual pleasure of botanical art.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

1.5 Objectives

- To stimulate research and disseminate knowledge of the succulent plant family Mesembryanthemaceae to a broad end-user group using datasets and the Internet.
- To create a user-friendly interactive tool for rapid accessibility to Mesembryanthemaceae taxonomic and biogeographic information.
- To establish a web-based interactive site for the rapid on-line identification of mesemb genera and species (under construction).
- To assess broad patterns of diversity and endemism in an analysis of the floristic diversity of Mesembryanthemaceae at genus and species levels.
- To identify and discuss morphological characters and assess their usefulness in constructing a multi-access identification key to genera.
- To assess the usefulness of selected morphological characters in making phylogenetic inferences and hypotheses of evolution.
- To evaluate character sets and highlight homoplasy and morphological convergence which is very common in highly adapted taxa such as mesembs.
- To provide a supra-generic classification for the Mesembryanthemaceae.

1.6 Hypotheses

- An understanding of evolutionary processes and relationships in the Mesembryanthemaceae can be reached through a morphological, cladistic and systematic approach to character analysis. Such an approach may solve questions of placement of difficult genera and serve to create hypotheses of supra-generic groups.
- In the past, the sophisticated structure of mesemb fruit has been over-emphasized at the expense of other characters. Floral structure may serve to resolve supra-generic relationships in the mesembs.
- Water-filled storage cells (bladder cell idioblasts) on leaves and stems define mesembs and the higher order group Aizoaceae. Elaboration of this idioblast-type

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

epidermis enabled different survival strategies in arid and semi-arid conditions. Characters of the epidermis might be taxonomically significant in elucidating phylogeny and not purely adaptational.

- Specialized structural-functional syndromes and adaptive responses have evolved as adaptations to survival of mesembs in the arid landscape. Several ecological factors have been involved, with pollinator interactions, drought stress and rainfall type being the most influencial.
- Present distribution patterns of genera and species are likely to provide some clues regarding the evolution of the group.

1.7 Layout of thesis

The thesis is composed of several parts: a written document or thesis, a website 'Interactive Mesembs' and a comprehensive list of species and associated data on CD, as well as an extended appendix that includes published papers. Each chapter is concluded by a list of published contributions emanating from this study. A complete list of references consulted is provided at the end of the thesis (p. 269). Author citations for all species are provided in Appendix 6, or can be obtained from the accompanying CD or the Internet site.

The Introduction (Chapter 1) highlights the size of the group and its significance as a large component of southern Africa's flora. A brief historical review of mesemb systematics is given to contextualize this study. The objectives of the study and hypotheses to be tested are succinctly put forward at the end of Chapter 1.

The sources of information used for the study are provided in the methodological section (Chapter 2). Character analysis is discussed and the character sets used are provided, as well as the methods used for the discrimination of characters into two types: characters used for identification of genera and those used for phylogenetic purposes. The layout and purpose of the illustrated atlas for identification of mesemb genera is described. The species database and Internet site are discussed and their fields described at the end of Chapter 2.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

A detailed background to systematics and classification of Mesembryanthemaceae is provided in Chapter 3. Their position in the angiosperm phylogeny is discussed as is their classification at family level. Their supra-generic classification is outlined and data relating to each mesemb genus is given in a comprehensive table.

An analysis of the species data is provided in Chapter 4, as a published paper entitled 'Patterns of floristic diversity in Mesembryanthemaceae'. Here, new data on species and genus distribution and endemism is given at the biome level.

An expanded character list with discussion of morphological characters comprises Chapter 5. Characters are assigned to different character sets. They have been polarized where possible and cross-referenced to illustrations in Chapter 6. Where possible the functional significance of characters is discussed .

The illustrated atlas for identification of mesemb genera comprises the stand-alone Chapter 6. Here, each genus is portrayed using samples from the Bolus Herbarium collection of mesemb type paintings. Distinguishing features and a description of the fruit are provided for each genus. Characters illustrated are listed and indicated. A map showing the broad distribution of each genus, the number of species in each genus and biome(s) in which species occur is provided.

An overview of the thesis and its results is given in the general discussion (Chapter 7). The approach and results are discussed in broad terms, and recommendations for future research are provided.

Concluding statements are summarized in Chapter 8. This section is followed by references used in the thesis. The appendices include all published papers relevant to this study, and a taxon x character matrix concludes this work.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

1.8 Publications relevant to this chapter

Chesselet, P., Mössmer, M. & Smith, G.F. 1995. Research priorities in the succulent plant family Mesembryanthemaceae Fenzl. *South African Journal of Science.* 91: 197–209. (Appendix 1: 298).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

CHAPTER 2

METHODOLOGY AND ELECTRONIC PRODUCTS

2.1 Sources of information

2.1.1 Descriptive data

Data for morphological analyses were sourced primarily from a compilation of comprehensive genus-level descriptions of genera of Mesembryanthemaceae (Appendix 2), published in Chesselet *et al.* (2000a), and accumulated following an intensive search through published taxonomic literature, as well as through observation of herbarium and live material.

2.1.2 Visual information

The most instructive and comprehensive source of visual information involving mesemb species and infraspecific taxa is the collection of botanical illustrations (±1 980), held at the Bolus Herbarium, University of Cape Town. These were produced during the 1920s and 1930s and depict live plants with mainly floral, but also some fruit details of type specimens.

In the present study, this valuable collection was photographed, digitized and included as a dataset to accompany the species names on the 'Interactive Mesembs' website. It was also digitally sampled in an attempt to characterize each genus for the 'Illustrated atlas for identification of mesemb genera', presented in Chapter 6.

The usefulness of these type paintings is in facilitating correct species identifications. Additionally, details of the paintings were used to illustrate specific character states in the character list provided in Chapter 5.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

2.2 Character analysis

2.2.1 Character list and discussion of characters

An extensive preliminary character list was constructed for the genera of Mesembryanthemaceae. This was achieved through partitioning the observed variation in mesemb genera into discrete characters and states.

Characters were grouped as belonging to different character sets. The **Vegetative character set** includes three categories: **Life cycle and growth form**; **Leaves**; **stems and branches.** In the **Reproductive character set** characters include those describing **Flowering, inflorescence and flowers** and **Fruit**. Although not traditionally used in identification, broad geographical distribution data is included in the key. The highly endemic nature and restricted distribution of many mesembs make this kind of information useful for identification. The **Geographic data set** includes **Broad distribution ranges** at country, province and biome levels. In 'Interactive Mesembs', local distribution data is provided at district level where possible.

Characters are classified into those used for identification (KEY), those useful for phylogenetic reconstruction (PHYLO), and those that are purely descriptive (DESC). Where possible, characters of phylogenetic significance have been polarized into postulated evolutionary series. These character transformations are reflected in the numbering sequence of character states (primitive to advanced). Descriptions, interpretations and hypotheses relating to function and evolution are provided in the expanded character list in Chapter 5. The primary character list appears at the beginning of Chapter 6 and accompanies the 'Illustrated atlas for identification of mesemb genera'.

2.2.2 Characters and software used for identification

Characters were selected for their diagnostic content rather than their phylogenetic significance in the construction of the interactive key. Preference was given to vegetative features that can be observed with ease, speed and convenience,

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

avoiding techniques that require dissection and microscopy. A hand lens, or preferably a dissecting microscope, is however necessary for the observation of the internal structure of mesemb fruit.

LucID Professional (1999) is the software package used in this study for the iterative testing of selected characters, and for the generation of an identification key matrix. For LucID, genera are coded in a 'taxon x character state' data matrix. The programme differs from INTKEY, part of the DELTA system (Dallwitz 1980), in which the data are stored in a 'taxon x character' matrix. This feature of LucID ('taxon x character state' data matrix) allows the setting of multiple states for a single taxon, and the matrix thus generated consists of 1s and 0s.

Such a matrix, generated by LucID, and constructed for the identification of mesemb genera was then imported into Microsoft Access for incorporation by Pastel e-Business (Softline edge-1, 3rd Floor Mariendahl House, Main road, Newlands 7700, South Africa) into the 'Interactive Mesembs' website. The matrix was used for the dual purpose of a) coding for the identification key, and b) extrapolation of genus descriptive data for current species in the database.

2.2.3 Assessment of characters for their phylogenetic significance

The phylogenetic significance of selected characters was displayed and tested using a so-called 'Dahlgrenogram' (Dahlgren & Clifford 1982; Dahlgren *et al.* 1985) or 'bubble diagram' which is introduced in Chapter 3. The position of bubbles shows the supposed relationships among mesemb genera, and the size of the bubble reflects the number of species in that genus. The bubble diagram has been updated since its original publication in Chesselet *et al.* (2000b). Following initial assessment using the bubble diagrams, selected characters were included in a data matrix upon which cladistic analyses were performed using Hennig86 (Farris 1988) and PAUP (Swofford 1998). The provisional results of cladistic analyses still require refinement and detailed interpretation. A simplified cladogram based on selected characters has been supplied in Chesselet *et al.* (2002) and revised in Chesselet *et al.* (2004).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

2.3 Illustrated atlas for identification of mesemb genera

Characterization of Mesembryanthemaceae at the genus level is the primary purpose of the morphological atlas. It was constructed by sampling representative species from the collection of digitized botanical paintings (see 2.1.2 Visual information).

In addition to a composite plate representing the genus, a description of the genus and its fruit characteristics are provided. Morphological characters are illustrated and cross-referenced to the character list provided at the beginning of Chapter 6. Classification into subfamily and tribe (if applicable) is given.

A distribution map and the number of species are provided for each genus. Characters are discussed at length in the character analysis (Chapter 5). The distribution of characters amongst genera can be extracted from the taxon x character matrix provided in Appendix 15.

As fruit characters are not adequately represented in the type illustrations, a separate section at the end of Chapter 6 provides guidelines and illustrations to facilitate the use of the fruit character set in identification.

2.4 Database and internet site

2.4.1 Enriched nomenclatural database

A comprehensive nomenclatural species-level database lies at the core of the 'Interactive Mesembs' Internet site which can be accessed at <http://www.mesembs.org>, <http://www.edge-1.com/mesembs>, or from the National Botanical Institute's site <http://www.nbi.ac.za>.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

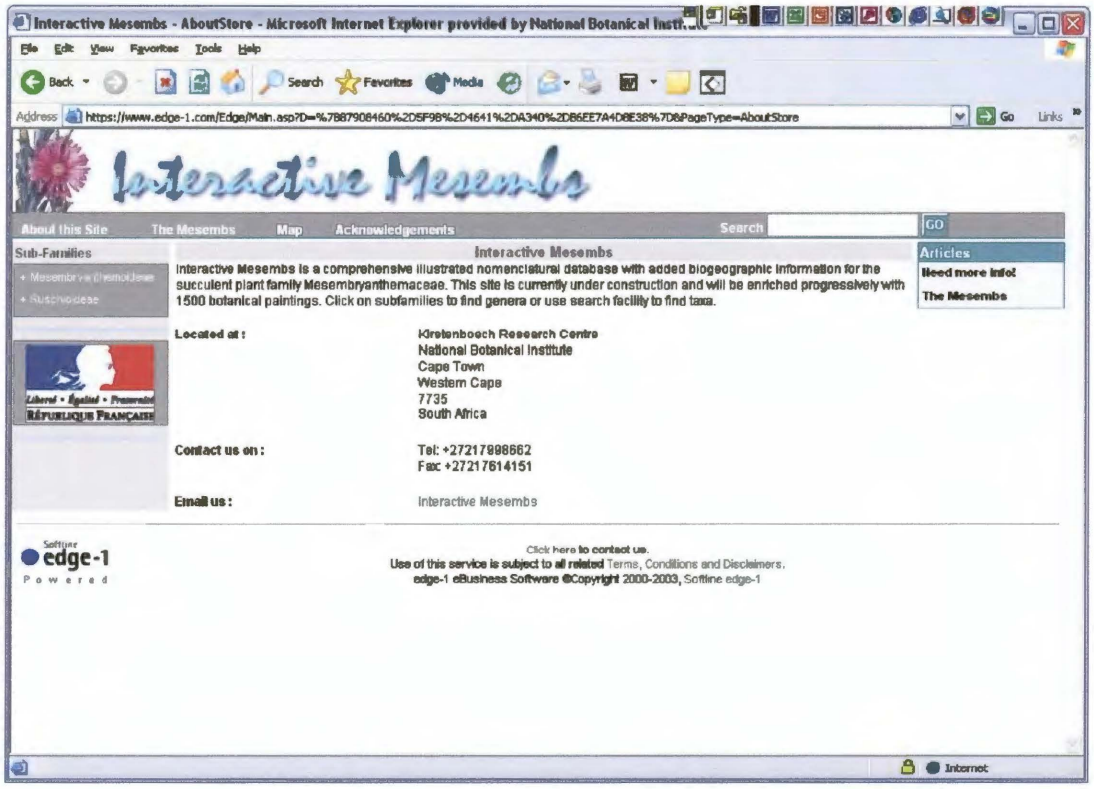


Figure 2.4.1.1 Landing page of 'Interactive Mesembs' site.

The mesemb database has been assembled from taxonomic literature, field-based research and observations, herbarium collections, vegetation and distribution maps. The nomenclature reflects latest revisions and the data cover the entire family. The database contains 5 957 records of which 1 666 are current names and the rest are incorporated synonyms. The database has been so designed that name changes are easy to effectuate. Species images (botanical illustrations) are linked to both currently accepted names and synonyms to accommodate a fluid and seamless taxonomy where sunken species names may be reinstated following further taxonomic work. This aspect of the site is under construction.

Bibliographic information is associated with each species name. Although type data is available for each name, this field is not shown on the Internet. (*Type specimen* details include type locality, collector and number, as well as the herbarium in which the specimen is housed.). This information is included on the accompanying CD.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

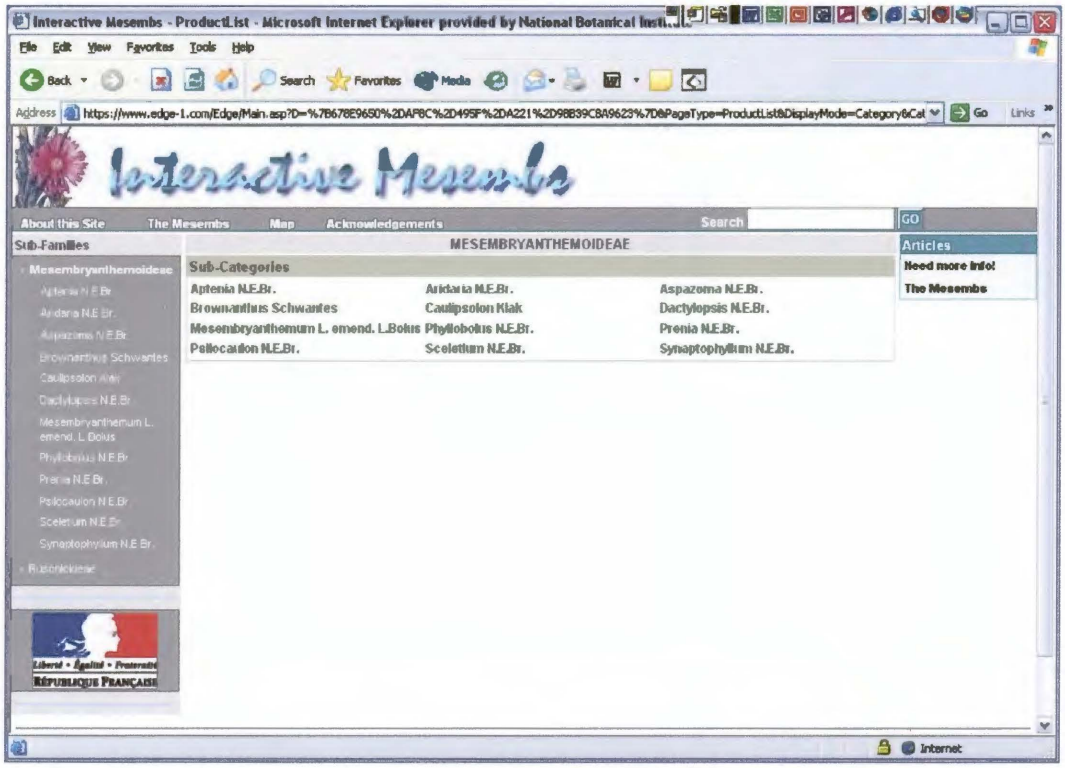


Figure 2.4.1.2 'Interactive Mesembs' site showing arrangement of genera into subfamilies Mesembryanthemoideae and Ruschioideae.

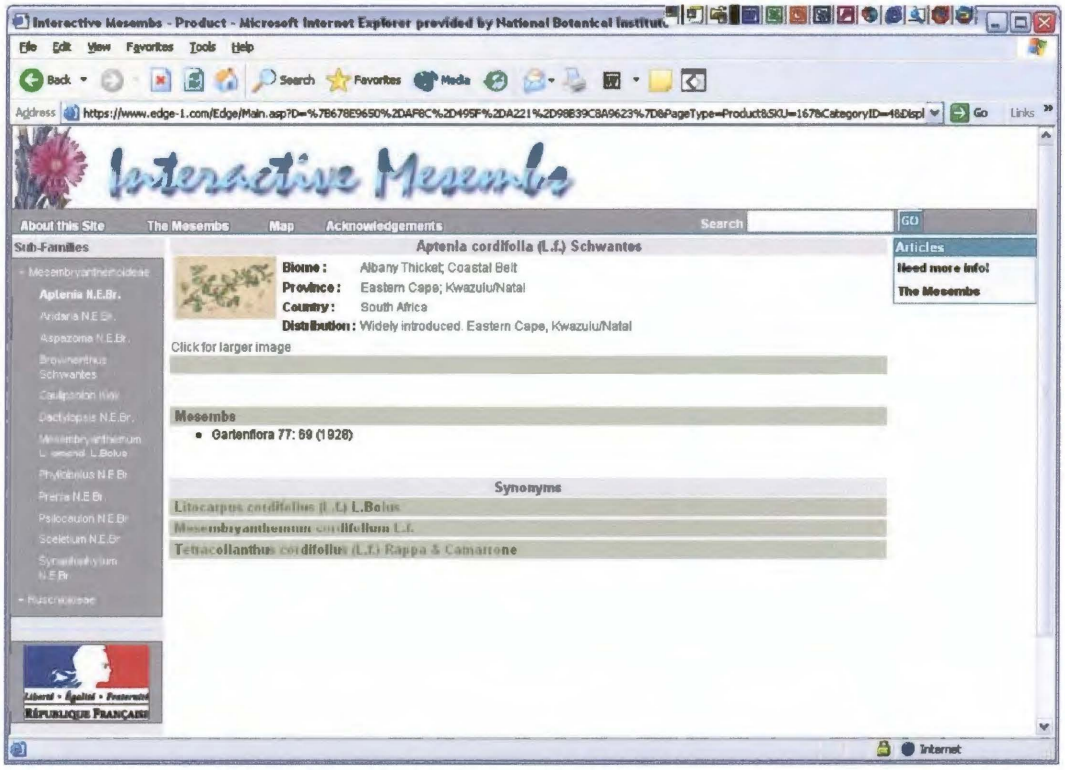


Figure 2.4.1.3 'Interactive Mesembs' site showing *Aptenia cordifolia* with associated bibliographic and geographic data. Linked synonyms appear below.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Data fields containing distribution information reflect geographic entities. *Biome* is significant at regional level. As biomes reflect broad groupings determined mostly by climatic conditions. The *Country* in which the plant occurs is given and *Province* within South Africa is provided to enable easy extraction of lists of names for provincial conservation bodies, and politically discrete entities. Although the distribution ranges of most mesembs are insufficiently known, *local distribution* data is given at district level as this is how it is mostly presented in the mesemb literature e.g. Jacobsen (1960), Hartmann (2001a, b).

2.4.2 The Internet site

The Internet site has been developed using an e-business software package that enables the creation of HTML files from existing databases. This unique software is now part of the Pastel e-Business range of programs. Software development has enabled a virtually seamless transfer of the database onto the Internet. Development of the Internet site is ongoing, as is the updating of data.

A specialized search facility has been developed for the 'Interactive Mesembs' site. This customized facility mimics interactive keys in that it is able to search on existing search results. This iterative search process enables taxon identification through the elimination of taxa not possessing the searched feature. It is also able to narrow searches through searching on other fields included in the database such as genus names and geographic data, in addition to searching key morphological features (currently under construction). Interactive identification will also be possible through the on-line interactive key detailed in **2.2.2** above. The interactive key is currently being developed based on the initial key to genera developed using LucID (Appendix 15). In the meantime, a dichotomous key to genera is in place.

2.5 Publications relevant to this chapter

Chesselet, P., Smith, G.F., Burgoyne, P.M., Klak, C., Hammer, S.A., Hartmann, H.E.K., Kurzweil, H., Van Jaarsveld, E.J., Van Wyk, B-E., & Leistner, O.A.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

2000a. Mesembryanthemaceae. In: Leistner, O.A. (ed), *Seed plants of southern Africa: families and genera. Strelitzia* 10: 360–410. (Appendix 2: 312).

Chesselet, P., Smith, G.F. & Van Wyk, A.E. 2000. Systematic and evolutionary significance of morphology in the Mesembryanthemaceae: interactive database and illustrated atlas for identification. *Aloe* 37: 46–51. (Appendix 3: 358).

Chesselet, P., Smith, G. F. & Van Wyk, A.E. 2002. A new tribal classification of the Mesembryanthemaceae: evidence from floral nectaries. *Taxon*: 295–308. (Appendix 4: 365).

Chesselet, P., Van Wyk, A.E. & Smith, G. F. 2004. Notes on African plants. Mesembryanthemaceae. A new tribe and adjustments to infrafamilial classification. *Bothalia* 34: 47–51. (Appendix 5: 380).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

CHAPTER 3

CLASSIFICATION OF MESEMBRYANTHEMACEAE

3.1 Position in angiosperm phylogeny

Historically, the group of plants generally referred to, in a broad sense, as Aizoaceae have enjoyed fluctuating status in various systematic treatments. Characters describing the morphology and structure of the perianth and ovary were used to distinguish groups by Hooker (1867), who recognized three tribes: Mesembryeae, Aizoideae and Mollugineae, and then by Pax (1889) who recognized Ficoideae (superior or inferior ovary and tubular perianth) and Molluginoideae (ovary superior, perianth 5-partite). Differences between these two subfamilies were considered sufficient by Hutchinson (1959) to warrant family status for both Ficoidaceae and Molluginaceae. Friedrich (1955) removed *Tetragonia* and *Tribulocarpus* from Ficoidaceae and placed them in the separate family Tetragoniaceae. The mesembs specialists Schwantes (1947), Jacobsen (1960) and Herre & Volk (1948), separated the family Mesembryanthemaceae from Ficoidaceae on the grounds of the peculiar fruit, the calyx tube and the petaloid staminodes. However, the discovery of the hygrochastic properties of the fruit of *Aizoanthemum* cast doubt, once again, on this separation. Takhtajan (1980) and Cronquist (1981) separated the family Molluginaceae from the rest of Aizoaceae on the grounds of the free perianth lobes in Molluginaceae. Molecular data clearly resolves the separateness of Molluginaceae (see Cuénoud *et al.* 2002), that together with Caryophyllaceae do not produce betalain pigments. However, the taxonomic structure within the Aizoaceae is not yet fully resolved or unambiguous (Cuénoud *et al.* 2002).

Currently, the mesembs are most often classified in a broadly defined family Aizoaceae Martynov *nom. cons.*, excluding Molluginaceae (Bittrich & Hartmann 1988; Hartmann 1993, 2001a&b). Aizoaceae is considered part of the core families of Order Caryophyllales sensu Cronquist (1981), also referred to as Centrospermae (Eckardt 1976). For a modern review of the Caryophyllales refer to Behnke & Mabry (1994). The possession of betalains as flower pigments and the presence of ferulic

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

acid in unlignified cell walls support the inclusion of Aizoaceae (including Mesembryanthemaceae) in the order Caryophyllales which itself is defined by free-central (sometimes basal) placentation, perisperm and curved embryos (Bittrich 1993). This position is supported by molecular data (APG 1998; Cuénoud *et al.* 2002). A recent update of the classification for orders and families of flowering plants (APG 2003) suggests that relationships within Caryophyllales remain, to some extent, uncertain.

3.2 Family delimitation and subfamilies included

The taxonomy of the mesembs is controversial and still unresolved for many groups, in regard to specific and generic delimitation and higher-level classification. The perspective used throughout this study is to consider Mesembryanthemaceae Fenzl in the strict sense, as a separate family, comprising two subfamilies: Mesembryanthemoideae and Ruschioideae Schwantes in Ihlenf., Schwantes & Straka emend. Bittrich & H.E.K.Hartmann (Fenzl 1836; Herre & Volk 1948; Herre 1971; Chesselet *et al.* 1995, 2000a, 2003a). The continued usage of this concept is supported by a number of characteristics that distinguish mesembs clearly from sister taxa in Aizoaceae. Assigning rank to taxonomic entities is a subjective decision, and often requires forcing items that may be part of a continuum, into categories. Were it not for the problem of paraphyly it would be tempting to assign family status to subfamily Ruschioideae, based on its sheer size. To avoid paraphyly, Mesembryanthemoideae must however be incorporated, so that all descendants of the common ancestor are included in the family concept Mesembryanthemaceae.

This approach is in contrast to the more widely-used and broader concept, Aizoaceae. For up-to-date, comprehensive, species-level treatments of Aizoaceae refer to Hartmann (2001a&b). This broader concept comprises five subfamilies: Mesembryanthemoideae Ihlenf., Schwantes & Straka, Ruschioideae Schwantes in Ihlenf., Schwantes & Straka emend. Bittrich & H.E.K.Hartmann, Aizooideae, Sesuvioideae Lindley and Tetragonioideae Lindley (Fig. 3.2.1).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Morphological characters that distinguish the mesembs and support their monophyly include: semi-epigynous or epigynous flowers, petals of staminodial origin, raphide crystals of calcium oxalate, and the basic chromosome number n = 9. Features that distinguish Aizoaceae *sensu stricto* from Mesembryanthemaceae, are: perianth petaloid on inside, sepaloid on outside, druse crystals of calcium oxalate, and the basic chromosome number n = 8.

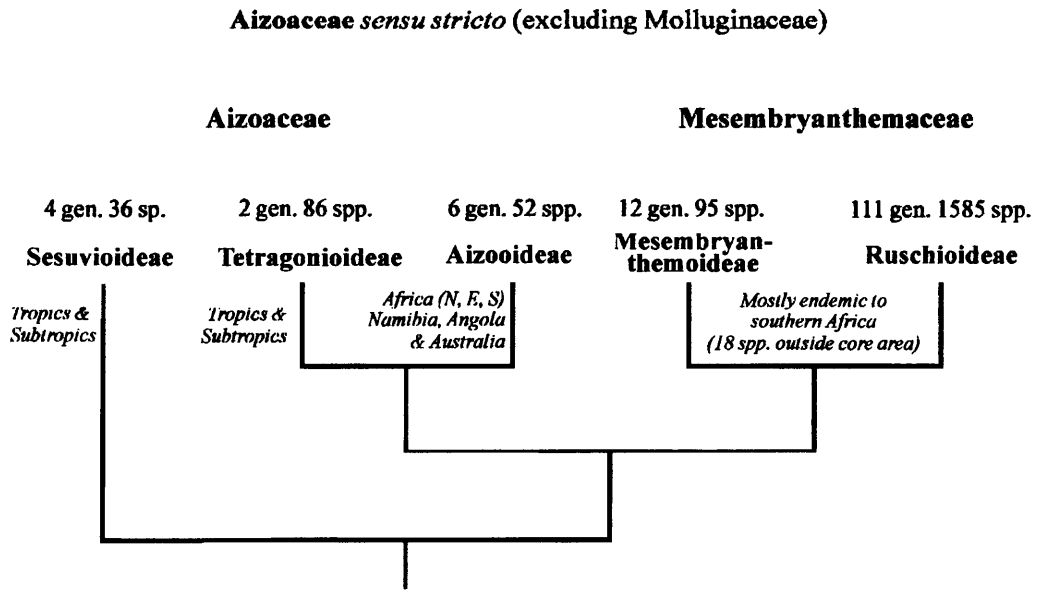


Figure 3.2.1 Distinction between families Mesembryanthemaceae and Aizoaceae within the broader concept of Aizoaceae *sensu stricto* showing subfamilies, their distribution and number of taxa.

The entire Aizoaceae *sensu stricto* (excluding Molluginaceae, including Mesembryanthemaceae) rests on a single synapomorphy: the presence of epidermal bladder cell idioblasts (Bittrich & Hartmann 1988). Simple hygrochastic fruit capsules with septal expanding tissue have been used as another possible synapomorphy for Aizoaceae *sensu stricto*. Although such hygrochastic fruit are known from *Aizoon* and *Aizoanthemum*, of subfamily Aizooideae, others such as *Tetragonia* have winged nuts containing a single pendulous ovule and indehiscent fruit (Herr 1984). It is therefore a

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

little presumptive to extrapolate hygrochastic fruit to be the second morphological synapomorphy defining Aizoaceae *sensu stricto*, as Bittrich & Hartmann (1988), and J. Thiede (pers. comm.) suggest.

Recent investigations into evolutionary relationships within Aizoaceae *sensu stricto* include the work of Wallace (1998) and Klak *et al.* (2003a, 2003b). Wallace (1998), using comparative plastid DNA sequencing (*rpl* 16 intron), showed the mesembs to be monophyletic and derived relative to the other groups or subfamilies sensu Bittrich & Hartmann (1988). The clade represented by *Sesuvium* was found to be basal in the family with *Tetragonia* and *Aizoon* as sister taxa.

More recent work by Klak *et al.* (2003a, 2003b), using the *rps* 16 intron and the *trnL-F* gene region showed that three of the currently recognized subfamilies within Aizoaceae, namely Sesuvioideae, Mesembryanthemoideae and Ruschioideae, are each strongly supported monophyletic groups. Results showed that Tetragonioideae is polyphyletic with *Tribulocarpus,* a genus placed with *Tetragonia* in Tetragoniaceae by Friedrich (1955), as sister to Sesuvioideae. *Tetragonia* is described by Klak *et al.* (2003b) as embedded in Aizooideae. According to Klak *et al.* (2003b) the fact that Sesuvioideae, Aizooideae and Tetragonioideae do not form a monophyletic group is sufficient justification not to recognize Mesembryanthemaceae as a separate family, for fear of creating small families. This view is not supported here: I find the state of flux and uncertainty in the delimitation of subfamilies in Aizoaceae (excluding Mesembryanthemaceae) all the more reason to keep the clearly monophyletic and highly speciose and endemic mesembs as a separate family!

3.3 Supra-generic classification

A natural classification that reflects evolutionary relationships between taxa is one of the prime objectives of systematic studies. In Mesembryanthemaceae, precise hypotheses of relationship at the supra-generic level will only be achieved once genera are classified into natural groups. Cohesive delimitation of tribes and subtribes is prerequisite to understanding evolutionary relationships of the group as a whole.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

The supra-generic classification of Schwantes (1947) revised by Ihlenfeldt and Straka (Ihlenfeldt *et al.* 1962) and published in Hans Herre's (1971) *Genera of the Mesembryanthemaceae*, is no longer a true reflection of current knowledge. The character combinations used to delimit these subtribes often reflect superficial similarities in gross morphology and convergence of growth forms is common in highly succulent plants. Homology of characters is a complex problem that is not easy to address without ontogenic studies. Despite its inadequacy, this classification has been used as a starting hypothesis for several taxonomic studies e.g. Mitrophyllinae (Ihlenfeldt 1978; Ihlenfeldt & Jörgensen 1973), Leipoldtiinae (Hartmann 1982, 1983a, 1983b, 1983c; Hartmann & Dehn 1987), Ruschiinae (Dehn 1988, 1992; Glen 1986; Hartmann & Stüber 1993), Dorotheanthinae (Ihlenfeldt & Struck 1987), Erepsiinae (Liede 1989), Conophytinae (Hammer 1993) and Carpobroteae (Wisura & Glen 1993). Although some of Schwantes's groups may be valid, and others are known not to be so, no formal supra-generic classification, at the subtribal level, replaces his.

For subfamily Mesembryanthemoideae there is, at this stage, no revised tribal or subtribal classification despite a number of taxonomic and systematic studies on the group (Bittrich 1986; Gerbaulet 1995, 1996a, 1996b, 1996c, 1997; Klak & Linder 1998; Gerbaulet in Hartmann 2001a, b). Changes in rank and clarification of generic boundaries have been the focus of several of studies although a number of genera, including the recently revised *Mesembryanthemum* and *Phyllobolus*, are thought to be polyphyletic as suggested by molecular evidence (Klak *et al.* 2003b). Contrary to recent revisions and other genus-level treatments (Gerbaulet in Hartmann 2001; Smith *et al.* 1998) the sinking of *Dactylopsis* is not always recognized (Chesselet *et al.* 2000a) and the re-instatement of this bizarre genus as distinct from *Phyllobolus* is supported by molecular studies (Klak pers. comm.).

For the more complex and numerous members of subfamily Ruschioideae, modern researchers rely mostly on the informal classification of genera put forward by Hartmann (1991, 1993, 1998). Even though genera are provisionally assigned to groups, this categorization is probably the closest approximation to a subtribal

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

classification available at present and provides a working hypothesis for mesemb taxonomists. This grouping system is based on extensive studies of fruit (Hartmann 1988) and flower morphology, epidermal and seed characters, and growth form. It arranges subfamily Ruschioideae into 12 groups, each characterized by a combination of features. Hartman's classification was used as a baseline for this study and followed by Chesselet *et al.* (2000a). However, during the course of this work, results of character analysis led Chesselet *et al.* (2001, 2002) to propose a new tribal classification for Ruschioideae based on characters of the floral nectary that was modified by Klak *et al.* (2003b). A revised classification based on the congruence between morphological and molecular data was put forward by Chesselet *et al.* (2004).

Chesselet *et al.* (2002, 2004) recognize four distinct tribes within the subfamily Ruschioideae. These are: **Apatesieae** Schwantes, Ihlenf., Schwantes & Straka emend. Chesselet, G.F.Sm. & A.E.van Wyk; **Dorotheantheae** (Schwantes ex Ihlenf. & Struck) Chesselet, G.F.Sm. & A.E.van Wyk; **Ruschieae** Schwantes ex Ihlenf., Schwantes & Straka emend. Klak, Khunou, Reeves & Hedderson and **Drosanthemeae** Chesselet, Gideon F.Sm. & A.E.van Wyk. These four tribes are reflected in Fig. 3.3.1.

In the present study, a Dahlgrenogram representing the Mesembryanthemaceae was drawn up to visually represent an hypothesis for the generic and supra-generic relationships among mesemb genera—the purpose being to plot the taxonomic distribution of characters investigated, and to assess their taxonomic significance (Chesselet *et al.* 2000b). A similar approach has been used successfully by, amongst others, Dahlgren *et al.* (1985) to plot character distribution in the monocotyledons. This so-called bubble diagram represents all mesemb genera in a time slice (Fig. 3.3.1). The size of the 'bubbles' reflects the size of genera. The relative position of taxa in the diagram is not absolute but follows current concepts of groupings within the Ruschioideae (Hartmann 1988, 1991, 1993, 1998a; Chesselet *et al.* 2002, 2004).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

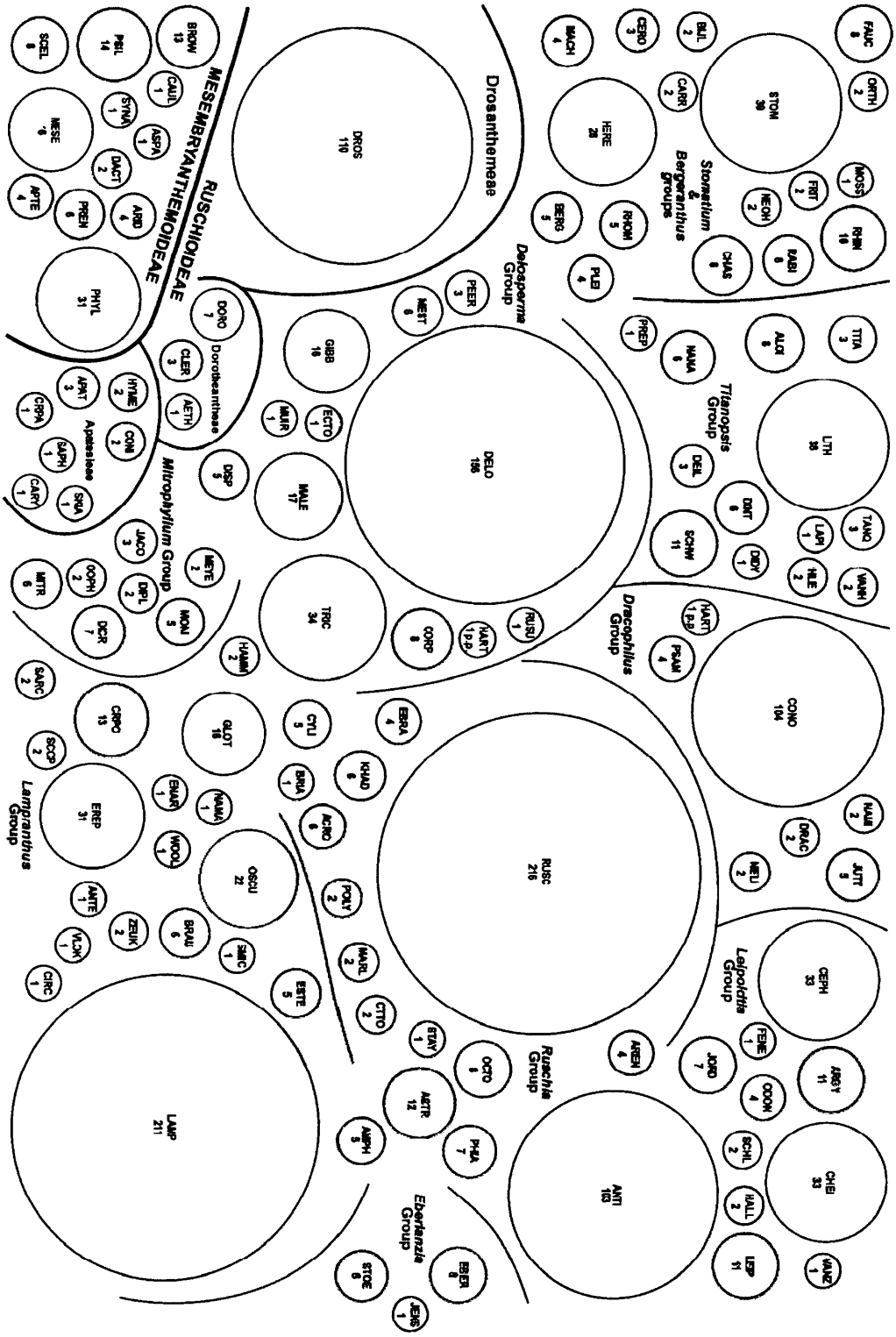


Figure 3.3.1 Bubble diagram for Mesembryanthemaceae showing genera and supra-generic groupings used for the purposes of this study and should be regarded as a working hypothesis.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

3.4 The genera of Mesembryanthemaceae

As discussed above, family Mesembryanthemaceae contains the two subfamilies: Mesembryanthemoideae and Ruschioideae with the latter subfamily comprising the bulk of mesembs. The two subfamilies are easily distinguished from each other. Mesembryanthemoideae which contains 12 genera and ±101 species are mostly flat-leaved and often weedy, few are highly succulent. Genera classified in subfamily Mesembryanthemoideae share the following characters: stamens and petals (mostly) forming a tube; nectaries koilomorphic (shell-shaped); cortical bundles present; expanding tissue present as expanding keels extending from centre of capsule to tips of valves.

The extremely speciose subfamily Ruschioideae comprises 114 genera and ±1565 species. Synapomorphies defining subfamily Ruschioideae include: stamens hairy at base; nectaries lophomorphic (crest-shaped); placentation basal or parietal; expanding keels ± restricted to valves; covering membranes often present. Although this subfamily is characterized by a placenta that is parietal to basal, sometimes with a central portion, it is axile in the genera *Hymenogyne* and *Caryotophora*, and in some species of *Conophytum*. Most members of Ruschioideae are leaf succulent subshrubs, but a diversity of succulent growth forms occurs, ranging from minute 'stone plants' to tree-like shrubs. The currently recognized genera of Mesembryanthemaceae are listed in Table 3.4.1.

In his 'Key to the Genera' Brown (1925) gave the first breakdown of the Linnean genus *Mesembryanthemum* into a number of segregate genera. Prominence was given to vegetative characters in this key. This, he did specifically for cultivators wishing to use the key and having neither flower nor fruit available, as may happen in Europe. Currently, more than 120 mesemb genera are recognized (Herre 1971; Smith *et al.* 1998; Chesselet *et al.* 2000a; Hartmann 2001a, b), and features of the fruit provide essential diagnostic characters for identification to genus level.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Genus concepts in mesembs have changed dramatically: initially all mesembs were assigned to the single genus *Mesembryanthemum*. Following the fragmentation of this all-encompassing genus, very narrow concepts were defined. Then Bittrich (1986) once again broadened concepts in Mesembryanthemoideae. However, since this work (Bittrich 1986), narrower concepts were put back into use for the subfamily. Ihlenfeldt (1994) points out that, in mesembs, there exist natural groups of closely related genera (based on synapomorphies) and these are surrounded by 'satellite' genera that are clearly more distantly related, but with distinct affinities with other clusters of genera. Criteria for the delimitation of genera were discussed by Bittrich (1986); who recognizes three major concepts of genera: 1) genera defined by apomorphies; 2) genera with character states equally distant from two other existing genera; 3) genera characterized by character combinations. Both Bittrich (1986) and Hartmann (1992) found that none of these criteria could be applied in isolation for the delimitation of mesemb genera.

An analysis of the numbers of species per genus in the mesembs (Chesselet *et al.* 1995) showed that, as in most modern classifications (Williams 1964), the number of monotypic genera is greater than the number of genera with two species; and the number of genera with two species exceeds the number of genera with three species and so forth, with few large genera comprising more than 100 species. This pattern of decreasing numbers of genera with increasing numbers of species indicates that the family is composed of taxa of different ages, with well-defined and isolated taxa (especially genera), often of limited distribution showing signs of being relicts of ancient evolutionary levels (Ihlenfeldt 1994; Hartmann 1991). The large genera are often composed of complexes of closely related taxa that are difficult to delimit; they generally have larger distribution areas. Dial & Marzluff (1989) have shown that hollow curve distributions of taxonomic diversity are common in nature and show that assemblages are dominated by one or very few diverse taxa, and that this phenomenon is compounded as one moves down the taxonomic hierarchy. They suggest that over-dominance of certain taxa reflect real differences in the evolutionary success of units within an assemblage.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

A comprehensive treatment of mesembs genera (Chesselet *et al.* 2000a) is published in Leistner's (2000) treatment of southern African seed plants, and is included as Appendix 2.

Table 3.4.1. List of currently recognized genera in Mesembryanthemaceae and numbers of taxa. Mesembs total 126 genera, 1666 species, 4 hybrids, 152 subspecies and 1780 infrageneric taxa (excluding hybrids). Acronyms used throughout this study (column 1), genus names and author citations (column 2), number of species (column 3), subspecies (column 4), and total number of species and subspecific taxa (column 5).

Acro-nym	Genus Name & author citation	# species	# sub-species	# taxa
Subfamily Mesembryanthemoideae : 12 genera; 101 species; 11 subspecies; 108 taxa				
APTE	*Aptenia* N.E.Br.	4	–	4
ARID	*Aridaria* N.E.Br.	4	3	6
ASPA	*Aspazoma* N.E.Br.	1	–	1
BROW	*Brownanthus* Schwantes	13	2	14
CAUL	*Caulipsolon* Klak	1	–	1
DACT	*Dactylopsis* N.E.Br.	2	–	2
MESE	*Mesembryanthemum* L. emend. L.Bolus	16	–	16
PHYL	*Phyllobolus* N.E.Br.	31	2	32
PREN	*Prenia* N.E.Br.	6	4	9
PSIL	*Psilocaulon* N.E.Br.	14	–	14
SCEL	*Sceletium* N.E.Br.	8	–	8
SYNA	*Synaptophyllum* N.E.Br.	1	–	1
Subfamily Ruschioideae: 114 genera, 1565 species (+4 hybrids); 141 subspecies; 1672 taxa				
ACRO	*Acrodon* N.E.Br	6	–	6
AETH	*Aethephyllum* N.E.Br.	1	–	1
ALOI	*Aloinopsis* Schwantes	8	–	8
AMPH	*Amphibolia* L.Bolus ex A.G.J.Herre	5	–	5
ANTE	*Antegibbaeum* Schwantes ex C.Weber	1	–	1
ANTI	*Antimima* N.E.Br. emend. Dehn	103	–	103

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Acro-nym	Genus Name & author citation	# species	# sub-species	# taxa
APAT	*Apatesia* N.E.Br.	3	–	3
AREN	*Arenifera* A.G.J.Herre	4	–	4
ARGY	*Argyroderma* N.E.Br.	11 (+1 hybrid)	2	13
ASTR	*Astridia* Dinter	12	–	12
BERG	*Bergeranthus* Schwantes	5	–	5
BIJL	*Bijlia* N.E.Br.	2	–	2
BRAU	*Braunsia* Schwantes	6	–	6
BRIA	*Brianhuntleya* Chesselet, S.A.Hammer & I.Oliver	1	–	1
CALA	*Calamophyllum* Schwantes	(3)		
CRPA	*Carpanthea* N.E.Br.	1	–	1
CRPO	*Carpobrotus* N.E.Br.	13	2	14
CARR	*Carruanthus* (Schwantes) Schwantes	2	–	2
CARY	*Caryotophora* Leistner	1	–	1
CEPH	*Cephalophyllum* N.E.Br.	33	–	33
CERO	*Cerochlamys* N.E.Br.	3	–	3
CHAS	*Chasmatophyllum* Dinter & Schwantes	8	–	8
CHEI	*Cheiridopsis* N.E.Br.	33	–	33
CIRC	*Circandra* N.E.Br.	1	–	1
CLER	*Cleretum* N.E.Br.	3	2	4
CONI	*Conicosia* N.E.Br.	2	3	4
CONO	*Conophytum* N.E.Br.	104	88	173
CORP	*Corpuscularia* Schwantes	8	–	8
CYLI	*Cylindrophyllum* Schwantes	5	–	5
DEIL	*Deilanthe* N.E.Br.	3	–	3
DELO	*Delosperma* N.E.Br. emend. Lavis	156	–	156
DICR	*Dicrocaulon* N.E.Br.	7	–	7
DIDY	*Didymaotus* N.E.Br.	1	–	1
DINT	*Dinteranthus* Schwantes	6	–	6
DIPL	*Diplosoma* Schwantes	2	–	2
DISP	*Disphyma* N.E.Br.	5	2	6
DORO	*Dorotheanthus* Schwantes	7	2	8
DRAC	*Dracophilus* (Schwantes) Dinter & Schwantes	2	–	2
DROS	*Drosanthemum* Schwantes	110	–	110
EBER	*Eberlanzia* Schwantes	8	–	8

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Acro-nym	Genus Name & author citation	# species	# sub-species	# taxa
EBRA	*Ebracteola* Dinter & Schwantes	4	–	4
ECTO	*Ectotropis* N.E.Br.	1	–	1
ENAR	*Enarganthe* N.E.Br.	1	–	1
EREP	*Erepsia* N.E.Br.	31 (+ 2 hybrids)	–	33
ESTE	*Esterhuysenia* L.Bolus	5	–	5
FAUC	*Faucaria* Schwantes	8	–	8
FENE	*Fenestraria* N.E.Br.	1	2	2
FRIT	*Frithia* N.E.Br.	2	–	2
GIBB	*Gibbaeum* N.E.Br.	16	–	16
GLOT	*Glottiphyllum* N.E.Br.	16	–	16
HALL	*Hallianthus* H.E.K.Hartmann	2	–	2
HAMM	*Hammeria* Burgoyne	2	–	2
HART	*Hartmanthus* S.A.Hammer	2	–	2
HERE	*Hereroa* (Schwantes) Dinter & Schwantes	28	–	28
HYME	*Hymenogyne* Haw.	2	–	2
IHLE	*Ihlenfeldtia* H.E.K.Hartmann	2	–	2
JACO	*Jacobsenia* L.Bolus & Schwantes emend. Ihlenf.	3	–	3
JENS	*Jensenobotrya* A.G.J.Herre	1	–	1
JORD	*Jordaaniella* H.E.K.Hartmann	7	–	7
JUTT	*Juttadinteria* Schwantes	5	–	5
KHAD	*Khadia* N.E.Br.	6	–	6
LAMP	*Lampranthus* N.E.Br.	211	0	211
LAPI	*Lapidaria* (Dinter & Schwantes) N.E.Br.	1	–	1
LEIP	*Leipoldtia* L.Bolus	11	3	13
LITH	*Lithops* N.E.Br.	38	24	53
MACH	*Machairophyllum* Schwantes	4	–	4
MALE	*Malephora* N.E.Br.	17	–	17
MARL	*Marlothistella* Schwantes	2	–	2
MEST	*Mestoklema* N.E.Br. ex Glen	6	–	6
MEYE	*Meyerophytum* Schwantes	2	–	2
MITR	*Mitrophyllum* Schwantes	6	–	6
MONI	*Monilaria* (Schwantes) Schwantes	5	2	6
MOSS	*Mossia* N.E.Br.	1	–	1
MUIR	*Muiria* N.E.Br.	1	–	1

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Acro-nym	Genus Name & author citation	# species	# sub-species	# taxa
NAMA	*Namaquanthus* L.Bolus	1	–	1
NAMI	*Namibia* (Schwantes) Dinter & Schwantes	2	–	2
NANA	*Nananthus* N.E.Br.	6	–	6
NELI	*Nelia* Schwantes	2	–	2
NEOH	*Neohenricia* L.Bolus	2	–	2
OCTO	*Octopoma* N.E.Br.	8	–	8
ODON	*Odontophorus* N.E.Br.	4	2	5
OOPH	*Oophytum* N.E.Br.	2	–	2
ORTH	*Orthopterum* L.Bolus	2	–	2
OSCU	*Oscularia* Schwantes	22	–	22
OTTO	*Ottosonderia* L.Bolus	2	–	2
PEER	*Peersia* L.Bolus	3	–	3
PHIA	*Phiambolia* Klak	7	–	7
PLEI	*Pleiospilos* N.E.Br.	4 (+1 hybrid)	5	9
POLY	*Polymita* N.E.Br.	2	–	2
PREP	*Prepodesma* N.E.Br.	1	–	1
PSAM	*Psammophora* Dinter & Schwantes	4	–	4
RABI	*Rabiea* N.E.Br.	6	–	6
RHIN	*Rhinephyllum* N.E.Br.	10	–	10
RHOM	*Rhombophyllum* (Schwantes) Schwantes	5	–	5
RUSC	*Ruschia* Schwantes	217	2	218
RUSU	*Ruschianthus* L.Bolus	1	–	1
SAPH	*Saphesia* N.E.Br.	1	–	1
SARC	*Sarcozona* J.M.Black	2	–	2
SCHL	*Schlechteranthus* Schwantes	2	–	2
SCHW	*Schwantesia* Dinter	11	–	11
SCOP	*Scopelogena* L.Bolus	2	–	2
SKIA	*Skiatophytum* L.Bolus	1	–	1
SMIC	*Smicrostigma* N.E.Br.	1	–	1
STAY	*Stayneria* L.Bolus	1	–	1
STOE	*Stoeberia* Dinter & Schwantes	6	–	6
STOM	*Stomatium* Schwantes	39	–	39
TANQ	*Tanquana* H.E.K.Hartmann & Liede	3	–	3
TITA	*Titanopsis* Schwantes	3	–	3
TRIC	*Trichodiadema* Schwantes	34	–	34

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Acro-nym	Genus Name & author citation	# species	# sub-species	# taxa
VANH	*Vanheerdea* L.Bolus ex H.E.K.Hartmann	2	–	2
VANZ	*Vanzijlia* L.Bolus	1	–	1
VLOK	*Vlokia* S.A.Hammer	1	–	1
WOOL	*Wooleya* L.Bolus	1	–	1
ZEUK	*Zeuktophyllum* N.E.Br.	2	–	2

3.5 Publications relevant to this chapter

Chesselet, P., Smith, G.F., Burgoyne, P.M., Klak, C., Hammer, S.A., Hartmann, H.E.K., Kurzweil, H., Van Jaarsveld, E.J., Van Wyk, B-E., & Leistner, O.A. 2000a. Mesembryanthemaceae. In: Leistner, O.A. (ed), *Seed plants of southern Africa: families and genera. Strelitzia* 10: 360–410. (Appendix 2: 312).

Chesselet, P., Burgoyne, P.M., Klak, C., Kurzweil, H., Griffin, N.J. & Smith G.F. 2003a. Mesembryanthemaceae. In: Germishuizen, G. & Meyer, N. (eds), *Plants of southern Africa: names and distribution. Strelitzia*: 633–738. (Appendix 6: 386).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

CHAPTER 4

PATTERNS OF FLORISTIC DIVERSITY IN MESEMBRYANTHEMACEAE

This chapter is exceptional as it consists of the published paper:

CHESSELET, P., VAN WYK, A.E., GRIFFIN, N. & SMITH, G. F. 2003. Patterns of floristic diversity in Mesembryanthemaceae. *Aloe* 40: 80–85.

Since the publication of this paper (Chesselet *et al.* 2003b), the new tribe Drosanthemeae has been described by Chesselet *et al.* (2004). The Delospermeae has been discarded and its taxa distributed between Drosanthemeae and Ruschieae.

In this chapter I have followed the concept of Albany Thicket Biome. However, this biome is a mosaic of vegetation types belonging to Grassland, Nama-Karoo and Thicket. For the rest of the thesis, the term Albany Centre is used.

The geographic data presented in this chapter is available on the accompanying CD or from the 'Interactive Mesembs" Internet site.

4.1 Publications relevant to this chapter

Chesselet, P. & Smith, G.F. 2002. The rediscovery of *Ruschia acutangula* (Haw.) Schwantes (Mesembryanthemaceae Fenzl). *Bradleya* 20: 17–22. (Appendix 7: 551).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Patterns of floristic diversity in Mesembryanthemaceae

Pascale Chesselet, Abraham E. van Wyk, Neil Griffin & Gideon F. Smith

Introduction

The species-rich succulent plant family Mesembryanthemaceae shows extraordinary degrees of endemism at all scales of the ecological hierarchy. With 1663 currently recognised species in 124 genera the mesembs have shown extensive diversification in southern Africa. Massive speciation events in mesembs are thought to be relatively recent, estimated at 1.8 MA (Goldblatt 1978) and attributed to the inception of the winter rainfall climate, at approximately 5 MA (Ihlenfeldt 1994), that created an entirely new, ecologically diverse habitat, the Succulent Karoo. Some of the more primitive clades within Mesembryanthemaceae, however, are undoubtedly older. Climatic fluctuations, as recent as 18 000 BP, during the Pleistocene are invoked by Midgley *et al.* (2001a) as driving speciation in the greater Cape Mediterranean Region that includes both Fynbos and Succulent Karoo. Both the Cape Floristic Region and the Succulent Karoo Region are biodiversity "hotspots" of global significance (Meyers *et al.* 2000). Succulent Karoo is the world's only arid hotspot and is currently most vulnerable to global climate change (Midgley *et al.* 2001b).

An astonishing 98.8% of mesemb species are endemic to southern Africa with only about 20 species belonging to the genera *Carpobrotus*, *Delosperma*, *Disphyma*, *Mesembryanthemum* and *Sarcozona*, occurring naturally elsewhere (Blake 1969; Poppendieck & Ihlenfeldt 1978; Marais 1979; Bittrich 1986, Jürgens 1990; Hartmann 1991; Chinnock 1996; Smith *et al.* 1998; Hartmann 2001a&b). Dispersal mechanisms for these species are not all known, however recent long-distance dispersal by sea birds has been invoked to explain disjunctions at continental level in species of *Disphyma*. In southern Africa, mesembs are abundant in arid to semi-arid regions, notably the Succulent Karoo and centres of plant diversity therein (see Van Wyk & Smith 2001). In southern Africa mesembs range from Angola down to the Cape Peninsula and eastwards over the central plateau of southern Africa into Zimbabwe and Botswana. Aspects of mesemb phytogeography are discussed in Hartmann (1991, 1993, 1994, 2001a,b).

The comprehensiveness and quality of mesemb data has dramatically improved recently following intensified taxonomic research and published revisions of genera and species (Hartman 1991, 1993, 2001a,b; Chesselet *et al.* 2000a; Chesselet *et al.* in press). It is noteworthy that the taxonomic treatment of a flora greatly affects the statistics concerning its distribution and endemism, and it is well known that succulent plants pose their own taxonomic problems in terms of the consistency of concepts in the taxonomic hierarchy (Raven 1970).

A comprehensive and up-to-date taxonomic database for the family Mesembryanthemaceae (Chesselet *et al.* 2000b) that incorporates geographic information was used to analyze biogeographic patterns in endemic and widespread taxa using SQL (Structured Query Language) queries. Accurate distribution data relies on well-identified collections. Here, distribution data is based on type specimen collections combined with known localities (resolved to the level of district). Distributions are unknown for 75 of a total of 1663 species. The problem posed by early names is that original localities have been lost, forgotten, or described so broadly that they cannot help us pinpoint distribution. Haworth is the author of 50% of names without localities; these are often accompanied by highly stylised iconotypes and brief descriptions that could apply to a number of related taxa (Chesselet & Smith 2001). The lack of distribution data for early names highlights the need for field exploration and a dedicated taxonomy that attempts to link these names with known taxa (Chesselet & Smith 2002). Despite some missing data overall trends can elucidate relationships in the group. In this study we have analyzed patterns of floristic diversity of mesembs at a bioregional scale. Interpretations presented here apply to mesembs and may be different for other families (e.g. Goldblatt 1978; Gibbs-Russell 1987). In this contribution we provide provisional points emerging from the database; a more complete analysis will be published elsewhere.

Analysis of biomes

A biome is a vegetation region representing a major natural system. As a classification unit it is delimited primarily on plant growth form and various climatic indices such as rainfall seasonality, summer aridity and minimum winter temperatures (Rutherford & Westfall 1986; Van Wyk & Smith 2001). In a forthcoming publication Mucina & Rutherford (in prep.) recognise nine distinct biomes in southern Africa, namely Albany Thicket, Coastal Belt, Desert, Forest, Fynbos, Grassland, Nama-Karoo, Savanna and Succulent Karoo. These are the biomes used in the present assessment of broad-scale mesemb distribution in southern Africa.

Points emerging from distributional data at bioregional scale:

- Mesembs show extremely high levels of endemism at *species* level in Fynbos (93%), Albany Thicket (91%), Succulent Karoo (89%), and Grassland (84%), highlighting the distinctness of these vegetation types.
- Of the 382 mesemb species that occur in Fynbos, 357 are endemic to it. This is a high number of succulent plants for a so-called sclerophyllous vegetation type dominated by small trees, shrubs and grass-like reeds. A number of these taxa are adapted to fire cycles e.g. *Erepsia* (Liede 1990), *Caryotophora* and *Saphesia* (Hickey & Van Jaarsveld 1995).
- Albany Thicket has high levels of endemism at species level (91%), but genus endemism is low (13%). Recognised only fairly recently as a biome (Low & Rebelo 1996), high levels of endemism at species level in the mesembs support its distinctness as a separate biotic division.
- A total of 871 mesemb species occur in Succulent Karoo, representing the highest diversity of Mesembryanthemaceae. Of these 778 are endemic to Succulent Karoo—a biome characterised by the dominance of succulent sub-shrubs of which Mesembryanthemaceae are the principal family.

ALOE 40:3&4:2003. ISSN 0002-6301

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

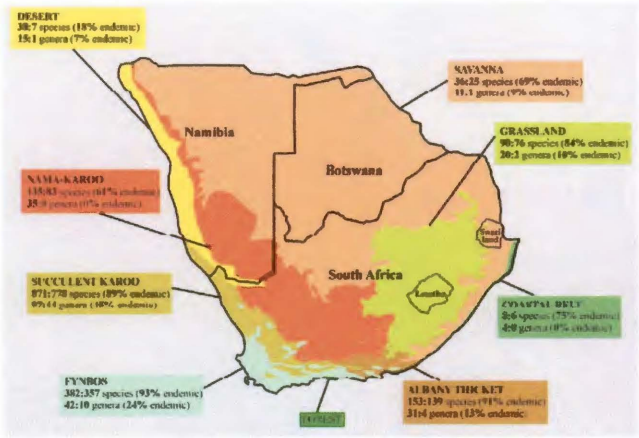


Figure 1. Distribution of Mesembryanthemacaeae among biomes of southern Africa showing ratio of total to endemic species, and genera, as well as percentage endemism for species and genera for each biome (biome boundaries based on information kindly supplied by L. Mucina, M. Rutherford and L. Powrie).

- At *genus* level, endemism is highest in Succulent Karoo (45%) and then Fynbos (24%). High endemism at genus level usually suggests a long period of isolation. However, indications are that diversification in mesembs has been rapid, and in the more advanced taxa, recent.
- The impoverishment of mesembs in the Desert Biome may be due, at least in part, to the presence of shifting sand and the absence of the Mediterranean climate with winter rainfall—a zonal climatic state strongly associated with leaf succulence (Jürgens 1990). With the exception of few coastal species in the genera *Carpobrotus*, *Cephalophyllum*, *Disphyma* and *Drosanthemum*, mesembs do not appear to thrive in areas of unconsolidated sand. The only genus endemic to the Desert Biome is *Jensenobotrya*, a monotypic taxon restricted to rocky outcrops at Dolphin Head, on the Skeleton Coast of Namibia (Burgoyne 1998).
- South Africa's largest biome, the Savanna Biome, contains one endemic mesemb genus (*Prepodesma*). The biome shares species with Grassland, Nama Karoo and Desert Biomes. Gibbs-Russell (1987) found that biomes of the summer-rainfall region (Savanna, Grassland, Nama-Karoo and Desert) form a distinct group. This group belongs in the Palaeotropic Kingdom that is floristically distinct from the Cape Floristic Kingdom (equivalent to the Cape Floristic Region and largely congruent with the Fynbos Biome).
- There are no known mesembs in the Forest Biome of South Africa. "*Ruschia*" *knysnana*, for example, grows near the sea shore from Knysna to Humansdorp, and probably belongs with "*Ruschia*" *promontori* as separate taxa in the (mostly) coastal genus *Amphibolia*.

Interrelationships among biomes

The number of mesemb species and genera that are biome-endemic as well as those that are shared between biomes are informative and can be used to show relationships among the biomes of southern Africa. The more widespread taxa indicate historical and geographical connections or relationships while endemics characterise individual areas.

- Most shared genera are between Succulent Karoo & Fynbos (12 genera), suggesting closer links between these two biomes than any others in terms of their mesemb flora. This corroborates data from Gibbs Russell (1987) who found that floristically, Succulent Karoo is most similar to Fynbos.
- Most species are shared between Nama-Karoo & Succulent Karoo (34). This may be attributable to the extensive interface between these two biomes and the widespread distribution of non-specialist taxa shared between them. This is in contrast to Gibbs Russell's (1987) findings in a family-level analysis that showed Nama-Karoo to be floristically closest to Savanna. It may also suggest that mesembs are moving into Savanna, the low degree of endemism indicating a more recent presence in this biome.
- Albany Thicket shares species with Succulent Karoo, Nama-Karoo, Grassland, Coastal Belt and Fynbos. This biome is especially complex as it is located in a region that is the meeting point of a number of biomes and phytochoria (Goldblatt 1978).
- The link between Nama-Karoo and Albany Thicket supports the hypothesis of Jürgens (1997) that warmer lowland pockets of the Eastern Cape could have served as refugia where the tropical arid taxa of the Nama-Karoo survived during the last glacial maximum.
- The 17 mesembs shared between Succulent Karoo and Desert reflect to some extent the recent inclusion of a narrow strip along the Gariep River, in the Gariep Centre of endemism, as part of the Desert Biome e.g. *Astridia*, *Brownanthus*, *Cephalophyllum*, *Conophytum*, *Eberlanzia*. However, the validity of treating this particular portion of the Lower Gariep River Valley (see Figure 1) as part of the Desert Biome is questioned by the present authors.

Taxonomic distribution

In modern classifications nearly all floras and faunas are comprised of a few common species and many that are rare. In Mesembryanthemaceae, there exist well-defined and isolated taxa, often with very restricted distribution, and large complexes of closely related taxa that are difficult to delimit, with much wider distributions (Ihlenfeldt 1994). These differences in taxon size and distribution range are probably an indication that the family is composed of taxa of different ages. Floristic data were plotted on a "bubble diagram" that shows groups of genera and their relative sizes (Chesselet *et al.* 2000b) to show the distribution of taxa across biomes in southern Africa

- It is mainly larger genera that show outliers in different biomes.
- Smaller genera are generally confined to a single biome.
- Subfamily Mesembryanthemoideae is surprisingly widespread despite the small size of the genera. Species in this group are often weedy, opportunistic and found in disturbed vegetation. The smaller genera of non-weedy species, such as *Dactylopsis* and *Aspazoma* are habitat specialists, confined to the Succulent Karoo. These wide distributions may also suggest that the generic taxa have experienced a fairly long history of environmental change (Jürgens 1990).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

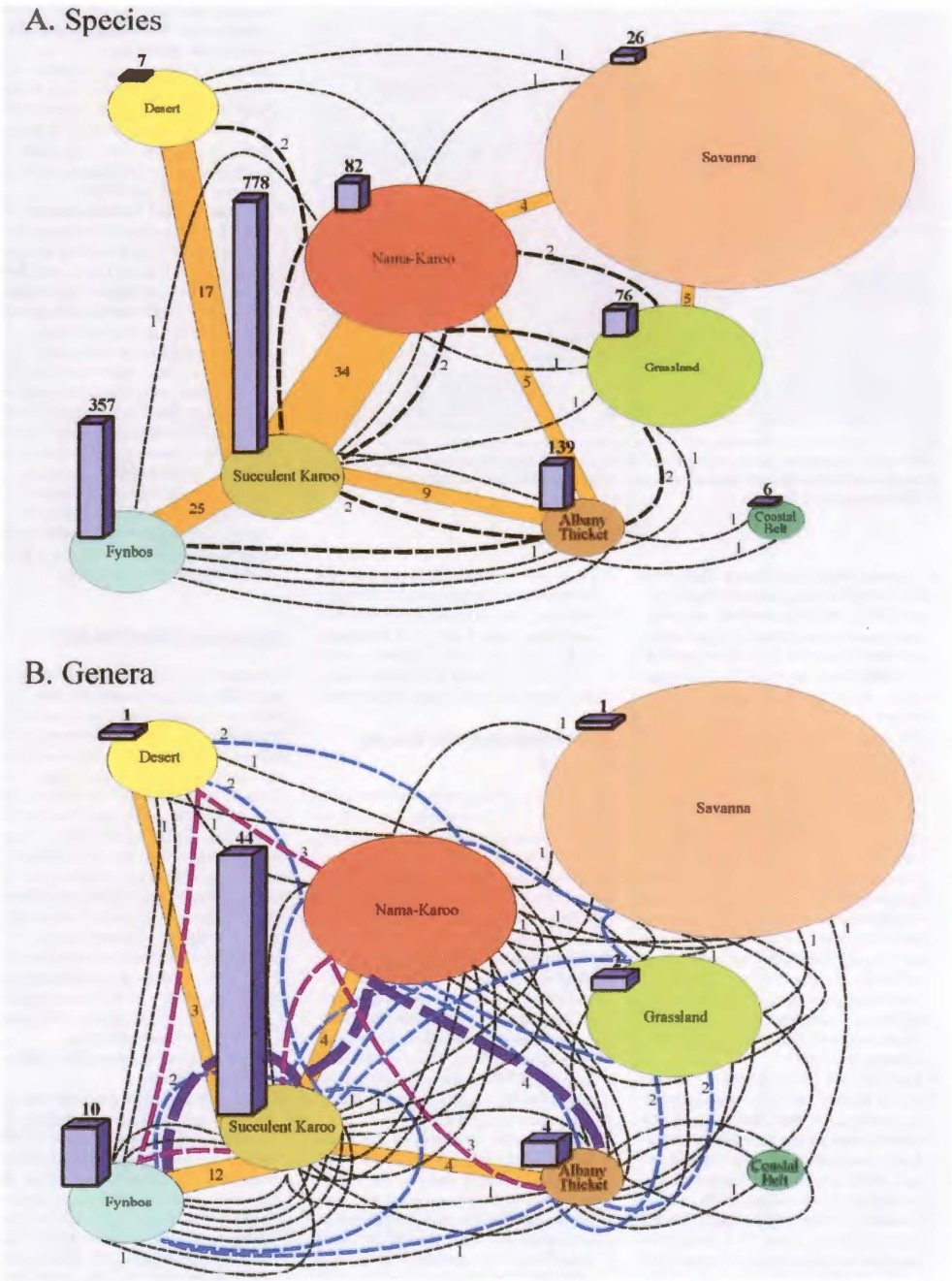


Figure 2. Distribution of endemic and shared species (A) and genera (B) among the biomes of southern Africa. (bubbles not to scale, indicating only largest to smallest biome.). Shared taxa between biomes are indicated as by solid (yellow) or dotted lines with the number of shared genera or species indicated, the thickness of lines is proportional to the number of taxa (each dotted line is numbered in at least one place). The complex "web" in (B) shows the large number of genera shared among biomes.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

- In subfamily Ruschioideae only the presumed more primitive *Apatesia* Group, *Cleretum* Group and *Mitrophyllum* Group (excluding *Glottiphyllum* and *Disphyma* that are not correctly placed here) do not contain large, widespread genera. All other groups contain at least one relatively large, widespread genus and a range of smaller ones, suggesting that these groups may still be undergoing active speciation.
- The most primitive extant tribe in subfamily Ruschioideae, the Apatesieae (Chesselet *et al.* 2002), is clearly geographically clustered and almost entirely confined to the wetter south-western Cape. The semi-succulent, flat-leaved species in this group are interpreted as remnants of a previously more wide-ranging group, now isolated both phylogenetically and geographically by the extinction of close relatives. Most of its genera are monotypic or very small.
- The core of the *Mitrophyllum* Group (excluding *Glottiphyllum* and *Disphyma*) is entirely confined to the Succulent Karoo. Features of the epidermis and fruit suggest a primitive position in tribe Ruschieae. Their restriction to Succulent Karoo supports the hypothesis that the centre of diversification for the mesembs lies in this biome. It is noteworthy that this group also comprises small genera of between one and seven species, suggesting a similar evolutionary regression as in Apatesieae.
- With the exception of *Ectotropis* and *Muiria*, genera in the *Delosperma* Group are large and widespread. *Gibbaeum*, the most specialised, morphologically, is almost entirely restricted to Succulent Karoo.
- Mesembs are not restricted to the winter-rainfall region of southern Africa although winter rainfall is an important zonal factor for the predominance of leaf succulents (Jurgens 1990). Mesembs in summer-rainfall biomes often have thick storage roots, leaf rosettes or tufted leaves. Few are shrubby e.g. the widespread and variable *Ruschia hamata* and some *Delosperma* species.
- The genera *Lampranthus*, *Erepsia* and *Esterhuysenia* contain mostly Fynbos species. The large genus *Lampranthus* extends into Succulent Karoo and Albany Thicket, with an outlier grassland species in the Pondoland Centre.
- The *Stomatium* and *Titanopsis* groups contain a number of summer-rainfall taxa. Growth forms are mostly compact in this group.
- The mostly semi-succulent genus *Delosperma* has radiated in the summer-rainfall area. Albany Thicket and Grassland biomes contain the majority of its species. Its distribution extends into north-eastern Africa, Madagascar and La Réunion.

Conclusions

The patterns of floristic diversity presented here at biome level do provide some trends and clues regarding the phytogeographic history of mesembs in southern Africa, the region where they are most diverse. Any interpretation is, however, complicated by recent (Pleistocene) palaeoecological factors relating to climate change and consequent changes in vegetation types as well as their regional distribution patterns. This suggestion is supported by the presence of relict Fynbos (with strong Cape floristic elements) in the Kamiesberg, for example (Van Wyk

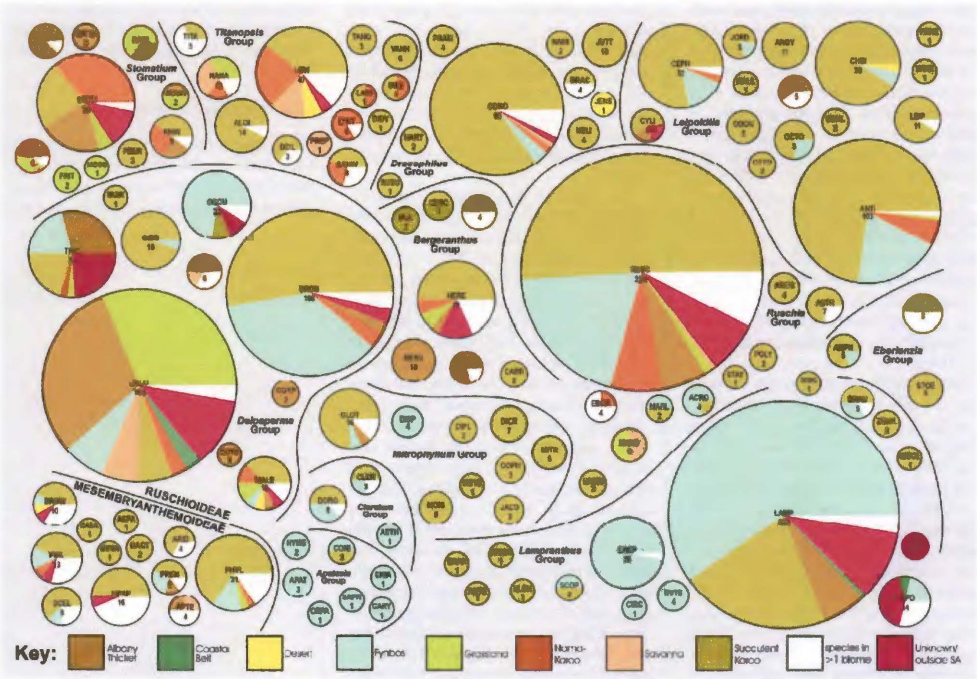


Figure 3. Distribution of biomes among genera of Mesembryanthemaceae. For explanation of diagram and genus acronyms refer to Chesselet *et al.* (2000).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

& Smith 2001). It has, for instance, been claimed that as recently as the last glacial maximum, the northern limits of the winter rainfall region may have been north of present day Namibia (Bayer 1984). Although arid conditions on the Atlantic coast are thought to be ancient, rainfall amount and seasonality as well as temperature regime may have changed dramatically in more recent times (Jürgens 1997). Increasing aridity and cooling over the past 10 MA (Van Wyk & Smith 2001) are associated with the development of the cold Circum-Antarctic Current and Benguela Current along southern Africa's West Coast – the latter resulting in the inception of the Mediterranean climate and winter rainfall regime in the region. Pleistocene climate change has been invoked as a possible cause for the unusual richness of the arid flora of the Succulent Karoo (Midgley *et al.* 2001a). In their current ecological context Desmet & Cowling (1999) suggest that the isolated nature of populations due to life history attributes such as short distance dispersal, pollinator behaviour and accelerated generation turnover resulting from drought-induced mortality as factors contributing to the tremendous speciation of this group. Rutherford & Westfall (1986) suggest that diversity and functional adaptations of plants are negatively related to warm season rainfall, and that the variation within plant life form increases in areas of greater environmental stress. This, compounded by survival in refugia, such as the Knersvlakte, Little Karoo, Albany Thicket and the Gariep Centre during cooler times, may explain the extreme concentration of highly adaptive taxa in these centres of endemism. In the mesembs, extreme morphological variation and speciation is closely coupled to extreme convergence in growth form across a wide range of taxa, making mesembs one of the most difficult groups, taxonomically, in southern Africa.

Genus level affinities of the mesemb flora of Fynbos and Succulent Karoo support the concept first presented by Bayer (1984) of a winter rainfall biome, a greater Cape Mediterranean Region that includes both Fynbos and Succulent Karoo (Jürgens 1997, Midgley *et al.* 2001a, Van Wyk & Smith 2001). The two components are largely separated by edaphic factors at their interface: Fynbos associated with sandstone soils derived from the Cape Supergroup, and Succulent Karoo associated with the richer substrates of the Karoo Supergroup and related non-quartzitic substrates. This geological division is not absolute, however, the Gariep Centre (Van Wyk & Smith 2001), for example, contains 222 endemic or near endemic mesemb species in 45 genera, of which 16 are endemic. These high levels of endemism in the Gariep Centre suggest that it may have been an ancient refuge for mesembs. The quartzitic mountains of the Richtersveld have had a tendency to accumulate endemics, thus leading to diversification of taxa in these specialised substrates (e.g. Schmiedel 2001). The high levels of endemism at species level in Fynbos and Succulent Karoo support their distinctiveness and highlight the role of edaphic specialisation, variation in habitats and isolated refuges as explanations for levels of endemism comparable to figures for isolated oceanic islands. The greatest floristic divide exists between the Cape Flora and the Palaeotropic Flora (Gibbs Russell 1987; Jürgens 1997) that separates the (mainly) winter rainfall and summer rainfall areas. This division supports the hypothesis put forward (Chesselet *et al.* 2001; 2002) which divided the subfamily Ruschioideae into four tribes (Apatesieae, Dorotheantheae, Delospermeae & Ruschieae) on the basis of characters of the floral nectary. The last two have diversified mostly in the summer-rainfall and winter/all year-rainfall areas respectively. Nectary characteristics suggest that Delospermeae (27 genera; ca. 524 sp.) are more primitive than Ruschieae (71 genera; ca. 1013 sp.) that comprise the bulk of mesembs. This does not mean, however, that a *Delosperma-like* ancestor did not exist under previous climatic conditions in the Cape Flora prior to the inception of the Mediterranean climate.

The existence of a periodic arid corridor from the arid western parts of southern Africa with similar areas in north eastern Africa (Chapin 1923; Verdcourt 1969; De Winter 1971) has been put forward as an explanation for current disjunct distributions patterns in the arid regions of Africa. The closest relatives of mesembs, believed to be members of Aizoaceae, occur in the Tropics and Subtropics (Tetragonioideae and Sesuvioideae), and in North, South and East Africa, as well as Namibia, Angola and Australia for the (mostly) weedy arid taxa of subfamily Aizooideae. The ancestral stock from which mesembs evolved may have originated in the Palaeotropical Kingdom. To attempt to discover the centre of origin of Mesembryanthemaceae from present distribution data is perhaps not appropriate in view of the evidence reviewed here. Also, present-day centres of mesemb diversity are not necessarily centres of origin (Hartmann 1991). It is nevertheless suggested that the mesembs had a long presence in the Greater Cape Floristic Region with periodic waxing and waning of range following the northward and southward extension and retreat of the frontal systems mainly responsible for the Mediterranean-type climate with which most members of the family are currently associated. The existence of persistent refugia may have served as a source from which new bursts of adaptive radiation could have been activated at different times. Being at the southern end of the African continent, the Cape Floristic Region (mainly Fynbos Biome) and its enclaves of Succulent Karoo would qualify as perhaps the most persistent and mesic of such refugia and the region most likely to still harbour remnants of some of the ancestral forms in the group. The presence of the postulated primitive mesemb groups in the Fynbos Biome supports this idea. Extreme diversification of more advanced groups in the Succulent Karoo has probably been brought about by the availability of new ecological niches and a remarkable suite of adaptive morphological features of the plants themselves that include ontogenetic abbreviation (neotony), heterophylly, mimicry of substrates, novel rain-driven dispersal mechanisms (hygrochastic fruit), and specialised pollination behaviour, all of which may have contributed to their extraordinary success under the particular climatic conditions of the Succulent Karoo.

Acknowledgements

We thank Professor Laco Mucina, Dr Mike Rutherford and Les Powrie for making unpublished information on the biomes of southern Africa available to us.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

References

Bayer, M.B. 1984. The Cape Flora and the Karoo – A winter rainfall biome versus a fynbos biome! *Veld & Flora* **70**: 17–19.

Bittrich, V. 1986. Untersuchungen zu Merkmalsbestand, Gliederung und Abgrenzung der Unterfamilie Mesembryanthemoideae (Mesembryanthemaceae Fenzl). *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* **21**: 5–116.

Blake, S.T. 1969. A revision of *Carpobrotus and Sarcozona* in Australia, genera allied to Mesembryanthemum (Aizoaceae). *Contributions from the Queensland Herbarium* **7**: 1–65.

Burgoyne, P.M. 1998. *Iensenobotrya lossowiana*: an island of genetic material in a sea of sand. Aloe **35**: 94–96.

Chapin, J.P. 1923. Ecological aspects of bird distribution in tropical Africa. *American Naturalist* **57**: 106–125.

Chesselet, P., Burgoyne, P.M., Klak, C., Kurzweil, H., Dold, A.P., Griffin, N.J. & Smith G.F. in press. Mesembryanthemaceae. In Meyer, N. (ed.). *Plants of southern Africa: names and distribution. Strelitzia.*

Chesselet, P. & Smith, G.F. 2001. *Antimima aristulata* comb. nov. (Mesembryanthemaceae Fenzl); a heterophyllous succulent from Cape Town, South Africa. *Bradleya* **19**: 121–123.

Chesselet, P. & Smith, G.F. 2002. The rediscovery of *Ruschia acutangula* (Haw.) Schwantes (Mesembryanthemaceae Fenzl). *Bradleya*: 17–22.

Chesselet, P., Smith, G.F., Burgoyne, P.M., Klak, C., Hammer, S.A., Hartmann, H.E.K., Kurzweil, H., Van Jaarsveld, E.J., Van Wyk, B-E., & Leistner, O.A. 2000a. Mesembryanthemaceae. In: Leistner, O.A. (ed.), *Seed plants of southern Africa: families and genera. Strelitzia* **10**: 360–410.

Chesselet, P., Smith, G.F. & Van Wyk, A.E. 2000b. Systematic and evolutionary significance of morphology in the Mesembryanthemaceae: interactive database and illustrated atlas for identification. *Aloe* **37**: 46–51.

Chesselet, P., Smith, G.F. & Van Wyk, A.E. 2001. A new tribal classification for the Mesembryanthemaceae Fenzl based on characters of the floral nectary. *Aloe* **38**: 25–28.

Chesselet, P., Smith, G. F. & Van Wyk, A.F. 2002. A new tribal classification of the Mesembryanthemaceae: evidence from floral nectaries. *Taxon*: 295–308.

Chinnock, R.J. 1996. To the limits of *Disphyma* (Aizoaceae: Ruschioideae) and beyond. *Aloe* **33**: 59–61.

Desmet, P.G. & Cowling, R.M. 1999. Biodiversity, habitat and range-size aspects of a flora from a winter-rainfall desert in northwestern Namaqualand, South Africa. *Plant Ecology* **142**: 23–33.

De Winter, B. 1971. Floristic relationship between the northern and southern arid areas in Africa. *Mitteilungen aus der Botanischen Staatssammlung. München* **10**: 424–437.

Gibbs Russell G.E. 1987. Preliminary floristic analysis of the major biomes in southern Africa. *Bothalia* **17**: 213–227.

Goldblatt, P. 1978. An analysis of the flora of Southern Africa: its characteristics, relationships and origins. *Annals of the Missouri Botanical Garden* **65**: 369–346.

Hartmann, H.E.K. 1991. Mesembryanthema. *Contributions from the Bolus Herbarium* **13**: 75–157.

Hartmann, H.E.K. 1993. Aizoaceae. In K. Kubitzki, J.G. Rohwer & V. Bittrich (eds), *The families and genera of vascular plants – Dicotyledons* 2. Springer-Verlag, Berlin.

Hartmann, H.E.K. 1994. On the phytogeography and evolution of Mesembryanthema (Aizoaceae). Pp. 1165–1180 in: Seyani, J.H. & Chikuni, A.C., *Proceedings XIIIth Plenary Meeting AETFAT*, Malawi 2.

Hartmann, H.E.K. 2001a. *Illustrated Handbook of Succulent Plants. Aizoaceae A–E.* Springer.

Hartmann, H.E.K. 2001b. *Illustrated Handbook of Succulent Plants. Aizoaceae F–Z.* Springer.

Hickey, B. & Van Jaarsveld, E. 1995. Propagation of three rare and endangered vygies. *British Cactus and Succulent Journal* **13**: 141–146.

Ihlenfeldt, H.-D. 1994. Diversification in an arid world: The Mesembryanthemaceae. *Annual Review and Ecology and Systematics* **25**: 521–546.

Jürgens, N. 1990. Remarks on the biogeography of Mesembryanthemaceae and their possible use in other arid regions. *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* **23**: 1047–1060.

Jürgens, N. 1997. Floristic biodiversity and history of African arid regions. *Biodiversity and Conservation* **6**: 495–514.

Liede, S. 1990. Studies in the genus *Erepsia* – on the ecology of a Fynbos succulent. *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* **23**: 759–766.

Low, A.B. & Rebelo, A. (eds). 1996. *Vegetation of South Africa, Lesotho and Swaziland* Department of Environmental Affairs & Tourism. Pretoria.

Marias W. 1979. A new species of *Delosperma* (Mesembryanthemaceae) from Madagascar. *Kew Bulletin of Miscellaneous Information* **33**: 521–522.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B. & Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* **403**: 853–858.

Midgley, G.F., Hannah, L., Roberts, R., MacDonald, D.J. & Allsopp, J. 2001a. Have Pleistocene climatic cycles influenced species richness patterns in the greater Cape Mediterranean Region? *Journal of Mediterranean Ecology* **2**: 137–144.

Midgley, G.F., Rutherford, M.C. & Bond, W. 2001. *The heat is on...impacts of climate change on plant diversity in South Africa.* National Botanical Institute, South Africa.

Mucina, L. & Rutherford, M.C. in prep. *Vegetation map of South Africa, Lesotho and Swaziland: an illustrated guide. Strelitzia.*

Poppendieck H.-H. & Ihlenfeldt H.-D. 1978. *Delosperma harazianum* (Defler) Poppend. & Ihlenf., eine wenig bekannte Mesembryanthemaceae aus dem Südjemen. *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* **16**: 183–187.

Raven, P.H. 1970. Taxonomy of *Lithops* – more enlightenment. *Bulletin of the African Succulent Plant Society* **5**: 156–160.

Rutherford, M.C. & Westfall, R.H. 1986. Biomes of southern Africa: an objective categorization. *Memoirs of the Botanical Survey of South Africa* **54**: 1–98.

Schmiedel, U. 2001. Specialized succulents from southern African quartz fields: tracing the ecology of a fascinating flora. *Cactus & Succulent Journal (U.S.)* **73**: 170–175.

Smith, G.F., Chesselet, P., Van Jaarsveld, E.J., Hartmann, H., Hammer, S., Van Wyk, B.-E., Burgoyne, P., Klak, C. & Kurzweil, H. 1998. *Mesembs of the world.* Briza Publications, Pretoria.

Van Wyk, A.F. & Smith, G.F. 2001. *Regions of floristic endemism in southern Africa. A review with emphasis on succulents.* Umdaus Press, Hatfield.

Verdcourt, B. 1969. The arid corridor between the north-east and south-west areas of Africa. *Palaeoecology of Africa* **4**: 140–144.

Pascale Chesselet

Compton Herbarium,
National Botanical Institute,
Private Bag X7,
Claremont 7735,
South Africa.
E-mail: chesselet@nbict.nbi.ac.za;
http://www.nbi.ac.za

Abraham E. van Wyk

H.G.W.J. Schweickerdt Herbarium,
Department of Botany,
University of Pretoria,
Pretoria 0002,
South Africa.
E-mail: avanwyk@scientia.up.ac.za

Neil Griffin

International Ocean Institute of Southern Africa,
Department of Biodiversity and Conservation Biology,
University of the Western Cape,
Private Bag X17,
Bellville 7535,
South Africa.

Gideon F. Smith

Chief Director,
National Botanical Institute,
Private Bag X101,
Pretoria 0001,
South Africa.
E-mail: gfs@nbipre.nbi.ac.za;
http://www.nbi.ac.za

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

CHAPTER 5

CHARACTER ANALYSIS

5.1 Approach

Systematists, over the years, have used different methods to group and order biodiversity. The fundamental objective of systematics is to discover orderly pattern in nature (Brower 2000). Stuessy (2003) views the objectives of systematics in three different contexts: a) constructing classification; b) revealing and reconstructing phylogeny; and c) understanding the process of evolution. Already in the mid-20th century, the 'new systematics' of Huxley (1940) redefined the fundamental problem of systematics from discovering hierarchy in nature to 'detecting evolution at work' (Brower 2000), with a focus on process. Although morphological features are useful to circumscribe and key out taxa (two major issues in mesemb taxonomy), Endress (2003) points out that in addition to their importance in phylogenetic analysis, morphology is still more important and interesting for evolutionary reconstruction once well-supported and detailed phylogenetic trees have been generated.

Character analysis is a logical priority to phylogenetic analysis (Brower 2000), and is regarded the *bête noire* of plant systematics (Pogue & Mickevich 1990). It is the process that precedes tree construction and differences in character construction can have dramatic effects on results. At the core of character analysis is the problem of primary homology. Patterson (1982) equated homology with synapomorphy although de Pinna (1991) points out that synapomorphies are the end products of cladistic analysis, distinguished from convergence by cladogram construction and from sympleisiomorphies by rooting.

In intermediates, homology is a matter of degree and features may be partially homologous to typical representatives of structural categories (Sattler 1996). Classical morphology shows only the striking differences between typical representatives of different morphological categories. There are different views of plant form and that of

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

a plant morphologist may be quite different from a systematist's interpretation, and may concentrate on the description of developmental processes rather than on phylogeny reconstruction. Sattler (1996) shows that continuum morphology is more comprehensive, encompassing both typical and intermediate states. In this approach, each structure is seen as a process combination and thus the structural continuum is a continuum of process combinations.

The Linnean (hierarchical) classification system assigns ranks and names to categories and groups. Classical morphology is based on 'either-or' Aristotelian logic and reduces the diversity of plant form into mutually exclusive categories. In the absence of sharp distinctions (discontinuities), intermediates that link the typical representatives of categories in a morphological continuum need consideration and Aristotle already recognized gradations, applying a philosophy of 'more-or-less' (Sattler 1996).

In recent years there has been an extensive debate surrounding approaches to modern classification systems (e.g. Brummitt 1996; Sosef 1997; Van Welzen 1997; Freudenstein 1998; Brummitt 2002). Although cladistic theory and molecular systematics have been the most influencial factors on methods of classification in the 20th century, phylogenetic systematics (*sensu* Hennig 1966) insists on monophyly and is unaccepting of paraphyletic groups. Currently Linnean nomenclature and hierarchy are the currency for naming and ordering diversity, and it seems that this system is incompatible with phylogenetic systematics. As Brummitt (1996, 2002) shows, paraphyly is part of a system that places taxonomic entities into ranks, as opposed to clades. The Angiosperm Phylogeny Group, APG (1998, 2003), elucidates phylogeny for the purposes of a phylogenetic classification, and is especially concerned with monophyly, avoiding paraphyly not to mention polyphyly, at all costs.

The evolutionary viewpoint is more conventional and broader than a strictly cladistic approach to systematics, as both cladogenesis (phylogeny) and anagenesis (degree of specialization) are considered as important processes. Dupont (1968) discussed 'evolution phylogenique' and 'evolution adaptive' in the context of

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

mesembs. Considering anagenesis brings an appreciation for the structural changes brought on by morphological specializations that are unique in mesembs. A molecular approach does not distinguish between these two aspects. In this study, emphasis is placed on using a practical approach for users of plant names with greater importance placed on structural differences than on phylogeny with the aim to provide a classification that reflects structural diversity and has high predictive power, for example, in plant identification.

Following a strictly molecular phylogenetic approach to mesemb systematics may result in the loss of taxa, genera in particular, due to the lack of molecular resolution particularly in more recently evolved taxa. Molecular evidence has not been very successful in resolving relationships in mesembs at the genus level, particularly in subfamily Ruschioideae (Klak *et al.* 2003a, 2003b). This may be due to the very recent diversification of the group (Goldblatt 1978; Ihlenfeldt 1994; Chesselet *et al.* 2003b; Klak *et al.* 2004). Typical of the family is uncertainty in the delimitation of taxa, particularly at the level of genus and species. Recent molecular studies (Klak *et al.* 2003b) have, however, provided valuable information that can be used for congruence testing of morphological character state polarities (Chesselet *et al.* 2004), thus enabling hypotheses of character evolution that ultimately can serve to resolve phylogenetic hypotheses for the mesembs.

How then do we analyse such a morphologically 'plastic' and diverse family as Mesembryanthemaceae? Dahlgrenograms have been used to visually assess characters, plot character distributions among genera and show trends. However, as highlighted by Dahlgren *et al.* (1985) the assessment of the phylogenetic significance of the distributions of character conditions is always hampered by the possibility of convergence, as was found in the case of the lophomorphic meronectary of some members of Delospermeae (Chesselet *et al.* 2002, 2004). Published molecular data (Klak *et al.* 2003b) served to highlight the incidence of convergence. In morphological cladistics, homoplasies form the most crucial problem (Endress 2003).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

The atomization of the morphological diversity observed in the mesembs into discrete characters is used here for two ends: 1) identification and 2) the construction of a morphological data matrix for future phylogenetic analyses and key construction. When used in combination with a molecular phylogeny, hypotheses of character evolution are possible, thus giving insights into the evolution of the group as a whole. Characters that are used for identification can be quite different from those useful in phylogenetic reconstruction, or plant descriptions. Characters are listed below according to character sets, and the usefulness of each character is indicated, either for identification (KEY), and or phylogenetic analyses (PHYLO). Descriptive characters that have not been discussed or used further are indicated as (DESC).

A first character list for the mesembs and outgroup as well as an assessment of evolutionary polarity of character states was published by Bittrich & Struck (1989). These authors refrained from publishing any cladograms resulting from their analysis. Since then, new information has become available, from both morphological and molecular sources thus enabling a sounder base for assessments of character evolution. The following steps, outlined by Bower (2000) were followed in the construction of the character list presented here: a) finding comparable features among taxa. This is referred to as topographical identity, the different manifestation of the same character referred to as Patterson's (1982) transformational homology; b) parsing the variation of the features into discrete states; c) ordering of characters and linking them into transformation series that differentially weight the various possible state transformation. The limitations of this procedure are that it is not possible to know the true transformation series among character states, nor where one character ends and another begins. Bower (2000) suggests that minimizing assumptions by using unordered states or presence/absence coding may alleviate this problem. However, a loss of phylogenetic information may result, and in this study presence/absence characters have been avoided as much as possible and complex characters are preferred (see, particularly, fruit characters). Characters here labelled as KEY are not necessarily interpreted as transformational series or homologous characters. Those labelled as PHYLO are postulates of homologies and are arranged, where possible, as transformation series. In some cases, where polarization was not possible or applicable over the whole series, the characters are coded as Unordered

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Multistate (UM) characters and therefore contain no assumptions or hypotheses of evolution. A combination of outgroup analysis, character association and a published molecular phylogeny (Klak *et al.* 2003b) have been used to establish hypotheses of character transformation. An overview of characters is given under 6.2 at the beginning of Chapter 6.

The vegetative character sets include life cycle and growth form, leaves, stems and branches. Features of the epidermis yield valuable phylogenetic information in the vegetative character set (Dupont 1968; Ihlenfeldt & Hartmann 1982), though much of the variation of the epidermis is a manifestation of degrees of succulence, at times extreme in taxa that are highly adapted to their surroundings. Phylogenetically important vegetative features of the leaves and stems include specialization of water storage tissue of epidermal and subepidermal layers (Dupont 1968; Ihlenfeldt & Hartmann 1982). Notably, bladder cell idioblasts define the Aizoaceae *sensu stricto* including Mesembryanthemaceae (Bittrich & Hartmann 1988). Stomatal characters are linked to epidermal types and also provide clear taxonomic patterns. Newly described wide band tracheids have also shown to be significant in mesemb systematics (Landrum 2001), representing a synapomorphy for the more advanced taxa (Drosanthemeae and Ruschieae) of the Ruschioideae. Early subdivisions of *Mesembryanthemum sensu lato*, e.g. Haworth's work, rely almost entirely on habit and vegetative characters (Brown 1925). Vegetative characters can be useful in the identification of species and genera.

The reproductive character sets contain flowering, inflorescence, flowers and fruit. Characters extracted from floral morphology have yielded very useful and stable characters for grouping at supra-generic levels, floral nectaries in particular (Chesselet *et al.* 2001, 2002, 2004). Although fruit characters are fundamental to Hartmann's (1991, 1993) informal classification of Ruschioideae taxa, their value in the systematics of the group may have been overestimated at the expense of other character sets. Fruit types may to some extent reflect rainfall regime rather than phylogenetic relationship. Although included in the key, data on geographic distribution is discussed separately in Chapter 4.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

5.2 Character list and discussion of characters

5.2.1 Vegetative character set: Life cycle and growth form

As popularly understood, a succulent plant is a plant having thick fleshy leaves and/or stems above ground. In a narrow definition, Smith *et al.* (1993) defined a succulent plant as one that stores water in the tissue, giving it a fleshy appearance. Such a definition of succulence is fraught with difficulties due to the heterogeneity of succulent attributes, the varying degrees of succulence and the cryptic succulence of some herbs and trees. In a broader and controversial concept, Smith *et al.* (1997) define a succulent plant as one that stores water in its tissues as a mechanism to survive periods of drought in the growing phase. This definition excludes tuberous or bulbous plants that usually survive drought in the dormant phase. An alternative definition is given by Ihlenfeldt (1989) who defines succulents as plants that store considerable amounts of water in their body which can be mobilized and used in other parts of the plant in times of water deficiency to maintain essential life processes. In a definition adapted to include succulent plants Von Willert *et al.* (1992) describe the **life cycle** as comprising all events in the plant's life between germination of the seed, or beginning of growth from another reproductive unit, and the death of the individual that developed from it after producing new seeds or other reproductive units. The crucial phase of the life cycle follows germination and entails the establishment of seedlings. In this phase mortality is high. Life cycle is significant as it implies life strategy and longevity e.g. short-lived opportunists vs. longer-lived perennials; generalists vs. specialists (Ihlenfeldt 1989).

The success of the mesembs and their dominance in the Succulent Karoo is attributed to an extremely broad spectrum of highly specialized life forms and life strategies (Ihlenfeldt 1989, 1994). A life form concept, including anatomical characters adapted for the description of succulent plants was put forward by Jürgens (1990a). Convergence in growth forms is high in succulent plants due to the strong selective pressures that can result in similar adaptations in taxonomically distant groups. Traditional **growth form** categories have not been followed here, as broad

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

groupings are used to describe growth forms purely for identification purposes (Character 2: Overall appearance).

Character 1: Life cycle (longevity of plants) (KEY; PHYLO - UM)

0. Annual
1. Biennial
2. Perennial with annual branches
3. Perennial

An **annual** plant has a lifespan that ends within one year after germination and completes its life cycle within that year or sooner. The annual habit is significant in the avoidance of drought. An ephemeral or opportunistic plant will respond to seasonal and aseasonal rains e.g. *Mesembryanthemum crystallinum* (Von Willert *et al.* 1992). Chamaephytes are characteristic of the Desert biome of southern Africa (Rutherford & Westfall 1986). In mesembs, tribe Dorotheantheae is entirely annual. The annual habit is closely linked to the possession of (sometimes petiolate) mesophytic-looking, semi-succulent leaves that are flat in the more primitive condition. Annual mesembs are herbaceous and from a phylogenetic perspective, herbaceous growth forms are considered primitive in Mesembryanthemaceae by Bittrich & Struck (1989). Ihlenfeldt (1960) considered shrubs as primitive in Mesembryanthemaceae. However, Cronquist (1981) suggested that in the Centrospermae (Caryophyllales), woody growth forms may have arisen secondarily. This is in contrast to the trend in angiosperm taxa where the annual habit is thought to be a derived trait. Bittrich & Struck (1989) substantiate their point using the correlation criterion, suggesting that most mesemb taxa showing other primitive characters are more or less herbaceous. The annual life cycle is found in some species of Mesembryanthemoideae, and in the more primitive Apatesieae and Dorotheantheae that are mostly confined to the Fynbos Biome (Chesselet *et al.* 2003b).

A **biennial** plant lives for two years. In the first year, a basal rosette of leaves is developed with flowers and fruits produced in the second year of growth. Biennial plants are known in the genus *Mesembryanthemum*. The biennial life cycle does not occur in ruschioid species. A **perennial with annual branches** often has thickened roots or an enlarged tuberous rootstock. This is typical of species such as *Delosperma*

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

mahonii from the summer rainfall interior of southern Africa including southern Zimbabwe. Traditionally, roots are used nutritionally by shepherds (C. Makgakga pers. comm.). The combination of persistent rootstock and annual leaves is an adaptive feature mostly noted in summer rainfall mesemb taxa. Due to the taxonomic position of *Delosperma* in the Ruschieae, this character cannot be polarized and is coded UM. For strictly phylogenetic purposes the character could be coded as (0) annual or biennial, (1) perennial. But, due to the presence of perennial taxa in Aizoaceae *sensu stricto* (excluding Mesembryanthemaceae), the perennial habit may be a reversal and the character could then be polarized as follows: (0) perennial, (1) annual or biennial.

A **perennial** plant lives for three or more years. Perennial mesemb species are usually drought tolerant. Some perennial mesemb species are unique in producing only a single pair of highly succulent leaves per year (Von Willert *et al.* 1992). In the Richtersveld, Jürgens *et al.* (1999) showed that leaf succulents of the Succulent Karoo have remarkably short lifespans, with variation among species and ranges of 4.6 to 5.6 years. These short life cycles were shown not to be the result of drought but to inherently short lifespans attributable to the small stature, limited water storage capacity and shallow root systems of these winter-rainfall desert succulents. In contrast, Desmet & Cowling (1999) suggest that accelerated generation turnover—resulting from drought-induced mortality as a factor, amongst others, such as the isolated nature of populations, short distance dispersal and pollinator behaviour—contributes to the tremendous speciation of the mesembs. The more advanced mesembs in tribes Drosanthemeae and Ruschieae are all perennial, and in the mesembs this state can be therefore regarded as derived.

Character 2: Overall appearance (KEY)

0. Semi-succulent, fleshy herb, often soft-leaved, glistening [Fig. 6.73]
1. Stem-succulent [Fig. 6.18]
2. Creeping succulent [Fig. 6.43]
3. Tufted, or clump-forming or rosette-leaved succulent, sometimes glistening [Fig. 6.82]
4. Stone plants consisting mostly of succulent leaves (stems not visible, miniatures) [Fig. 6.69]
5. Succulent-leaved shrub (including dwarf shrubs) [Fig. 6.57]
6. Spiny succulent-leaved shrub or subshrub [Fig. 6.103]

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

This character broadly describes the different growth forms found in mesembs. Character states have no phylogenetic content or assumptions and are solely used for identification. Plants described as **semi-succulent, fleshy herbs, often soft-leaved and glistening** are herbaceous and soft-tissued (not woody). The stems and leaves are often glistening or grey-green and soft in texture. Halophytism in the form of salt tolerance and/or accumulation is characteristic of a number of species in this group e.g. *Mesembryanthemum longistylum*, from the Worcester area (Western Cape Province), the leaves of which have a very salty taste, and of other species, particularly in Mesembryanthemoideae. Fleshy semi-succulent growth forms are characteristic of several more weedy members of subfamily Mesembryanthemoideae. Tribe Dorotheantheae is characteristically soft-leaved with glistening water cells on the leaf and stem surfaces.

Few mesemb genera are **stem succulents**. Stem succulence is characteristic of *Brownanthus* and *Psilocaulon*, and some species of *Ruschia* e.g. *R. crassa*, although this form of stem succulence represents a special case. Jürgens (1986) suggested that leaf and stem succulence are adaptive responses to low but predictable water supply. Stem succulence is correlated with high temperatures or high evapotranspiration in both dry and rainy seasons e.g. *Brownanthus arenosus* that dominates in some parts of the Richtersveld. In contrast, leaf succulence correlates with low evapotranspiration (due to high relative humidity or cooler temperatures) during the growing season. In the New World, Cactaceae are predominantly stem succulents whereas stem succulence is less common in southern Africa's western, winter rainfall arid areas. In southern Africa, stem succulence is also represented in the families Asclepiadaceae, Crassulaceae, Euphorbiaceae, Asteraceae, Zygophyllaceae, Portulacaceae, Geraniaceae, Cactaceae, Chenopodiaceae, Vitaceae, Pedaliaceae, Lamiaceae and Dioscoreaceae (Smith *et al.* 1993).

Creeping succulents have leaves of variable shape but stems all creep along the ground, forming dense or sparse mats. Creeping forms occur throughout the mesembs, sometimes rooting at the nodes and other times not. Flower stalks are upright and are either solitary or in cymes. Creeping mesembs are often found in

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

sandy habitats e.g. species of *Jordaaniella* and *Drosanthemum*. These mostly root at nodes and have shallow rooting systems.

In **tufted, clump-forming and rosette-leaved succulents, sometimes glistening**, the often finger-like leaves are erect and crowded together. Leaves may be cylindrical or three-sided (trigonous or triquetrous), and plants form tufts or clumps. Stems are usually short and the roots thickened e.g. *Hereroa* and *Khadia*. In the interactive key, plants with leaves arranged in rosettes, such as *Stomatium* or *Aloinopsis* for example, are included in this category to avoid confusion. The 'bead-leaved mesembs' (Smith *et al.* 1998) are included in this group.

The **stone plants consisting mostly of succulent leaves (stems not visible, miniatures),** have extremely succulent leaf pairs that are fused and rounded. Leaves occur in single pairs or in small groups, stems are not visible, and plants are often difficult to detect. The sunken forms usually grow in soft, silty, loamy or sandy ground of fine texture, usually with the soil surface loosely covered with quartz pebbles, rarely with limestone (Hammer & Hartmann 1990). The plants grow below ground with just the apices of their leaves reaching the soil surface. In cultivation, the leaves are usually above ground. Miniature forms are interpreted as evolutionarily derived (Midgley & Van der Heyden 1999) and are thought to have competitive advantages. In terms of succulent strategies, their miniaturization is thought to be significant in terms of water use efficiency; the smaller the plant the more significant the amount of water. Midgley & Van der Heyden (1999) interpreted minutism in west coast species as a key factor in deriving a significant proportion of their water requirements from the fog bank. This is a broad category, including both sunken and other forms such as *Muiria* and *Argyroderma*, and is more or less equivalent to the 'stone plants' of Smith *et al.* (1998). In mesembs, gigantism appears to be suppressed. The only large mesembs are in the genera *Stoeberia* and *Mestoklema*. The small stature of mesembs may be a family trait and also due to a general lack of woodyness in the Caryophyllales.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Succulent-leaved shrubs (including dwarf shrubs) are shrubby with creeping or erect stems that are clearly visible. This category includes all variations from dwarf to tall shrubs, the tallest being in the genus *Stoeberia* although *Mestoklema* also contains tree-like species. Small, woody shrubs with succulent leaves and are a unique growth form. Plants with such a habit characterize many parts of the Succulent Karoo. The large genera such as *Ruschia*, *Lampranthus* and *Drosanthemum* contain numerous succulent-leaved shrubs and identifications are most difficult in these groups. 'Cushion plants' has not been included in the character list due to the possibility of confusion arising as to which plants this state should be assigned to. In several *Antimima* species, and in *Drosanthemum luederitzii*, for example, compact cushions are formed with a definite dome of tightly packed leaves. This growth habit is normally associated with exposure to wind, as may be the case for *D. luederitzii*. *Antimima* species often grow at high altitude, and cushion-like growth forms may be an adaptative response to the exposed and windy conditions of their mountainous habitats. Cushion plants are well-known in the Apiaceae inhabiting the high mountains of the Andes.

Spiny succulent-leaved shrubs or subshrubs are short or tall shrubby plants with thorny projections mostly in the inflorescences. In Mesembryanthemoideae, thorny species include *Phyllobolus roseus,* previously in the genus *Amoebophyllum*, which has spiny projections along the stem, although it is not generally considered spiny. A taxonomic treatment of the spiny mesembs is provided by Hartmann & Stüber (1993). Originally, all spiny mesembs were included in the genus *Eberlanzia*. These authors placed the ten species involved into several genera including *Antimima*, *Eberlanzia*, *Leipoldtia* and *Ruschia* subgenus *Spinosae*, thus indicating that spinyness is a convergent feature. To date, however, the taxonomic problems relating to spiny mesembs are still not fully resolved, and a new genus should be erected for those species placed in *Ruschia* subgenus *Spinosae* (pers. obs.; H.E.K. Hartmann and P.M. Burgoyne, pers. comm.). Hartmann & Stüber (1993) found that spines play a protective role mainly in the dry season but heavily grazed spiny mesembs have been noted. The functional significance of spines is probably a complex interaction of factors, both phylogenetically and ecologically based. Milton (1991) found spinyness

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

to be related to increasing aridity and fertility of soils. Other possible functions of spines are discussed in detail by Hartmann & Stüber (1993).

Character 3: Roots (KEY)

0. Fibrous, not enlarged, or slighly thickened
1. Caudiciform stem and swollen roots
2. Single or multiple swollen tubers (potato-like) [Fig. 6.74]
3. Thick tuberous roots, branching underground (woody) [Fig. 6.3]
4. Becoming thick and fleshy with age
5. Roots, thick, spreading laterally, giving rise to suckers

Roots are usually shallow in succulent plants from arid habitats. The shallow **fibrous root** system with pronounced lateral extensions of most succulent mesembs, is an adaptation to infrequent rainfall events and serves to exploit water that does not penetrate deeply into the soil (Von Willert *et al.* 1992). Few mesemb taxa develop a large caudex and are termed **caudiciform** e.g. *Mestoklema tuberosum*. This condition is associated with swollen stems and roots. The only caudiciforms among the mesembs are the six species of *Mestoklema*, from the surroundings of Graaff-Reinet. The stems of these species have very tough bark, presumably as a protection against herbivores. **Single or multiple swollen tubers (potato-like)** are found in perennial plants with annual branches e.g. *Delosperma*. The storage roots and annual branches may be an adaptation to grassland habitats that experience severely cold winters and almost predictable seasonal fires during the dry season. **Thick tuberous underground branching roots (woody)** occur in several mesemb genera including *Hereroa*, *Khadia*, *Aloinopsis* and other summer rainfall taxa. Roots of *Nananthus* species may be baked in the oven and eaten as a kind of sweet potato (A.E. van Wyk, pers. comm.). The roots of *Khadia* (Afrikaans *moerwortels* = yeast root, directly translated to English) was used traditionally in beer-making fermentation process (Chesselet *et al.* 1998), 'Khadi" being the name of a beer-like beverage. In Aizoaceae, thickened roots are known only from *Gunniopsis glabra*. Roots without a specialized storage function are viewed as primitive in Mesembryanthemaceae (Bittrich & Struck 1989). The importance of tuberous roots, in terms of survival, has possibly been underestimated in the mesembs. They are generally found in grassland taxa from the summer-rainfall areas of southern Africa. In grasslands fires occur frequently in short cycles, and resprouting from underground roots is a viable survival strategy for perennial plants. Reseeding is not an option, as the frequent fires [high fire frequency]

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

leave[s] insufficient time to produce a seed bank. In the Cape Floristic Region, both resprouters and reseeders occur, probably due to the much longer fire cycles (5–25 years) of this Mediterranean-type vegetation. In extremely cold places such as Sutherland, where temperatures may drop to –10°C during winter, *Aloinopsis spathulata* survives as large underground rootstocks, with very small leaves protruding above-ground.

5.2.2 Vegetative character set: Leaves

Distributional data in Chapter 4 shows that the primitive flat-leaved, mesophytic ruschioid taxa in Apatesieae and Dorotheantheae are found in the more mesic Fynbos Biome, with the radiation of highly adaptive succulent taxa mostly in the Succulent Karoo, and summer rainfall parts of southern Africa. This adaptive radiation reflects, to some extent, the extreme specialization of the leaves of certain groups. Leaves represent the interface for gas exchange and special features of the surface, stomata and photosynthetic mode reflect the increasing ability to survive under drought conditions. In many cases, specialized features of the leaves have evolved more than once in the group. Such convergent features such as neoteny, heterophylly, specializations of the surface such as hairs, teeth, bumps and pustules, windows, as well as the ability to mimic colours and textures of the surrounding substrate have contributed to their great success in habitats that other plant groups were unable to colonize.

Features of mesemb leaves can be traced from the more primitive to the more specialized groups of mesembs. Although useful for identification, few characters of the leaf have useful phylogenetic content due to their extremely adaptive nature.

Character 1: Attachment of leaves to stem (KEY)

0. Petiolate [Fig. 6.7]
1. Stem-clasping [Fig. 6.116]
2. Without petiole [Fig. 6.35]

The highly succulent leaves of mesembs are generally basally fused with a short sheath. These heavy, water-filled leaves are not subtended by a stalk (petiolate).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

However, in the more primitive groups with semi-succulent leaves, leaves are **petiolate** e.g. *Apatesia*, *Aptenia* (with or without petioles), *Carpanthea*, *Dorotheanthus* (petiole-like), *Hymenogyne* and *Mesembryanthemum* (pseudo-petiole). Petiolate leaves are interpreted as primitive in the group on the grounds of association with other postulated primitive characters such as flat, semi-succulent leaf blades, and also their established phylogenetic position within the more primitive mesemb taxa.

In the mesembryanthemoid genera *Synaptophyllum* and *Aspazoma,* leaves are sessile or **stem-clasping** at their bases and free at the tips. In *Aspazoma*, the lower part of each leaf is a tubular sheath that clasps the stem closely for almost the whole length of the internode while the upper part recurves away from the stem into a cylindrical or three-angled shape. A modification of stem-clasping leaves is noted in *Dactylopsis*, a genus sunk under *Phyllobolus* in previous taxonomic treatments (Gerbaulet 1997; Gerbaulet in Hartmann 2001b), but recently re-instated in others (Chesselet *et al.* 2000a, 2003a). Its basic leaf structure, over and above the high degree of succulence, suggests a close relationship with *Aspazoma* as suggested by Schwantes (Herre 1971), another specialist taxon belonging to the mostly widespread Mesembryanthemoideae. In the rest of the family leaves may be free or fused at their base, and sheathing, but the highly succulent leaves of most mesembs are generally **not petiolate**.

Character 2: Leaf arrangement (KEY)

0. Leaves alternate [Fig. 6.105]
1. Leaves alternate in the inflorescence [Fig. 6.93]
2. Leaves opposite [Fig. 6.32]
3. Leaves distichous [Fig. 6.54]

The concept of **alternate leaves** is complicated in mesembs, particularly so in the genera postulated to have retained primitive characters. In Ruschioideae, *Caryotophora* has alternate leaves, *Conicosia* sometimes has alternate leaves and in *Dorotheanthus* leaves are mostly alternate. In *Saphesia* and *Skiatophytum* leaves are alternate but apparently opposite on younger branches. Leaves are alternate on the flowering branches or sometimes on the whole plant in *Mesembryanthemum* and *Aptenia*. Some species of *Phyllobolus* have leaves that are decussate or alternate in the inflorescence or alternate throughout the plant. *Psilocaulon* and *Sceletium* have

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

decussate leaves becoming alternate in the inflorescence. The manifestation of alternate leaves is restricted to subfamily Mesembryanthemoideae, and some members of the primitive ruschioid genera of tribe Apatesieae. It is therefore interpreted as the primitive condition.

The majority of mesembs have **opposite leaves** that are borne in pairs across from one another at the same node. **Distichous leaves** are arranged in two vertical ranks or rows on opposite sides of an axis. This unusual arrangement is a characteristic of some species of the strap-leaved genus *Glottiphyllum*, thus representing a synapomorphy for the group of species exhibiting this character state. The functional significance of this arrangement is unknown, although it enables a denser packing of leaves on the more or less indistinguishable internodes, and a more compact growth form.

Character 3: Leaf pairs (degree of fusion) (KEY; PHYLO - UM)

0. Free [Fig. 6.43]
1. Basally connate [Fig. 6.66]
2. Partly fused [Fig. 6.95]
3. Entirely fused [Fig. 6.30]

Leaves are **free** and often petiolate and semi-succulent in the more primitive mesemb genera. This character is significant for the newly established tribe Drosanthemeae (Chesselet *et al.* 2004), and basally fused leaves provide the only putative synapomorphy for tribe Ruschieae. Members of the latter tribe have leaves that are **basally connate**, **partly fused** or **entirely fused**. This increase in the fusion of leaf pairs reflects an evolutionary series towards a higher degree of fusion, thus affecting the surface to volume ratio and associated with increasing succulence and drought resistance, enabling survival in the drier habits of southern Africa. Although arranged in an evolutionary series, this character is difficult to polarize unequivocally due to the high degree of convergence in taxa with highly succulent leaves (states 2 and 3).

Character 4: Leaf shape (KEY)

0. Flat, mesophytic [Fig. 6.22]
1. Flattish, withering to skeleton [Fig. 6.107]

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

2. Linear, mesophytic [Fig. 6.29]
3. Flattish, grooved upper surface, semi-succulent [Fig. 6.35]
4. Trigonous or triquetrous [Fig. 6.113]
5. Cylindrical, semi-cylindrical [Fig. 6.33]
6. Clavate [Fig. 6.62]
7. Tongue, strap-shaped, succulent [Fig. 6.54]
8. Fused and stem-sheathing at base, diverging at tips, highly succulent [Fig. 6.112]
9. Ovate in outline, succulent [Fig. 6.39]
10. Spatulate [Fig. 6.34]
11. Falcate or lunate [Fig. 6.104]
12. Fused to form conical, oblong, or spherical bodies [Fig. 6.87]
13. Globose, forming a rounded body and only fused basally [Fig. 6.38]
14. Rhomboid [Fig. 6.102]

The shape of leaves in mesembs shows all transitions from flat, weakly succulent to cylindrical to highly succulent. Here, leaf characters are used solely for identification purposes and no attempt has been made to identify homologous states. Leaf shape is generally linked to growth form. Leaves with a higher degree of succulence require a higher level of organization in their construction. Jürgens (1986) has shown that with increasing succulence, a central water-storing tissue is established and this is usually coupled to a reduction or modification of the primitive epidermal water storage tissue. The functional significance of leaf dimension in leaf succulents embraces four key aspects: drought survival, potential productivity, structural costs and transpirational cooling. It is well known that increasing succulence affects the surface to volume ratio until the organ approaches a spherical or cylindrical shape. The size of the water-storing organ is also important, particularly with regard to water storage capacity. Midgley & Van der Heyden (1999) suggest that massive succulents are able to survive longer droughts. They suggest that the predominance of leaf succulents with low surface to volume ratios in the Succulent Karoo may be due to the low risk of extended drought in the biome allowing small-leaved succulents to take advantage of low structural costs.

Leaves described as **flat, mesophytic** are semi-succulent. Mesophytic plants grow in average moisture conditions (in contrast to xerophytes or hydrophytes), and many semi-succulent mesembs are confined to the Fynbos Biome (most taxa in Apatesieae and Dorotheantheae), with the more widespread semi-succulents belonging in subfamily Mesembryanthemoideae.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

The most striking morphological feature of *Sceletium*—a genus comprising clustered or scrambling perennial subshrubs—are the sceletonized leaves with lignified veins by means of which the withered leaves retain their shape and assume a skeleton-like appearance. In this genus leaves are described as **flattish, withering to skeleton.** The dry leaves persist on the plants and enclose the young buds during the dry season. The venation patterns differ between species and are of diagnostic value in species identification (Gerbaulet 1996c). Both leaves and roots of *Sceletium* are used traditionally for their high contents of the psycho-active ingredient Mesembrine (Smith *et al.* 1996).

Linear, mesophytic leaves are semi-succulent, long and narrow with more or less parallel sides. They occur in the more primitive mesemb genera *Aptenia*, *Carpanthea*, *Caryotophora*, *Cleretum*, *Conicosia*, *Dorotheanthus*, *Saphesia* and *Skiatophytum*. Leaves with a **flattish, grooved upper surface and semi-succulent** blade are found in the genera: *Apatesia*, *Conicosia*, *Delosperma* and *Ectotropis*. This state is characteristic of certain species of *Delosperma*, allied to *D. cooperi*, and is useful in identification. The function of the grooved upper surface may be in the reduction in water loss from the papillate leaves in these genera. Species of *Conicosia* inhabiting Namaqualand have grooved leaf surfaces representing a rolling of the leaf into a more or less cylindrical shape. **Trigonous or triquetrous** leaves are three-angled or three-edged. This represents the most common condition in ruschioid taxa. **Cylindrical, semi-cylindrical** leaves are cylinder-shaped; elongate and round in cross section. **Clavate** leaves are club-shaped, gradually widening towards the apex. **Tongue, strap-shaped, succulent** describes the leaves in certain species of *Glottiphyllum*.

Leaves **fused and stem-sheathing at base, diverging at tips, highly succulent** occur in *Ottosonderia*, *Polymita*, *Ruschia*, *Schlechteranthus*, *Smicrostigma* and *Vanzijlia*. These appear to have evolved several times in Ruschieae and represent a kind of stem succulence achieved through stem-clasping leaf sheaths. Whole plants of *Polymita albiflora* are used in the Kamiesberg by local people to build shelters.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

They degrade slowly and are referred to as 'muisore', a colloquial name describing the free parts of the fused leaves that resemble the ears of a mouse.

Leaves that are **ovoid, ovate in outline, succulent** are found in species of *Aloinopsis*, *Antimima*, *Aptenia*, *Cheiridopsis*, *Deilanthe*, *Diplosoma* and *Namibia.* Many plants with the rosette growth form have **spatulate** succulent leaves with a rounded blade gradually tapering to the base. These are found in the genera *Aloinopsis*, *Chasmatophyllum*, *Deilanthe*, *Faucaria*, *Stomatium* and *Titanopsis.* **Falcate or lunate**, sickle- or crescent-shaped leaves occur in the genera *Astridia*, *Bijlia*, *Esterhuysenia*, *Leipoldtia*, *Oscularia*, *Rhombophyllum*, *Ruschia* and *Ruschianthus*. There are many gradations in the shape of these leaves, the distinction from triquetrous leaves becoming obscure at times.

Some mesemb species have leaves **fused to form conical, oblong, or spherical bodies**. These include the stone plants (*Conophytum*, *Gibbaeum* and *Muiria*) but may also be found in more shrubby genera such as *Dicrocaulon* belonging to the bead-leaved mesembs (Smith *et al.* 1998) of the *Mitrophyllum* Group that includes *Meyerophytum*, *Mitrophyllum*, *Monilaria* and *Oophytum.* Beaded leaves occur sequentially, simultaneously or in early developmental stages only e.g. *Jacobsenia.*

Leaves are **globose, forming a rounded body and only fused basally** in stone plants belonging in the genera *Argyroderma*, *Cheiridopsis*, *Didymaotus*, *Dinteranthus*, *Lithops*, *Pleiospilos*, *Tanquana* and *Vanheerdea.* In the current circumscription of *Mesembryanthemum*, *M. nodiflorum* has globose leaves. **Rhomboid**, almost rhombic leaves with obtuse lateral edges are found in the closely allied genera *Hereroa* and *Rhombophyllum.* This unusual shape contributes to their desirability in succulent plant collections.

Character 5: Leaf surface (KEY)

0. Sticky, with sand adhering (psammophorous) [Fig. 6.9]
1. Distinctly waxy [Fig. 6.71]
2. Visible bladder cells, glistening and shiny in the light [Fig. 6.36]

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

3. Bladder cells elevated and pointed at one or both ends [Fig. 6.119]
4. Xeromorphic bladder cells, hard water cells (10x lens) [Fig. 6.18]
5. Elongated, hair-like bladder cells
6. Smooth and untextured [Fig. 6.70]
7. Pellucid dots (subepidermal tannin idioblasts) [Fig. 6.100]
8. Papillate, rough to the touch [Fig. 6.64]
9. Velvety, from soft hairs [Fig. 6.86]
10. Echinate, prickly
11. Scattered visible hairs [Fig. 6.19]
12. Rough with white bumps or pustules [Fig. 6.118]
13. Ridges, woolly appearance [Fig. 6.123]
14. Textured with ridges and markings [Fig. 6.69]

Characters of the leaf surface are used here solely for identification purposes. Together with the character 'overall appearance', this character is very useful in the identification of mesemb genera. The surface of the plant is the interface between the plant body (including its photosynthetic parts) and the environment. In plants that are exposed to extreme environmental conditions, such as aridity and/or salinity, the leaf surface plays an extremely important role in survival. In harsh arid and semi-arid environments, specialization of the leaf surface may be regarded as having adaptive significance although experimentation does not necessarily show this. In a study of epidermis structure and its significance for the optical properties of leaves, Tanner & Eller (1986) found that the different epidermal structures influence the absorption of solar radiation only to a very small degree. In Mesembryanthemaceae an array of epidermal types occur and these have been investigated in detail, using modern techniques (Dupont 1968; Ihlenfeldt & Hartmann 1982; Ihlenfeldt 1983; Niesler 1997a).

In some arid-adapted plants, an unusual phenomenon occurs: plants have developed a specialized epidermis that produces a sticky fluid from glandular tissue. This enables species that possess this feature to fix a protective layer of sand grains on parts of their surface until leaves become covered with sand or dust with age. Leaf surfaces that are **sticky, with sand adhering**, termed psammophorous, are thought to have evolved in response to habitats that experience the high impact from wind-blown sands (Jürgens 1996). This character occurs in species of *Psammmophora* (4 species) and in *Arenifera pillansii*. It also shows convergence with the monocots *Chlorophytum viscosum*, *Trachyandra divaricata* and *Ornithogalum psammophorum* (Jürgens 1996). The occurrence in sandblasted habitats of psammophorous species

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

may not be the only explanation for this phenomenon. A sand-covered epidermis may have a protective function, providing a shield against the high levels of UV-B radiation. Musil & Wand (1999) found that critical UV-B zones in southern Africa include mainly mountainous areas in the northern and northeastern regions of the Fynbos biome, and areas with reduced winter precipitation in the northern and eastern regions of the Succulent Karoo. The sticky liquid exuded by the epidermis of psammophorous species may be a sort of varnish to protect leaves from strong light. Benefits such as mimicry of substrate, protection from light and/or deterrence of herbivores may be incidental effects or exaptations *sensu* Gould & Vrba (1982).

Although most mesembs have waxy substances on the epidermis, this character is included only to describe plants with an extremely waxy appearance. Many mesemb species have waxy surfaces, although it is not very apparent, undermining the value of this character in identification. **Distinctly waxy** leaves with wax platelets that are easily seen, and can be rubbed off are found in *Prenia sladeniana,* and some species of *Malephora* and *Brianhuntleya intrusa.*

Visible bladder cells, glistening and shiny in the light are termed idioblasts and may reach more than 10 000X the volume of ordinary epidermal cells, changing shape according to water supply. Idioblasts may be sculptured with dome-like structures (*Aptenia*), hair-like papillae (*Jacobsenia*), or may have single elongated hair-like papillae (*Drosanthemum*) or paired hair-like papillae (*Trichodiadema).* The elaborations of these bladder cells may serve in the harvesting of water. This character is discussed in more detail below (Character 10: State 0).

Xeromorphic bladder cells, hard water cells (10x lens) are visible in the genera *Aspazoma, Brownanthus, Delosperma, Drosanthemum, Ectotropis, Frithia, Phyllobolus* and *Psilocaulon.* **Elongated, hair-like bladder cells** occur in *Brownanthus, Drosanthemum* and *Psilocaulon.* In *Brownanthus ciliatus* and *B. marlothii,* these form a fringe of hairs around the nodes. **Smooth and untextured** succulent leaves occur in many mesembs, notably in the tufted mesembs of the Fynbos genus *Machairophyllum* (Kurzweil & Chesselet 2003).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Pellucid dots (subepidermal tannin idioblasts) are visible to the naked eye as they exceed the surrounding cells in size. Pellucid dots are subepidermal tannin-containing cells or idioblasts that are lodged in the assimilating tissue. Their contents are translucent in the fresh leaf and they lie close to the surface. They are characteristic of the genera *Khadia* (Chesselet *et al.* 1998), *Hereroa* and *Pleiospilos.* The function of these enlarged cells containing proanthocyanidins is not known. In grasses, tannin-containing cells are thought to function in protection from high levels of UV radiation, and may function in anti-herbivory defences (Chesselet *et al.* 1992). In the mesembs, however, the presence of these cells is a taxonomic character at genus level.

Some mesemb have leaves that are **papillate, and rough to the touch** due to the presence of microscopic rounded bumps or projections. Such papillate leaves occur in heterophyllous species of *Antimima* as well in the mostly arid species in *Astridia*, *Cheiridopsis*, *Dracophilus*, *Eberlanzia*, *Esterhuysenia*, *Hartmanthus*, *Ihlenfeldtia*, *Jacobsenia*, *Juttadinteria*, *Lapidaria*, *Lithops*, *Namibia*, *Phiambolia*, *Ruschianthus*, *Schwantesia* and *Vanheerdea*. Fine sculpturing of the epidermis has been discussed in detail by Ihlenfeldt & Hartmann (1982), and is an adaptation of the epidermis to sometimes extremely arid conditions.

Leaf surfaces are **velvety, from soft hairs** in some species of *Braunsia*, *Cheiridopsis*, *Conophytum*, *Deilanthe*, *Gibbaeum*, *Muiria* and *Odontophorus*. In these taxa, hairs are seen under a 10x lens and the leaves have a velvety appearance. Presumably such hairs create additional protection and a moist micro-climate in a desiccating environment. In the angiosperms, many plants with dorsiventral leaves have their lower surfaces protected by hairs. In mesembs, however, the cylindrical shape of leaves does not require differentiation of the upper from the lower surfaces.

Leaves are **echinate, prickly** notably in *Delosperma ecklonis* and *D. echinatum* as well as species of *Drosanthemum*. The function of these prickles is unknown. They appear to have evolved independently in *Delosperma*, *Drosanthemum* and some Crassulaceae species. **Scattered visible hairs** are found in *Carpanthea*

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

pomeridiana and species of *Delosperma* allied to *D. sutherlandii*. In these taxa, leaves are mesophytic and semi-succulent. *C. pomeridiana* occurs in Fynbos whereas the delospermas occur in Mpumalanga, in the northeastern parts of southern Africa.

A number of mostly summer rainfall taxa have leaves that are **rough with white bumps or pustules.** They belong in the genera *Aloinopsis*, *Arenifera*, *Cheiridopsis*, *Faucaria*, *Nananthus*, *Neohenricia*, *Rabiea*, *Rhinephyllum*, *Rhombophyllum*, *Ruschia*, *Sarcozona* (from Australia), *Stomatium*, and most prominently in *Titanopsis*. These bumps and pustules contain calcium oxalate and pigments and play a significant role in the camouflage of these species. The elusive genus *Wooleya* has **woolly** leaves with ridged surfaces. Many of the mimicry plants in Mesembryanthemaceae, such as *Conophytum*, *Dinteranthus*, *Faucaria* and *Lithops*, have highly succulent and often **textured leaves with ridges and markings.**

Character 6: Leaf pair types (KEY)

0. One leaf type only (isophyllous plant) [Fig. 6.1]
1. Differently shaped leaves at different seasons (heterophyllous plant) [Fig. 6.77]
2. Differently shaped leaves on different parts of the plant [Fig. 6.85]
3. Heterophyllous in seedling stages only

The character describing leaf pair types does not represent homologous states and is solely used for identification. Heterophyllous plants are characterized by the development of different leaf-pair types—different kinds of leaf on the same plant. However, most mesembs have **one leaf type only** and plants are **isophyllous.**

Differently shaped leaves at different seasons (heterophyllous plants) are found in *Antimima* subgenus *Microphylla* (Dehn 1988). In this genus, leaves are sharply triquetrous in winter and in early spring when the plant flowers. In the dry season, this set of leaves is replaced by smaller; more rounded micro-papillate (highly textured) leaves that better survive the harsh conditions of summer aridity and high insolation. Different leaf types often differ in their epidermal sculpturing including, papillae, toothed edges and so forth. The heterophyllous species of *Antimima* are often found at high altitudes in the Cape Mountains. Great confusion can arise when trying to identify them as plants collected at different times of the year can look quite

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

different, and type specimens are not necessarily inclusive of both summer and winter growth. The phenomenon of heterophylly is poorly understood in terms of ecophysiology and plant structural-functional relationships (Chesselet & Smith 2001). Seasonal leaf dimorphism (heterophylly) occurs in diverse genera including *Antimima, Cheiridopsis*, *Dicrocaulon*, *Diplosoma*, *Meyerophytum*, *Mitrophyllum*, *Monilaria* and *Oophytum*. The character describing heterophylly cannot be coded as a binary character as it is convergent, having arisen independently several times in Mesembryanthemaceae. It appears to be driven by factors relating to seasonality of climatic variables. The dead leaf pair from the previous season acts as a protective sheath around new growth, or still dormant primordia. The character, **differently shaped leaves on different parts of the plant,** is not equivalent to (seasonal) heterophylly. This condition can be observed in the genera *Octopoma*, *Ottosonderia* and *Vanzijlia*. In *Octopoma* and *Ottosonderia*, plants have normal tufted growth below, with flowering branches arising above the plants and different leaves subtending these inflorescences. This unusual arrangement is discussed by Chesselet *et al.* (2000c). The genus *Jacobsenia* is **heterophyllous in seedling stages only**, suggesting, from an ontogenetic perspective that heterophylly, strictly within Mitrophyllinae, is the primitive condition (sympleisiomorphic).

Character 7: Leaf sheaths (KEY)

0. Absent
1. Old leaf sheaths persistent, papery or parchment-like [Fig. 6.33]
2. Leaves, enclosed by brown to black sclerotic sheaths [Fig. 6.39]
3. Internodes enclosed by sclerotic bases of old leaf sheaths [Fig. 6.77]

The presence of leaf sheaths is often linked to heterophylly. The sheath is the portion of a leaf that partially surrounds another organ, as a leaf base can surround a stem. In most mesemb species such specialized sheaths are **absent**.

Old leaf sheaths are **persistent, papery or parchment-like** in the genera *Antimima*, *Cheiridopsis*, *Conophytum*, *Dactylopsis*, *Dicrocaulon*, *Diplosoma*, *Hammeria*, *Lithops*, *Meyerophytum*, *Mitrophyllum*, *Muiria* and *Oophytum*. Leaves are **enclosed by brown to black sclerotic sheaths** in *Diplosoma*. **Internodes** are **enclosed by sclerotic bases of old leaf sheaths** in *Monilaria*. In some *Brownanthus*

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

species, the remains of leaf sheaths form a fringe of hairs around each node (Character 5.2.3 – 6(5): Stem surface texture or ornamentation- with a fringe of hair at nodes).

Character 8: Leaf tips (KEY)

0. Pointed or rounded [Fig. 6.72; Fig. 6.5]
1. Distinctly apiculate or mucronate [Fig. 6.16]
2. Tipped with diadem of hairs [Fig. 6.119]
3. Windowed [Fig. 6.51]

The usefulness of this character is limited despite the large variation in the tips of mesemb leaves. However, some leaf tip characters are diagnostic at genus level and have therefore been included in the key. In most mesembs leaf tips may be **pointed** or **rounded** in outline. Pointed tips are usually associated with trigonous or triquetrous leaves and rounded tips with cylindrical leaves. Distinctly **apiculate or mucronate** leaves are known from several genera, notably from *Braunsia*, and the winter leaves of heterophyllous species of *Antimima*. These types are not very useful for identification and do not provide distinction among genera. It is difficult to draw the distinction between pointed leaves and mucronate leaves, for example, due to the intermediate conditions.

The leaves of *Trichodiadema* are thought to be diagnostic for the genus as they are **tipped with diadem of hairs**. This stellate or star-shaped arrangement of hairs has several to many hairs radiating from the base. Such diadems are found in tips of sepals too. They may function in harvesting moisture, and their structure has taxonomic value in distinguishing species (Niesler 1997b; Hartmann & Niesler 2003).

The **windowed** leaves of many stone plants have fascinated botanists and collectors alike. They are associated with an almost subterranean habit although not all sunken plants develop windows and not all species with apical windows have sunken growth forms. The minute window plant *Frithia*, through the shrinking of water-filled cells, pulls itself back into the ground during the dry winter conditions of the Highveld. Popular thinking is that windows function as lenses in the harvesting of light. However, Egbert & Martin (2000) have shown that light penetration via windows does not increase photosynthesis. Windowed leaves are highly succulent

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

with flatted transparent tips. Water parenchyma (water storage tissue) comes into direct contact with the epidermis (Hammer & Hartmann, 1990). The chloroplasts that cause the dark green colour and constitute the assimilation tissue, as well as stomata that serve in gas exchange, are lacking from windowed parts of the leaf (Hartmann 1982; Rauh 1974). There is variation in the appearance of windows depending on the distribution of assimilation tissue in the leaf tips and in the sizes of the translucent areas. Micro-windows are thought to be aggregates of pellucid dots and can be mistaken for windows as in *Lithops fulviceps*, for example (Cole 1988). Windows are often surrounded by surface ornamentation such as papillae and may contain deposits of pigments or calcium oxalate crystals. Their manifestation can be directly influenced by the turgor of the plant (Hammer & Hartmann 1990).

From a developmental perspective, windows are thought to be homologous to pustules. These are swollen, clear parts at the base on the inside of succulent leaf pairs. Hammer & Hartmann (1990) report that Schanderl (1935) was the first to recognize similarities between pustules and windows. He suggested that with a reduction of the free part of the leaf, the pustule situated at the base of this free part would become the window. Hammer & Hartmann (1990) have argued that since pustules are common features in most mesembs (in groups considered as primitive and advanced) the ancestors of *Conophytum* are thought to have possessed pustules. The feature may represent the primitive state from which large windows are derived. In *Conophytum* large windows are not correlated to the sunken habit or a single type of environment as the majority of windowed *Conophytum* species occur in rocky habitats (Hammer & Hartmann 1990). They link the initial development of large windows to improved light harvesting in shady places.

Character 9: Leaf margins and keel (KEY)

0. Small bladder cells at margins
1. Undulated when young
2. Undulated or pinnatifid in adult leaf [Fig. 6.2]
3. Margins ciliate [Fig. 6.19]
4. Serrated margins or keel [Fig. 6.6]
5. Hard teeth or bristles on margins or keel [Fig. 6.50]
6. Keel oblique or twisted [Fig. 6.109]

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Both mesophytic and highly succulent leaves of mesembs may have features on the leaf margins and the keel that are useful in plant identification. **Small bladder cells at leaf margins** occur in the Mesembryanthemoideae genera *Brownanthus* and *Synaptophyllum*.

Leaf margins are **undulated when young** in *Skiatophytum*. **Margins undulated or pinnatifid in adult leaves** are pinnately cleft or lobed half the distance or more to the midrib, but not reaching the midrib. Such undulations of the leaf margin are diagnostic for *Aethephyllum pinnatifidum* and *Cleretum herrei*. These two species belonging in different genera are easily confused in the vegetative stage. *Mesembryanthemum crystallinum* may also have undulated leaf margins. Undulated leaf margins are a feature of the more primitive mesembs in Mesembryanthemoideae and in the annual, semi-succulent Dorotheantheae.

Leaf **margins ciliate** with a fringe of hair at the edges of the leaf is characteristic of *Carpanthea pomeridiana*, of the Apatesieae.

Leaves with **serrated margins or keels**, appearing toothed, are found in most species of *Acrodon*, species in *Antimima* subgenus *Microphylla*, also in *Braunsia*, *Carpobrotus*, *Cephalophyllum*, *Circandra*, *Erepsia*, *Octopoma*, *Polymita*, *Ruschia*, particularly subgenus *Ruschia* (Subgenus *Ruschia*, or 'Uncinata' group), *Sarcozona* and *Zeuktophyllum*. The function of these serrations is unknown but may represent a mechanical form of defence against herbivores.

Hard teeth, or bristles on margins or keel occur in *Acrodon, Aloinopsis, Carruanthus, Chasmatophyllum, Cheiridopsis, Dracophilus, Faucaria, Hammeria, Ihlenfeldtia, Juttadinteria, Octopoma, Odontophorus, Orthopterum, Oscularia, Rhinephyllum, Ruschia, Sarcozona, Schlechteranthus, Schwantesia, Stomatium* and *Vanheerdea*. Toothed leaves appear to have evolved a number of times in Mesembryanthemaceae and are not useful from a systematic point of view. In some species teeth are small and hard, whilst in others they may be long and soft. In

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Faucaria, for example, a genus notable for its teeth, these may function in harvesting moisture, in their comparatively dry, Eastern Cape habitats. These soft teeth do not appear to be a plastic character and are fixed, irrespective of environmental conditions.

In the genera *Bijlia*, *Cerochlamys* and *Glottiphyllum* the leaf **keel** may be **oblique or twisted**. This twisting is characteristic but its significance is obscure and may have to do with the compact packing of leaves in a rosette-like growth form.

Character 10: Epidermis type (PHYLO)

0. Idioblast-type
1. Intermediate
2. Xeromorphic-type

Although many of the vegetative characters discussed so far are not useful from a phylogenetic perspective, some characters of the epidermis appear to be stable and systematically informative. An in-depth systematic and evolutionary study of the epidermis of mesembs was carried out by Dupont (1968). This study was published in French and the importance of her results was not widely publicized. Overviews of mesemb epidermal features are provided by Ihlenfeldt & Hartmann (1982) and Ihlenfeldt (1983). The recently resurrected genus *Corpuscularia*, for example, species of which Dupont (1968) identified as not belonging in *Delosperma* on the grounds of epidermis type, has only recently received attention (Hartmann 2001a).

From a phylogenetic perspective, Bittrich & Struck (1989) interpret the presence of bladder cell idioblasts as the most important synapomorphy for the entire Aizoaceae *sensu stricto* (excluding Molluginaceae) and regard this epidermis type as primitive in mesembs. A simplified interpretation of epidermis types has been plotted on a bubble diagram shown in Fig. 5.2.2.1. Ihlenfeldt & Hartmann (1982) recognize two major types of leaf surfaces in the mesembs: the **idioblast-type** epidermis is thought to have evolved further into the more homogeneous **xeromorphic-type** that is associated with increasing internal water storage tissue. In the idioblast-type epidermis, bladder cells are enlarged and serve as outer water reserves. The

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

possession of such water-filled cells may seem counter-intuitive as plants expose the very water that they treasure. The layer of water-filled cells may act as a barrier to UV radiation, but also, these cells contain a strong saline, osmotically active solution. The increased osmotic potential will hold water more tightly thereby increasing the hydraulic power of roots to suck water from the ground.

In species of *Brownanthus*, these idioblasts possess xeromorphic walls (Jürgens 1986). This idioblast-/xeromorphic-type subdivision is not absolute. A number of soft-leaved genera are assigned the **intermediate** condition that includes soft-leaved mesembs and those with flattened bladder cell idioblasts such as *Lampranthus* and *Erepsia*. (Fig. 5.2.2.1). Species of *Lampranthus* usually have homogeneous mesomorphic leaf surfaces with modest outer cell walls lacking crystal incrustations and with superficial stomata in combination with a central water storage tissue (Klak *et al.* 2003a). In general, the xeromorphic-type with a more homogeneous pattern of epidermal cells prevails in most Ruschioideae (Hartmann 1993).

The xeromorphic-type epidermis generally has thick outer epidermal walls, a thick (epicuticular) wax cover, calcium oxalate incrustations in the outer epidermal walls and stomata that may be sunken or variously hidden (Hartmann 1993). Xeromorphic leaf surfaces are usually homocellular. They are, however, heterocellular and highly sculptured in species of *Namibia*, *Dracophilus*, *Juttadinteria* and *Psammophora* that occur in the very arid parts of southern Africa (Ihlenfeldt & Hartmann 1982).

Characteristic of the xeromorphic-type epidermis is the possession of sunken stomata (Dupont 1968; Hartmann 1993). Stomata are never sunken in the idioblast-type epidermis. In their assessment of character polarities, Bittrich & Struck (1989) conclude that non-sunken stomata are more primitive than sunken ones in Mesembryanthemaceae.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

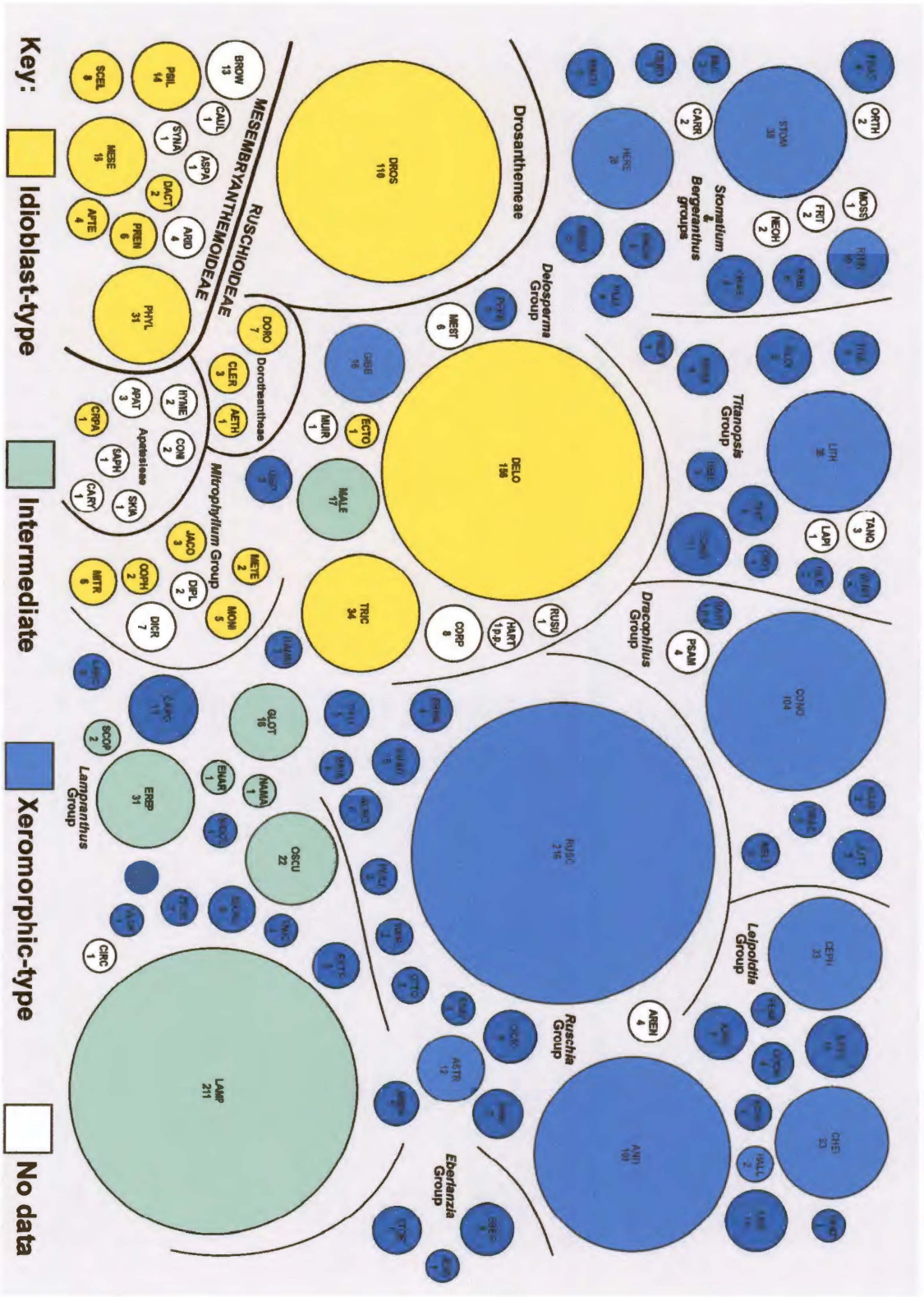


Figure 5.2.2.1. Bubble diagram showing taxonomic distribution of epidermal types in Mesembryanthemaceae.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

The presence of cell inclusions such as tannins and crystals plays a significant part in the functioning of the xeromorphic-type epidermis. Hartmann (1993) reports condensed tannins in xeromorphic members of the Ruschioideae and in some Tetragonioideae. This may indicate convergence. They are absent in most Mesembryanthemoideae and those members of the Ruschioideae with idioblasts on the leaf surface. *Hymenogyne*, in addition to having axile placentation, presents the exception as it is reported to have epidermal tannin idioblasts. The presence of tannins corresponds to the xeromorphic-type of epidermis, and possibly contributes to the evolution of drought-adapted leaf surfaces. Calcium oxalate crystals are found in the outer epidermal walls of all taxa with the xeromorphic-type of epidermis, these crystal layers vary in size from crystal sand to druses (Ötzig 1940; Ihlenfeldt & Hartmann 1982). In Aizoaceae *sensu stricto* (excluding Mesembryanthemaceae) calcium oxalate is present as druse crystals, whereas in the mesembs they form bundles of raphide crystals, thus representing a synapomorphy for the group (Fig. 5.2.4.3). Calcium oxalate is an inert substance, not soluble in water. Crystal raphides represent a more potent anti-herbivore defence mechanism through their ability to penetrate mucous membranes as little 'injection needles'. The damage caused to the mouths of herbivores allows other substances to cause infection. In this way, the switch from druse crystals to crystal raphides represents a passive form of defence without extra structural costs to the plants.

Epidermal characters are closely linked with stomatal characters. In addition to their association with superficial stomata, the combined occurrence of all three stomatal types (anomocytic-anisocytic-paracytic) i.e. the primitive condition for Mesembryanthemaceae (Figure 5.2.2.2), correlates with the taxonomic distribution of the idioblast-type epidermis. In morphological (Chesselet *et al.* 2002) and molecular (Klak *et al.* 2003b) studies, the Mitrophyllinae resolve in tribe Ruschieae. Yet epidermal and stomatal characters of this group are the primitive types (sympleisiomorphic).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Character 11: Stomatal types (PHYLO)

0. Anomocytic-anisocytic-paracytic
1. Anisocytic-paracytic
2. Paracytic

Stomatal types provide useful phylogenetic information for the Mesembryanthemaceae. They appear to be consistent within genera (Dupont 1968) and are conservative characters from a systematic point of view. Data sourced from work by Dupont (1968) is plotted in the bubble diagram presented in Fig. 5.2.2.2. Three stomatal types are found in the Mesembryanthemaceae: anomocytic, anisocytic or paracytic. These may occur in three different combinations: **anomocytic-anisocytic-paracytic**, **anisocytic-paracytic**, and **paracytic** only. Cotyledons always have anomocytic stomata (Dupont 1968), suggesting, from an ontogenetic perspective, that this is the primitive stomatal type. The combination of all three stomatal types is the primitive condition for the mesembs. Only this putatively primitive combination is found in Aizoaceae *sensu stricto* (Bittrich & Struck 1989) thus enabling polarizations of this character using outgroup comparison. This character state (anomocytic-anisocytic-paracytic) is also present in the genera *Delosperma*, *Drosanthemum* and *Trichodiadema*, and those members of the Mitrophyllinae that were investigated. This primitive stomatal condition persists in these taxa as a pleisiomorphic feature. *Glottiphyllum*, which is tentatively placed in the *Mitrophyllum*-Group by Hartmann (1991, 1993) has anisocytic-paracytic stomata supporting its exclusion from this subtribe, based on characters of the epidermis.

The intermediate anisocytic-paracytic stomatal combination occurs in most of the *Stomatium* Group (*Faucaria*, *Stomatium*, *Rabiea* and *Rhinephyllum*) and some members of the *Titanopsis* Group (*Titanopsis*, *Nananthus* and *Aloinopsis*). In the *Leipoldtia* Group, this intermediate condition is found in *Argyroderma* and in *Pleiospilos*. This, together with the possession of pellucid dots, supports the exclusion *Pleiospilos* from the *Leipoldtia* Group of Hartmann (1991, 1993). The intermediate stomatal combination occurs in *Carruanthus* (*Bergeranthus* Group), and in *Erepsia* and *Enarganthe* of the *Lampranthus* Group. Most mesembs have the more advanced paracytic stomatal arrangement only, a requirement for the xeromorphic epidermis.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

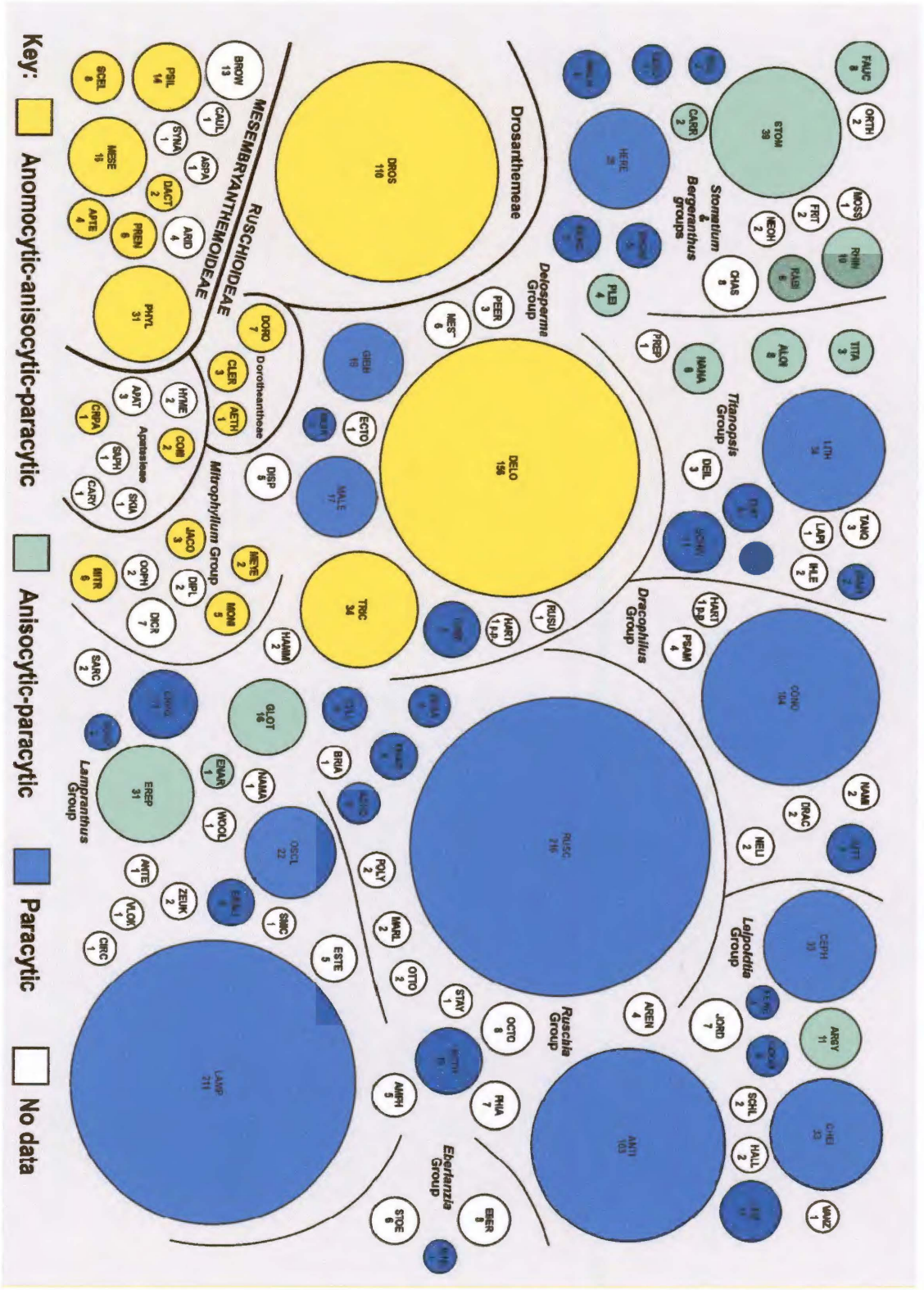


Figure 5.2.2.2. Bubble diagram showing taxonomic distribution of stomatal types in the Mesembryanthemaceae.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Character 12: Leaf persistence on plant (DESC)

0. Leaves not deciduous
1. Leaves deciduous

The persistence of leaves on mesemb plants appears to have a significant ecological role, as well as being a species-specific trait. Some plants drop all their dead leaves, forming leaf litter around the plants (**leaves deciduous**). Others, such as *Ottosonderia monticola*, for example (Chesselet *et al.* 2000c), retain dead leaves on the plant (**not deciduous**). As this character has not been investigated to date, it is included to draw attention to this aspect of mesemb phenology. Jürgens (1990a) views the slow and long-lasting 'death' of a succulent structure (leaf, shoot or stem) as the exploitation of the accumulated water reserves that are stored in these structures. He regards this exploitation as a function, rather than just shedding of parts. It may not always be advantageous to shed leaves due to the associated loss of carbon, but *Psilocaulon*, for example, sheds its tiny leaves, and can probably afford it as they are rudimentary and the plant uses the stem for photosynthesis.

Character 13: Relative length of two leaves forming a pair (DESC)

0. Leaves of a pair equal (isophyllous plant) [Fig. 6.58]
1. Leaves of a pairs of distinctly different lengths (anisophyllous plant) [Fig. 6.53]

The leaf pairs of most mesemb species are more or less of equal length, and plants with **leaves of a pair** that are **equal** are termed **isophyllous**. However, in a number of genera plants are **anisophyllous** with the **leaves of a pair of distinctly different lengths**. In some species of *Gibbaeum* this trait is extreme and diagnostic. The character is not included in the key or in phylogenetic analyses, however, due to the variation in the more or less anisophyllous plants such as *Khadia* for example (Chesselet *et al.* 1998).

5.2.3 Vegetative character set: Stems and branches

Classical morphological characters that define Caryophyllales include the centrospermous embryological syndrome, the betalain pigments (with Caryophyllaceae and Molluginaceae not possessing these) and the sieve-element

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

plastids that have a subperipheral ring of proteinaceous filaments. In addition, both stems and roots exhibit anomalous secondary growth (Behnke & Mabry 1994).

Character 1: Wide band tracheids (PHYLO)

0. Absent
1. Present

In a recent study of stem and leaf anatomical characters of succulent plants in families of the order Caryophyllales, Landrum (2001) discovered 'wide-band tracheids'. These tracheids occur only in leaves and have wide secondary walls hypothesized to prevent cell collapse under water stress. These he found in Cactaceae, Portulacaceae and, in the mesembs, only in subfamily Ruschioideae, but not in the more primitive Apatesieae and Dorotheantheae. The taxonomic distribution of wide-band tracheids is plotted in Figure 5.2.3.1. These specialized conducting cells occur in all other (more advanced) genera of the Ruschioideae except in the genera *Glottiphyllum*, *Erepsia*, *Carpobrotus*, *Conophytum*, *Rabiea*, *Chasmatophyllum* and *Gibbaeum*.

Character 2: Branches (KEY)

0. Procumbent or decumbent or sprawling (not rooting at nodes) [Fig. 6.23]
1. Creeping or saltating (rooting at nodes) [Fig. 6.63]
2. Erect [Fig. 6.48]
3. Climbing

Most mesembs are succulent shrubs and some characteristics of the stems and branches can be useful in identification. These features also determine the overall appearance of the plant. Some taxa root at the nodes and others do not. In *Ruschia*, for example, the subgenera *Tumidula* and *Sarmentosa* can be confused and the presence of roots at the nodes is diagnostic for the distinction between members of these groups (N. Jürgens, pers. comm.). Some mesemb species may be **procumbent or decumbent or sprawling (not rooting at nodes)** whilst others are **creeping or saltating (rooting at nodes)**. Many are **erect**. Some species, such as *Antimima subtruncata*, *A. dekenahii* and others grow under other shrubs and are **climbing** on their branches.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

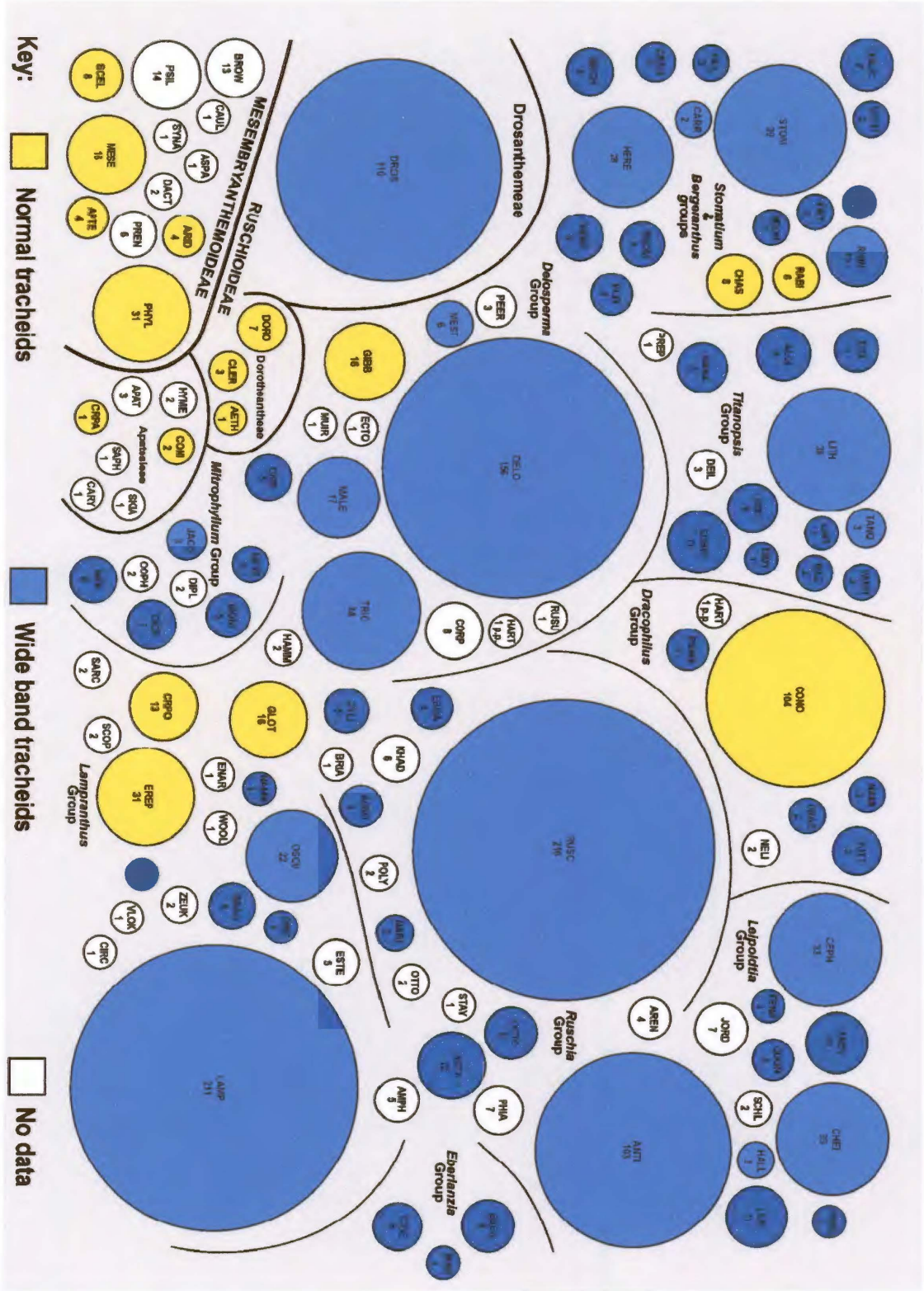


Figure 5.2.3.1. Bubble diagram showing taxonomic distribution of wide band tracheids (data from Landrum 2001).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Character 3: Stem (internodes) (KEY)

0. Visible, internodes easily seen [Fig. 6.47]
1. Visible, but very short, bearing tufts of leaves [Fig. 6.19]
2. Present, but hidden by highly fused sheathing leaves [Fig. 6.95]
3. Visible, very short, hidden by densely packed leaves along branches [Fig. 6.31]
4. Not visible (internodes abbreviated or hidden) [Fig. 6.94]

The variation in growth habit of mesembs is largely determined by the presence, reduction or seeming absence of internodes. Most mesembs have **visible internodes** that are easily seen. In some genera stems are **visible, but very short, bearing a tuft of leaves.** In still others, they are **present, but hidden by highly fused sheathing leaves**. Internodes may also be **visible, very short, hidden by densely packed leaves along branches.** Stems that are **not visible (internodes abbreviated)** are associated with the phenomenon of ontogenetic abbreviation, or neoteny, which characterizes the stone plants. In this growth form the adult plant resembles the seedling, and plants often have no stems or internodes visible. In others, internodes are reduced in length and tufted growth forms result. In others, internodes are hidden by sheathing leaves that may, or may not, be shed. In the majority, however, stems and internodes are visible, accounting for the shrubby appearance of this unique succulent growth form.

Character 4: Stem consistency (KEY)

0. Fleshy (soft) [Fig. 6.8]
1. Succulent (hard) [Fig. 6.18]
2. Spongy or corky [Fig. 6.63]
3. Woody [Fig. 6.103]

The consistency of stems is linked to the colouring and shape. Stems may be **fleshy (soft), succulent (hard), spongy or corky** as in *Jordaaniella*, notably in *J. spongiosum*. **Woody**-stemmed succulent shrubs are widespread in the shrubby genera such as *Drosanthemum* and *Ruschia*.

Character 5: Stem shape (KEY)

0. 4-angled [Fig. 6.8]
1. Winged [Fig. 6.73]
2. Cylindrical [Fig. 6.114]
3. Articulated, beaded [Fig. 6.77]

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

The shape of stems can be diagnostic, although it is the exception rather than the norm. In cross-section, stems may be **4-angled** in e.g. *Aptenia haeckeliana*, or **winged** in e.g. *Mesembryanthemum crystallinum*. Most mesemb species have **cylindrical** stems. **Articulated**, or **beaded** stems are characteristic of species of the 'bead-leaves mesembs' such as those in the genus *Monilaria*.

Character 6: Stem surface texture and ornamentation (KEY)

0. Papillate with large easily visible water cells [Fig. 6.28]
1. Xeromorphic water cells [Fig. 6.18]
2. Hairy [Fig. 6.43]
3. Papillate in young stems [Fig. 6.43]
4. Smooth [Fig. 6.66]
5. Fringe of hair at nodes [Fig. 6.18]

The surface texture of stems can be useful in identification. Most semi-succulents belonging in the Mesembryanthemoideae, Apatesieae and Dorotheantheae have stems that are **papillate with large easily visible, glistening water cells**. Stem succulents in the genera *Brownanthus* and *Psilocaulon* have hard **xeromorphic water cells** on their surfaces that are diagnostic in species identification (Klak & Linder 1998; Smith *et al.* 1998; Klak 1999). In the genera *Delosperma*, *Drosanthemum* and *Carpanthea*, stems may appear **hairy** from elongated papillae. In some species of *Drosanthemum*, stems may only be **papillate when young**, loosing their hairs with age. Most species of Ruschioideae have **smooth** stems. The most unusual stems are found in the stem succulents *Brownanthus ciliatus* and *B. marlothii* that have a **fringe of hair at each node**.

Character 7: Stem colour at maturity (KEY)

0. Greenish [Fig. 6.8]
1. Yellowish [Fig. 6.63]
2. Brown [Fig. 6.103]
3. Whitish or grey [Fig. 6.4]
4. Bluish green [Fig. 6.110]
5. Reddish [Fig. 6.66]

Stem colour at maturity is mostly difficult to categorize and is not very useful for identification. Some taxa, however, have distinctive stem colouring. Many of the semi-succulent mesembs have **greenish** stems, corresponding to herbaceous growth forms. Stems are characteristically **yellowish** and somewhat spongy in species of

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Jordaaniella and in *Acrodon purpureostyla*. Many of the Nama-Karoo subshrubs belonging in the genus *Drosanthemum*, such as *D. lique*, and *Ruschia* e.g. *R. robusta*, have shiny **brown** stems. **Whitish or grey** stems are characteristic of *Amphibolia* species. **Bluish green** stems characterize *Scopelogena* species and **reddish** stems characterize many species in *Lampranthus*, for example.

5.2.4 Reproductive character set: Flowering, inflorescence & flowers

Characters belonging to this set describe the flowering parts of mesembs: the presentation of flowers, the branching of inflorescences and floral features. In arid habitats, succulents generally invest highly in their floral displays (Ihlenfeldt 1989). It is upon flowers, and their presentation, that pollination has acted as a selective force. In mesembs, they are brightly pigmented, produce nectar and synchronize their opening hours for specific times of day or night. Although pollinators include bees, butterflies, moths and wasps (Vogel 1954; Gess & Gess 1989; Hartmann, 1991; Ihlenfeldt 1994), not much is known of their pollination biology. Different floral syndromes have evolved in mesembs. Factors such as opening time, production of attractants including scent and nectar, petals and their pigmentation all contribute to particular pollination syndromes.

Character 1: Inflorescence characteristics (KEY)

0. Leafy inflorescences [Fig. 6.8]
1. Cymose, mostly solitary (difficult to separate from strictly solitary) [Fig. 6.103]
2. Paired, two flowers produced simultaneously on either side of plant body [Fig. 6.37]
3. Cymose, mostly in threes [Fig. 6.102]
4. Angular cyme [Fig. 6.11]
5. Many-flowered dichasia or compound cymes [Fig. 6.44]
6. Succulent cymose inflorescence (persistent, highly succulent) [Fig. 6.90]
7. Candelabra
8. Spiny inflorescences [Fig. 6.103]

Inflorescences in the mesembs follow the simple pattern found in the Aizoaceae and most centrosperms (Hartmann 1991). The pattern is mostly dichasial or cymose, or according to the typification system of Troll & Weberling (1981) 'monotelic synflorescences with thyrsiform mode of ramification'. Such inflorescences are also typical of the anthocyanin-producing families Molluginaceae and Caryophyllaceae, and it seems likely that this type is primitive in the order

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Caryophyllales (Bittrich & Struck 1989). It is noteworthy that subfamily Tetragonioideae is not characterized by dichasial monotelic cymes.

Leafy inflorescences occur in more primitive genera e.g. *Mesembryanthemum*. The predominance of large frondose bracts in Aizooideae, Tetragonioideae and Mesembryanthemoideae often make it difficult to discriminate between the vegetative shoot and the inflorescence in these subfamilies. With few exceptions (Ihlenfeldt 1960; Troll & Weberling 1981; Poppendieck 1976; Liede & Hammer 1990; Hartmann & Stüber 1993; Rust *et al.* 2002), inflorescence morphology in the mesembs has not as yet been investigated in detail, and no morphologically-based system of inflorescence classification applies to the group as a whole.

In the **cymose, mostly solitary** inflorescence type, flowers occur singly and are not usually in a cluster or group. See for example *Acrodon*, which has mostly solitary flowers and may develop a cymose inflorescence. It is difficult to distinguish strictly solitary inflorescences in mesembs. A reduction to solitary flowers in the lateral or terminal position occurs in both Aizoaceae *sensu stricto* and Mesembryanthemaceae (Bittrich & Struck 1989). Hartmann (1993) interprets uniflory as the result of reduction in branching. Solitary flowers are widespread in the highly succulent Ruschioideae where the terminal flower only is retained. Solitary flowers are associated with the creeping habit in *Carpobrotus*, *Drosanthemum*, *Lampranthus*, *Chasmatophyllum* and *Khadia borealis*, as well as in certain subgeneric groups in *Ruschia*. Flowers are often solitary in tufted genera such as *Khadia* (Chesselet *et al.* 1998). Some species of *Hereroa* have solitary flowers.

The **angular cyme** of *Aridaria* is characteristic of this genus providing an easy way to identify its species. **Many-flowered dichasia or compound cymes** display complex branching arising from modular additions on a basically cymose pattern. The names of species such as *Ruschia umbellata*, *R. multiflora*, and '*Ruschia milleflora*', currently sunk under *Eberlanzia dichotoma*, suggest that branching patterns of the inflorescence characterize the species. Inflorescences commonly show varying degrees of elaboration. Generally a common ground-plan runs through such

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

inflorescences, but they differ in the degree of branching and/ or in the number of internodes or their elongation, so that different terms apply to such variously elaborated inflorescences. Highly branched inflorescences seem to have evolved a number of times in the evolution of Mesembryanthemaceae and are found in the genera *Eberlanzia*, *Leipoldtia*, *Mesembryanthemum*, *Mestoklema*, *Oscularia*, *Prenia*, *Ruschia*, *Ruschianthemum*, *Scopelogena*, *Stayneria*, *Stoeberia* and *Synaptophyllum*.

The **succulent cymose inflorescence**, unique to *Ottosonderia monticola,* has been described by Chesselet *et al.* (2000c). Succulent bract-like structures subtend the flowers. The **candelabra**-type inflorescence is rare in the mesembs. It is characterized by an apparent loss of bracts on the pedicels. The bunched pedicels appear in single double tiers. 'Ruschia candelabra' was originally used as a field name for *Eberlanzia ebracteata* by researchers from the University of Cologne, Germany. The loss of bracts, and a candelabra-like inflorescence also characterize *Ruschia elineata*. **Spiny inflorescences** are known from *Phyllobolus roseus*, and some species of *Antimima*, *Ruschia*, *Leipoldtia* and *Arenifera*.

Character 2: Pedicel length (KEY)

0. Flower subtended by long pedicel [Fig. 6.7]
1. Flower subtended by short pedicel [Fig. 6.60]
2. Flower sessile or sub-sessile [Fig. 6.124]

The length of the pedicel can be useful in the identification of mesembs. Pedicels are coded as **long** or **short** despite intermediates, or seemingly absent, in which case, flowers are **sessile or sub-sessile**.

Character 3: Pedicel shape and behaviour (DESC)

0. Pedicel upright, long-lived and woody [Fig. 6.1]
1. Pedicel bending after flowering, capsule lies on ground [Fig. 6.24]
2. Pedicel S-shaped (sigmoid) [Fig. 6.51]
3. Pedicel from which capsule breaks off after ripening leaving a prickly star (sclerotinized bases of 5 bundles)
4. Pedicel succulent, drying out and breaking when fruit is ripe [Fig. 6.17]

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

The pedicel is involved in flower and fruit presentation, and has different shapes. Pedicels may be long-lived and woody, soft and S-shaped (sigmoid), bend after flowering, curl down to reach the ground after pollination, or the capsule may break off after ripening leaving a prickly star: the sclerotinized bases of 5 vascular bundles of the pedicel. This occurs across many taxa and the dispersal of entire fruit shed from pedicels is probably underestimated when considering mesemb dispersal modes.

Character 4: Bracts (KEY)

0. Present, 1 pair [Fig. 6.14]
1. Present, 2 pairs
2. Absent

Bracts are leaf-like structures that differ in form from the foliage leaves. They do not contain an axillary bud and are associated with an inflorescence or a flower. Bracteoles are small bract-like structures borne singly or in pairs on the pedicel or below the calyx of a flower. The terms bract and bracteole have been applied inconsistently to bract-like structures that are not always equivalent. They are relative terms, and neither are they in every case clearly distinguishable. Bracts may be present as a single pair or in the case of *Carruanthus* two pairs of bracts are situated sequentially along the pedicel. Bracts may be absent. These characters are helpful in the identification of some genera.

Character 5: Flowering time (seasonal) (KEY)

0. Winter
1. Spring
2. Summer
3. Autumn

A short but copious flower display is characteristic of many arid and semi-arid regions. In Namaqualand, blooming on a massive scale is a draw-card for ecotourism. Succulents flower most prolifically in dry years in contrast to non-succulent shrubs that produce greater numbers of flowers in wetter years (Struck 1994). In one of the few phenological studies of flowering in mesembs, Struck (1994) found that taxonomically related species usually flower sequentially with their flowering periods slightly overlapping e.g. in *Ruschia*. He infers that timing of flowering is indirectly

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

determined by the first considerable drop in air temperatures in autumn and/or by the increase of temperatures at the beginning of spring. Flowering of individual species and number of blossoms produced is greatly influenced by the pattern and amount of seasonal precipitation. Mesembs optimize their reproductive output by mass flowering for short periods with good synchronization within populations. In the key, flowering times have been separated into the four seasons: **Winter, spring, summer, autumn.** Most mesembs flower in springtime, but genera such as *Erepsia* characteristically flower in January and February, in which case season of flowering is useful in generic identification.

Character 6: Diurnal floral rhythm (KEY)

0. Opening in sunshine, midday, or in the afternoon
1. Opening in the evening or at night [Fig. 6.84]
2. Continuously open [Fig. 6.44]

The mesembs are widely known as 'midday flowers, reflecting the original name *Mesembrianthemum,* proposed by Breyne in 1689, and attributable to the opening of flowers around noon. Flowers of many mesembs open for limited periods during the day and the majority of mesemb flowers can be described as **opening in sunshine, midday, or in the afternoon**. Limited opening of flowers, it seems, prevents excessive water loss to a hot, dry and sometimes windy environment.

Diurnal floral rhythms also play a significant role in plant-animal interactions and pollination behaviour. Moth-pollinated mesemb flowers have evolved floral syndromes that include **opening in the evening or at night.** Such crepuscular or nocturnal mesemb flowers often have long stigmas, and yellow petals as for example the yellow-petalled species of the *Bergeranthus* Group, such as *Hereroa*, for example. Flowers open at dusk, produce scent and are pollinated by small moths (pers. obs.). Some white-petalled *Conophytum* species are nocturnal, as is *Aridaria noctiflora* in Mesembryanthemoideae. The limited opening of flowers to dusk and night time may further serve to reduce water loss in addition to attracting moths.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

In rare instances mesemb flowers remain **continuously open**, such as in *Erepsia inclaudens* as the name suggests and in species of *Nelia.* Flowers of both *Antimima pilosula* and *Eberlanzia gravida* remain continuously open and these two species may be co-generic. Their close alliance was suggested by Bolus (1929). The inclusion of *Ruschia gravida* L.Bolus into *Eberlanzia* Hartmann (1998b) is not supported here, and their floral behaviour may support this.

Character 7: Flower colour (KEY)

0. Cream, yellowish [Fig. 6.107]
1. Greenish [Fig. 6.93]
2. White [Fig. 6.64]
3. Pale pink [Fig. 6.42]
4. Pink with stripe [Fig. 6.1]
5. Pink [Fig. 6.6]
6. Orange [Fig. 6.66]
7. Magenta [Fig. 6.5]
8. Red [Fig. 6.13]
9. Yellow [Fig. 6.26]
10. Yellowish-orange with stripe [Fig. 6.82]
11. Copper-coloured [Fig. 6.74]
12. Multi-coloured [Fig. 6.41]
13. Bicoloured, pink or magenta and white [Fig. 6.52]

The most striking features distinguishing mesembs from aizoaceous taxa, in addition to the extreme succulence of some taxa, are bright petals and sometimes large flowers. Petals are mostly yellow or magenta with many variations. All Aizoaceae, including mesembs, produce betalains as flower pigments (Bittrich & Struck 1989), a characteristic of Caryophyllales excluding Molluginaceae and Caryophyllaceae (Behnke & Mabry 1994). The presence of betanidin plays an important role in flower colour of mesembs (Strack *et al.* 1990) and flowers showing violet-red colours have betanidin as the dominant pigment. On the other hand, those flowers showing red colours or red-violet colours have betanin as the sole or dominant pigment. In members of the Lampranthinae these pigments are often accompanied by appreciable amounts of Lampranthin-II.

A thin-layer electrophoretic survey by Reznik *et al.* (1988) of yellow floral tissue showed the presence of betaxanthins and betalamic acid. Dopaxanthin and betalamic acid are the yellow pigments found in petal extracts. They interpret Dopaxanthin as a major chemical marker for subfamily Ruschioideae.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

In *Conophytum*, petals comprise the entire range of colours found in mesembs, except for greenish and pure scarlet (Liede & Hammer 1990). They are either uniformly-coloured, bicoloured or very rarely striped. Filamentous staminodes either match petal colour or contrast it. Similarly, *Dorotheanthus* species show great variation in flower colour (Fig. 6.41). In a long-term study of flower colour polymorphism in the desert annual *Linanthus parryae*, Schemske & Bierzychudek (2001) found that colour is subject to selection that varies in both time and space in its direction and magnitude. They found differences in fitness between colour morphs and significant differences in seed production. At their study site in the Mojave Desert, blue-flowered plants typically had a fitness advantage in years of low spring precipitation, whereas white-flowered plants had a fitness advantage in years of high spring precipitation. They conclude that this temporal variation in selection may contribute to the maintenance of the flower-colour polymorphism. Similar dominance of colour morphs at different times have been observed for *Dorotheanthus* species in Namaqualand (A. le Roux, pers. comm.), but no such long term studies have been conducted for the mesembs.

Character 8: Flower size (KEY)

0. Small (<20 mm) [Fig. 6.114]
1. Medium (20–40 mm) [Fig. 6.45]
2. Large (>40 mm) [Fig. 6.47]

Mesemb flowers have been categorized as **small** (<20 mm), **medium** (20–40 mm) or **large** (>40 mm), based on flower diameter. The size of mesemb flowers relates closely to whether inflorescences bear solitary or numerous flowers. Solitary flowers are mostly larger than those borne on highly branched inflorescences. Allometric relationships such as these depend on pollination mechanisms and other factors such as growth form and inflorescence characters, which may be advantageous under different circumstances. Measurement data is not particularly useful since the protandrous flowers of mesembs (Hartmann 1991) show growth of floral parts during anthesis.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Character 9: Number of sepals (DESC)

0. 4 [Fig. 6.117]
1. 5 [Fig. 6.42]
2. 6 [Fig. 6.37]
3. 7 [Fig. 6.94]
4. 8
5. 9 or more [Fig. 6.38]

The number of sepals may be useful in identification of certain genera. Sepal data was analyzed by Chesselet *et al.* (2002) who related merosity of the gynoecium to numbers of sepals in mesemb genera. In certain genera with mutilocular fruit such as *Gibbaeum*, and other genera with 6 – 9 locules have 6 – to 9 sepals. The number of meronectary segments also corresponds with sepal number. Sepals function in sheathing the flower bud, and often sepals have membranous margins for additional protection from light, heat or physical damage. In the outgroup Aizoaceae *sensu stricto* (excluding Mesembryanthemaceae), sepals are petaloid on the inside.

Character 10: Relative length of sepals (DESC)

0. Unequal in length [Fig. 6.111]
1. Almost equal in length [Fig. 6.81]

Sepals distinctly **unequal** or **almost equal** in length, with 2 or 3 longer sepals are found in the more primitive ruschioid genera belonging to tribes Apatesieae and Drosanthemeae. In species of *Delosperma,* sepals may be very long, often with 2 or 3 longer sepals extending further than the others. In the more succulent taxa, sepals are mostly of equal length.

Character 11: Position of the ovary (KEY; PHYLO)

0. Half-inferior [Fig. 6.12]
1. Inferior [Fig. 6.79]

The position of the ovary is one of the more significant characters distinguishing Mesembryanthemaceae from its sister taxa in Aizoaceae. The septate ovary is nearly superior in subfamilies Aizooideae and Sesuvioideae. In Tetragonioideae, the ovary may be half-inferior or inferior with a single, pendulous ovule and the similarity to mesembs in ovary displacement towards inferior, is

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

considered parallelism by Bittrich & Hartmann (1988). In Mesembryanthemoideae the ovary is **half-inferior** (semi-epigyny) and in Ruschioideae it is **inferior** (epigyny). Bittrich & Struck (1989) interpret the half-inferior ovary of Mesembryanthemoideae as more primitive than the completely inferior ovary of the Ruschioideae. The inferior position of mesemb fruit has enabled the development of fruit capsules with deep and often complex bases, enabling a diversification of rain-driven dispersal of seed.

Character 12: Hypanthium (DESC)
0. Absent [Fig. 6.117]
1. Present [Fig. 6.10]

In some epigynous flowers such as in the genera *Argyroderma* and *Erepsia*, *Carpobrotus*, *Rabiea* and *Stomatium* a weak **hypanthium** may develop (Hartmann 1993). This shallow cup-shaped structure may serve in pollination biology enabling a microclimate to develop in those flowers with a tubular aggregation of filaments and petaloid staminodes, enclosing the pollen, stigmas and nectaries. The protection of liquid nectar may be a significant aspect of specialized pollination interactions in a desiccating environment. In *Stomatium*, nectar forms a large droplet in five places along the inner walls of the hypanthium. *Erepsia* species are characterized by filaments growing down into the hypanthium, thus presenting anthers by curling upwards at the centre of the flower. In *Argyroderma*, the hypanthium is associated with stigmata that are fused into a disc (Fig. 6.10). In *Erepsia* and *Carpobrotus*, the hypanthium may indicate phylogenetic affinity, and in the genera *Stomatium* and *Rabiea*, the presence of the hypanthium may show a close relationship between these two genera. Although possibly indicating affinity between these two genera, the character may have arisen independantly. The hypanthium may have evolved a number of times in the mesemb lineage and is therefore a convergent character with limited phylogenetic significance.

Character 13: Placentation (KEY; PHYLO)
0. Axile [Fig. 6.116]
1. 'Basal' or parietal [Fig. 6.56]

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

The fundamental distinction between mesembs with axile placentae (Mesembryanthemoideae) and those with basal or parietal placentae (Ruschioideae) was first noted by Brown (1925). The arrangement of the placentae is a significant character at family and subfamily level, distinguishing major groups in Aizoaceae *sensu stricto*. The placenta is the portion of the ovary bearing ovules and later, the seeds. the transition from the half-inferior ovary of the Mesembryanthemoideae to the inferior one in Ruschioideae is coupled with the movement of the placentae from the axis to the bottom and the sides of the fruit, and the transition from the 'koilomorphic', shell-shaped, hollowed out nectarines of Mesembryanthemoideae to those of ruschioid taxa that occur in a ring above the ovary, with bumps and projections of nectariferous, glandular tissue. These represent major changes in the structure of mesemb reproductive parts that resulted in the co-evolvolution of mesemb flowers with insect pollinators. These fundamental changes in the gynoecium structure, particularly in Ruschioideae, had major effects on the morphological potential of mesemb fruit—the deep base (inferior ovary), the potential for a multiplication in the number of parts (merosity), and septate nature of the gynoecium (loculicidal) together with specialized opening mechanisms of the cell lids promoted diversification of hygrochastic fruit in response to different kinds of rain: winter, summer, fog, drizzle, sporadic rains, soft rains, hard rains, etc.

In Mesembryanthemaceae placentation is **axile**, or after ontogenetic displacement, **'basal'** or **parietal** (Payer 1857; Eichler 1878; Bittrich & Struck 1989). The latter type has also been named pseudo-parietal (e.g. Straka 1955) in order to delimit this type terminologically from parietal placentation in paracarpous ovaries (ovaries whose carpels are joined together by the margins only). Axile placentation is found in the Aizoaceae *sensu stricto* as well as in subfamily Mesembryanthemoideae and is considered to be the primitive condition. Basal or parietal placentation represents a major synapomorphy for the Ruschioideae. However, in Apatesieae two genera have axile placentae: *Caryotophora* and *Hymenogyne*. This may represent a reversal due to the unique seed dispersal mechanism in these genera. In the schizocarpic fruit of *Hymenogyne* each seed, with a wing-like membrane, disperses in the wind from an axile attachment. In *Caryotophora*, single seeds are embedded in woody nut-like fruit. The Apatesieae show a variety of degrees and modes of

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

schizocarpy. The embedding of some seeds deep in the woody walls of *Conicosia* fruit, for example, requires specialized placentae. In the Drosanthemeae, seed chambers at the base of the fruit are widespread. Such seed caches are also found in *Disphyma*. In the more advanced ruschioid taxa, locules containing single seeds in a nut-like fruit are found in *Stoeberia gigas* (Chesselet & Van Wyk 2002). In Mesembryanthemoideae, nuts with one or two large seeds per locule are known from *Brownanthus nucifer*. The arid environment of the Richtersveld may have provided the prime selective pressure for convergent evolution of this type of fruit across the two subfamilies.

Character 14: Development of petals (petaloid staminodes) (PHYLO)
0. Petals absent, sepals petaloid inside
1. Petals present, of staminodial origin [Fig. 6.2]

In contrast to aizoaceous taxa with **sepals** that are **petaloid on the inside** (internally petaloid and externally sepaloid), mesembs evolved **petals of** a **staminodial origin** (Ihlenfeldt 1960). These are often bright-coloured, shiny and numerous. They attract a range of specialized insect pollinators, including bees, butterflies, moths and wasps (Vogel, 1954; Gess & Gess, 1989). The presence of petaloid staminodes is one of the characters that define the Mesembryanthemaceae (Bittrich & Struck 1989), and represents a major evolutionary innovation contributing to the success of this group. Bittrich & Struck (1989) view the possession of (petaloid) staminodes as the most important character distinguishing Mesembryanthemaceae from Aizoaceae *sensu stricto* from which they are absent. Mesemb flowers differ significantly from those of their relatives in the Aizoaceae. A number of synapomorphies for family Mesembryanthemaceae (e.g. multilocularity, floral nectary structure and placentation), are linked to these differences.

Character 15: Filamentous staminodes (KEY; PHYLO-UM)
0. Present, spreading [Fig. 6.32]
1. Present, gathered with stamens in central cone [Fig. 6.121]
2. Absent (0 to few) [Fig. 6.120]

In mesemb flowers, the distinction between petals (petaloid staminodes) and filamentous staminodes is not always clear, and the presence/absence and behaviour

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

of the filamentous staminodes has some taxonomic significance, and may be characteristic of certain genera. Petaloid staminodes are petal-like in appearance and develop ontogenetically as modified stamens that are sterile and produce no pollen. Filamentous staminodes are intermediate elements between stamens and petals (Hartmann 1993). Ihlenfeldt (1960) distinguishes three different types of androecium in mesemb flowers: a) transitional stages occur between the inner fertile stamens and the outer petaloid staminodes; b) in addition to the fertile stamens, two types of staminodes may be distinguished by their morphology and partly by their colour; c) fertile stamens are clearly distinct from the petaloid staminodes, and other types of staminodes are absent.

In this study, three characters describing filamentous staminodes are used. They may be **present and spreading, present and gathered with stamens in central cone**, or **absent (0 to few).** From a phylogenetic perspective the pattern is not clear-cut and obvious. Filamentous staminodes are present in the primitive *Hymenogyne*, from the Apatesieae, in much of the *Ruschia* Group but not in *Acrodon* (which may not belong in the *Ruschia* group, despite superficial resemblances). These are absent from the *Lampranthus* Group but not from *Erepsia* that may also be better placed elsewhere. The character can be confusing, as sometimes, stamens only are gathered in a cone and filamentous staminodes are absent.

Character 16: Filaments (PHYLO)
0. Naked [Fig. 6.59]
1. Papillate [Fig. 6.28]

The bases of filaments and sometimes of filamentous staminodes have small unicellular hairs in many species of Ruschioideae. Such hairs are absent in Mesembryanthemoideae and Aizoaceae *sensu stricto*, with the rare exception of *Gunniopsis calva* Chinnock. Outgroup comparison suggests that the primitive state is filaments **naked** or without hairs (Bittrich & Struck 1989). However, filaments are **papillate** in most Ruschioideae, and this state represents a synapomorphy for the subfamily (Fig. 5.2.4.3). In the more primitive genera such as *Cleretum,* (see e.g. *C. papulosum*), these hairs are very well developed (Fig. 6.28). To date, no function has been suggested but they appear to bind the bases of the filaments and may preserve the moist microenvironment in the flower, thus protecting the more exposed nectaries

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

of ruschioid taxa against desiccation. The filaments at the bases of filamentous staminodes have enabled the aggregation of these elements into a tubular structure, thus mimicking a tubular flower. It is tempting to suggest that this is a convergent trend aimed at producing a floral tube with filaments.

Character 17: Fusion of petals (PHYLO)

0. Fused at their base for a few millimetres [Fig. 6.73]
1. Free [Fig. 6.41]

In most species of Mesembryanthemoideae, members of the androecium are basally connate thus forming a short tube. Such a staminal tube is lacking in Aizoaceae. Petals **fused at their base for a few millimetres** to form a staminal tube is a synapomorphy for subfamily Mesembryanthemoideae (Fig. 5.2.4.3) (Bittrich & Struck 1989). Petals are **free** in Ruschioideae, except in the genera *Conophytum* and *Frithia*. Here the tubular shape of the corolla has significance in the pollination biology of the flowers. In *Conophytum* the flowers are extruded from the tiny hole in the top of the fused leaf pairs, and the formation of a corolla tube is undoubtedly an adaptation to this unique growth form.

Character 18: Floral nectaries (KEY)

0. Koilomorphic meronectary [Fig. 6.33]
1. Broad, flat holonectary [Fig. 6.7]
2. Broad, flat meronectary [Fig. 6.28]
3. Lophomorphic meronectary [Fig. 6.26]
4. Specialized meronectary of the *Stomatium*-type [Fig. 6.115]
5. Lophomorphic holonectary [Fig. 6.42]
6. Nectary inconspicuous, absent [Fig. 6.54]

Largely neglected in the past, floral nectaries of Mesembryanthemaceae have proved to be the most constant and useful morphological characters for higher-level classification in this group. Many plants secrete sweet exudations from nectariferous tissue in the form of a sugary, sticky fluid that acts as an attractant for pollinators. Functionally, floral nectaries are involved in pollination biology and mesemb flowers with their bright-coloured shiny petals are apparently always insect-pollinated. Nectar and/ or pollen may serve as a reward to pollinators. For most angiosperms, characters of the nectary are very constant in higher order groups and there is a close association between nectary type and the position of the ovary (Brown, 1938). Brown attributes

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

the apparent lack of interest in the systematic significance of nectaries to the fact that herbarium specimens are usually used in taxonomic studies. Being generally soft-tissued structures in the mesembs, features of the nectary are easily lost upon drying.

In the Mesembryanthemaceae, the floral nectary is situated on the receptacle at the base of the petals and stamens, to the inside of the inner whorl of filaments. An aggregation of nectariferous tissue as a ring in the same position is characteristic of the Caryophyllales, Polygonales, and nectariferous Chenopodiales, and characters of the nectary alone could be used to justify placement of the Nyctaginaceae in the Caryophyllales (Brown 1938), a position recently substantiated by molecular evidence (APG 1998). In addition, Zandonella (1977) used nectary characters to establish a basis for a phylogenetic system of the Caryophyllales (=Centrospermales).

Floral nectaries are particularly informative for defining major groups within family Mesembryanthemaceae (Chesselet *et al.* 2000b, 2001, 2002, 2004). Aspects of floral nectaries have been included in a number of studies on the classification of the mesembs (Rappa 1912; Brown 1925; Schwantes 1927; Ihlenfeldt 1960; Rappa & Camarrone 1962; Bittrich & Struck 1989; Hartmann 1998b), but the potential of these structures for systematic resolution was not fully realized and understood. Nectary structure is widely documented in species descriptions (Bolus 1928, 1928–1935, 1936–1958) and graphically, in the large collection of paintings of mesemb type specimens (Smith & Walker, 2001) held at the Bolus Herbarium (BOL), University of Cape Town.

The range of nectary types in mesembs was analyzed and discrete character states were established. Five major groups of genera were discerned on the basis of nectary type by Chesselet *et al.* (2002), but an additional type is added here to describe the unique floral nectaries of the crepuscular and nocturnal flowers of *Stomatium* species. Subfamily Mesembryanthemoideae is defined by a **koilomorphic meronectary** (Bittrich 1986; Bittrich & Hartmann 1988), which is a synapomorphy for the group (Fig. 5.2.4.1). In the Apatesieae the nectary is a broad flat continuous ring (**broad, flat holonectary**). In Dorotheantheae species, the nectary is composed of

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

discrete, broad, flat segments in a ring-like arrangement (**broad, flat meronectary**). The presence and taxonomic significance of these flat nectary types has largely been overlooked in previous publications, including those of Rappa & Camarrone (1962) and Zandonella (1977), and they are only briefly mentioned by Ihlenfeldt & Struck (1987), Ihlenfeldt & Gerbaulet (1990) and Hartmann (1991).

The bulk of the Ruschioideae are split into two large groups on the basis of nectary types, namely a group comprising taxa with a segmented, crested (or lobed) nectary (**lophomorphic meronectary**), the Drosanthemeae, and a group with an annular, crested (or lobed) nectary (**lophomorphic holonectary**), the Ruschieae. Convergence testing using published molecular data (Klak *et al.* 2003b) has shown that the meronectary has either arisen secondarily (reversal), has persisted as a pleisiomorphic feature, or is evidence of major genes switching on and off in the *Delosperma* group (excluding *Drosanthemum*), and the *Bergeranthus* and *Stomatium* groups, that are included in Ruschieae (Chesselet *et al.* 2004). Both these groups are defined by the lophomorphic (crested/ lobed) state. The apparent lack of nectaries, a rare state reported for the genus *Glottiphyllum*, needs further investigation to determine whether the nectary is in fact lost, or expressed in another way (**nectary inconspicuous, absent**). The **specialized meronectary of the *Stomatium*-type** is composed of 5 distinct nectariferous regions that are not lophomorphic (lobed or crested in appearance). Large drops of nectar exude from these five regions in the shallow hypanthium of *Stomatium* flowers. This may be a specialization for the crepuscular and nocturnal pollination of species in this genus.

Previous studies on nectaries in the mesembs have failed to yield phylogenetically useful data primarily because the definitions of morphological characters and character states followed were not adequately resolved. In a discussion on methods and problems of character construction, Wilkinson (1995) suggests that two important questions be posed initially: a) Can smaller units or components subsumed within the character be identified? b) Does the variation in these units indicate or suggest that they have evolved independently?

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

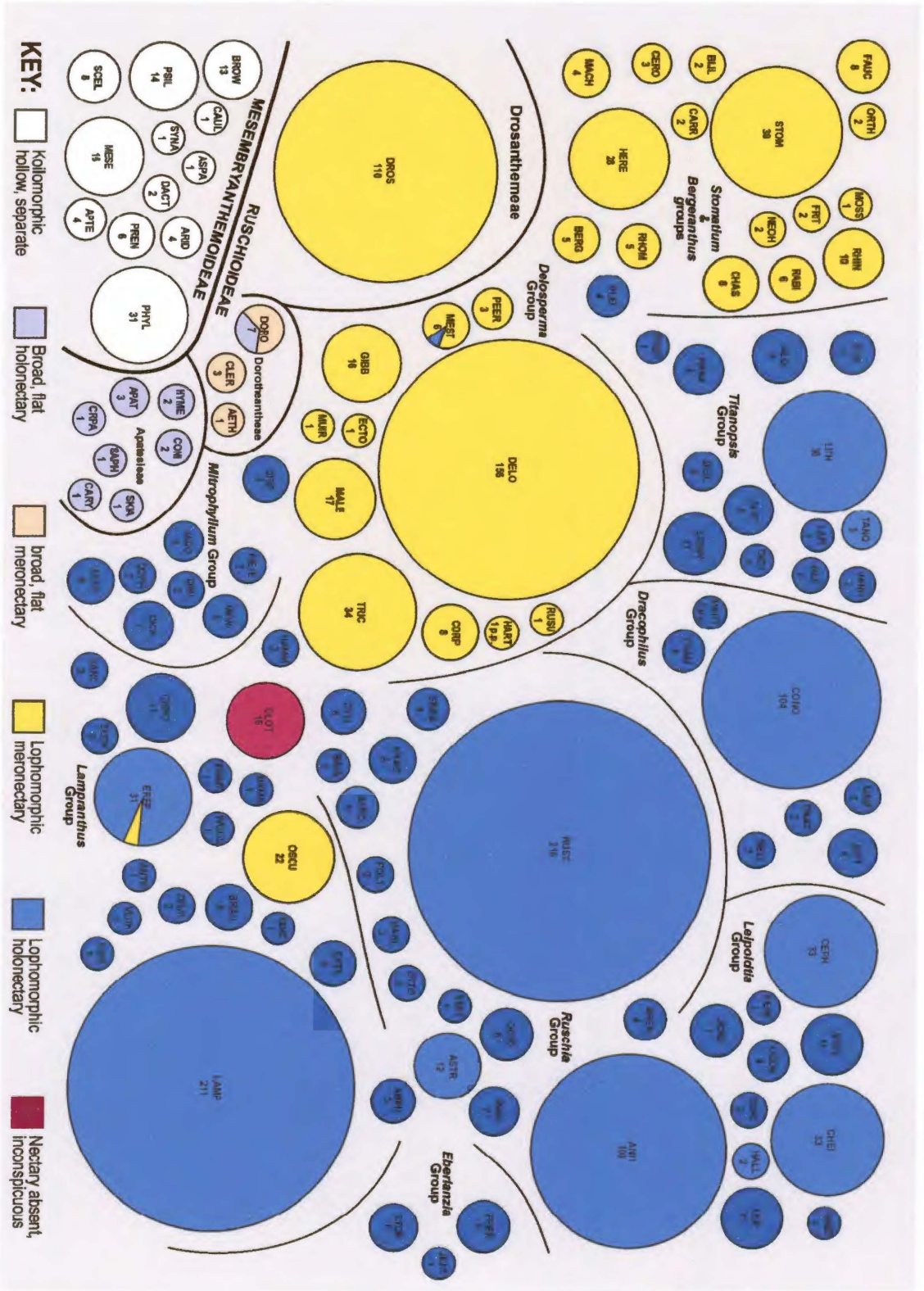


Figure 5.2.4.1. Bubble diagram showing taxonomic distribution of nectary types. Note the *Stomatium*-type is here broadly classified as a lophomorphic meronectary.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Nectary types (character 18) were therefore used in the construction of the key, whereas nectary structure and the shape of the nectary surface were used as two separate characters for preliminary phylogenetic analysis (Chesselet *et al.* 2002). Nectary types described above are based on two separate characters that appear to have evolved independently of each other (Figure 5.2.4.2). Transformations in one are not logically coupled to transformations in the other.

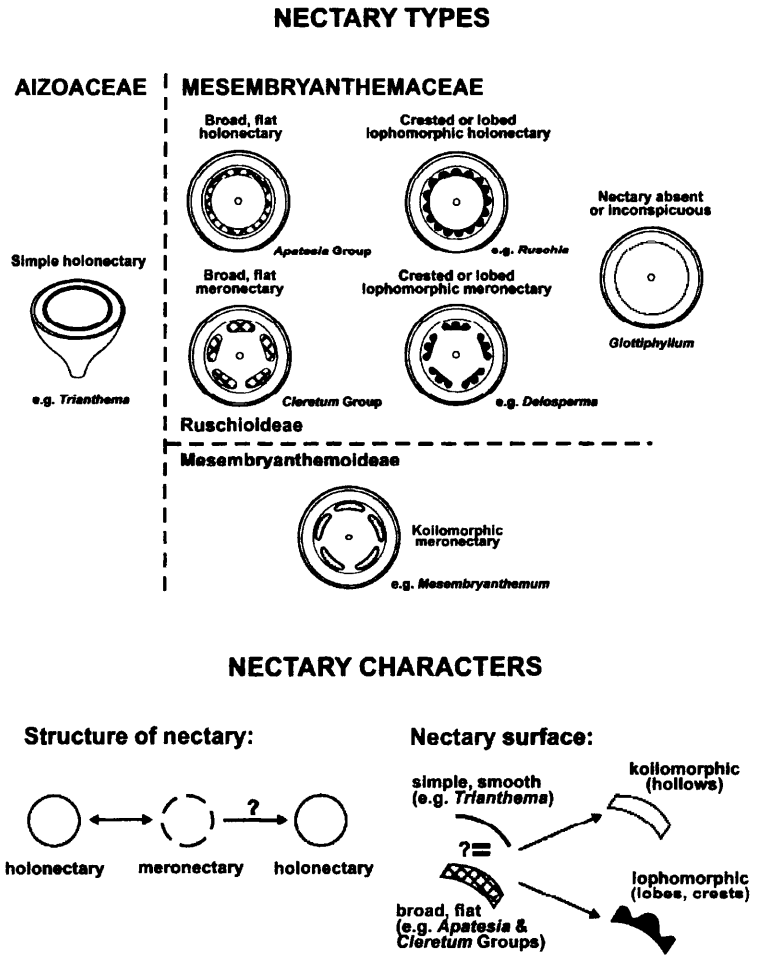


Figure 5.2.4.2. Analysis of mesemb nectary characters showing variation in nectary types and analysis of nectary characters separating nectary structure from nectary surface (from Chesselet *et al.* 2002).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

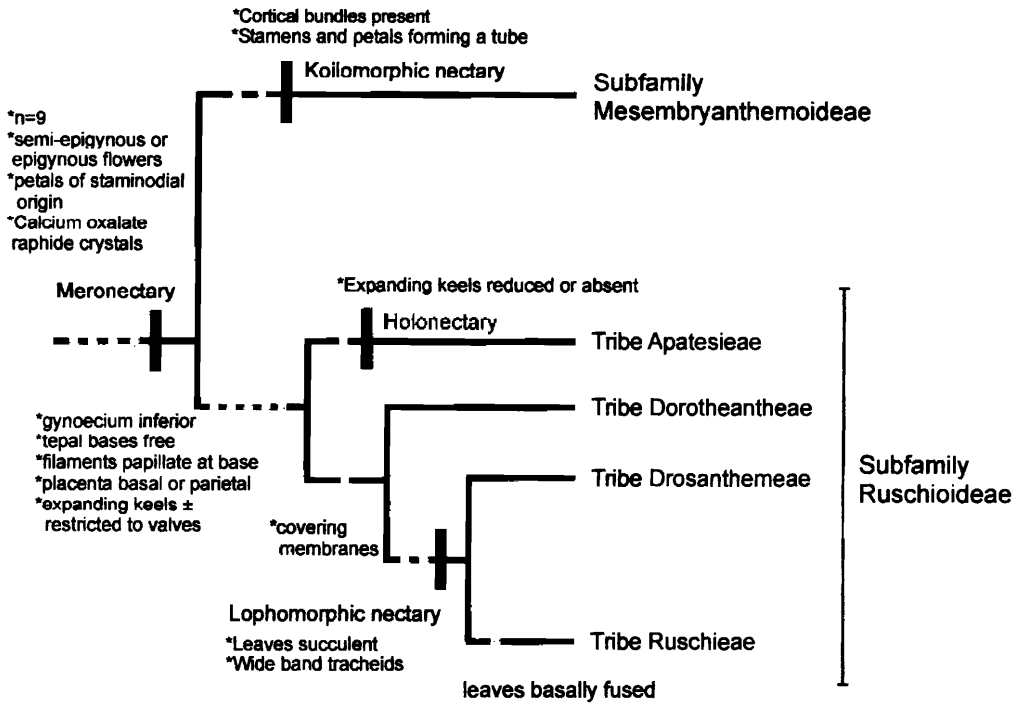


Figure 5.2.4.3. Cladogram showing phylogeny of Mesembryanthemaceae and morphological characters representing synapomorphies. Characters describing floral nectaries indicated as black crossbars (from Chesselet *et al.* 2004).

Character 19: Structure of nectary (PHYLO)

0. Continuous ring (holonectary)
1. Segmented into as many parts as there are carpels in the gynoecium (meronectary)

The first character relates to the structure of the nectary, namely whether it is in a **continuous ring (holonectary)** or whether it is **segmented (meronectary)** into as many parts as there are carpels in the gynoecium. Outgroup comparison shows that the ancestral condition, in the context of the mesembs, is the simple ring-shaped holonectary (Brown 1938; Zandonella 1977; Rappa 1912). Holonectaries are found in all other members of the Caryophyllales (Zandonella 1977). Segmentation of the ring into a meronectary is interpreted as derived (Rappa 1912), and represents a synapomorphy for the Mesembryanthemaceae (Bittrich & Struck 1989) (Fig. 5.2.4.3).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

The nectary forms a continuous flat ring in the Apatesieae. This reappearance of the holonectary, a synapomorphy for the group, may represent a reversal to the ancestral state for the family (Fig. 5.2.4.2). Members of the Dorotheantheae have broad, flat meronectaries, presumably the pleisiomorphic state. This tribe, composed of annual semi-succulent herbs, is not defined by any synapomorphy in terms of nectary type.

In species belonging to tribe Ruschieae and included in the *Dracophilus, Eberlanzia, Lampranthus, Leipoldtia, Mitrophyllum, Ruschia* and *Titanopsis* Groups, with the characteristic lophomorphic holonectary, the annular state (holonectary) is combined with a crested or lobed surface (lophomorphic). This combination is here interpreted as representing an evolutionary innovation rather than a reversal.

Association of characters suggests the primitiveness of the meronectary within this subfamily as it is found in taxa showing other primitive features (Bittrich & Struck 1989). This observation is substantiated by outgroup comparison that shows members of the sister group Mesembryanthemoideae with a segmented nectary, though hollow rather than lobed or crested. The lophomorphic meronectary of Drosanthemeae (Chesselet *et al.* 2004) establishes its primitiveness in relation to the lophomorphic holonectary of the majority of Ruschieae.

Character 20: Shape of nectary surface (PHYLO)

0. Flat [Fig. 6.28]
1. Sunken as pits and hollows (koilomorphic) [Fig. 6.11]
2. Raised and crested or lobed [Fig. 6.64]
3. Smooth nectariferous tissue, raised as droplet-like structures on inner walls of shallow hypanthium [Fig. 6.115]

The second character describing mesemb nectaries relates to the shape of the nectary surface. In the mesembs, nectaries are either **flat**, or **sunken as pits and hollows (koilomorphic)**, or **raised and crested/lobed (lophomorphic)**. In addition

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

to these states given in Chesselet *et al.* (2002), an additional state is provided here to describe the meronectary of *Stomatium* species. In this genus, the five nectary segments are situated at the basal edges of a shallow hypanthium. Nectar accumulates in an area close to the stigmata, and a sticky viscous fluid is visible on **raised smooth nectariferous tissue**. This state is clearly associated with a very specific pollination syndrome—*Stomatium* flowers have their own distinctive scent. Pollination and nectary structure in this genus require further investigation.

Outgroup comparison shows that a relatively narrow, flat nectary is the primitive condition and the hollow, shell-shaped (koilomorphic) and crested or lobed (lophomorphic) states are more advanced (Bittrich & Struck 1989). Unequivocal polarization of states is not possible for this character. Whether the broad, flat nectary characteristic of the Apatesieae and Dorotheantheae should be interpreted as a separate state from the primitive, relatively flat nectary found in other Aizoaceae *sensu stricto* (excluding Mesembryanthemaceae) is uncertain. Hence, these two conditions are coded as a single character state.

In interpreting the variation of nectar presentation in the mesembs, Chesselet *et al.* (2002) analysed the association of the different nectary types with other characters including position of the ovary, merosity of the gynoecium and sepal number. Nectaries of subfamily Mesembryanthemoideae form separate hollows in the upper surface of the ovary. In this group they are associated with the half-inferior ovary and axile placentation. In the Ruschioideae, the ovary is inferior, the placenta is generally basal or parietal and the nectaries are primitively composed of separate glandular units. However, in the Apatesieae and Ruschieae (excluding members of the *Delosperma*, *Bergeranthus* and *Stomatium* groups) the nectary is an entire ring of glandular tissue. To interpret the latter state it is hypothesized that the development of the holonectary in these ruschioid taxa may be related to the extreme multiplication of carpels in the gynoecium of certain species. Chesselet *et al.* (2002) hypothesized that the annular nectary may have preceded the evolution of multilocularity, a condition that has contributed towards the explosive diversification and elaboration of fruit types in the mesembs. With regard to variation in floral organ number among the

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

mesembs, Chesselet *et al.* (2002) report that the mesembs appear to have a low evolutionary potential for synorganization of floral elements, as reflected by the variability in organ number. In angiosperms this tendency towards higher merosity is generally regarded as primitive.

Character 21: Nectary colour (DESC)
0. Green (as surrounding tissue) [Fig. 6.28]
1. Dark green (distinct in colour from surrounding tissue) [Fig. 6.49]
2. Yellowish [Fig. 6.42]

The colour variation of mesemb nectaries is provided here. To date, however, nothing is known of their functional significance. Yellowish nectaries are noted in some members of the *Dracophilus* group, and some *Hereroa* species.

5.2.5 Reproductive character set: Fruit

5.2.5.1 Introduction

In view of the importance of fruit morphology in Mesembryanthemaceae systematics, and particularly in genus identification it is appropriate to provide an extended introduction to this character set. Before Brown (1925) discovered major differences in mesemb fruit and flowers, the single umbrella genus *Mesembryanthemum* was unresolved and heterogeneous. At present, more than 120 genera are recognized in Mesembryanthemaceae (Smith *et al.* 1998; Chesselet *et al.* 2000; Hartmann 2001). Fruit structure provides essential diagnostic characters for identification of mesembs to genus level (Hartmann 1988; Smith *et al.* 1998: 20–25).

5.2.5.2 Classification of mesemb fruit

With few exceptions, loculicidal hygrochastic capsules, which repeatedly open when wet, and close when dry, characterize the Mesembryanthemaceae. When fully expanded, mesemb fruit have a star-like appearance, and Schwantes (1957: 343) described them as '...not only the most complicated but also the most beautiful fruits

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

of this type in the whole plant kingdom'. He was the first to classify the diversity of fruit encountered in mesembs (Schwantes 1952). His work was refined by Hartmann (1988) who described nine unique functional syndromes for fruit capsules of the entire group. Hartmann's (1988) revised fruit classification describes *Mesembryanthemum*-type, *Mitrophyllum*-type, *Apatesia*-type, *Drosanthemum*-type, *Titanopsis*-type, *Delosperma*-type, *Lampranthus*-type, *Ruschia*-type and *Leipoldtia*-type of fruit. For a dichotomous key to these mesemb fruit types refer to Chesselet *et al.* (2000a), Appendix 2. This system is followed here with some modification. No suggestion is made in Hartmann's (1988) treatment of the evolutionary sequence of fruit types. Hartmann (1988) assigns the fruit of the Dorotheantheae to the *Mitrophyllum*-type. In this study, the *Mitrophyllum*-type fruit is applied differently and a new fruit type is erected: the *Cleretum*-type fruit. This study confirms the separateness of the *Drosanthemum*- from the *Lampranthus*-type fruit, based on the relatively primitive position of Drosanthemeae within Ruschioideae (Chesselet *et al.* 2004).

5.2.5.3 Hypothesis of evolution of fruit types in Mesembryanthemaceae

The *Mesembryanthemum*-type fruit is regarded as most primitive in the mesembs. With its axile placenta, and flap-like valve wings, it differs significantly from fruit in Ruschioideae. The *Apatesia*-type fruit is not clearly definable. Within the Apatesieae, there is great variation in the often multilocular fruit, but overall the tendency is towards xerochasty. In the Dorotheantheae, the simple *Cleretum*-type fruit may or may not have covering membranes and seed is dispersed through the simple rain-splash mechanism. The *Drosanthemum*-type fruit, with flat translucent covering membranes and valve wings, is more primitive than the *Ruschia*, *Lampranthus* and *Leipoldtia* fruit types. This hypothesis is corroborated by the position of this tribe in the phylogeny of the mesembs. The *Lampranthus*-type fruit appears to be associated with winter rainfall in Fynbos vegetation. The *Delosperma*-type fruit and its multilocular variation, the *Titanopsis*-type fruit, tend to be associated with summer rainfall. Species with the 5-locular *Ruschia*- type and multilocular *Leipoldtia*-type fruits are widespread, particularly in Succulent Karoo vegetation. Fruit types therefore largely reflect environmental conditions (e.g. regional climate) and their use in systematics is not as reliable as previously thought. For example, assigning the fruits

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

of *Faucaria* and *Orthopterum* to the *Leipoldtia*-type on the grounds of their high merosity is clearly incorrect. These are summer- (to all year) rainfall taxa from the Albany Centre, and are not closely allied to Leipoldtiinae.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

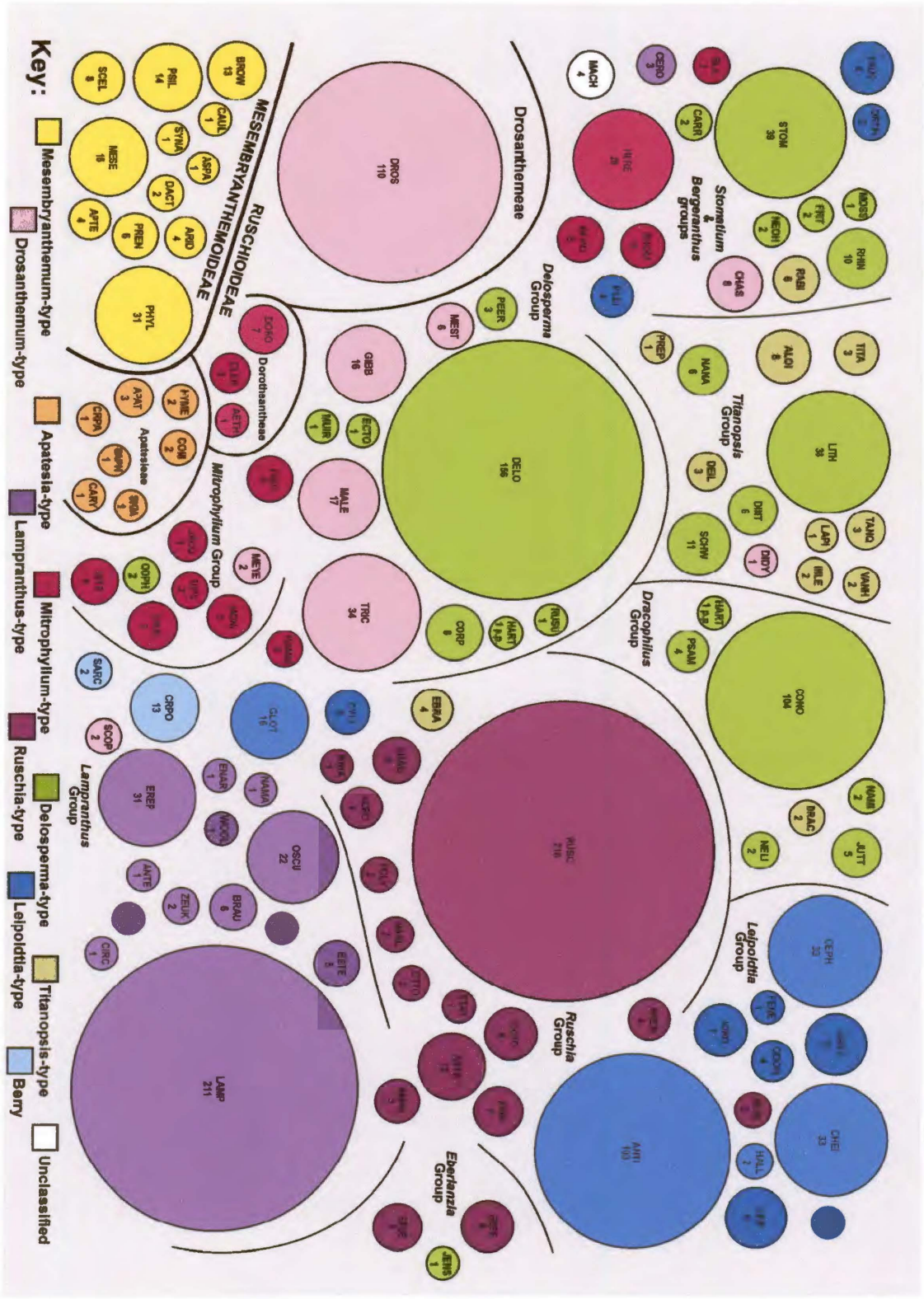


Figure. 5.2.5.2.1. Bubble diagram showing taxonomic distribution of Hartmann's (1988) fruit types.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Table 5.2.5.2.1 Classification of fruit types in Mesembryanthemaceae, from Hartmann (1988), with modification.

No.	Fruit type	Description
1	***Mesembryanthemum*-type**	Fruit capsule pale in colour with a corky rather than a woody texture. Placentae axile. Expanding keels of septal origin, radial on valves and extending from central axis of fruit to the valves. Valve wings broad, fused to margins of valves, as flaps under which seeds may become lodged in open fruit.
2	***Apatesia*-type**	Expanding sheet predominant over expanding keels, but expanding properties reduced. Fruit often schizocarpic with seeds dispersed in winged membranes or embedded in the woody walls of capsules.
3	***Cleretum*-type**	Fruit a simple splash-cup. Expanding keels parallel, merging into expanding sheets. Valve wings large, covering membranes present or absent.
4	***Drosanthemum*-type**	Expanding keel merging into expanding sheets or distinct from expanding sheet, parallel or divergent over the valves. Covering membranes compound (proximal part derived from valvar endocarp including the epidermis, marginal parts derived from inner endocarpal tissue), persistent in shape, translucent, ± flat, and of ± equal diameter throughout. Valve wings broad. Closing bodies absent with rare exceptions. Fruit sometimes with basal seed chambers.
5	***Mitrophyllum*-type**	Expanding sheets dominant, transgrading into an expanding keel in central valvar position; consequently expanding keels ± flat and appressed to valves. Covering membranes (derived from parts of valvar endocarp that do not develop into expanding tissue), simple, translucent, persistent in shape, ± flat. Closing ledges or bosses present, consisting of spongy cutinized tissue situated above the placenta and below the expanding sheet. Valve wings broad.
6	***Delosperma*-type**	Expanding keels ± radial, distinct from expanding sheets. Covering membranes absent or vestigial and declining into the empty locules. Valve wings broad.
7	***Titanopsis*-type**	Expanding keels distinct from expanding sheets, divergent and broadened towards the centre of the valve. Covering membranes compound (as in the *Drosanthemum*-type), but central parts thicker than marginal parts, and boundaries slightly raised into low ridges, and marginal parts bent into the empty locules, translucent and descending centrifugally; extension of very floppy, thin covering membranes reduced. Closing bodies absent or small. Valve wings broad.
8	***Lampranthus*-type**	Expanding keels divergent, sometimes broadened. Covering membranes rigid, stout, of persistent convex shape, with a distinct recurved rim above and a closing ledge below their distal ends. Closing bodies absent but with bunches of sterile funicular hairs at exits of locules. Valve wings mostly present, or absent.
9	***Ruschia*-type**	Expanding keels widely divergent, short, without a radial extension, not higher than broad. Covering membranes stout, of persistent convex shape with distal upright rims and prominent closing rodlets below. Closing bodies small, rodlet-shaped, each with a small central corky part. Valve wings narrow or absent.
10	***Leipoldtia*-type**	Expanding keels divergent, with distinct radial awns, not broadened; expanding sheets present. Covering membranes persistent, resilient, of permanent concave shape with curved radial upper edges, distally and distinctly recurved. Closing bodies large, distinctly stalked, outer layers sclerenchymatous, inner corky tissue well developed. Valve wings broad.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

5.2.5.4 Seed dispersal in Mesembryanthemaceae

Modes of seed dispersal vary widely in the mesembs depending on the inner construction of the fruit (Schwantes 1952; Straka 1955; Ihlenfeldt 1960; Hartmann 1988). Unlike most other mesembs, species of *Carpobrotus* have mammal-dispersed berry-like fleshy fruit with seed embedded in thick sticky mucilage. The Australian genus *Sarcozona*, similarly, has berry-like fruit that have 4 or 5 locules in contrast to the multilocular fruit of *Carpobrotus*.

Some members of the *Apatesieae* have poppy-like shakers or schizocarps that dehisce when dry, whilst others form nuts (Leistner 1958; Chesselet & Van Wyk 2002), but in the majority of mesembs the ovary matures to form a hygrochastic capsule. For these, rainfall is the primary agent for short distance dispersal of seed (ombrohydrochory). Secondary dispersal agents, such as herbivores, enable occasional long distance dispersal (endozoochory) (Milton 1992; Milton & Dean 2001). Wind is the dispersal agent for schizocarpic fruit e.g. *Conicosia* and a secondary dispersal agent for those species whose fruit tumble some distance from the mother plant (anemochory), e.g. *Fenestraria*.

In the *Apatesia*-type fruit the trend towards dry capsules results in an independence from rain for dispersal. In hygrochastic fruit, dispersal and germination are coupled, dependent on, and triggered by rain and particularly suited to habitats where rainfall is episodic, such as in the arid and semi-arid parts of southern Africa.

Rain-splash dispersal is known from diverse taxonomic groups in the plant kingdom including liverworts, species of *Sagina* L. and *Oenothera* L. (Brodie 1951; Poppendieck 1995). Hygrochastic fruit are known from certain members of the Aizoaceae ***sensu stricto*** (excluding Mesembryanthemaceae), notably species of *Aizoon* L. and *Aizoanthemum* Dinter ex Friedrich. In hygrochastic fruit, expanding tissue, in the form of expanding keels and/or expanding sheets, functions to open and close the valves or lids of the fruit (Hartmann 1988; Croizat 1993). This is accomplished through the swelling and shrinking of specialized expanding tissue composed of cells with pectin-cellulose tertiary walls that swell when water is

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

absorbed. For anatomical details refer to Straka (1955) and Garside & Lockyer (1930).

In rain-splash dispersal, seed release occurs upon impact from raindrops. Longer and more intense rains cause a greater release of seeds. Classic 'splash-cups' have certain features in common: they are funnel-shaped with sides sloping at angles of 60°–70° and are 5–7 mm in diameter at the rim; cups are broadly attached at the base, their walls resist battering by raindrops; bodies (spores or seeds) dispersed from splash-cups are lenticular in shape (Brodie 1951), as are those of most mesembs using splash-cup mechanisms.

Mesemb hygrochastic fruit differ from simple splash-cups as septal walls divide the fruit into locules that vary in number from 3 or 4 to 20 or more. Those mesemb fruit that function as simple splash-cups are generally small with comparable diameters e.g. *Delosperma*. Larger fruit with numerous locules are designed for ejection dispersal rather than rain-splash dispersal e.g. *Cheiridopsis*. The shape of mesemb seed varies from lenticular to round. The rounder seeds are associated with more sophisticated ejection mechanisms for dispersal. In hygrochastic fruit, Hartmann (1991) describes wash-out dispersal, splash-cup mechanisms (Brodie 1951), spring-board mechanisms (Brodie 1955), and ejection dispersal.

Large raindrops have diameters of about 4 mm and fall at a terminal velocity of $\pm$ 6 $m.s^{-1}$ (water drops reach their maximum terminal velocity after falling about 3 m). Raindrops are round, not tear-shaped as commonly depicted, and the main force keeping water molecules together is surface tension, which is more effective for smaller droplets. A splash is an explosion with radiating paths from the centre to every outlying point (Stevens 1974). Smaller droplets, initiated as spikes, form at the rim of a splash crater in a regular arrangement. A spike originates at a weak point in the perimeter of the splash and liquid flowing up a spike sucks more liquid into its stream (Stevens 1974). In rain-splash dispersal, raindrops plunge into the water-filled fruit and force the water out along the inclined sides of the fruit. Mesembs with hygrochastic fruit have utilized the splash explosion for directed, short-distance

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

dispersal of their seed. Brodie (1951) pointed out that the shape of splash-cups in nature bears a close resemblance to the splash pattern. If one looks at open mesemb fruit, the resemblance is remarkable—the hydrated fruit mirrors the splash pattern, a merging of both form and function!

The balance between seed expulsion and seed retention is maintained by the internal structure of the fruit. Brown (1921: 151), in his early observations of mesemb fruit, remarked, '...at first sight they [fruit] would seem to be specially designed to prevent the seed from escaping.' This observation highlights the fact that mesemb fruit are not all simple splash-cups. Seeds are retained, sometimes for several years in the protective fruit thus comprising a seed bank.

In certain hygrochastic fruit, the formation of basal seed chambers by 'false septa' prevents dispersal by rain of the portion of seed that is hidden. Presumably these seeds are released when the fruit breaks down. Basal seed chambers are known from species of *Drosanthemum*, *Cleretum*, *Disphyma* and *Malephora* (Hartmann 1988). Some members of Apatesieae, present in the fire-prone Fynbos vegetation of the Western Cape have specialized seed chambers or seed pockets, the 'Samentasche' of Schwantes (1949, 1957), in which some seed is entombed in woody tissue. Triggers for germination of these rather large and thick-coated seeds may include scarification by fire (Hickey & Van Jaarsveld 1995).

Adaptations that hinder dispersal (antitelechory) are widespread in desert plants and serve to reduce high mortality of seed or seedlings. Ellner & Shmida (1981) suggest that antitelechory is not directly related to seed dispersal but may have evolved: a) to protect seed from predation and flooding; b) to regulate the within-season timing of germination; and c) to spread dispersal and germination over several years.

Seeds expelled from mesemb fruit by raindrops travel very short distances: Parolin (2001) found that the mean distance of seed expulsion varied between 7 and

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

65 cm, with a maximum distance of 164 cm. Milton & Dean (2001), however, found that the germination of mesemb seeds from dung pellets of wild and domestic herbivores as well as ant and termite-eating insectivores such as aardvark and bat-eared fox, provide mechanisms for directed, long-distance dispersal (telechory).

For detailed descriptions of the inner construction of mesemb fruit refer to Hartmann (1988) and Smith *et al.* (1998). Fruit characters used in this study are discussed below.

5.2.5.5 Fruit characters

Character 1: Fruit type & dehiscence (KEY)

0. Hygrochastic, opening when wet [Fig. 6.41]
1. Xerochastic, dehiscent when dry (schizocarpic) [Fig. 6.29]
2. Fleshy, indehiscent [Fig. 6.20]
3. Nut-like fruit
4. schizocarpic fruit derived from the *Delosperma*-type ground-plan

Most mesembs fruit are described as loculicidal capsules. These are dry fruit composed of more than one carpel that dehisce through the locules rather than through the septa. Some mesembs, particularly in the Apatesieae, have indehiscent fruit that split into separate one-seeded segments (carpels) at maturity, termed schizocarpic fruit. Upon maturity, fruit dehiscence may be a response to hydration (hygrochastic) or to desiccation (xerochastic).

Most mesemb fruits are **hygrochastic, opening when wet**. This is the case in both Mesembryanthemoideae and Ruschioideae, although structural details and mechanisms may differ. In the Apatesieae there is a tendency towards the development of **xerochastic** fruit that are **dehiscent when dry (schizocarpic)**. The small extant genera belonging to this group show specific adaptations to their habitats, mostly in Fynbos (Hickey & Van Jaarsveld 1995; Chesselet & Van Wyk 2002).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

An exception to the dehiscent fruit of the majority of mesembs is presented in *Carpobrotus*, the fruit of which are **fleshy and indehiscent** berries. Fleshy, indehiscent fruit do not open at maturity along definite lines or pores, and the fleshy berries of *Carpobrotus* lack a pit or core. The seeds are embedded in a sour mucilage and the colloquial name of this species is 'suurvy' or 'sour fig' in English. The fruit of *Sarcozona* are also fleshy berries, but differ in only having five locules in contrast to the multilocular fruit of *Carpobrotus*.

A nut is a hard, dry, indehiscent fruit usually with a single, or few seeds. Nuts have developed in *Stoeberia gigas* and in *Brownanthus nucifer* (Chesselet & Van Wyk 2002). The sclerification of tissue and loss of hygrochastic properties in these **nut-like fruit** is associated with a reduction in seed number and an increase in seed size. These characteristics undoubtedly enhance the possibility of successful germination in the harsh habitats of the Richtersveld where dry periods are common. In contrast to most mesemb fruit in which numerous ovules are produced in each carpel, Bittrich & Struck (1989) noted a decrease in ovule number correlated with the development of indehiscent fruit such as those of *Hymenogyne* species, *Stoeberia gigas* and *Brownanthus nucifer*. Nut-like fruit have evolved several times in the mesembs with, for example, *B. nucifer* in Mesembryanthemoideae, and *S. gigas* (previously in *Ruschianthemum*), in Ruschioideae.

The phenomenon of xerochasty is not limited to some members of Apatesieae and *Frithia humilis* (Burgoyne *et al.* 2000) has developed a **schizocarpic fruit derived from the *Delosperma*-type ground-plan**. Expanding tissue is reduced and the fragile fruit break up into carpels that are dispersed easily by heavy rains (e.g. electrical thunderstorms) and wind characteristic of its savanna habitat. Mature fruit are rarely found on these plants (pers. obs.). This reduction in expanding properties may represent an adaptation to the gravelly Ecca shale patches that it inhabits. Rain-splash mechanisms have been lost and the force of rain is used to scatter the seed-bearing carpels.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Character 2: Number of locules (KEY)

0. 3
1. 4 [Fig. 6.116]
2. 5
3. 6
4. 7
5. 8
6. 9
7. 10 [Fig. 6.68]
8. 11
9. 12
10. More than 12

The number of locules in mesemb fruit is easily counted by the number of valves present on the top of the mesemb capsule. Locularity is a very important character in the diagnosis of genera and has been included in the key. Surprisingly, however, this character does not contain useful phylogenetic information due to convergence. The gynoecium in Mesembryanthemaceae is completely septate. The number of locules (carpels) ranges from three to more than twenty. The primitive mesembs have 5 (or 4) parts to the gynoecium, and in the order Caryophyllales, pentamerous flowers with 5 carpels have been proposed as the primitive pattern (Hofmann 1994). A remarkable feature of the Mesembryanthemaceae is that contrary to general evolutionary trends towards reduction in the number of floral parts evident in many plant groups, the number of carpels in the gynoecium has increased in many genera. For example, *Namibia* may have up to 28 locules, and *Argyroderma*, *Conicosia* and *Jordaaniella* up to 25. For a detailed discussion on merosity of mesemb fruit refer to Chesselet *et al.* (2002). Suffice it to say that the number of locules in mesemb fruit ranges from three to more than 20, and that multilocularity seems to rely to a large extent on the presence of a holonectary. Increased merosity of the gynoecium is particularly common in genera with the *Leipoldtia*- and *Titanopsis*-type fruit and those genera with xerochastic tendencies classified in tribe Apatesieae. In the key, the following states are recognized as discrete entities describing the number of locules: **3**; **4**; **5**; **6**; **7**; **8**; **9**; **10**; **11**; **12**; **more than 12**.

Character 3: Open hygrochastic fruit, covering membranes (KEY)

0. Absent (Mesembryanthemoideae)
1. Absent, reduced to a limb
2. Present, half to two thirds locule covered
3. Present, well developed

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Character 4: Covering membranes (PHYLO)

0. Not applicable due to structure of fruit
1. Absent (*Apatesia*-type fruit)
2. Absent in fruit with undifferentiated expanding tissue (expanding keels not distinct from expanding sheets) e.g. *Cleretum*
3. Present, simple (derived from valvar endocarp, translucent, persistent in shape and ± flat, expanding keels divergent) e.g. *Drosanthemum*
4. Absent in fruit with differentiated parallel expanding keels (or present as translucent covering membranes of septal origin) e.g. *Delosperma*
5. Present, compound (derived from valvar endocarp and inner endocarpal tissue, translucent, persistent in shape and ± flat)
6. Present, persistent in shape, and stout e.g. *Ruschia* and *Leipoldtia*

As mesemb fruit evolved more sophisticated dispersal mechanisms the structure and function of covering membranes became more complex. For this reason two sets of characters describe these structures, one for identification and another for phylogenetic analysis.

Covering membranes shield the locules of open expanded fruit by forming a roof or a ledge that covers the seed chambers or locules. Additionally, the more specialized covering membranes serve to propel seed in ejection dispersal. The presence of these structures is here interpreted as a synapomorphy for subfamily Ruschioideae excluding the basal Apatesieae. Covering membranes are simple, soft, and translucent in the more primitive ruschioid taxa, and may or may not be present in the Dorotheantheae. In a study of fruit of *Dorotheanthus*, Struck (1989) found a correlation between the amounts of annual rainfall and the presence, reduction or absence of covering membranes. The more fragile and simple fruit of this type were found in the driest parts of the distribution range of the group. This is a surprising result as one may expect covering membranes to be present in the drier habitats, holding seed back. The explanation may be that these annual plants are opportunistic in terms of rainfall in the drier parts of Namaqualand, and all seeds would be expelled from the simple splash-cup during a suitable rainfall event. In the Dorotheantheae, therefore, the presence of covering membranes is a variable character that appears to reflect climate.

The absence of covering membranes, without qualification, cannot be used as a phylogenetic character, as absence may be due to several reasons. The absence of

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

covering membranes was regarded as a primitive feature by Ihlenfeldt (1960), but this is not strictly so in the case of some members of the Ruschieae (e.g. *Delosperma*) and Dorotheantheae as shown by Struck (1989). Primitive ruschioid species such as *Cleretum papulosum* and *Aethephyllum pinnatifidum* do not have covering membranes, and in these taxa their absence may be interpreted as primitive. In *Delosperma*, this feature may be sympleisiomorphic, but it is associated with well-developed parallel expanding keels, and may therefore be derived. In character analysis, simple presence/absence character states describing covering membranes are not adequate to cover the variation encountered. They may be present, simple (derived from valvar endocarp), persistent in shape and more or less flat, or compound, derived from both valvar endocarp and inner endocarpal tissue, or derived entirely from inner endocarpal tissue, or rigid, convex with rims and ledges, or rigid, stout and concave in appearance (Hartmann 1988).

Character 5: Elaboration of rims of covering membranes (PHYLO)

0. No elaboration, covering membranes flat, of equal diameter throughout
1. Central part thicker than margin, margin inflected into empty locule
2. Recurved at distal end
3. Recurved at distal end with closing rodlets on under surface
4. Recurved at distal end with closing ledges and a bulge that gives covering membranes a concave appearance

The undersurface of the distal rims of covering membranes has also tended towards elaboration as seed expulsion and retention mechanisms became more sophisticated in the evolution of mesemb fruit. Some are plain, others recurved, and in those fruit with closing bodies, other appendages such as closing ledges and closing rodlets assist in blocking the distal exit of the locules, thus forcing seed expulsion to take place through the central slits between the adjacent covering membranes.

Character 6: Open fruit, closing devices at exits of locules (KEY)

0. Absent (placenta axile or basal to parietal)
1. Absent, large spongy closing ledge [Fig. 6.58]
2. Present, bifid or two-lobed [Fig. 6.40]
3. Absent, dense mass of funicular hairs at opening of locules
4. Present, small, white [Fig. 6.45]
5. Present, small, sometimes rod or hood-shaped
6. Present, lens-shaped, large, splitting longitudinally
7. Present, large, rounded, stalked and white

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Character 7: Structures that close distal exits of locules (PHYLO)

0. Absent
1. Present as bulges of the fruit wall
2. Present as small knobs, sometimes inconspicuous and surrounded by few funicular hairs
3. Present as thick bunches of funicular hairs that may swell and block distal exits of locules
4. Present as rod or hook-shaped structures
5. Present, lens-shaped, large, splitting longitudinally
6. Present as enlarged, stalked whitish closing bodies

As in the case of covering membranes this character is separated into states useful for identification and a separate set of states for phylogenetic analysis. The elaboration of ruschioid hygrochastic fruit from simple splash-cups to fruit with a sophisticated rain-driven ejection mechanism of seed dispersal required that openings at the periphery of the hydrated fruit be blocked. In the more primitive ruschioid taxa such as Dorotheantheae and Drosanthemeae there are no closing bodies, and fertile funicular hairs are present on parietal walls below the rim of the fruit. In Ruschieae, species with the *Mitrophyllum*-type fruit have a swelling or bulge at the distal openings of the locules. Members of *Lampranthus* and other genera with *Lampranthus*-type fruit (Fig. 5.2.5.2.1), characteristic of several winter-rainfall taxa, have large bunches of funicular hairs that block these exits. In species with the *Titanopsis*-type fruit the swelling of additional sterile funicular hairs may serve the secondary function of raising seed in the exposed locule to just below the covering membrane, thus positioning them for expulsion by the next well-positioned raindrop. Rod-shaped closing bodies are characteristic of the *Ruschia*-type fruit, where they serve to partially block the distal exits of the locules. In this type of fruit they co-occur with small closing ledges on the undersurface of rather stiff covering membranes. In those fruit of the *Leipoldtia*-type, exits are blocked completely by a combination of enlarged, stalked and rounded closing bodies, ledges on the underside of the stiff covering membranes. In *Hallianthus planus*, ejection dispersal is highly specialized. This is achieved through a turret shaped fruit that has covering membranes designed so that seeds are ejected through a sophisticated funnel created by the covering membranes.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Character 8: Open fruit, valve wings and flaps (KEY)

0. Large flaps (*Mesembryanthemum*-type fruit) [Fig. 6.12]
1. Valve wings present, well developed
2. Valve wings present, very long and ribbon-like
3. Valve wings well developed, hard (sclerified), rounded
4. Valve wings absent
5. Valve wings present, awn like

Character 9: Valve wings (PHYLO)

0. Present as flaps, entirely connate to valve
1. Present as variously shaped membranous wings on sides of valves
2. Absent (lost)
3. Present as awns at the ends of expanding keels

Valve wings evolved early in the mesemb lineage. In subfamily Mesembryanthemoideae, they exist as large flaps that are entirely connate to the valve, and function primarily in holding seeds back from washing out in the rain. These structures may not be homologous to those in Ruschioideae. Primitive ruschioids such as *Cleretum papulosum* have large membranous valve wings. Although no function has been assigned to them (Hartmann 1988), they seem to act as water harvesting wings, like upside down umbrellas, channelling water droplets onto the expanding keels and resulting in a more rapid opening of the fruit. Sometimes they function to catch seed and hold them back in the fruit upon dehydration and closure of the capsule. There is some variation in the structure of valve wings. In *Stoeberia*, for instance, the valve wings are sclerified and hard. The expanding keels break once the fruit opens and it does not close again, once opened. Remaining seed may then be shaken out by wind. Expanded valve wings may be narrow or broad structures on the edges of the valves depending upon fruit type. In fruit of the *Ruschia*-type, valve wings are lost altogether. In other genera, they are present as rather large awns on the ends of expanding keels. In *Jensenobotrya*, a monotypic genus from Dolphin Head, off the Namibian Skeleton Coast, valve wings form long ribbons (Fig. 6.62). They function presumably to harvest fog in the rainless desert that it inhabits. Characters for valve wings are separated into those used for identification and those that have phylogenetic significance.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Character 10: Fruit dehiscence, derivation of expanding tissue (PHYLO)

0. Hygrochastic, expanding tissue of septal origin
1. Hygrochastic, expanding tissue of valvar origin, tendency towards schizocarpy and xerochasty
2. Fully functional hygrochastic tissue of valvar origin

The mechanism for the opening and closing of mesemb hygrochastic fruit relies on expanding tissue that swells upon hydration. It is this expansion and swelling of cells of the expanding keels that pushes the valves covering the fruit to their open position. Bittrich and Hartmann (1988) regard the possession of hygroscopic expanding tissue as a possible synapomorphic character for the Aizoaceae *sensu stricto* (including Mesembryanthemaceae). In *Aizoon*, *Aizoanthemum* and *Gunniopsis*, as well as in all members of subfamily Mesembryanthemoideae, the septa of the fruit split early during development and form two parallel expanding keels (Hartmann 1988). Therefore, in subfamilies Aizooideae and Mesembryanthemoideae expanding tissue is of septal origin. In Mesembryanthemoideae 'septal expanding keels' extend from the central columella to the valves. In subfamily Ruschioideae expanding tissue originates from endocarpal tissue on the inside of the valves or cell lids, referred to by Hartmann (1988) as 'valvar expanding tissue'. With the shift of the placenta from the axile position to the basal or parietal position, the mechanism of hygrochasty re-invented itself, and 'valvar expanding tissue' can be regarded as a synapomorphy for subfamily Ruschioideae. This suggests strong selection for hygrochastic fruit. Expanding tissue in Ruschioideae cannot be considered strictly homologous to that of the more basal Mesembryanthemoideae, but these features are functionally homologous. Characters relating to the nature of expanding tissue are useful only for phylogenetic purposes.

Character 11: Differentiation of valvar expanding tissue (PHYLO)

0. Not applicable (septal origin)
1. Expanding sheets predominant but expanding properties reduced
2. Expanding sheets predominant merging into fully functional expanding keels
3. Expanding sheets clearly differentiated from expanding keels

Expanding tissue in Ruschioideae has two components, namely expanding sheets and expanding keels. Expanding sheets predominate as hygroscopic tissue in the more primitive ruschioid genera, and can be seen, spread on the insides of valves

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

or cell lids. In the Apatesieae, the expanding sheet predominates but its expanding properties are reduced as some members of the group tend towards xerochasty. This is achieved through a reduction in the thickness of layers and cell walls of the expanding sheets (Straka 1955). In the more primitive ruschioid genera such as *Aethephyllum*, *Cleretum* and members of the *Mitrophyllum* Group (Hartmann 1991, 1993), the expanding sheet dominates and merges into the expanding keels with expanding keels only slightly differentiated as elevations of concentrated expanding tissue. Hartmann (1988) suggested that the predominance of expanding sheets might represent a synapomorphy for the *Mitrophyllum*- and *Apatesia*-type fruit. However, in this study, this feature is separated into two states: a) expanding sheet predominant but expanding properties reduced, and b) expanding sheet predominant merging into fully functional expanding keels. In the more advanced ruschioid taxa, expanding keels are clearly differentiated from expanding sheets.

Character 12: Expanding keels (PHYLO)

0. Radial, from central axis of fruit to valves [Fig. 6.116]
1. Curved, merged with expanding sheets, ± restricted to valves [Fig. 6.76]
2. Expanding keels divergent, distinct from expanding sheet, broadened, ± restricted to valves
3. Expanding keels radial, distinct from expanding sheet (associated with lack of covering membranes), ± restricted to valves
4. Divergent, distinct from expanding sheet, short, not higher than broad, ± restricted to valves
5. Divergent, distinct from expanding sheet, sometimes with distinct radial awn, ± restricted to valves

Expanding keels comprise hygroscopic tissue that swells when water is absorbed. In mesemb fruit they act as 'muscles', expanding when wet and shrinking upon drying. Because of their attachment to the walls of the fruit and the inner walls of the cell lids or valves, they act in the opening and closing of the fruit. In subfamily Mesembryanthemoideae expanding keels are radial, extending from the centre of the fruit to the valves. In Dorotheantheae, and species with the *Mitrophyllum*-type fruit, expanding keels are merged with the expanding sheets. Covering membranes, which also originate from the endocarpal tissue of the valves, are thin and translucent in these groups.

Divergent expanding keels characterize the majority of the more advanced ruschioid species. This divergence is a significant innovation that contributed to the

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

elaboration of covering membranes from endocarpal tissue between the keels (Hartmann 1988), and consequently, enabled the development of more sophisticated mechanisms of seed ejection. In *Delosperma*, however, covering membranes of endocarpal origin were forfeited and expanding keels are radial, allowing for more rapid opening of the fruit (Hartmann 1988). The fruit of *Malephora* open rapidly with parallel expanding keels yet these fruit do have very thin covering membranes over the locules. In the *Delosperma*-type fruit covering membranes are mostly absent, and if present, manifest as small limbs of septal origin. In the *Ruschia*-type fruit expanding keels are stout whereas in a number of genera expanding keels are tipped by a radial awn. There is great variation in the rapidity with which mesemb fruit open. Small splash-cups usually expand very fast within a minute or two of being wetted, whereas some of the woodier, multilocular fruit may take considerably longer, up to 8 to 10 minutes (pers. obs.). The hygrochastic response of expanding keels differs considerably according to fruit type.

5.2.6 Geographic character Set: Broad distribution data

The database 'Interactive Mesembs' was analysed at biome level and is discussed in detail in the paper describing 'Patterns of floristic diversity' presented as Chapter 4.

Character1: Distribution (Global) (KEY)

0. South Africa
1. Namibia
2. Botswana
3. Lesotho
4. Swaziland
5. Mozambique
6. Zimbabwe
7. Angola
8. Madagascar & Reunion
9. Eastern Africa
10. Australia & New Zealand
11. USA
12. Chile
13. Mediterranean

Character 2: Province (South Africa) (KEY)

0. Western Cape
1. Northern Cape
2. Eastern Cape
3. Free State
4. North-West Province
5. Limpopo
6. Gauteng

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

7. KwaZulu/Natal
8. Mpumalanga

Character 3: Biome (southern Africa)

0. Albany Thicket
1. Coastal Belt
2. Desert
3. Forest
4. Fynbos
5. Grassland
6. Nama-Karoo
7. Savanna
8. Succulent Karoo

5.3 Publications relevant to this chapter

Chesselet, P., Smith, G.F. & Van Wyk, A.E. 2001. A new tribal classification for the Mesembryanthemaceae Fenzl based on characters of the floral nectary. *Aloe* 38: 25–28. (Appendix 8: 558).

Chesselet, P., Smith, G.F. & Van Wyk A.E. 2002. A new tribal classification of the Mesembryanthemaceae: evidence from floral nectaries. *Taxon* 51: 295–308. (Appendix 4: 365).

Chesselet, P., Van Wyk, A.E. & Smith, G. F. 2004. Notes on African plants. Mesembryanthemaceae. A new tribe and adjustments to infrafamilial classification. *Bothalia*: 34: 47–51. (Appendix 5: 380).

Chesselet, P., Smith, G.F. & Van Wyk, A.E. 2000c. The habit and peculiar inflorescence of *Ottosonderia monticola* (Sond.) L.Bolus, Mesembryanthemaceae. *Aloe* 37: 88–90. (Appendix 9: 563).

Chesselet, P. & Smith, G.F. 2001. *Antimima aristulata* comb. nov. (Mesembryanthemaceae Fenzl); a heterophyllous succulent from Cape Town, South Africa. *Bradleya* 19: 121–123. (Appendix 10: 567).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Chesselet, P. & Van Wyk, A.E. 2002. Mesembs with nut-like schizocarpic fruit and *Ruschianthemum* Friedrich sunk under *Stoeberia* Dinter & Schwantes Mesembryanthemaceae. *Bothalia* 187–189. (Appendix 11: 571)

Chesselet, P. & Anderson, F. 2003. *Dorotheanthus rourkei.* Mesembryanthemaceae. South Africa. *Flowering plants of Africa* 58: 70–73. (Appendix 12: 576).

Chesselet, P., Hammer, S.A. & Oliver, I. 2003. *Brianhuntleya*, a new genus endemic to the Worcester-Robertson Karoo, South Africa. Notes on African plants. Mesembryanthemaceae. *Bothalia* 33:160–164. (Appendix 13: 581).

Chesselet, P. 2001. A new combination in *Antimima* N.E.Br. (Mesembryanthemaceae). *Aloe* 38: 17. (Appendix 14: 587).

Taxon x character state matrix for identification of mesemb genera. (Appendix 15: 589).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

CHAPTER 6

ILLUSTRATED ATLAS FOR IDENTIFICATION OF MESEMB GENERA

6.1 Index of plates

Notes: The genera *Circandra* and *Calamophyllum* are not included (the former being extinct and the latter being one of the mysteries of mesemb taxonomy). Characters are not necessarily distinguishing characters for the genus in which they are illustrated.

Figure number; Genus	**Characters illustrated**
6.1 *Acrodon*	5.2.2 - 6 (0); 5.2.4 - 3 (0); 5.2.4 - 7 (4)
6.2 *Aethephyllum*	5.2.2 - 9 (2); 5.2.4 - 14 (1)
6.3 *Aloinopsis*	5.2.1 - 3 (3)
6.4 *Amphibolia*	5.2.3 - 7 (3)
6.5 *Antegibbaeum*	5.2.1 - 8 (0) 5.2.4 - 7 (7)
6.6 *Antimima*	5.2.2 - 9 (4); 5.2.4 - 7 (5)
6.7 *Apatesia*	5.2.2 - 1 (0); 5.2.4 - 2 (2); 5.2.4 - 18 (1)
6.8 *Aptenia*	5.2.3 - 4 (0); 5.2.3 - 5 (0); 5.2.3 - 7 (0); 5.2.4 - 1 (0)
6.9 *Arenifera*	5.2.2 - 5 (0)
6.10 *Argyroderma*	5.2.4 - 12 (1)
6.11 *Aridaria*	5.2.4 - 1 (4); 5.2.4 - 20 (1)
6.12 *Aspazoma*	5.2.4 - 11 (0); 5.2.5 - 8 (0)
6.13 *Astridia*	5.2.4 - 7 (8)
6.14 *Bergeranthus*	5.2.4 - 4 (0)
6.15 *Bijlia*	none
6.16 *Braunsia*	5.2.2 - 8 (1)
6.17 *Brianhuntleya*	5.2.4 - 3 (4)
6.18 *Brownanthus*	5.2.1 - 2 (1); 5.2.2 - 5 (4); 5.2.3 - 4 (1); 5.2.3 - 6 (1); 5.2.3 - 6 (5)
6.19 *Carpanthea*	5.2.2 - 5 (11); 5.2.2 - 9 (3); 5.2.3 - 3 (1)
6.20 *Carpobrotus*	5.2.5 - 1 (2)
6.21 *Carruanthus*	none
6.22 *Caryotophora*	5.2.2 - 4 (0)
6.23 *Caulipsolon*	5.2.3 - 2 (0)
6.24 *Cephalophyllum*	5.2.4 - 3 (1)
6.25 *Cerochlamys*	none
6.26 *Chasmatophyllum*	5.2.4 - 7 (9); 5.2.4 - 18 (3)
6.27 *Cheiridopsis*	none

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Figure number; Genus	Characters illustrated
6.28 *Cleretum*	5.2.3 - 6 (0); 5.2.4 - 16 (1); 5.2.4 - 18 (2); 5.2.4 - 20 (0); 5.2.4 - 21 (0)
6.29 *Conicosia*	5.2.2 - 4 (2); 5.2.5 - 1 (1)
6.30 *Conophytum*	5.2.2 - 3 (3)
6.31 *Corpuscularia*	5.2.3 - 3 (3)
6.32 *Cylindrophyllum*	5.2.2 - 2 (2); 5.2.4 - 15 (0)
6.33 *Dactylopsis*	5.2.2 - 4 (5); 5.2.2 - 7 (1); 5.2.4 - 18 (0)
6.34 *Deilanthe*	5.2.2 - 4 (10)
6.35 *Delosperma*	5.2.2 - 1 (2); 5.2.2 - 4 (3)
6.36 *Dicrocaulon*	5.2.2 - 5 (2)
6.37 *Didymaotus*	5.2.4 - 1 (2); 5.2.4 - 9 (2)
6.38 *Dinteranthus*	5.2.2 - 4 (13); 5.2.4 - 9 (5)
6.39 *Diplosoma*	5.2.2 - 4 (9); 5.2.2 - 7 (2)
6.40 *Disphyma*	5.2.5 - 6 (2)
6.41 *Dorotheanthus*	5.2.4 - 7 (12); 5.2.4 - 17 (1); 5.2.5 - 1 (0)
6.42 *Dracophilus*	5.2.4 - 7 (3); 5.2.4 - 9 (1); 5.2.4 - 18 (5)
6.43 *Drosanthemum*	5.2.1 - 2(2); 5.2.3 - 6 (2); 5.2.3 - 6 (3)
6.44 *Eberlanzia*	5.2.4 - 1 (5); 5.2.4 - 6 (2)
6.45 *Ebracteola*	5.2.4 - 8 (2); 5.2.5 - 6 (4)
6.46 *Ectotropis*	none
6.47 *Enarganthe*	5.2.3 - 3 (0); 5.2.4 - 8 (2)
6.48 *Erepsia*	5.2.3 - 2 (2)
6.49 *Esterhuysenia*	5.2.4 - 21 (1)
6.50 *Faucaria*	5.2.2 - 9 (5)
6.51 *Fenestraria*	5.2.2 - 8 (3); 5.2.4 - 3 (2)
6.52 *Frithia*	5.2.4 - 7 (13)
6.53 *Gibbaeum*	5.2.2 - 13 (1)
6.54 *Glottiphyllum*	5.2.2 - 2 (3); 5.2.2 - 4 (7); 5.2.4 - 18 (6)
6.55 *Hallianthus*	none
6.56 *Hammeria*	5.2.4 - 3 (1)
6.57 *Hartmanthus*	5.2.1 - 2 (5)
6.58 *Hereroa*	5.2.2 - 13 (0); 5.2.5 - 6 (1)
6.59 *Hymenogyne*	5.2.4 - 16 (0)
6.60 *Ihlenfeldtia*	5.2.4 - 2 (1)
6.61 *Jacobsenia*	none
6.62 *Jensenobotrya*	5.2.2 - 4 (6)
6.63 *Jordaaniella*	5.2.3 - 2 (1); 5.2.3 - 4 (2); 5.2.3 - 7 (1)
6.64 *Juttadinteria*	5.2.2 - 5 (8); 5.2.4 - 7 (2); 5.2.4 - 20 (2)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Figure number; Genus	Characters illustrated
6.65 *Khadia*	none
6.66 *Lampranthus*	5.2.2 - 3 (1); 5.2.3 - 6 (4); 5.2.3 - 7 (5); 5.2.4 - 7 (6)
6.67 *Lapidaria*	none
6.68 *Leipoldtia*	5.2.5 - 2 (7)
6.69 *Lithops*	5.2.1 -2 (4); 5.2.2 - 5 (14)
6.70 *Machairophyllum*	5.2.2 - 5 (6)
6.71 *Malephora*	5.2.2 - 5 (1)
6.72 *Marlothistella*	5.2.1 - 8(0)
6.73 *Mesembryanthemum*	5.2.1 - 2 (0); 5.2.3 - 5 (1); 5.2.4 - 17 (0)
6.74 *Mestoklema*	5.2.1 - 3 (2); 5.2.4 - 7 (11)
6.75 *Meyerophytum*	none
6.76 *Mitrophyllum*	5.2.5 - 12 (1)
6.77 *Monilaria*	5.2.2 - 6 (1); 5.2.2 - 7 (3); 5.2.3 - 5 (3)
6.78 *Mossia*	none
6.79 *Muiria*	5.2.4 - 11 (1)
6.80 *Namaquanthus*	none
6.81 *Namibia*	5.2.4 - 10 (1)
6.82 *Nananthus*	5.2.1 - 2 (3); 5.2.4 - 7 (10)
6.83 *Nelia*	none
6.84 *Neohenricia*	5.2.2 - 6 (1)
6.85 *Octopoma*	5.2.2 - 6 (2)
6.86 *Odontophorus*	5.2.2 - 5 (9)
6.87 *Oophytum*	5.2.2 - 4 (12)
6.88 *Orthopterum*	none
6.89 *Oscularia*	none
6.90 *Ottosonderia*	5.2.4 - 1 (6)
6.91 *Peersia*	5.2.4 - 21 (2)
6.92 *Phiambolia*	none
6.93 *Phyllobolus*	5.2.2 - 2 (1); 5.2.4 - 7 (1)
6.94 *Pleiospilos*	5.2.3 - 3 (4); 5.2.4 - 9 (3)
6.95 *Polymita*	5.2.2 - 3 (2); 5.2.3 - 3 (2)
6.96 *Prenia*	none
6.97 *Prepodesma*	none
6.98 *Psammophora*	none
6.99 *Psilocaulon*	none
6.100 *Rabiea*	5.2.2 - 5 (7)
6.101 *Rhinephyllum*	none

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Figure number; Genus	Characters illustrated
6.102 *Rhombophyllum*	5.2.2 - 4 (14); 5.2.4 - 1 (3)
6.103 *Ruschia*	5.2.1 - 2 (6); 5.2.3 - 4 (3); 5.2.3 - 7 (2); 5.2.4 - 1 (1)
6.104 *Ruschianthus*	5.2.2 - 4 (11)
6.105 *Saphesia*	5.2.2 - 2 (0)
6.106 *Sarcozona*	none
6.107 *Sceletium*	5.2.2 - 4 (1); 5.2.4 - 7 (0)
6.108 *Schlechteranthus*	none
6.109 *Schwantesia*	5.2.2 - 9 (6)
6.110 *Scopelogena*	5.2.3 - 7 (4)
6.111 *Skiatophytum*	5.2.4 - 10 (0)
6.112 *Smicrostigma*	5.2.2 - 4 (8)
6.113 *Stayneria*	5.2.2 - 4 (4)
6.114 *Stoeberia*	5.2.3 - 5 (2); 5.2.4 - 8 (0)
6.115 *Stomatium*	5.2.4 - 18 (4); 5.2.4 - 20 (3)
6.116 *Synaptophyllum*	5.2.2 - 1 (1); 5.2.4 - 13 (0); 5.2.5 - 2 (1); 5.2.5 - 12 (0)
6.117 *Tanquana*	5.2.4 - 9 (0); 5.2.4 - 12 (0)
6.118 *Titanopsis*	5.2.2 - 5 (12)
6.119 *Trichodiadema*	5.2.2 - 5 (3); 5.2.2 - 8 (2)
6.120 *Vanheerdea*	5.2.4 - 15 (2)
6.121 *Vanzijlia*	5.2.4 - 15 (1)
6.122 *Vlokia*	none
6.123 *Wooleya*	5.2.2 - 5 (13)
6.124 *Zeuktophyllum*	5.2.4 - 2 (0)
6.125 Fruit types	Pp. 254-255. All fruit types and morphological details illustrated.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

6.2 Concise character list

Note: Character numbering in this consice character list is according to numbering of the character analysis in Chapter 5. Characters are grouped according character sets.

5.2 Character list

5.2.1 Vegetative character set: Life cycle and growth form

Character 1: Life cycle (longevity of plants) (KEY; PHYLO)

0. Annual
1. Biennial
2. Perennial with annual branches
3. Perennial

Character 2: Overall appearance (KEY)

0. Semi-succulent, fleshy herb, often soft-leaved, glistening [Fig. 6.73]
1. Stem-succulent [Fig. 6.18]
2. Creeping succulent [Fig. 6.43]
3. Tufted, or clump-forming or rosette-leaved succulent, sometimes glistening [Fig. 6.82]
4. Stone plants consisting mostly of succulent leaves (stems not visible, miniatures) [Fig. 6.69]
5. Succulent-leaved shrub (including dwarf shrubs) [Fig. 6.57]
6. Spiny succulent-leaved shrub or subshrub [Fig. 6.103]

Character 3: Roots (KEY)

0. Fibrous, not enlarged, or slighly thickened
1. Caudiciform stem and swollen roots
2. Single or multiple swollen tubers (potato-like) [Fig. 6.74]
3. Thick tuberous roots, branching underground (woody) [Fig. 6.3]
4. Becoming thick and fleshy with age
5. Roots, thick, spreading laterally, giving rise to suckers

5.2.2 Vegetative character set: Leaves

Character 1: Attachment of leaves to stem (KEY)

0. Petiolate [Fig. 6.7]
1. Stem-clasping [Fig. 6.116]
2. Without petiole [Fig. 6.35] add to lucid

Character 2: Leaf arrangement (KEY)

0. Leaves alternate [Fig. 6.105]
1. Leaves alternate in the inflorescence [Fig. 6.93]
2. Leaves opposite [Fig. 6.32]
3. Leaves distichous [Fig. 6.54]

Character 3: Leaf pairs (degree of fusion) (KEY)

0. Free [Fig. 6.43]
1. Basally connate [Fig. 6.66]
2. Partly fused [Fig. 6.95]
3. Entirely fused [Fig. 6.30]

Character 4: Leaf shape (KEY)

0. Flat, mesophytic [Fig. 6.22]
1. Flattish, withering to skeleton [Fig. 6.107]
2. Linear, mesophytic [Fig. 6.29]
3. Flattish, grooved upper surface, semi-succulent [Fig. 6.35]
4. Trigonous or triquetrous [Fig. 6.113]

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

5. Cylindrical, semi-cylindrical [Fig. 6.33]
6. Clavate [Fig. 6.62]
7. Tongue, strap-shaped, succulent [Fig. 6.54]
8. Fused and stem-sheathing at base, diverging at tips, highly succulent [Fig. 6.112]
9. Ovate in outline, succulent [Fig. 6.39]
10. Spatulate [Fig. 6.34]
11. Falcate or lunate [Fig. 6.104]
12. Fused to form conical, oblong, or spherical bodies [Fig. 6.87]
13. Globose, forming a rounded body and only fused basally [Fig. 6.38]
14. Rhomboid [Fig. 6.102]

Character 5: Leaf surface (KEY)

0. Sticky, with sand adhering (psammophorous) [Fig. 6.9]
1. Distinctly waxy [Fig. 6.71]
2. Visible bladder cells, glistening and shiny in the light [Fig. 6.36]
3. Bladder cells elevated and pointed at one or both ends [Fig. 6.119]
4. Xeromorphic bladder cells, hard water cells (10x lens) [Fig. 6.18]
5. Elongated, hair-like bladder cells
6. Smooth and untextured [Fig. 6.70]
7. Pellucid dots (subepidermal tannin idioblasts) [Fig. 6.100]
8. Papillate, rough to the touch [Fig. 6.64]
9. Velvety, from soft hairs [Fig. 6.86]
10. Echinate, prickly
11. Scattered visible hairs [Fig. 6.19]
12. Rough with white bumps or pustules [Fig. 6.118]
13. Ridges, woolly appearance [Fig. 6.123]
14. Textured with ridges and markings [Fig. 6.69]

Character 6: Leaf pair types (KEY)

0. One leaf type only (isophyllous plant) [Fig. 6.1]
1. Differently shaped leaves at different seasons (heterophyllous plant) [Fig. 6.77]
2. Differently shaped leaves on different parts of the plant [Fig. 6.85]
3. Heterophyllous in seedling stages only

Character 7: Leaf sheaths (KEY)

0. Absent
1. Old leaf sheaths persistent, papery or parchment-like [Fig. 6.33]
2. Leaves, enclosed by brown to black sclerotic sheaths [Fig. 6.39]
3. Internodes enclosed by sclerotic bases of old leaf sheaths [Fig. 6.77]

Character 8: Leaf tips (KEY)

0. Pointed or rounded [Fig. 6.72; Fig. 6.5]
1. Distinctly apiculate or mucronate [Fig. 6.16]
2. Tipped with diadem of hairs [Fig. 6.119]
3. Windowed [Fig. 6.51]

Character 9: Leaf margins and keel (KEY)

0. Small bladder cells at margins
1. Undulated when young
2. Undulated or pinnatifid in adult leaf [Fig. 6.2]
3. Margins ciliate [Fig. 6.19]
4. Serrated margins or keel [Fig. 6.6]
5. Hard teeth or bristles on margins or keel [Fig. 6.50]
6. Keel oblique or twisted [Fig. 6.109]

Character 10: Epidermis type (PHYLO)

0. Idioblast-type
1. Intermediate
2. Xeromorphic-type

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Character 11: Stomatal types (PHYLO)

0. Anomocytic-anisocytic-paracytic
1. Anisocytic-paracytic
2. Paracytic

Character 12: Leaf persistence on plant (DESC)

0. Leaves not deciduous
1. Leaves deciduous

Character 13: Relative length of two leaves forming a pair (DESC)

0. Leaves of a pair equal (isophyllous plant) [Fig. 6.58]
1. Leaves of a pairs of distinctly different lengths (anisophyllous plant) [Fig. 6.53]

5.2.3 Vegetative character set: Stems and branches

Character 1: Wide band tracheids (PHYLO)

0. Absent
1. Present

Character 2: Branches (KEY)

0. Procumbent or decumbent or sprawling (not rooting at nodes) [Fig. 6.23]
1. Creeping or saltating (rooting at nodes) [Fig. 6.63]
2. Erect [Fig. 6.48]
3. Climbing

Character 3: Stem (internodes) (KEY)

0. Visible, internodes easily seen [Fig. 6.47]
1. Visible, but very short, bearing tufts of leaves [Fig. 6.19]
2. Present, but hidden by highly fused sheathing leaves [Fig. 6.95]
3. Visible, very short, hidden by densely packed leaves along branches [Fig. 6.31]
4. Not visible (internodes abbreviated or hidden) [Fig. 6.94]

Character 4: Stem consistency (KEY)

0. Fleshy (soft) [Fig. 6.8]
1. Succulent (hard) [Fig. 6.18]
2. Spongy or corky [Fig. 6.63]
3. Woody [Fig. 6.103]

Character 5: Stem shape (KEY)

0. 4-angled [Fig. 6.8]
1. Winged [Fig. 6.73]
2. Cylindrical [Fig. 6.114]
3. Articulated, beaded [Fig. 6.77]

Character 6: Stem surface texture and ornamentation (KEY)

0. Papillate with large easily visible water cells [Fig. 6.28]
1. Xeromorphic water cells [Fig. 6.18]
2. Hairy [Fig. 6.43]
3. Papillate in young stems [Fig. 6.43]
4. Smooth [Fig. 6.66]
5. Fringe of hair at nodes [Fig. 6.18]

Character 7: Stem colour at maturity (KEY)

0. Greenish [Fig. 6.8]
1. Yellowish [Fig. 6.63]
2. Brown [Fig. 6.103]
3. Whitish or grey [Fig. 6.4]
4. Bluish green [Fig. 6.110]
5. Reddish [Fig. 6.66]

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

5.2.4 Reproductive character set: Flowering, inflorescence & flowers

Character 1: Inflorescence characteristics (KEY)

0. Leafy inflorescences [Fig. 6.8]
1. Cymose, mostly solitary (difficult to separate from strictly solitary) [Fig. 6.103]
2. Paired, two flowers produced simultaneously on either side of plant body [Fig. 6.37]
3. Cymose, mostly in threes [Fig. 6.102]
4. Angular cyme [Fig. 6.11]
5. Many-flowered dichasia or compound cymes [Fig. 6.44]
6. Succulent cymose inflorescence (persistent, highly succulent) [Fig. 6.90]
7. Candelabra
8. Spiny inflorescences [Fig. 6.103]

Character 2: Pedicel length (KEY)

0. Flower subtended by long pedicel [Fig. 6.7]
1. Flower subtended by short pedicel [Fig. 6.60]
2. Flower sessile or sub-sessile [Fig. 6.124]

Character 3: Pedicel shape and behaviour (DESC)

0. Pedicel upright, long-lived and woody [Fig. 6.1]
1. Pedicel bending after flowering, capsule lies on ground [Fig. 6.24]
2. Pedicel S-shaped (sigmoid) [Fig. 6.51]
3. Pedicel from which capsule breaks off after ripening leaving a prickly star (sclerotinized bases of 5 bundles)
4. Pedicel succulent, drying out and breaking when fruit is ripe [Fig. 6.17]

Character 4: Bracts (KEY)

0. Present, 1 pair [Fig. 6.14]
1. Present, 2 pairs
2. Absent

Character 5: Flowering time (seasonal) (KEY)

0. Winter
1. Spring
2. Summer
3. Autumn

Character 6: Diurnal floral rhythm (KEY)

0. Opening in sunshine, midday, or in the afternoon
1. Opening in the evening or at night [Fig. 6.84]
2. Continuously open [Fig. 6.44]

Character 7: Flower colour (KEY)

0. Cream, yellowish [Fig. 6.107]
1. Greenish [Fig. 6.93]
2. White [Fig. 6.64]
3. Pale pink [Fig. 6.42]
4. Pink with stripe [Fig. 6.1]
5. Pink [Fig. 6.6]
6. Orange [Fig. 6.66]
7. Magenta [Fig. 6.5]
8. Red [Fig. 6.13]
9. Yellow [Fig. 6.26]
10. Yellowish-orange with stripe [Fig. 6.82]
11. Copper-coloured [Fig. 6.74]
12. Multi-coloured [Fig. 6.41]
13. Bicoloured, pink or magenta and white [Fig. 6.52]

Character 8: Flower size (KEY)

0. Small (<20 mm) [Fig. 6.114]

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

1. Medium (20–40 mm) [Fig. 6.45]
2. Large (>40 mm) [Fig. 6.47]

Character 9: Number of sepals (DESC)
0. 4 [Fig. 6.117]
1. 5 [Fig. 6.42]
2. 6 [Fig. 6.37]
3. 7 [Fig. 6.94]
4. 8
5. 9 or more [Fig. 6.38]

Character 10: Relative length of sepals (DESC)
0. Unequal in length [Fig. 6.111]
1. Almost equal in length [Fig. 6.81]

Character 11: Position of the ovary (KEY; PHYLO)
0. Half-inferior [Fig. 6.12]
1. Inferior [Fig. 6.79]

Character 12: Hypanthium (DESC)
0. Absent [Fig. 6.117]
1. Present [Fig. 6.10]

Character 13: Placentation (KEY; PHYLO)
0. Axile [Fig. 6.116]
1. 'Basal' or parietal [Fig. 6.56]

Character 14: Development of petals (petaloid staminodes) (PHYLO)
0. Petals absent, sepals petaloid inside
1. Petals present, of staminodial origin [Fig. 6.2]

Character 15: Filamentous staminodes (KEY; PHYLO)
0. Present, spreading [Fig. 6.32]
1. Present, gathered with stamens in central cone [Fig. 6.121]
2. Absent (0 to few) [Fig. 6.120]

Character 16: Filaments (PHYLO)
0. Naked [Fig. 6.59]
1. Papillate [Fig. 6.28]

Character 17: Fusion of petals (PHYLO)
0. Fused at their base for a few millimetres [Fig. 6.73]
1. Free [Fig. 6.41]

Character 18: Floral nectaries (KEY)
0. Koilomorphic meronectary [Fig. 6.33]
1. Broad, flat holonectary [Fig. 6.7]
2. Broad, flat meronectary [Fig. 6.28]
3. Lophomorphic meronectary [Fig. 6.26]
4. Specialized meronectary of the *Stomatium*-type [Fig. 6.115]
5. Lophomorphic holonectary [Fig. 6.42]
6. Nectary inconspicuous, absent [Fig. 6.54]

Character 19: Structure of nectary (PHYLO)
0. Continuous ring (holonectary)
1. Segmented into as many parts as there are carpels in the gynoecium (meronectary)

Character 20: Shape of nectary surface (PHYLO)
0. Flat [Fig. 6.28]
1. Sunken as pits and hollows (koilomorphic) [Fig. 6.11]

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

2. Raised and crested or lobed [Fig. 6.64]
3. Smooth nectariferous tissue, raised as droplet-like structures on inner walls of shallow hypanthium [Fig. 6.115]

Character 21: Nectary colour (DESC)
0. Green (as surrounding tissue) [Fig. 6.28]
1. Dark green (distinct in colour from surrounding tissue) [Fig. 6.49]
2. Yellowish [Fig. 6.42]

5.2.5 Reproductive character set: Fruit

Note: A separate section at the end of Chapter 6 is entirely dedicated to the identification of mesemb fruit. Only few characters are illustrated in the plates for mesemb genera as these were not adequately illustrated.

Character 1: Fruit type & dehiscence (KEY)
0. Hygrochastic, opening when wet [Fig. 6.41]
1. Xerochastic, dehiscent when dry (schizocarpic) [Fig. 6.29]
2. Fleshy, indehiscent [Fig. 6.20]
3. Nut-like fruit
4. Schizocarpic fruit derived from the *Delosperma*-type ground-plan

Character 2: Number of locules (KEY)
0. 3
1. 4 [Fig. 6.116]
2. 5
3. 6
4. 7
5. 8
6. 9
7. 10 [Fig. 6.68]
8. 11
9. 12
10. More than 12

Character 3: Open hygrochastic fruit, covering membranes (KEY)
0. Absent (Mesembryanthemoideae)
1. Absent, reduced to a limb
2. Present, half to two thirds locule covered
3. Present, well developed

Character 4: Covering membranes (PHYLO)
0. Not applicable due to structure of fruit
1. Absent (*Apatesia*-type fruit)
2. Absent in fruit with undifferentiated expanding tissue (expanding keels not distinct from expanding sheets) e.g. *Cleretum*
3. Present, simple (derived from valvar endocarp, translucent, persistent in shape and ± flat, expanding keels divergent) e.g. *Drosanthemum*
4. Absent in fruit with differentiated parallel expanding keels (or present as translucent covering membranes of septal origin) e.g. *Delosperma*
5. Present, compound (derived from valvar endocarp and inner endocarpal tissue, translucent, persistent in shape and ± flat)
6. Present, persistent in shape, and stout e.g. *Ruschia* and *Leipoldtia*

Character 5: Elaboration of rims of covering membranes (PHYLO)
0. No elaboration, covering membranes flat, of equal diameter throughout
1. Central part thicker than margin, margin inflected into empty locule
2. Recurved at distal end
3. Recurved at distal end with closing rodlets on under surface

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

4. Recurved at distal end with closing ledges and a bulge that gives covering membranes a concave appearance

Character 6: Open fruit, closing devices at exits of locules (KEY)

0. Absent (placenta axile or basal to parietal)
1. Absent, large spongy closing ledge [Fig. 6.58]
2. Present, bifid or two-lobed [Fig. 6.40]
3. Absent, dense mass of funicular hairs at opening of locules
4. Present, small, white [Fig. 6.45]
5. Present, small, sometimes rod or hood-shaped
6. Present, lens-shaped, large, splitting longitudinally
7. Present, large, rounded, stalked and white

Character 7: Structures that close distal exits of locules (PHYLO)

0. Absent
1. Present as bulges of the fruit wall
2. Present as small knobs, sometimes inconspicuous and surrounded by few funicular hairs
3. Present as thick bunches of funicular hairs that may swell and block distal exits of locules
4. Present as rod or hook-shaped structures
5. Present, lens-shaped, large, splitting longitudinally
6. Present as enlarged, stalked whitish closing bodies

Character 8: Open fruit, valve wings and flaps (KEY)

0. Large flaps (*Mesembryanthemum*-type fruit) [Fig. 6.12]
1. Valve wings present, well developed
2. Valve wings present, very long and ribbon-like
3. Valve wings well developed, hard (sclerified), rounded
4. Valve wings absent
5. Valve wings present, awn like

Character 9: Valve wings (PHYLO)

0. Present as flaps, entirely connate to valve
1. Present as variously shaped membranous wings on sides of valves
2. Absent (lost)
3. Present as awns at the ends of expanding keels

Character 10: Fruit dehiscence, derivation of expanding tissue (PHYLO)

0. Hygrochastic, expanding tissue of septal origin
1. Hygrochastic, expanding tissue of valvar origin, tendency towards schizocarpy and xerochasty
2. Fully functional hygrochastic tissue of valvar origin

Character 11: Differentiation of valvar expanding tissue (PHYLO)

0. Not applicable (septal origin)
1. Expanding sheets predominant but expanding properties reduced
2. Expanding sheets predominant merging into fully functional expanding keels
3. Expanding sheets clearly differentiated from expanding keels

Character 12: Expanding keels (PHYLO)

0. Radial, from central axis of fruit to valves [Fig. 6.116]
1. Curved, merged with expanding sheets, ± restricted to valves [Fig. 6.76]
2. Expanding keels divergent, distinct from expanding sheet, broadened, ± restricted to valves
3. Expanding keels radial, distinct from expanding sheet (associated with lack of covering membranes), ± restricted to valves
4. Divergent, distinct from expanding sheet, short, not higher than broad, ± restricted to valves
5. Divergent, distinct from expanding sheet, sometimes with distinct radial awn, ± restricted to valves

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

5.2.6 Geographic character set: Broad distribution data

Character 1: Distribution (Global) (KEY)

0. South Africa
1. Namibia
2. Botswana
3. Lesotho
4. Swaziland
5. Mozambique
6. Zimbabwe
7. Angola
8. Madagascar & Reunion
9. Eastern Africa
10. Australia & New Zealand
11. USA
12. Chile
13. Mediterranean

Character 2: Province (South Africa) (KEY)

0. Western Cape
1. Northern Cape
2. Eastern Cape
3. Free State
4. North-West Province
5. Limpopo
6. Gauteng
7. KwaZulu/Natal
8. Mpumalanga

Character 3: Biome (southern Africa)

0. Albany Thicket
1. Coastal Belt
2. Desert
3. Forest
4. Fynbos
5. Grassland
6. Nama-Karoo
7. Savanna
8. Succulent Karoo

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

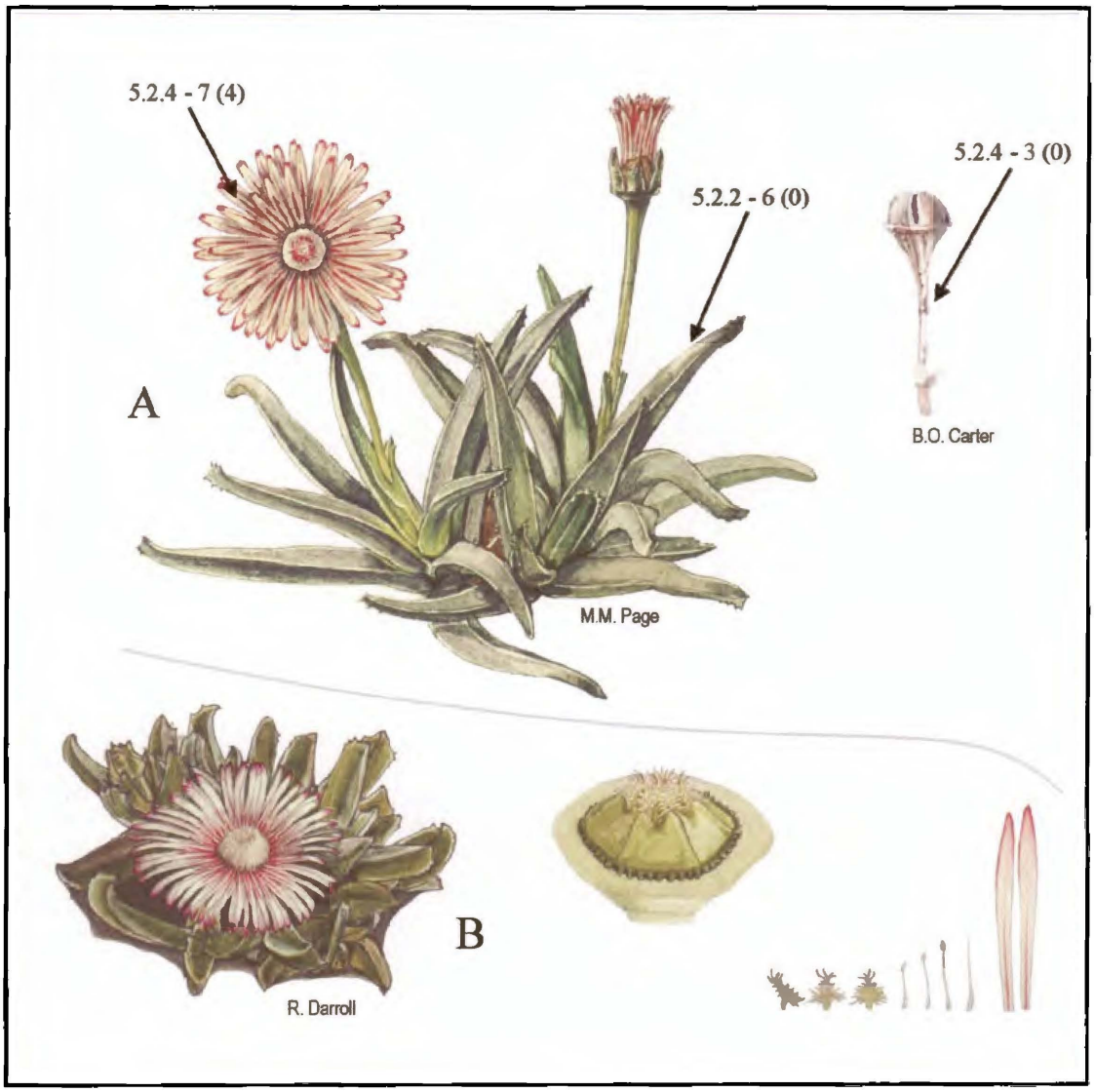


Fig. 6.1

TAXA
A. *A. bellidiflorus*
B. *Acrodon* sp.

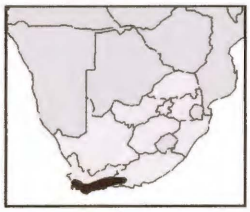
CHARACTERS
5.2.2 - 6 (0): Leaf pair types - One leaf type only (isophyllous plant).
5.2.4 - 3 (0): Pedicel shape and behaviour - Pedicel upright, long-lived and woody .
5.2.4 - 7 (4): Flower colour - Pink with stripe.

DISTINGUISHING CHARACTERS
Tufted or creeping perennials with sharply triquetrous leaves which are toothed on keel and at apex; mostly solitary flowers usually with striped petals and white pollen, stigmas short, plumose; fruit with lens-shaped closing bodies; seeds tuberculate.

Fruit a 5-locular capsule, nearest *Ruschia*-type, woody, valves opening incompletely; valve wings awn-like or rarely absent; expanding keels slightly diverging; covering membranes stiff, complete; closing bodies large, lens-shaped, splitting longitudinally.

NOTES
6 spp. Confined to the Fynbos Biome.
A. purpureostylus may be confused with *Brianhuntleya intrusa* and may, in the future, be removed from *Acrodon*.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

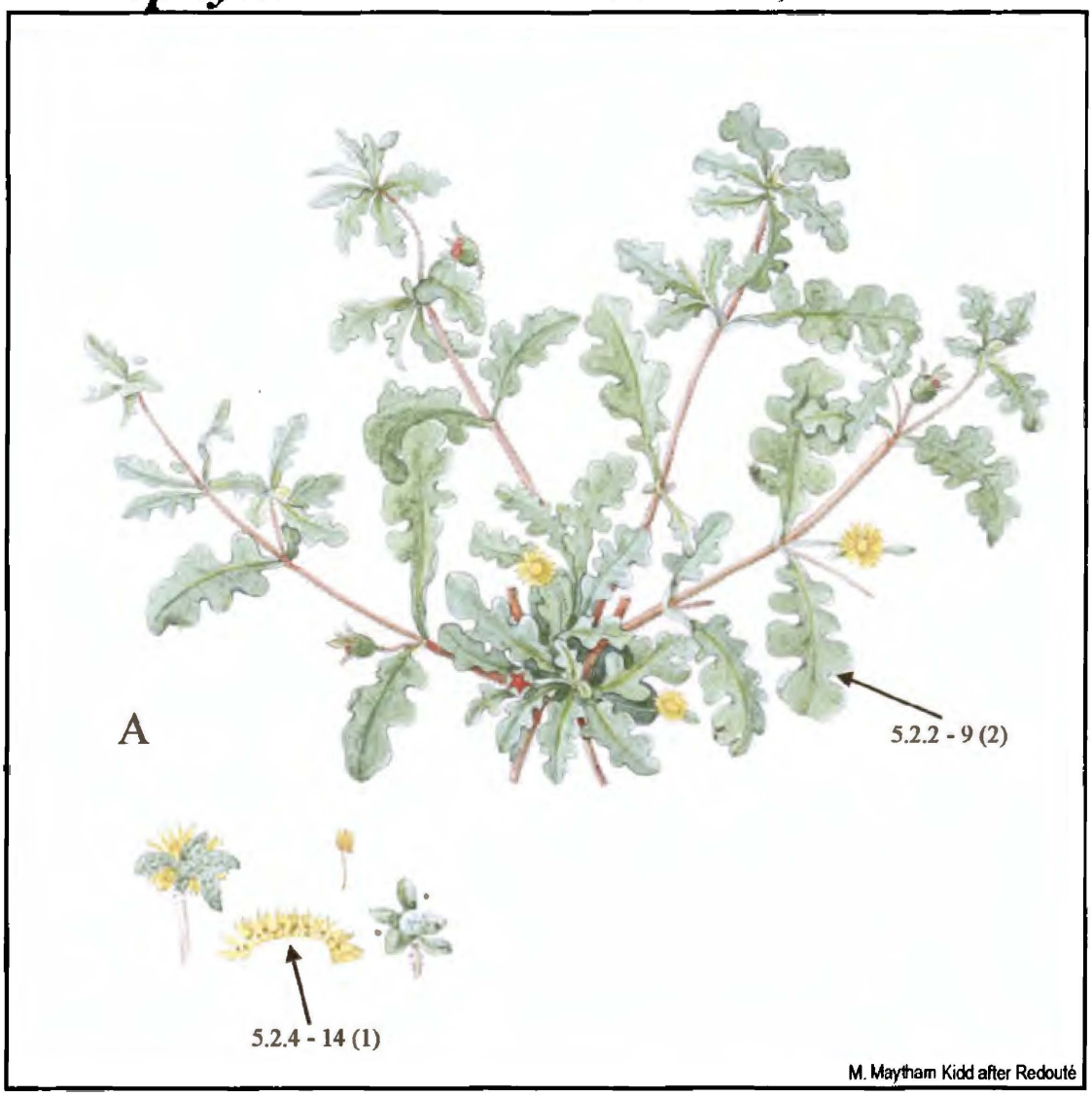


Fig. 6.2

TAXON
A. *A. pinnatifidum*

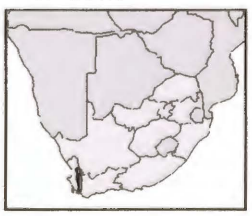
DISTINGUISHING CHARACTERS
Annual, semi-succulent herbs with flat-growing habit and pinnatifid leaves; fruit on relatively long pedicels and flat on top; flowers yellow.

Fruit a (4)5(6)-locular capsule, of *Cleretum*-type; expanding sheets large, tapering into loose apical membranes; covering membranes reduced to a limb.

CHARACTERS
5.2.2 - 9 (2): Leaf margins and keel: Undulated or pinnatifid in adult leaf.
5.2.4 - 14 (1): Development of petals (petaloid staminodes) - Petals present, of staminodial origin.

NOTES
1 sp. Confined to Fynbos Biome. *A. pinnatifidum* may be confused with *Cleretum herrei*.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

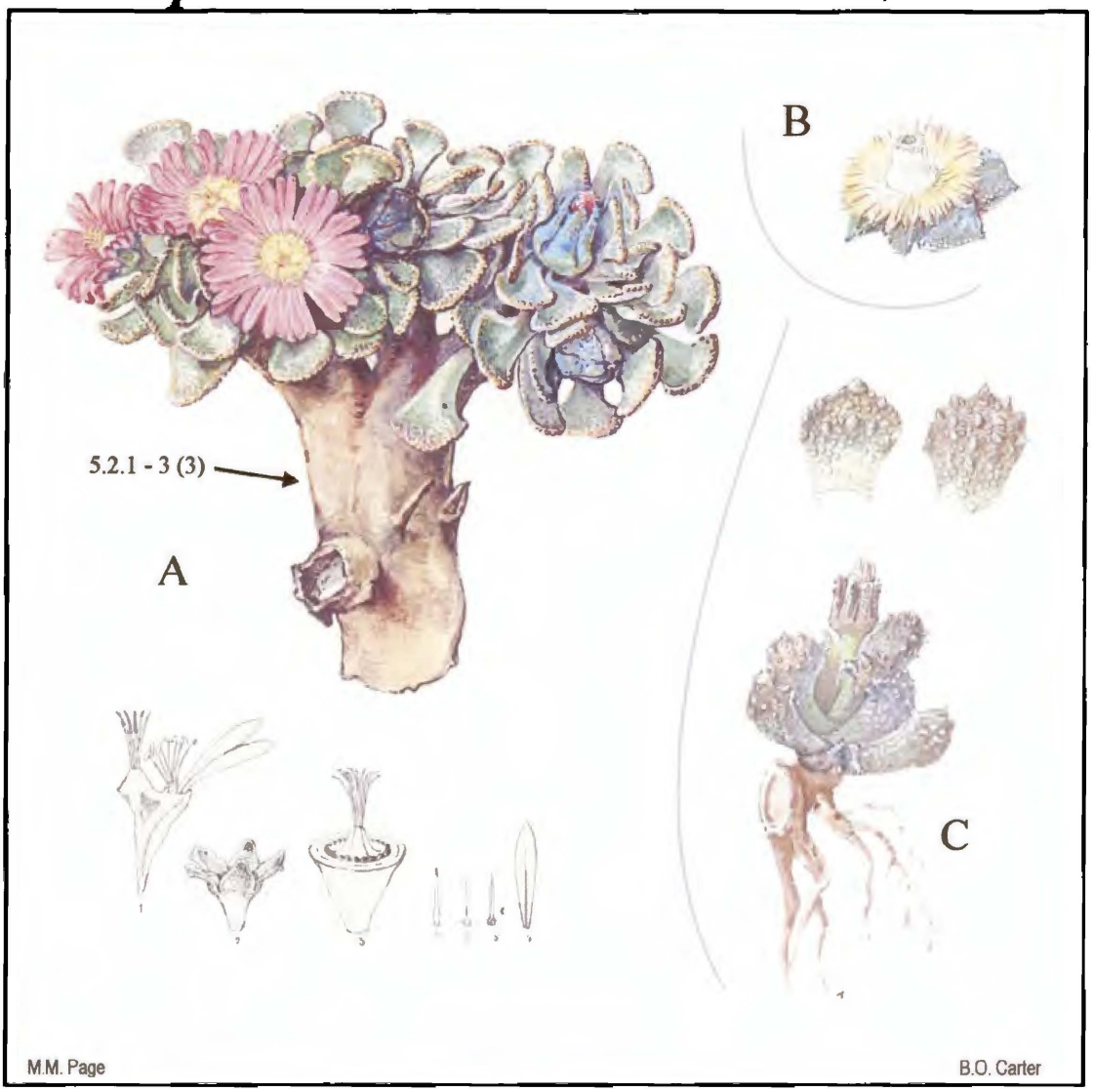


Fig. 6.3

TAXA
A. *A. spathulata*
B. *A. jamesii*
C. *A. luckhoffii*

DISTINGUISHING CHARACTERS
Rosette-forming perennials with rough, spoon-shaped leaves; roots tuberous; flowers with striped petals; seeds ovoid.

Fruit a 6–14-locular capsule of *Titanopsis*-type, nearly flat to conical above, semiglobose, convex, obconic or nearly flat below; expanding keels parallel, diverging at tips; covering membranes complete or relictual; valve wings well developed; closing bodies absent, rudimentary or well developed.

CHARACTERS
5.2.1 - 3 (3): Roots - Thick tuberous roots, branching underground (woody).

NOTES
8 spp. Mostly confined to Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

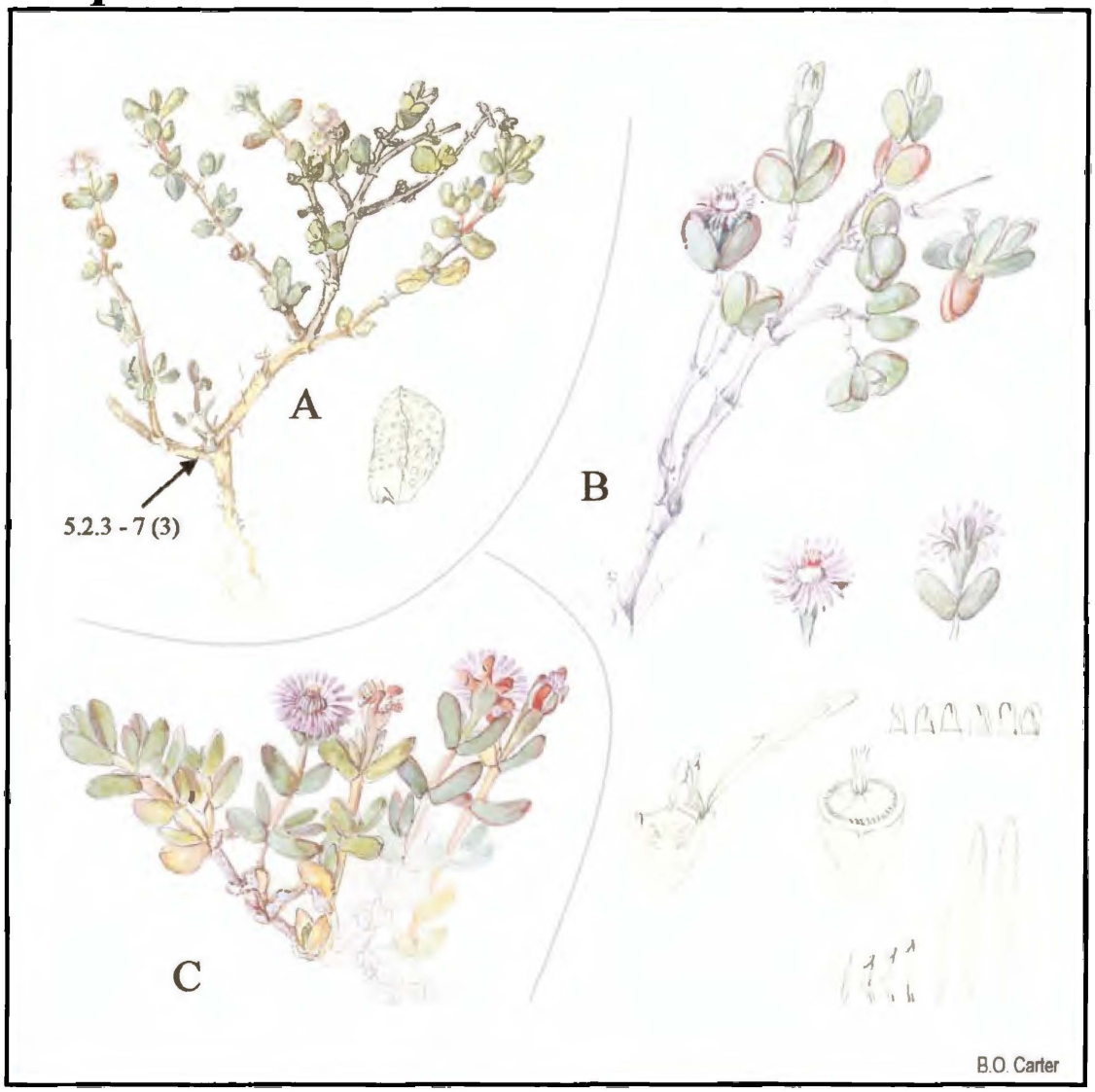


Fig. 6.4

TAXA
A. *A. rupis-arcuatae*
B. *A. saginata*
C. *A. laevis*

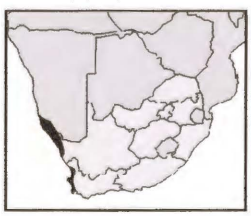
CHARACTERS
5.2.3 - 7 (3): Stem colour at maturity - Whitish or grey.

DISTINGUISHING CHARACTERS
White-stemmed shrubs; fruit with valve wings, without covering membranes; flowers with stamens gathered in a cone and pink stripes on petals.

Fruit a capsule, whitish, often filled with spongy tissue, 5-locular with locules deep and narrow, once open does not close again; valves with rectangular wings (as in *Lampranthus*-type); expanding keels diverging, touching at their bases; covering membranes with closing rodlets or thick closing ledges on distal undersurfaces; closing bodies small, white, endocarpal, sometimes deep in the locule.

NOTES
5 spp. The genus is mostly coastal. It probably contains another species (*Ruschia promontorii* currently sunk under *A. hutchinsonii*).

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

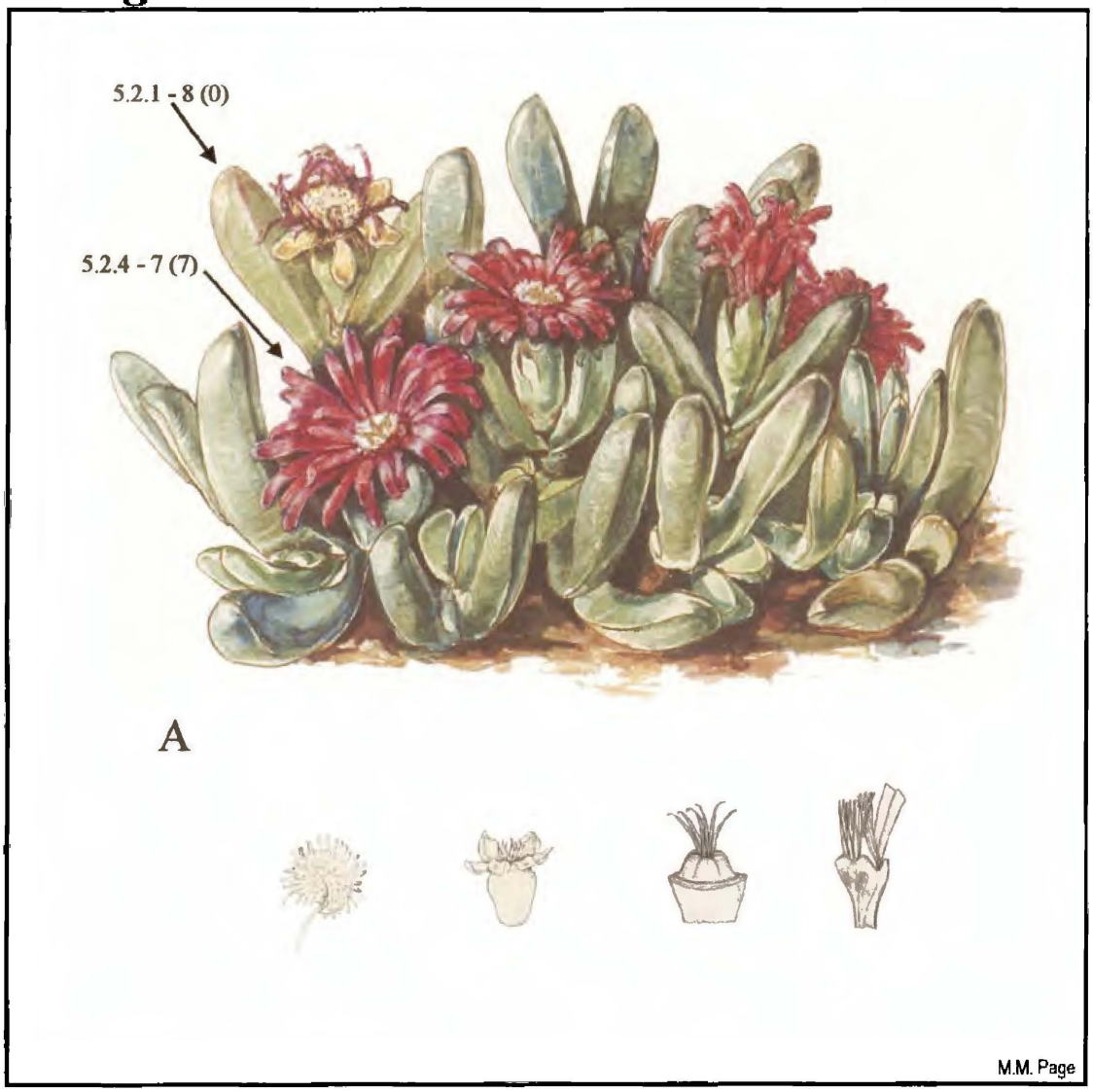


Fig. 6.5

TAXON
A. *A. fissoides*

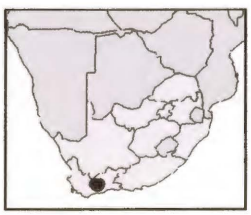
CHARACTERS
5.2.1 - 8 (0): Leaf tips - (Pointed or) rounded.
5.2.4 - 7 (7): Flower colour - Magenta.

DISTINGUISHING CHARACTERS
Tufted dwarf succulent with large magenta flowers (60 mm diameter); 6 locules, stigmas and sepals; nectary annular; seeds echinate.

Fruit a 6-locular capsule, of *Lampranthus*-type, shortly conical to convex, with prominent sutures; valve wings broad; covering membranes present; no closing bodies.

NOTES
1 sp. Endemic to the Little Karoo Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

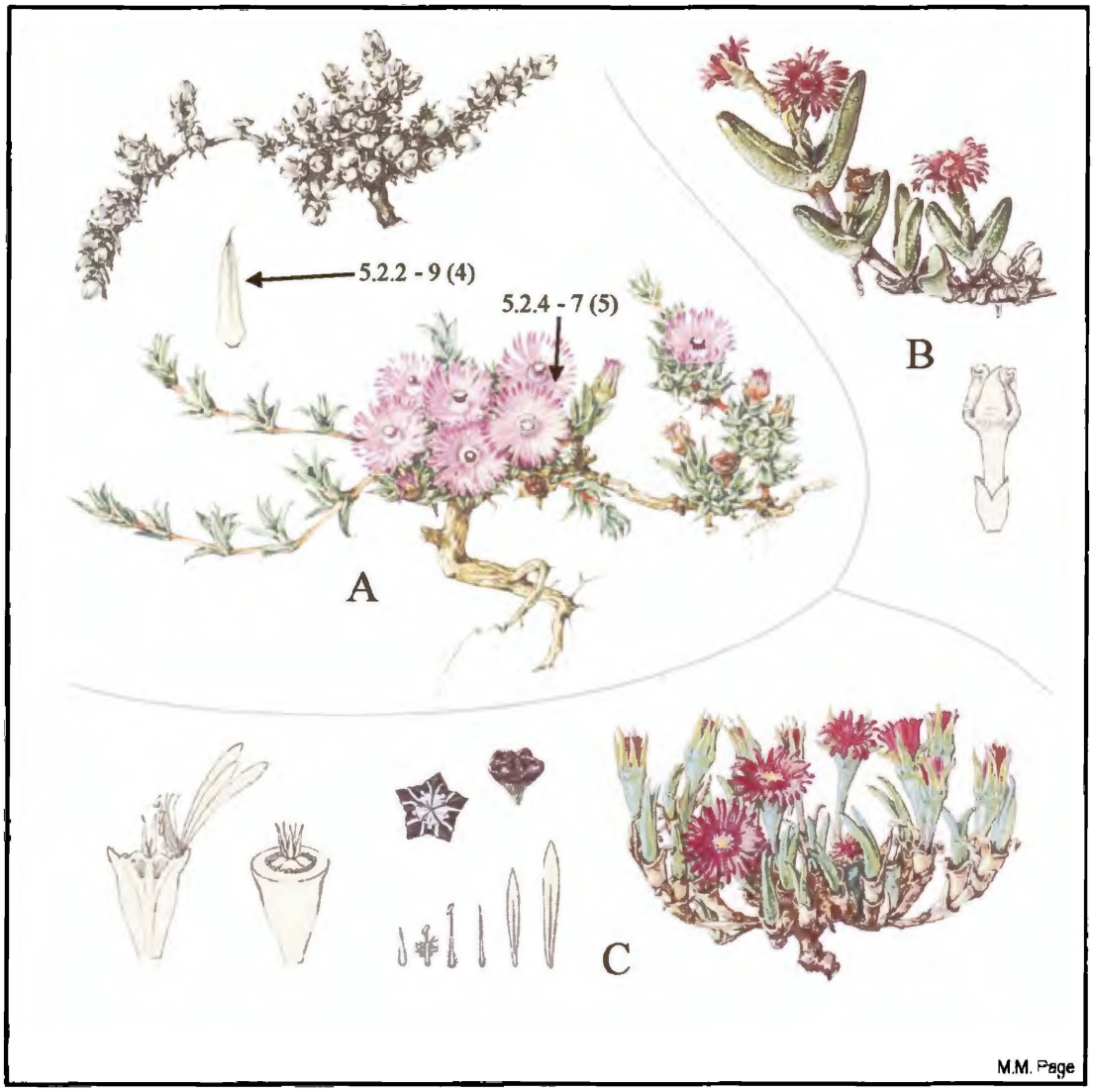


Fig. 6.6

TAXA
A. *A. aristulata*
B. *A. solida*
C. *A. peersii*

DISTINGUISHING CHARACTERS
Variable perennials, sometimes heterophyllous; leaves often rough-textured; 5-locular capsules with large, stalked, white closing bodies.

Fruit a 5(6)-locular capsule, close to *Letpoldtia*-type, pedicellate, always with persisting bracteoles, top with high or low valve rims, base mostly bowl-shaped, sometimes funnel-shaped; covering membranes undulate, more rarely straight, mostly elevated in centre, in several species with radial or tangential wings or other protrusions on them; closing bodies large, rarely small or absent; expanding keels broad, diverging and radial in distal part, reaching tip of valve; valves with or without mostly narrow valve wings.

CHARACTERS
5.2.2 - 9 (4): Leaf margins and keel - Serrated margins or keel.
5.2.4 - 7 (5): Flower colour - Pink.

NOTES
104 spp. Present in Fynbos, Succulent Karoo and Nama-Karoo biomes. The genus is subdivided into several subgenera, and may comprise several genera. *Antimima* urgently needs revision.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

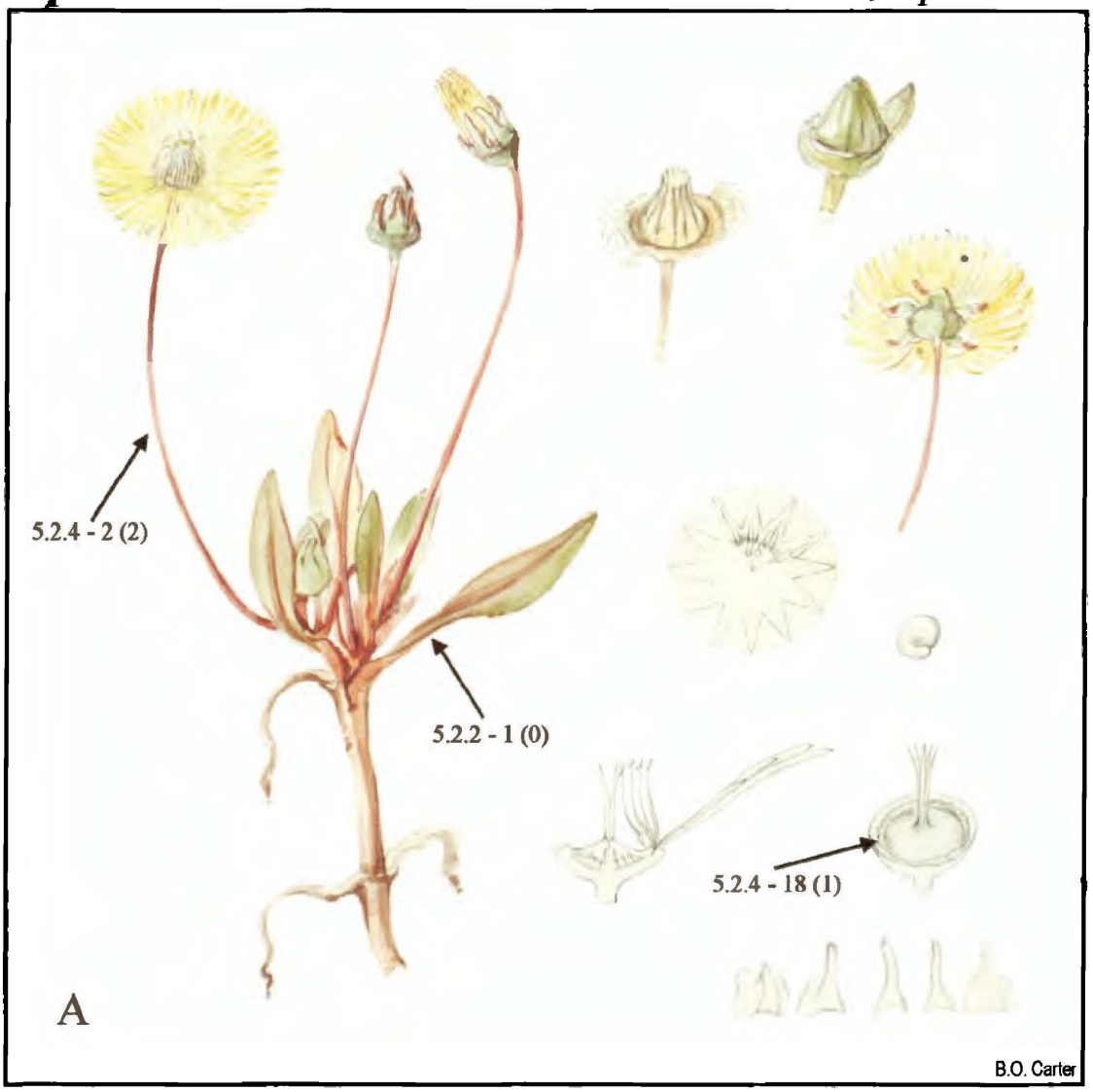


Fig. 6.7

TAXON
A. *A. sabulosa*

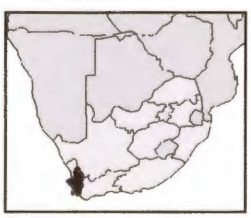
DISTINGUISHING CHARACTERS
Annual herbs with flat, petiolate leaves; pedicels long; seeds many, a few developing in seed-pockets (paraspermy); flowers yellow.

Fruit a 8–12-locular capsule, shallow, slightly convex beneath; valves horizontally spreading when expanded, narrowly deltoid; expanding keels ± half as long as valve and subcontiguous into a central keel, very small covering membranes present; *A. sabulosa* has valves with a narrow membranous rim (valve wings absent in the other 2 species); complete seed-pockets present at base.

CHARACTERS
5.2.2 - 1 (0): Attachment of leaves to stem - Petiolate.
5.2.4 - 2 (2): Pedicel length - Flower subtended by long pedicel.
5.2.4 - 18 (1): Floral nectaries - Broad, flat holonectary.

NOTES
3 spp. Confined to Fynbos Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

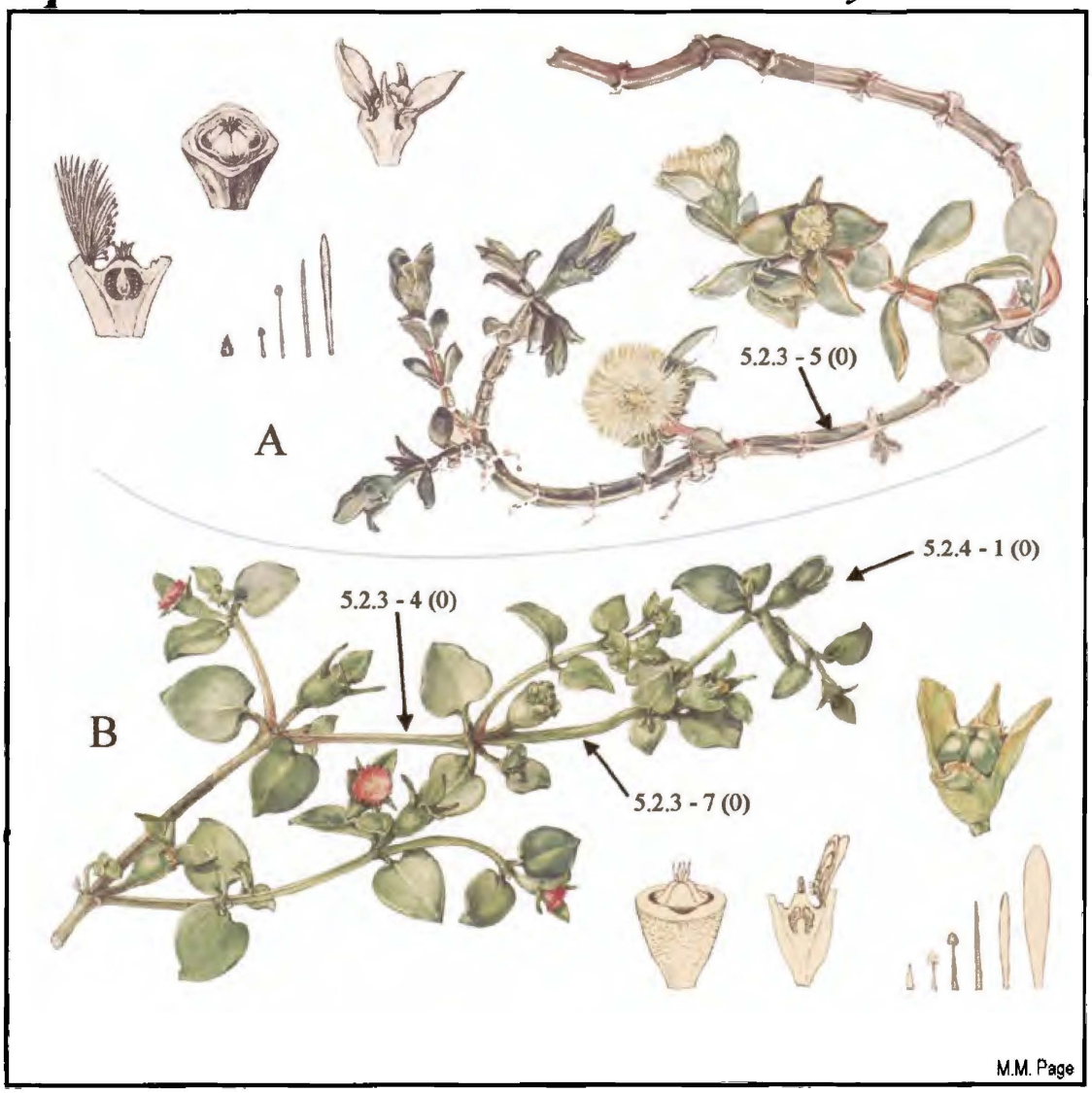


Fig. 6.8

TAXA
A. *A. haeckeliana*
B. *A. cordifolia*

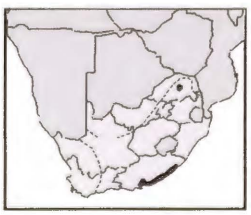
CHARACTERS
5.2.3 - 4 (0): Stem consistency - Fleshy (soft).
5.2.3 - 5 (0): Stem shape - 4-angled.
5.2.3 - 7 (0): Stem colour at maturity - Greenish.
5.2.4 - 1 (0): Inflorescence characteristics - Leafy inflorescence.

DISTINGUISHING CHARACTERS
Green succulent stems with closely arranged bladder cell idioblasts; seeds large and blackish brown.

Fruit a 4-locular capsule, of *Mesembryanthemum*-type, with or without valve wings; expanding keels extending to centre of fruit.

NOTES
4 spp. Widespread in cultivation. Indigenous to Albany Centre and Savanna biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

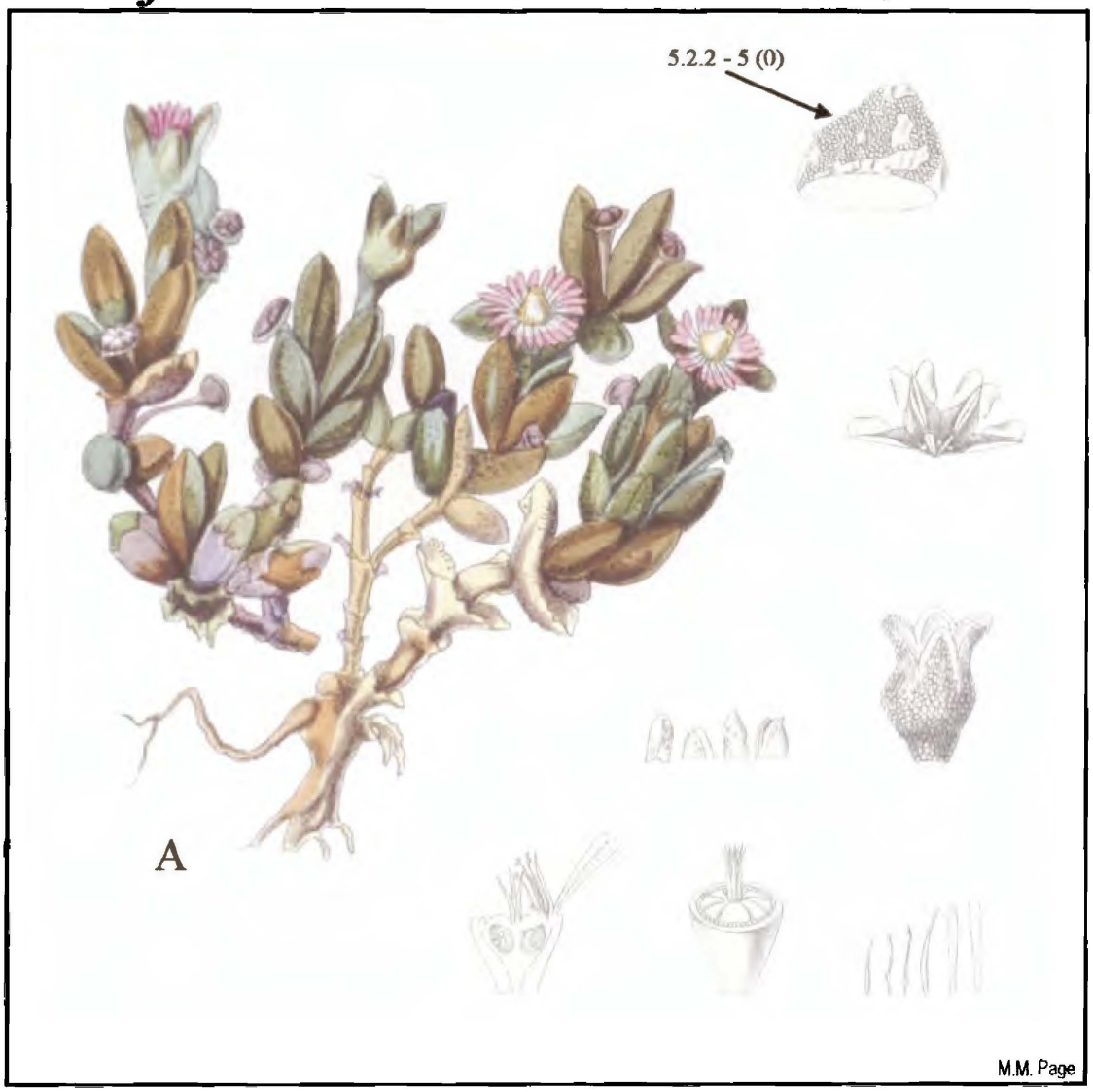


Fig. 6.9

TAXON
A. *A. pillansii*

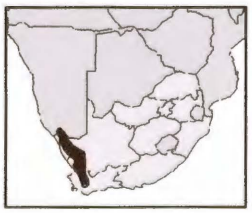
CHARACTERS
5.2.2 - 5 (0): Leaf surface - Sticky, with sand adhering.

DISTINGUISHING CHARACTERS
Many-branched perennials with reddish brown stems; leaves often with adhering sand.

Fruit a 6–8-locular capsule, of *Ruschia*-type but with valve wings, ± 8 mm in diameter, woody, margins of valves prominent, forming a small column in centre; valves transversely ribbed, with 2 conspicuous, recurved teeth at tip; valve wings large; expanding keels parallel, diverging widely at tips; covering membranes half covering locules, additional closing devices (projections) at opening; closing bodies conspicuous.

NOTES
4 spp. Confined to Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

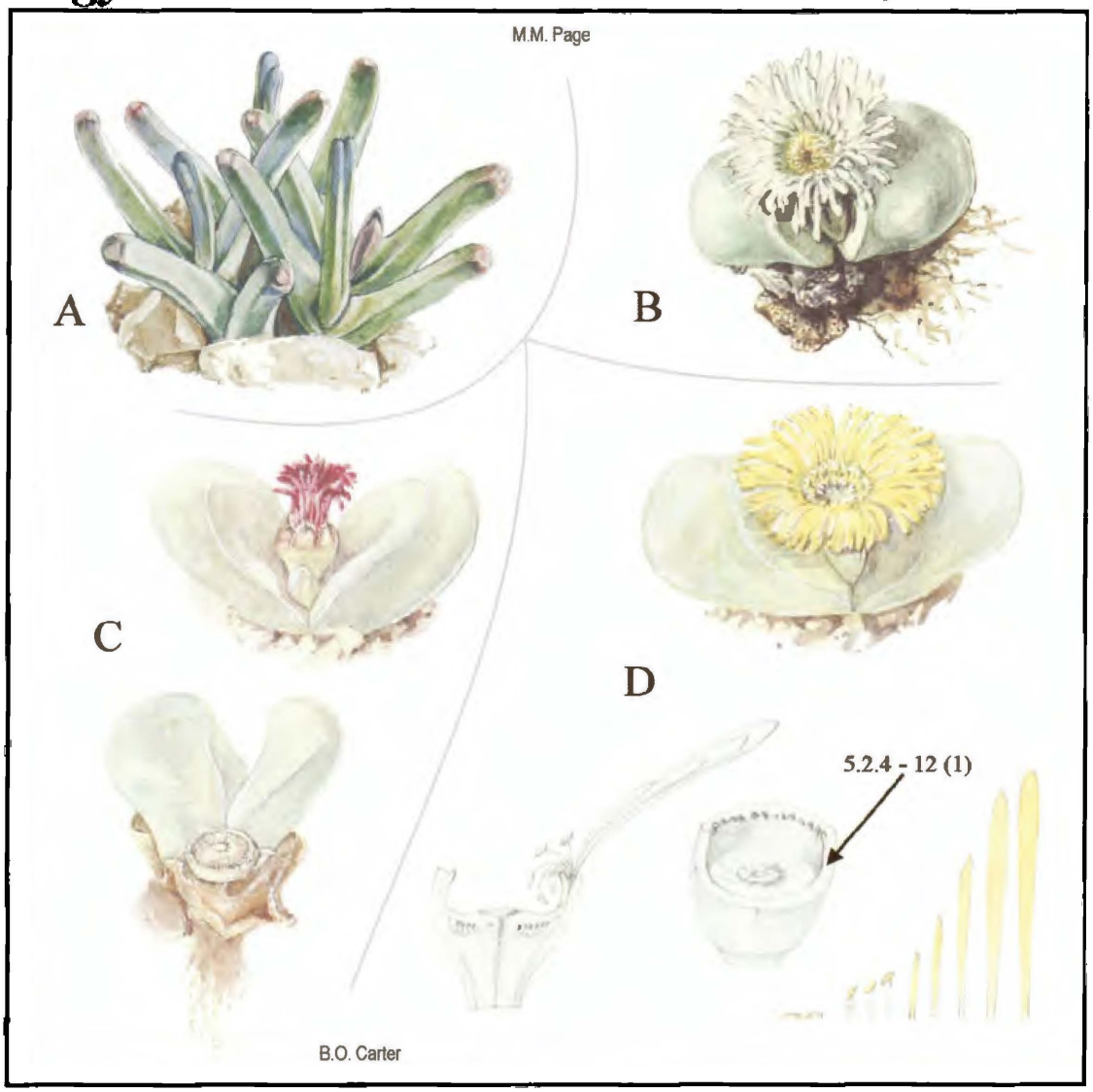


Fig. 6.10

TAXA
A. *A. fissum*
B. *A. testiculare*
C. *A. delaetii* (magenta flowers)
D. *A. delaetii* (yellow flowers)

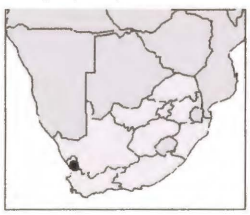
CHARACTERS
5.2.4 - 12 (1): Hypanthium - Present.

DISTINGUISHING CHARACTERS
Rounded, highly succulent perennials, single-bodied or tufted; leaves smooth, silver to grey-green; flowers solitary, with distinct hypanthium and stigmas fused into a disc.

Fruit a 12–25-locular capsule, of *Leipoldtia*-type, broad and shallow; covering membranes rather rigid; closing bodies large, nearly closing outer opening of locules; valve wings rather narrow; expanding keels stout, awned.

NOTES
11 spp. 2 subspp. 1 hybrid. Endemic to Knersvakte Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

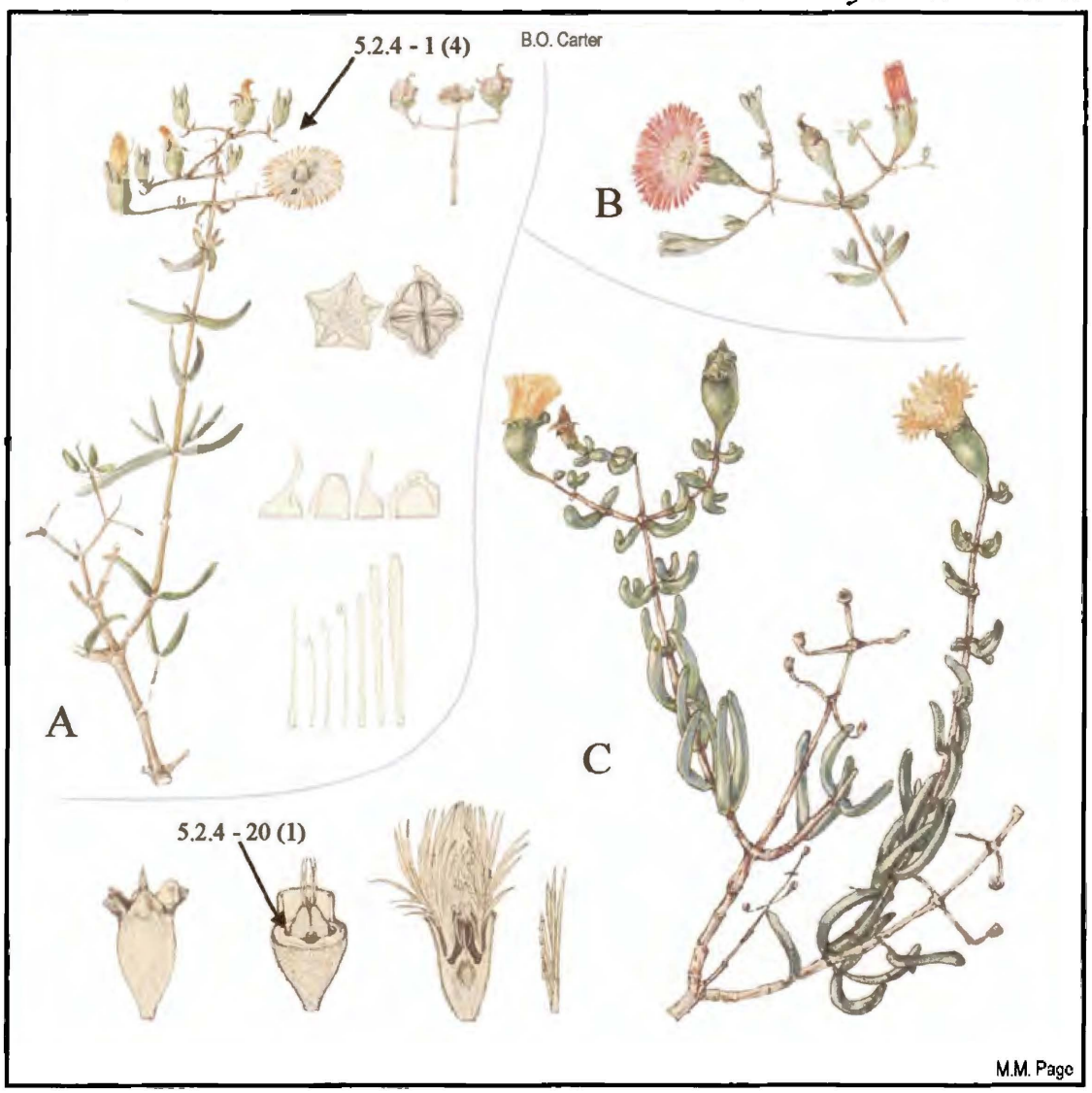


Fig. 6.11

TAXA
A. *A. brevicarpa*
B. *A. serotina*
C. *A. noctiflora*

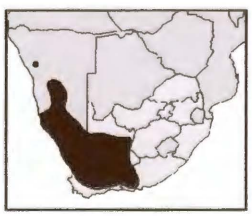
CHARACTERS
5.2.4 - 1 (4): Inflorescence characteristics - Angular cyme.
5.2.4 - 20 (1): Shape of nectary surface - Sunken as pits and hollows (koilomorphic).

DISTINGUISHING CHARACTERS
Stems woody; leaves with flattened bladder cell idioblasts; upper and lower parts of fruits of equal proportions.

Fruit a *Mesembryanthemum*-type capsule, 4- or 5-locular, hygrochastic, usually opening and closing repeatedly, rarely opening only once and not closing again; expanding keels parallel; valve wings present; fruit breaking off easily and stalks becoming spiny.

NOTES
4 spp. 3 subspp. Mostly Succulent Karoo Biome, with some species widespread across several biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

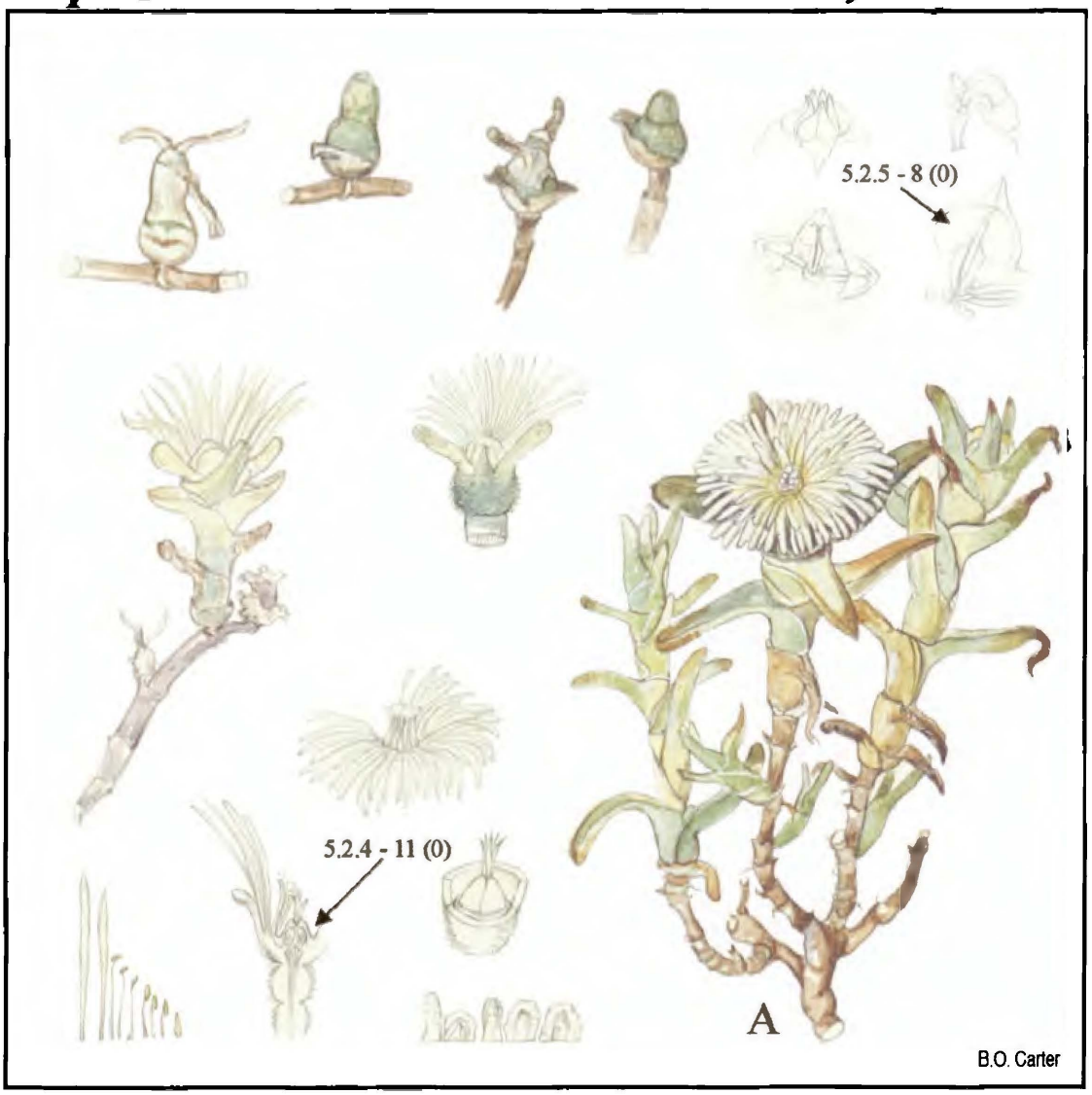


Fig. 6.12

TAXON
A. *A. amplectens*

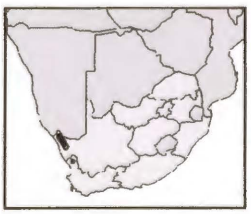
CHARACTERS
5.2.4 - 11 (0): Position of the ovary - Half-inferior.
5.2.5 - 8 (0): Open fruit, valve wings and flaps - Large flaps (*Mesembryanthemum*-type fruit).

DISTINGUISHING CHARACTERS
Leaves stem-clasping; seeds large.

Fruit a 4- or 5-locular capsule, of *Mesembryanthemum*-type; expanding keels with a broad, inflexed or erect submembranous flap or wing on each side, locules mostly with 2 seeds only.

NOTES
1 sp. Present in Gariep and Knersvlakte centres, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

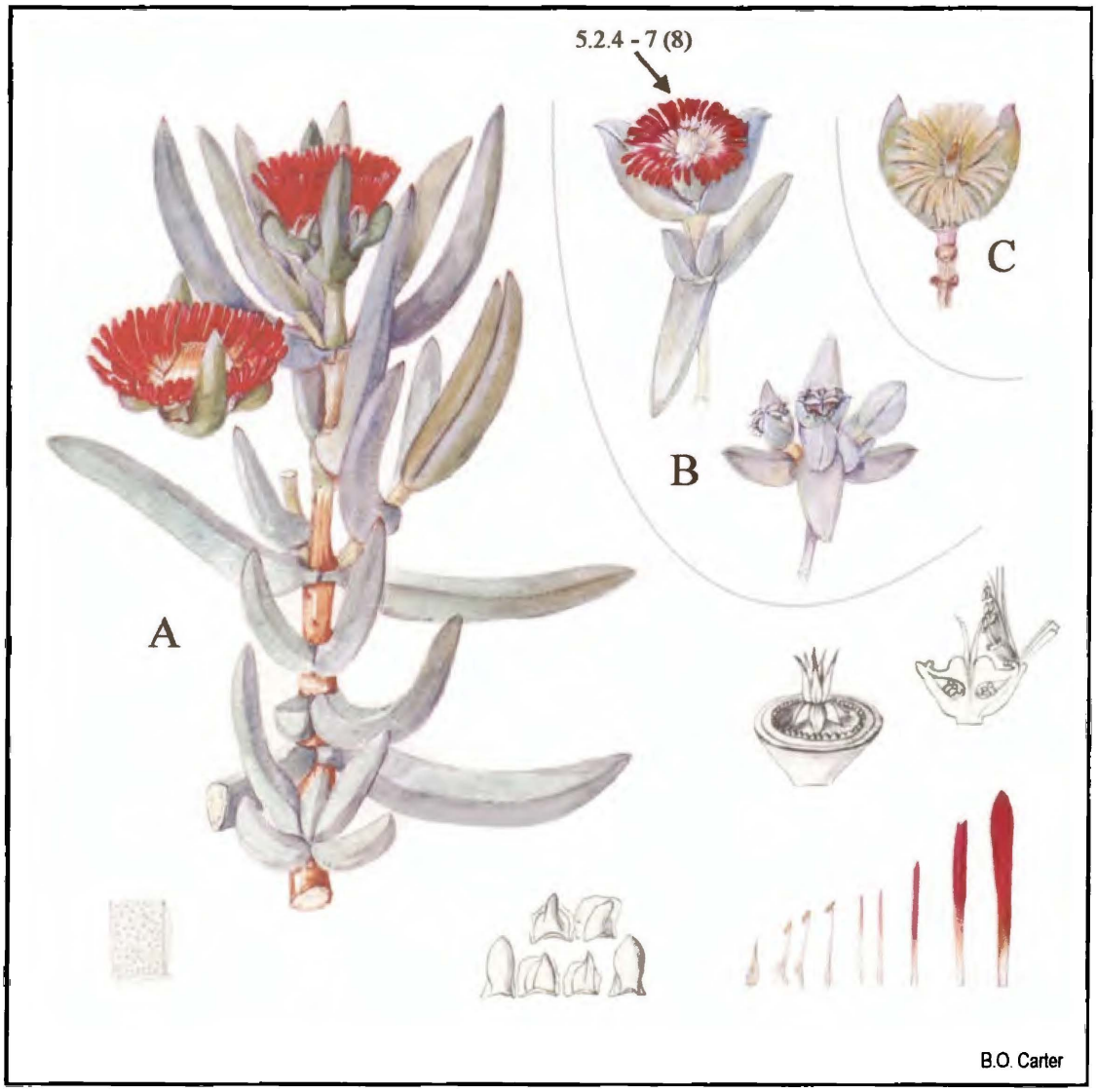


Fig. 6.13

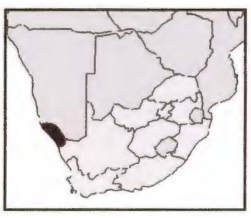
TAXA
A. *A. longifolia*
B. *A. rubra*
C. *A. citrina*

CHARACTERS
5.2.4 - 7 (8): Flower colour - Red.

DISTINGUISHING CHARACTERS
Robust perennials, erect, woody with large grey-green, smooth or textured leaves; sheathing stems at their partially fused bases; flowers large, solitary with bracts just below them; seeds echinate, tuberculate or hairy.

Fruit a 6-locular capsule of *Ruschia*-type, obconic below; sutures strongly compressed; expanded valves widely spreading, wingless; expanding keels parallel below, diverging upwards, aristate; closing bodies and covering membranes well developed, with 2 processes or additional closing devices on underside near exit, obconical.

NOTES
12 spp. Gariep Centre, mostly Succulent Karoo Biome.



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

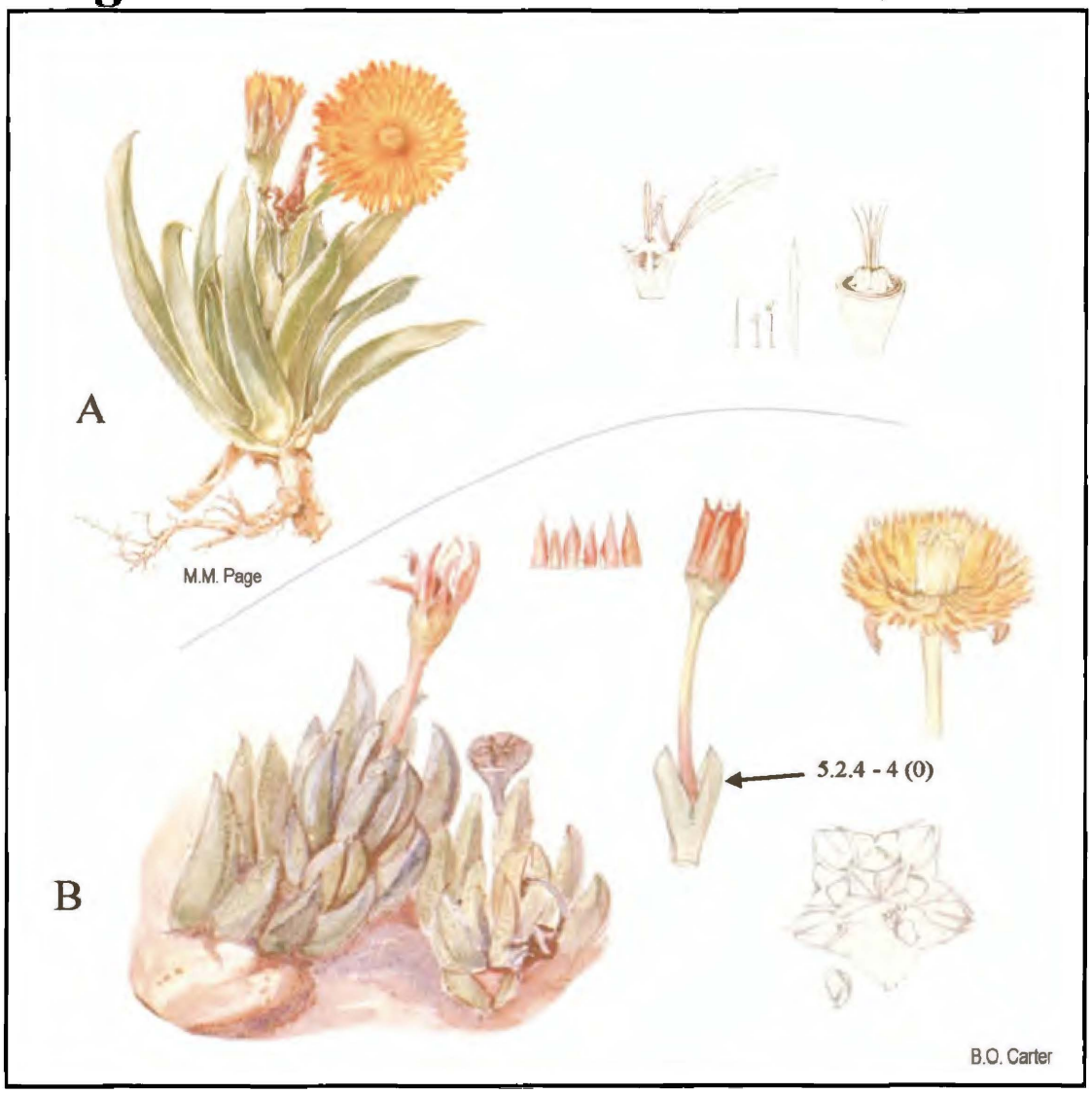


Fig. 6.14

TAXA
A. *B. scapiger*
B. *B. multiceps*

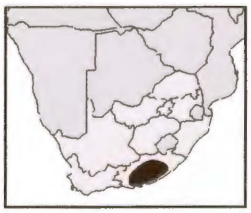
CHARACTERS
5.2.4 - 4 (0): Bracts - Present, 1 pair.

DISTINGUISHING CHARACTERS
Tufted perennials; leaves triquetrous, smooth; inflorescences cymose; pedicels bracteate; fruit with large, white closing bodies.

Fruit a 5-locular capsule, close to *Mitrophyllum*-type; with a well-developed broad spongy closing ledge; expanding keels in a more tangential position; broad, dark brown, with membranous points; covering membranes rigid; closing bodies large, somewhat trigonous.

NOTES
5 spp. Confined to Albany Centre.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

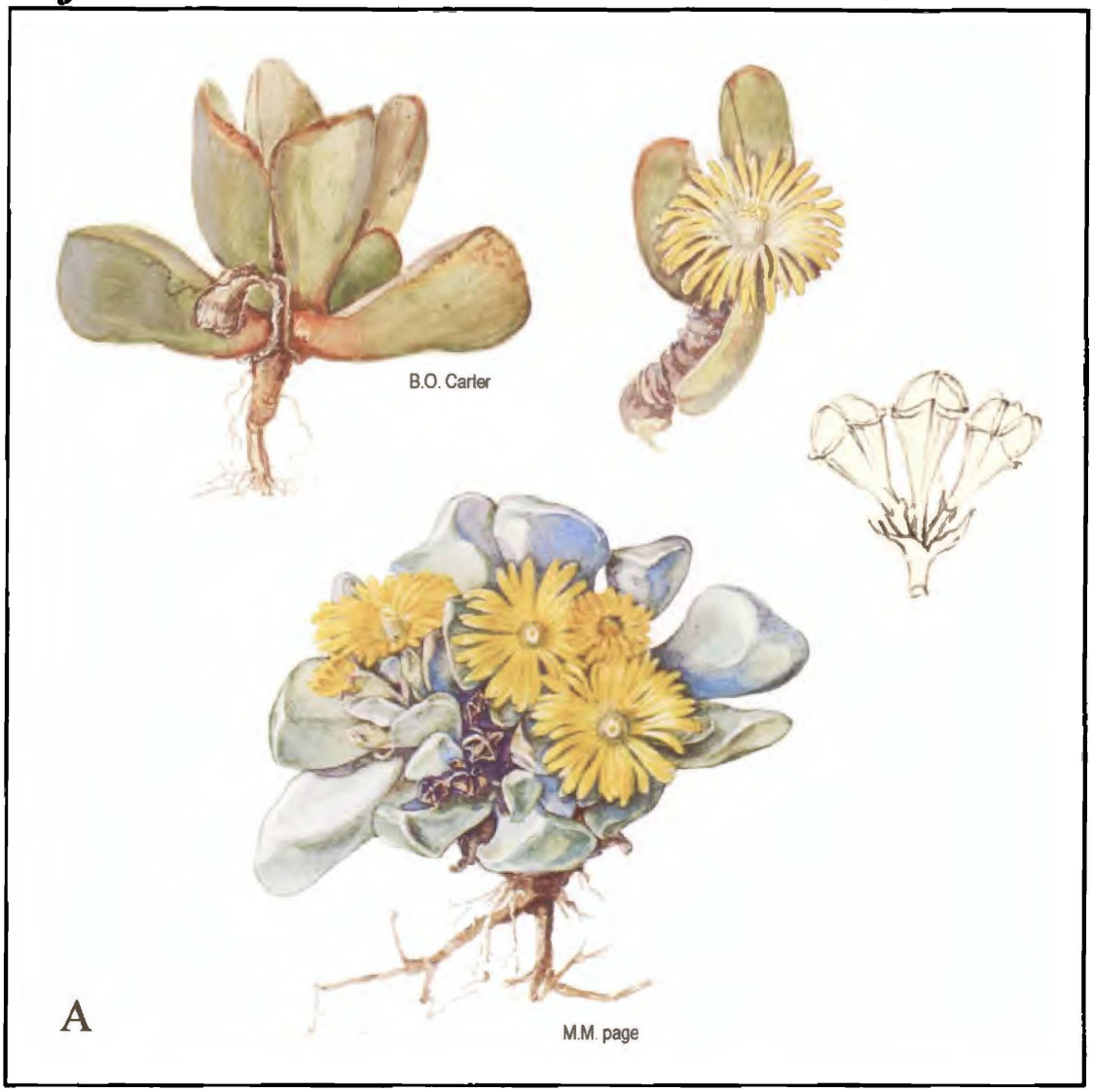


Fig. 6.15

TAXON
A. *B. tugwelliae*

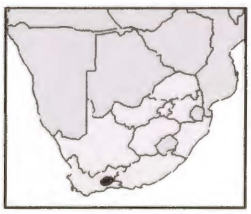
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Perennials with boat-shaped, unequal, light green to yellowish-white leaves; flowers large, yellow; fruit persistent.

Fruit a 5-locular capsule; valves erect in expanded capsule; valve rims broad; close to *Mitrophyllum*-type with well-developed hood-shaped closing bodies and short ± tangential expanding keels gradually merging into expanding sheets; covering membranes present, slightly stiff, with acute depressions between ridges.

NOTES
2 spp. Endemic to Little Karoo Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

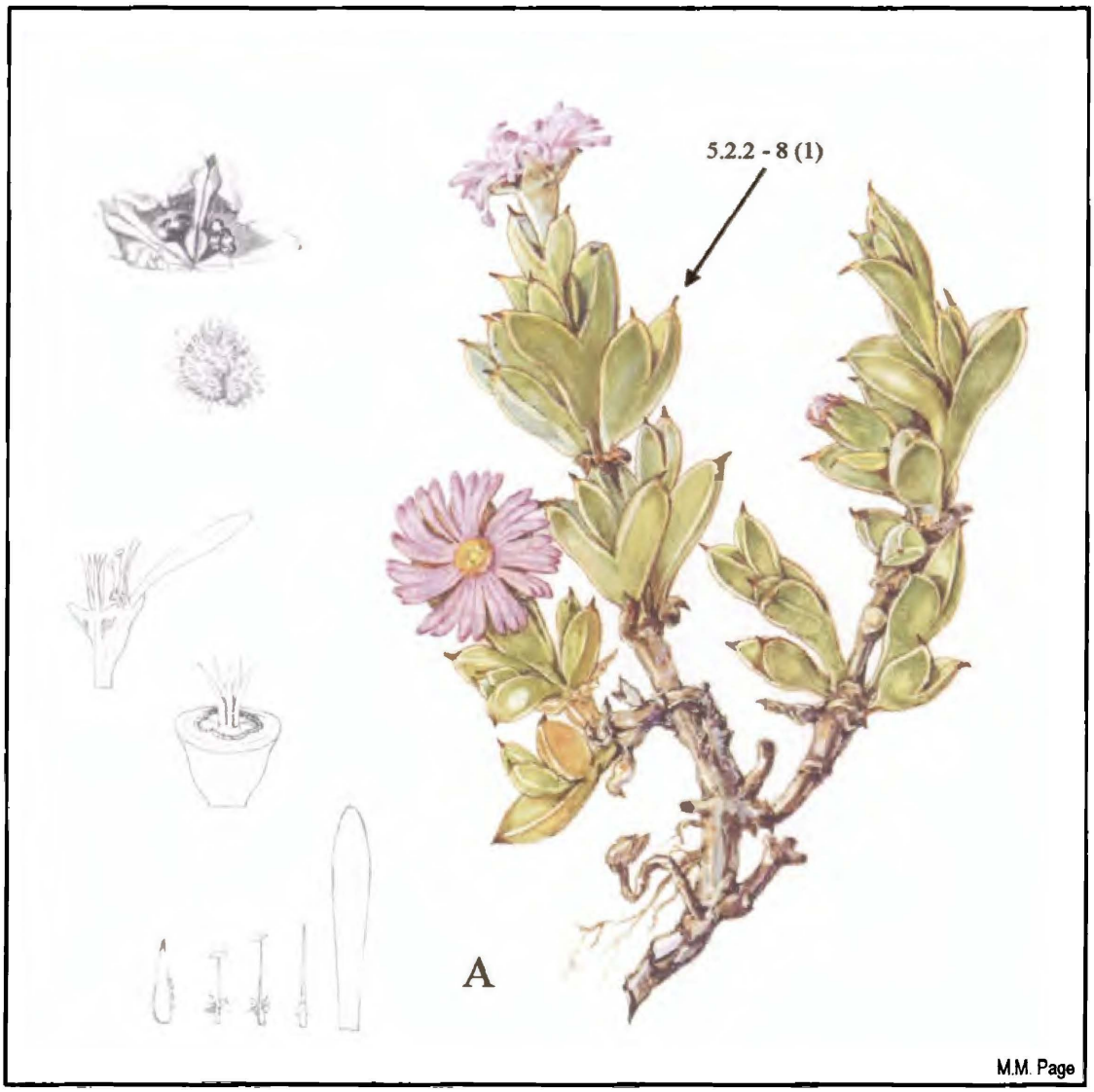


Fig. 6.16

TAXON
A. *B. apiculata*

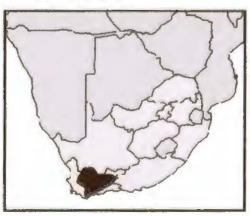
CHARACTERS
5.2.2 - 8 (1): Leaf tips - Distinctly apiculate or mucronate.

DISTINGUISHING CHARACTERS
shrublets with leaves fused for half their length, often with cartilaginous or serrated edges, sometimes velvety with a sharp tip; seeds echinate.

Fruit a (4)5(7)-locular capsule, of *Lampranthus*-type but covering membranes not as broad and long as in typical form; lacking closing ledges; expanding keels parallel, lacerate, aristate; covering membranes well developed or reduced to a limb; closing bodies 0; valve wings present.

NOTES
6 spp. Mostly Fynbos and Succulent Karoo biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

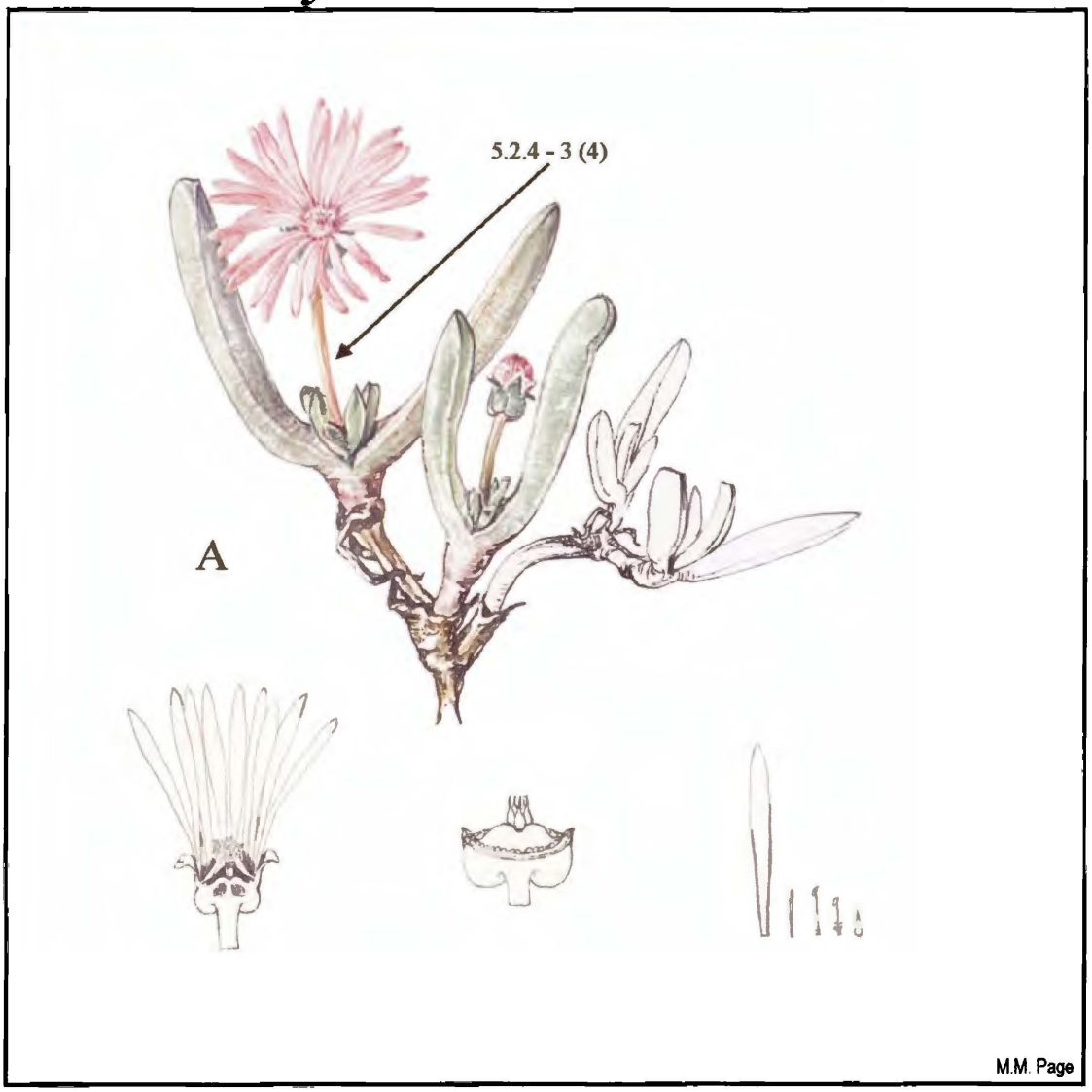


Fig. 6.17

TAXON
A. *B. intrusa*

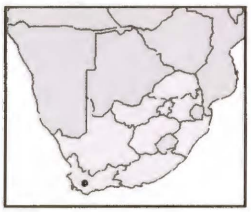
CHARACTERS
5.2.4 - 3 (4): Pedicel shape and behaviour - Pedicel succulent, drying out and breaking when fruit is ripe.

DISTINGUISHING CHARACTERS
Tufted to creeping perennials. Solitary pink flowers with pink to magenta petals and short stigmas. Sigmoid succulent pedicel that withers when fruit is ripe. Detachable fruit with bowl-shaped bases and papillate (echinate) seeds.

Fruit 5-locular, closest to *Ruschia*-type. Expanding keels diverging, covering membranes stiff, closing bodies lens-shaped, base flat.

NOTES
1 sp. Endemic to Worcester-Robertson Karoo Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

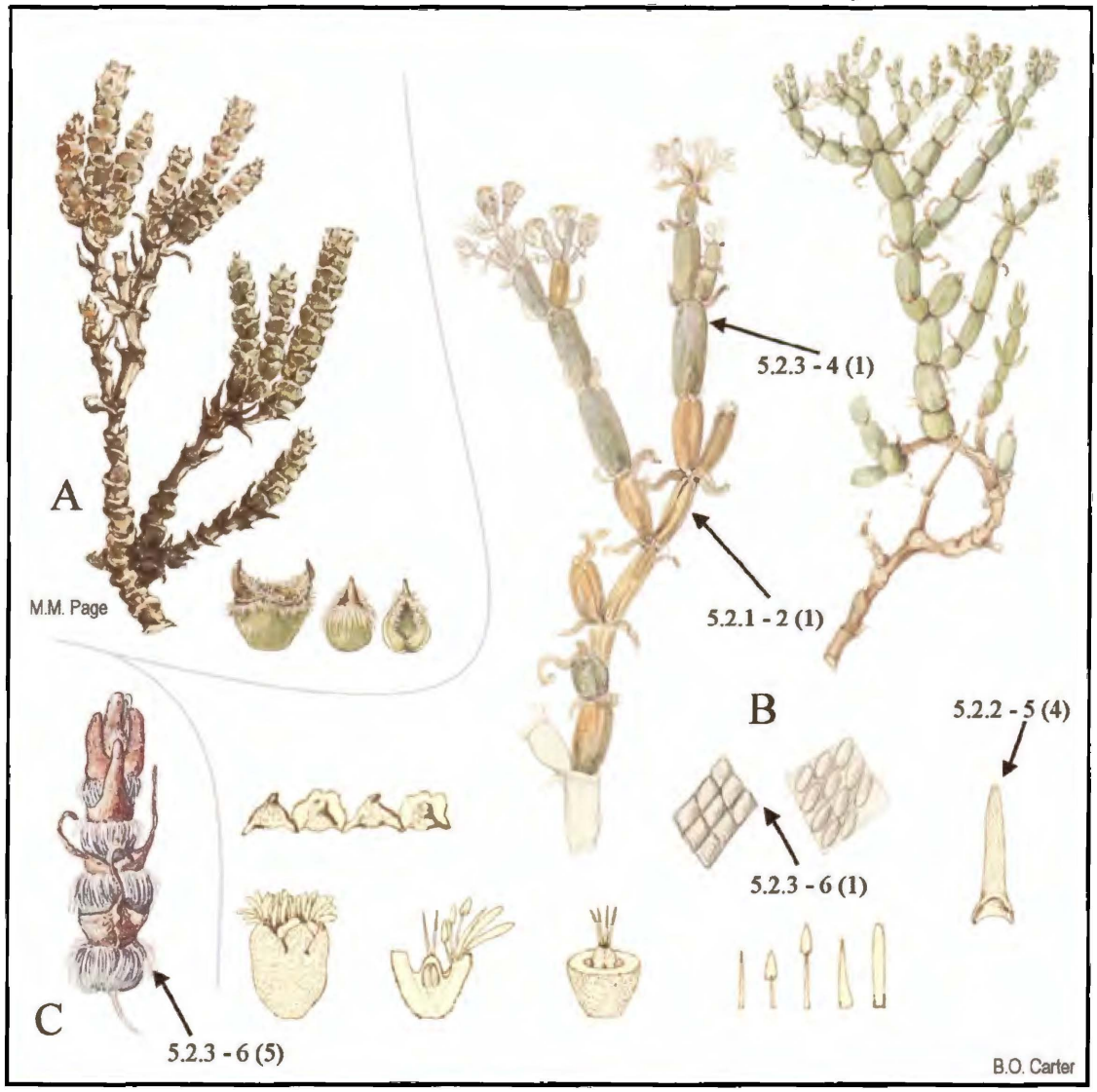


Fig. 6.18

TAXA
A. *B. marlothii*
B. *B. arenosus*
C. *B. marlothii*

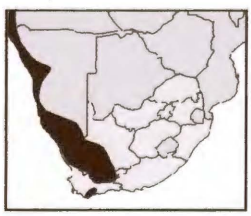
DISTINGUISHING CHARACTERS
Stems succulent, later becoming woody; different arrangements of bladder cell idioblasts on stems (closely packed) and leaves (loosely arranged); leaves free or shortly fused at the bases.

Fruit a 4- or 5-locular capsule, of *Mesembryanthemum*-type, rarely nut-like; expanding keels extending to centre of fruit; valve wings present; sometimes with a basal seed pocket, then expanding keels not separated by placenta.

CHARACTERS
5.2.1 - 2 (1): Overall appearance - Stem succulent
5.2.2 - 5 (4): Leaf surface - Xeromorphic bladder cells, hard water cells (10X lens).
5.2.3 - 4 (1): Stem consistency - Succulent (hard).
5.2.3 - 6 (1): Stem surface texture or ornamentation - Xeromorphic water cells.
5.2.3 - 6 (5): Stem surface texture or ornamentation - With fringe of hairs at nodes.

NOTES
13 spp. 2 subspp. Widespread, mostly in Succulent Karoo Biome, also Present in Fynbos and Desert biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

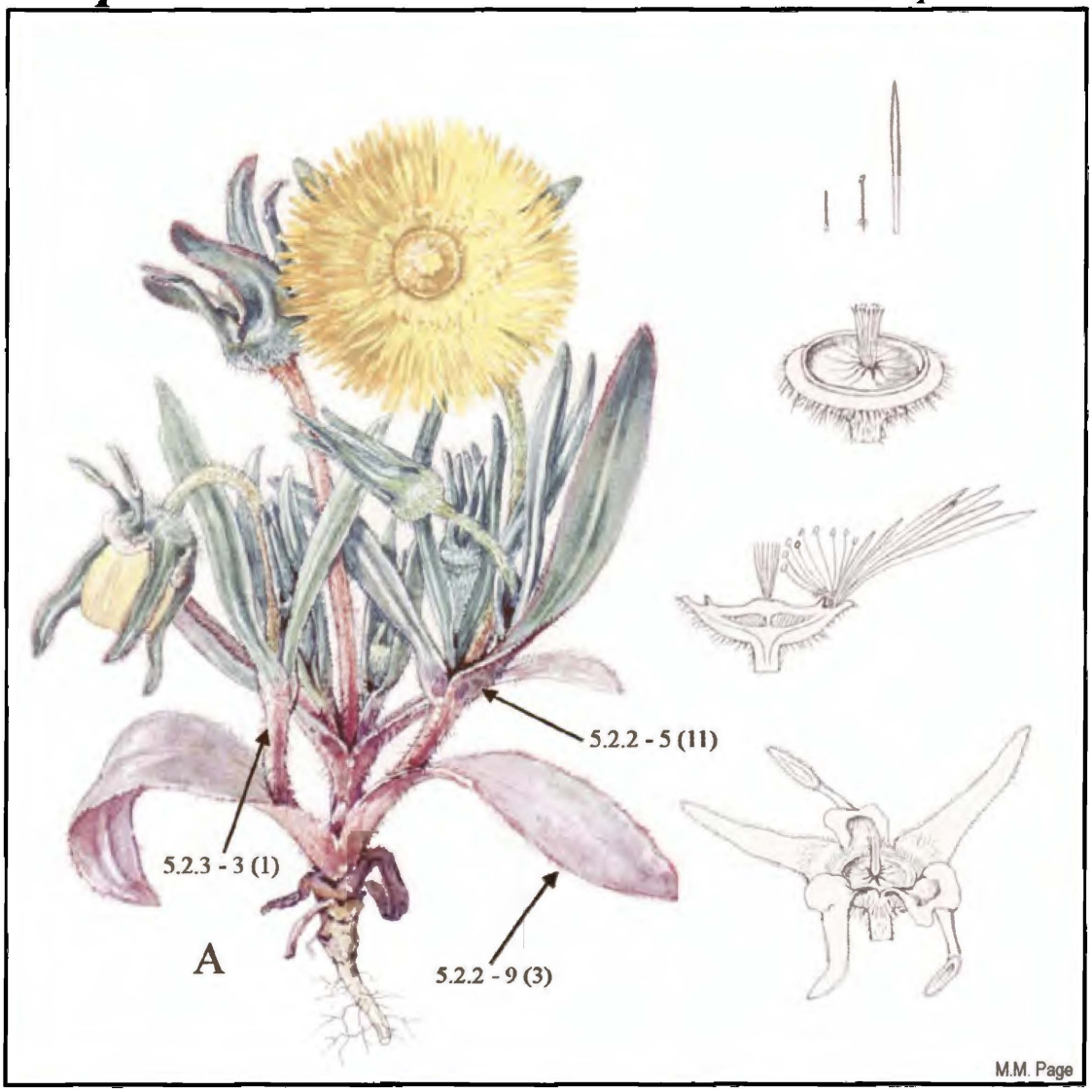


Fig. 6.19

TAXON
A. *C. pomeridiana*

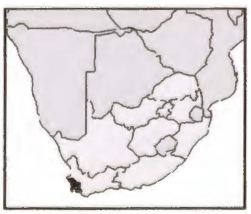
CHARACTERS
5.2.2 - 5 (11): Leaf surface - Scattered visible hairs.
5.2.2 - 9 (3): Leaf margins and keel - margins ciliate.
5.2.3 - 3 (1): Stem (internodes) - Visible, but very short, bearing tufts of leaves.

DISTINGUISHING CHARACTERS
Annual herbs with flat, green leaves; stems hairy; flowers yellow; fruit 12–18-locular with contiguous expanding keels ending in awns.

Fruit a 12–18-locular capsule, firm, persistent septa overarching locules from sides; placenta raised by a false basal septum, broader than deep; valves narrow, with a pair of closely contiguous expanding keels ending in awns; loculcs without covering membranes and with narrow exit for seeds.

NOTES
1 sp. Confined to Fynbos Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

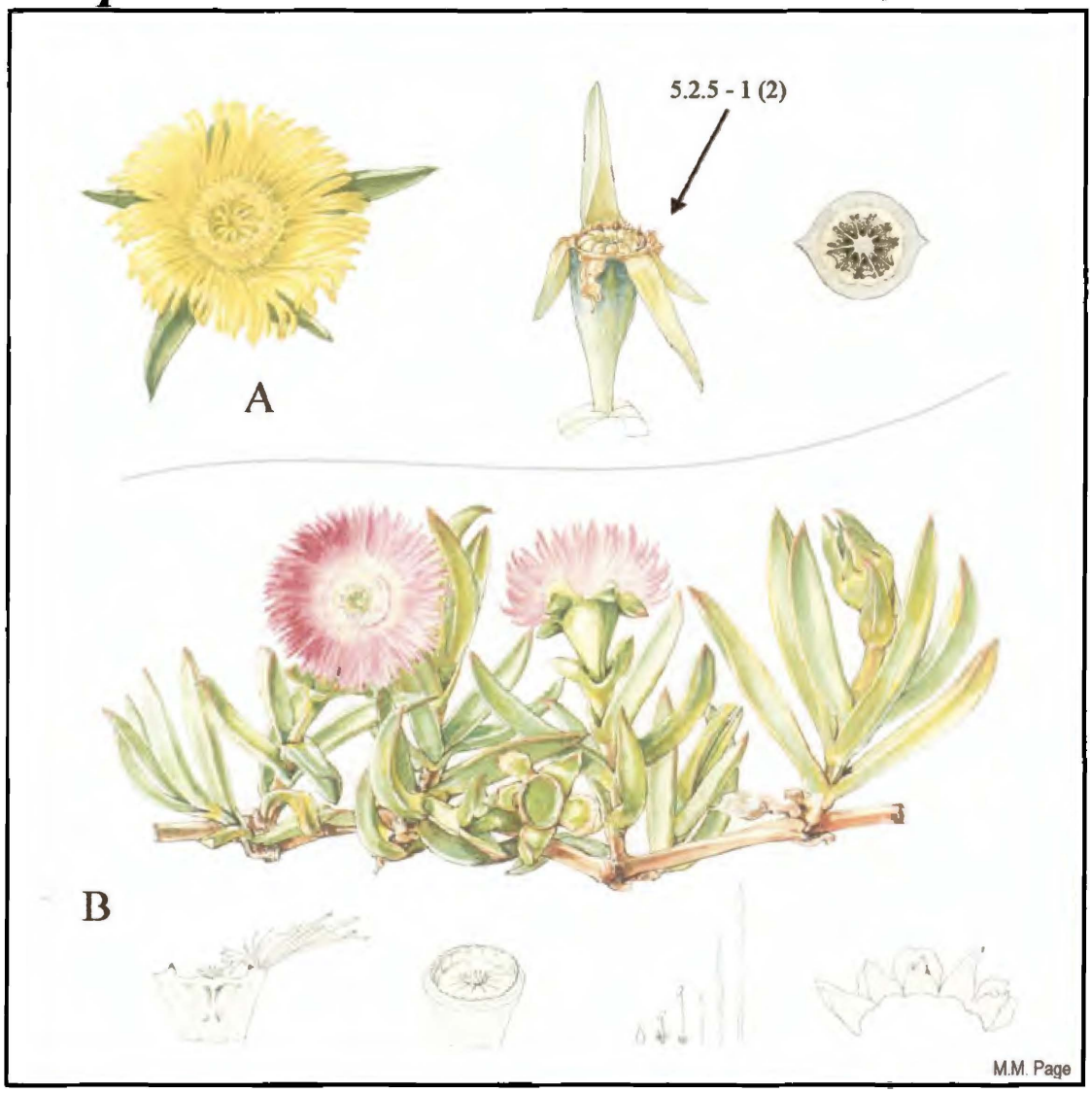


Fig. 6.20

TAXA
A. *C. edulis*
B. *C. dimitiatus*

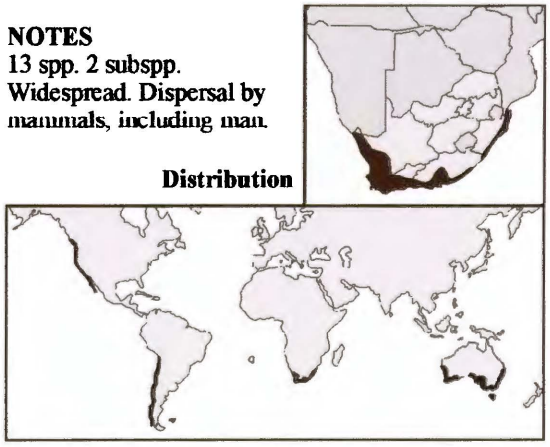
CHARACTERS
5.2.5 - 1 (2): Fruit type & dehiscence - Fleshy, indehiscent.

DISTINGUISHING CHARACTERS
Robust perennials, trailing; leaves triquetrous, smooth, long; flowers large, up to 150 mm in diameter; fruit fleshy, seeds embedded in mucilage.

Fruit fleshy-succulent, indehiscent, 4–20-locular, often edible.

NOTES
13 spp. 2 subspp.
Widespread. Dispersal by mammals, including man.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

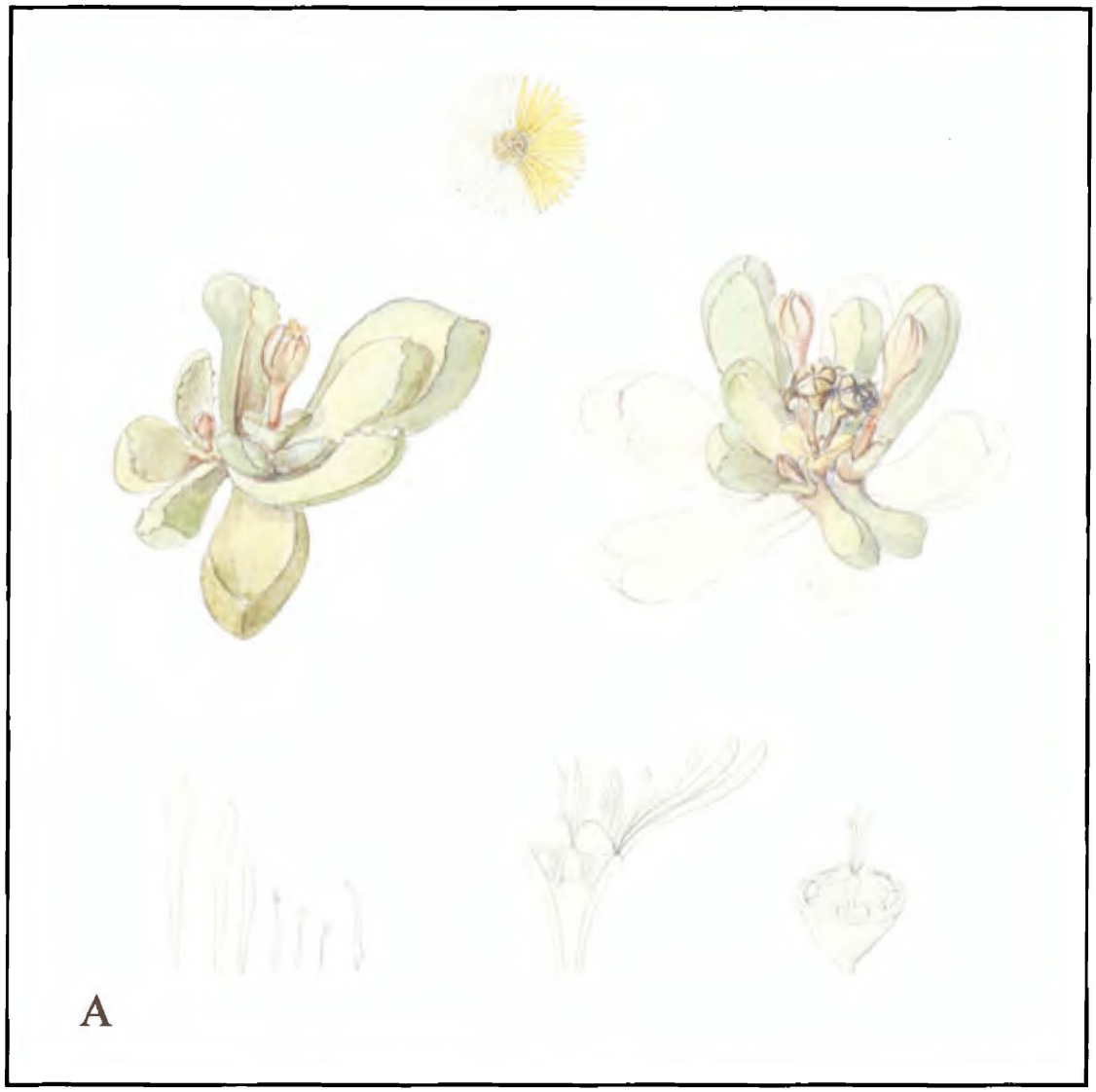


Fig. 6.21

TAXON
A. *C. ringens*

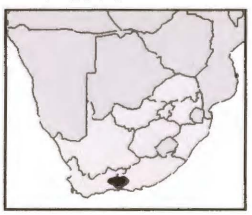
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Perennials with tuberous roots and toothed, smooth, yellowish green leaves; flowers yellow, pedicel long (up to 100 mm).

Fruit a 5-locular capsule; close to *Mitrophyllum*-type, but with narrow valve wings; resembling capsules of *Hereroa* or *Bergeranthus*; rims of valves very high and expanding keels diverging on valves, not reaching deep into locule, both features resulting in an incomplete opening of valves; covering membranes reduced to a limb; closing bodies reduced or absent.

NOTES
2 spp. Endemic to Little Karoo Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

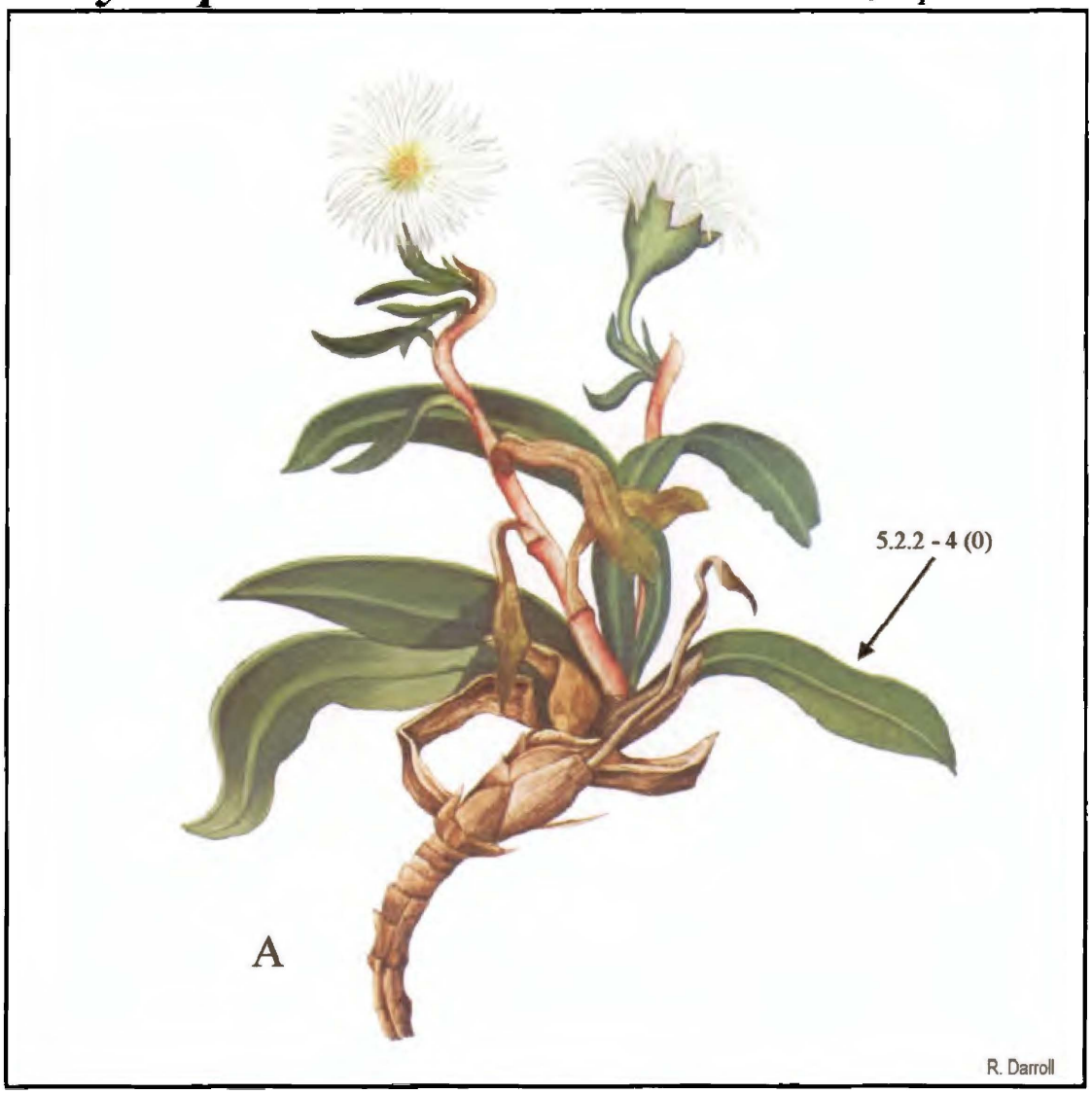


Fig. 6.22

TAXON
A. *C. skiatophytoides*

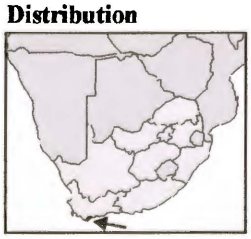
CHARACTERS
5.2.2 - 4 (0): Leaf shape - Flat, mesophytic.

DISTINGUISHING CHARACTERS
Flat, smooth, slightly succulent, lance- to spoon-shaped leaves; fruit comprising 3 to 4 nut-like parts; flowers white.

Fruit a schizocarp, with 3 or 4 bilocular, nut-like, woody mericarps, with a single ovule in each locule.

NOTES
1 sp. Highly localized endemic in Fynbos Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

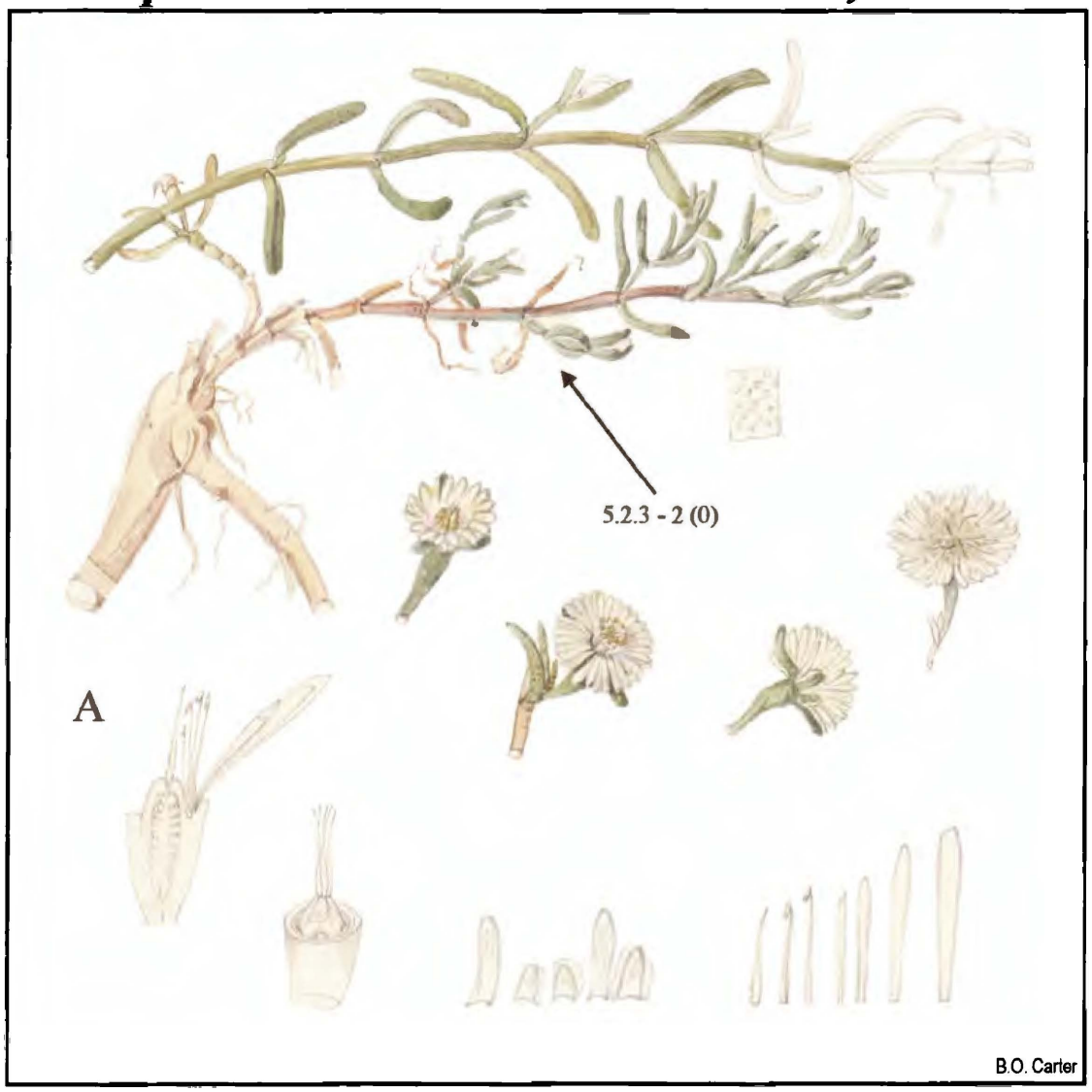


Fig. 6.23

TAXON
A. *C. rapaceum*

CHARACTERS
5.2.3 - 2 (0): Branches - Procumbent or decumbent or sprawling (not rooting at nodes).

DISTINGUISHING CHARACTERS
Tuberous rootstock; creeping annual stems; stems and leaves smooth; fruit funnel-shaped in lower part.

Fruit a 5-locular capsule of *Mesembryanthemum*-type, base funnel-shaped, to 10 mm deep; expanding keels extending to centre of fruit; valve wings reflexed and fused in pairs.

NOTES
1 sp. Near endemic to Knersvlakte Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

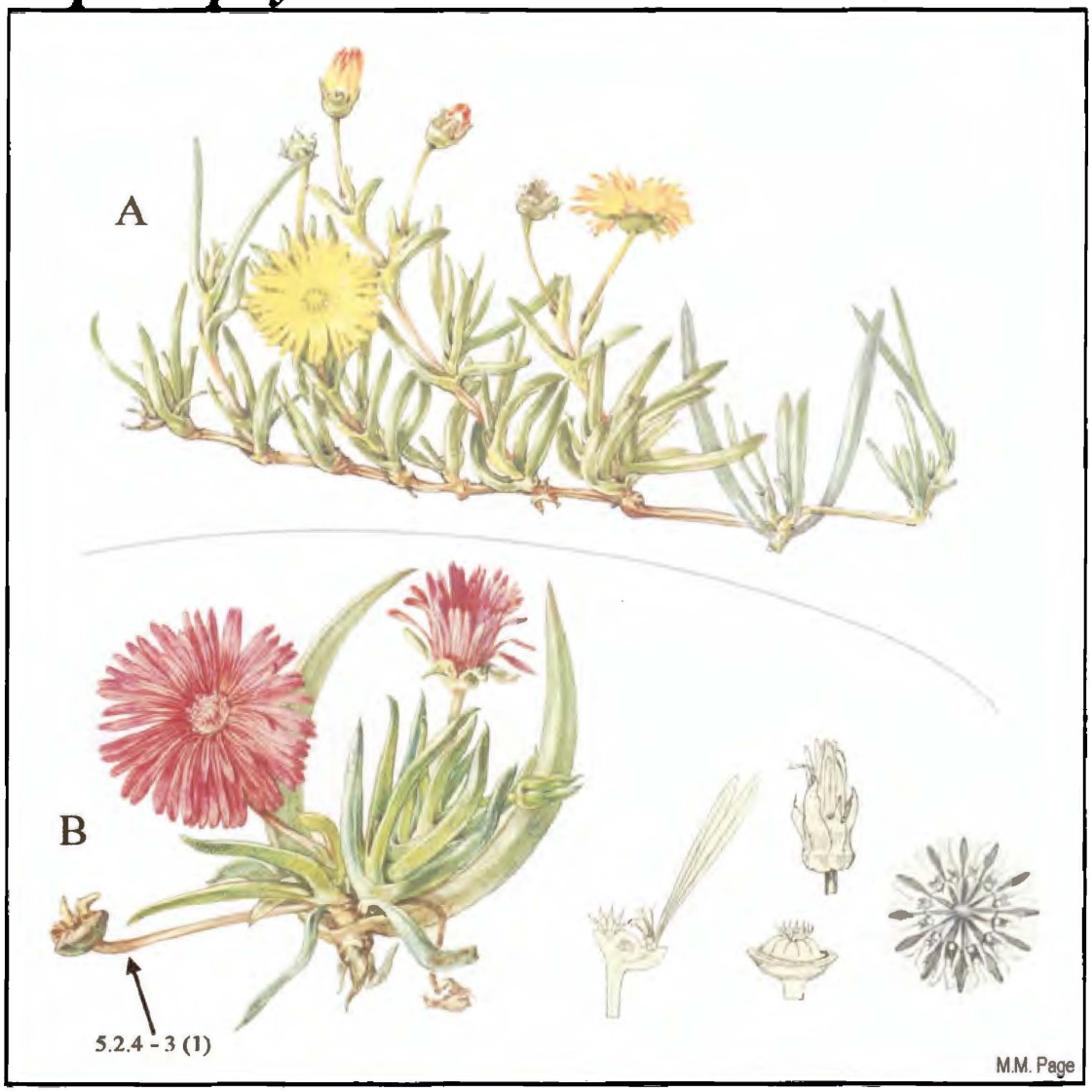


Fig. 6.24

TAXA
A. *C. purpureo-album*
B. *C. subulatoides*

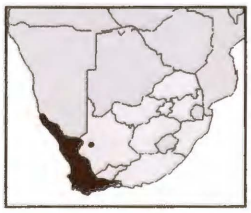
CHARACTERS
5.2.4 - 3 (1): Pedicel shape and behaviour - Pedicel bending after flowering, capsule lies on ground.

DISTINGUISHING CHARACTERS
Cushion-forming perennials, creeping or erect; flowers often brilliantly multicoloured; fruit 10–21-locular with large closing bodies, broad valve wings and covering membranes with large closing bulges distally.

Fruit a 10–21-locular capsule, of *Leipoldtia*-type; with a prominent closing bulge formed by roof of locule; valve wings well developed; expanding keels parallel; covering membranes present; closing bodies large; sometimes as tumble fruit.

NOTES
33 spp. Mostly Succulent Karoo Biome, also Fynbos and Nama-Karoo biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

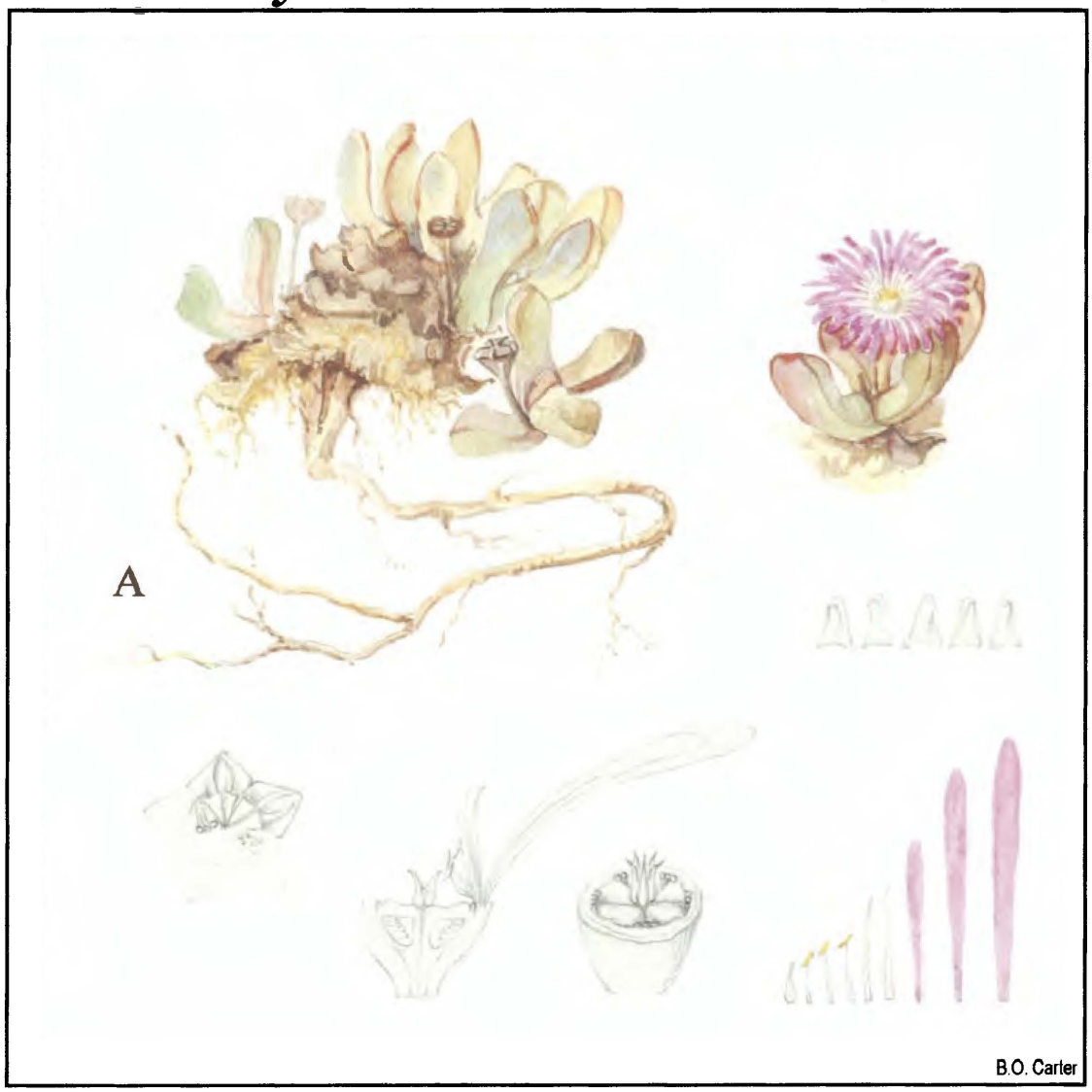


Fig. 6.25

TAXON
A. *C. pachyphylla*

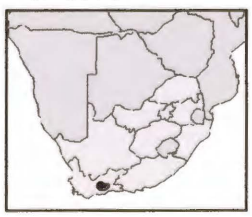
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Small tufted perennials flowering in mid-winter; leaves purplish green with a partially peeling waxy covering; capsule valves open to vertical position only.

Fruit a 5- or 6-locular capsule; persisting on the plant; shortly obconic to nearly flat, with raised sutures on top; possibly close to *Mitrophyllum*-type because of its widely diverging, broad expanding keels ending in awns, but valve wings absent; valves with high rims, only opening into a vertical position; spongy tissue separating locules; covering membranes stiff, acute, with dense mass of funicles at openings of locules.

NOTES
3 spp. Confined to Little Karoo Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

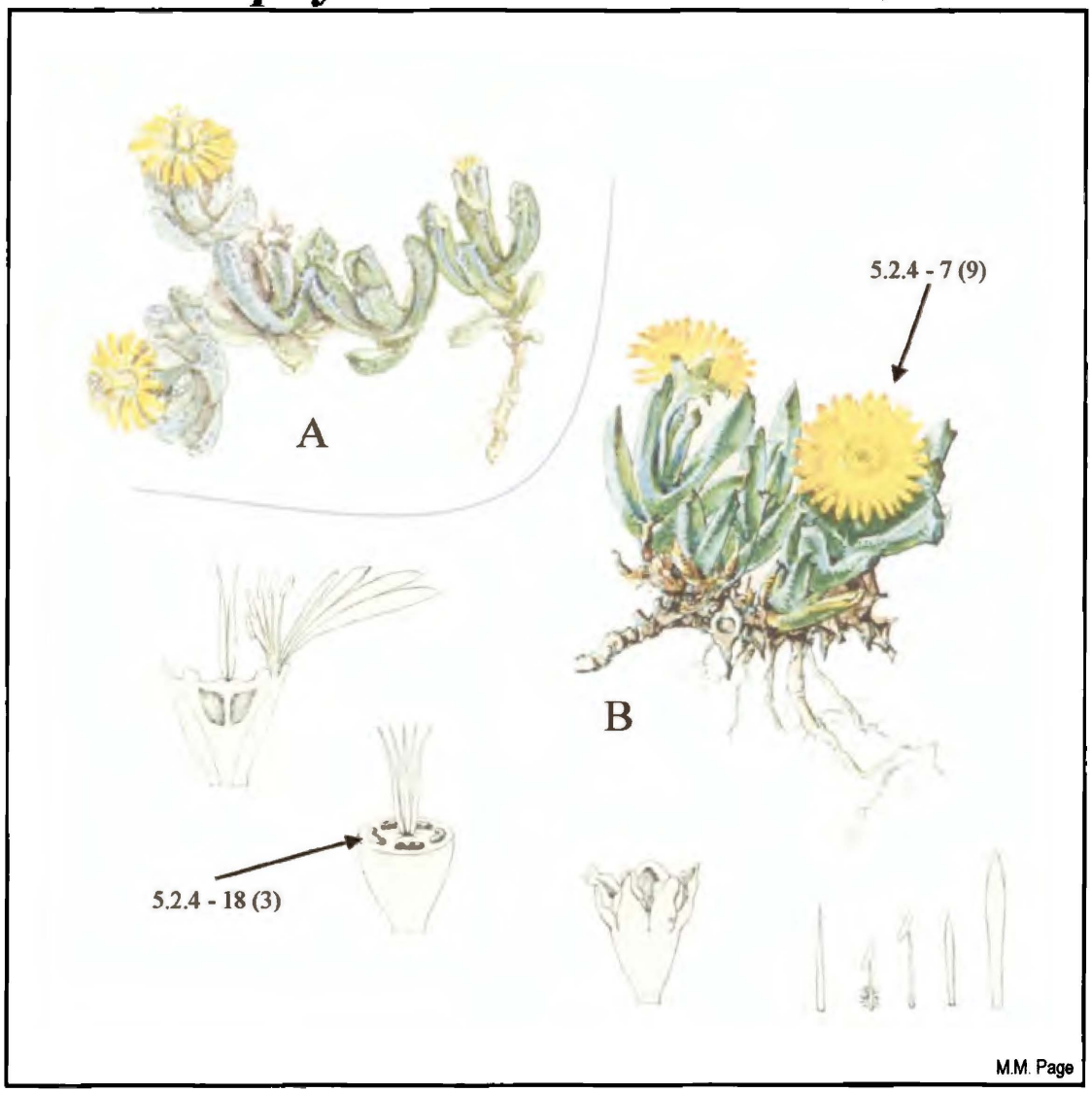


Fig. 6.26

TAXA
A. *C. maninum*
B. *C. musculinum*

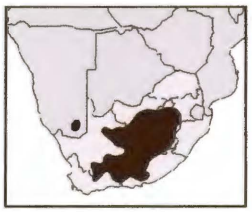
CHARACTERS
5.2.4 - 7 (9): Flower colour - Yellow.
5.2.4 - 18 (3): Floral nectaries - Lophomorphic meronectary.

DISTINGUISHING CHARACTERS
Small, compact, creeping perennials; leaves with soft whitish teeth; flowers yellow.

Fruit a 5-locular capsule, of *Drosanthemum*-type; with broad valve wings; covering membranes present.

NOTES
8 spp. Nama-Karoo, Grassland and Succulent Karoo biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

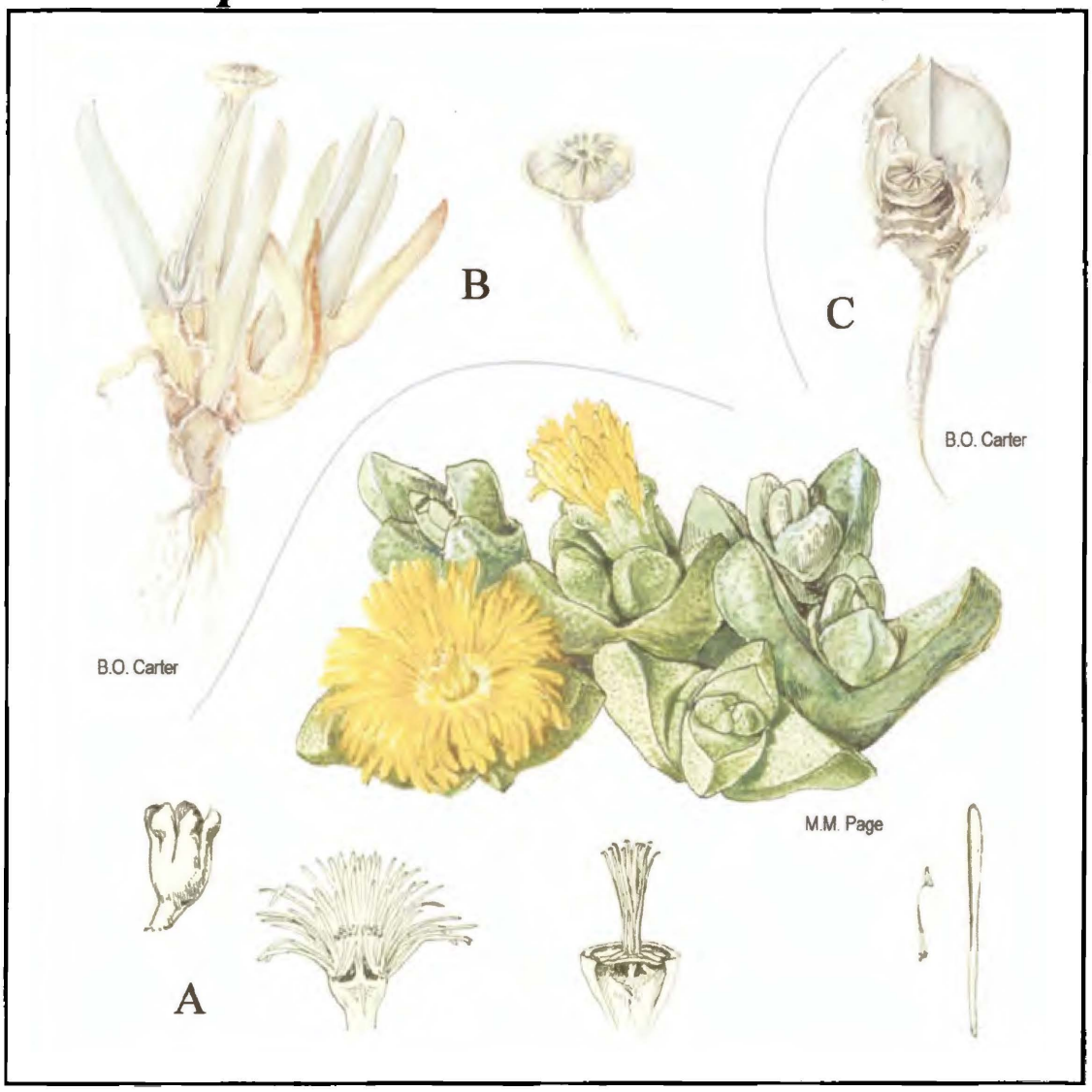


Fig. 6.27

TAXA
A. *C. caroli-schmidtii*
B. *C. denticulata*
C. *C. peculiaris*

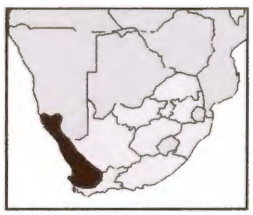
DISTINGUISHING CHARACTERS
Mostly tufted, variable perennials; leaf pairs closely pressed together, old leaves sometimes forming papery sheaths; flower stalk may be curved; fruit 10–20-locular, with awn-like points at ends of valves.

Fruit a 10–20-locular capsule, of *Leipoldtia*-type with rather straight covering membranes and reduced additional closing devices; often with dorsal appendages (wings, tubes, flanges) on the covering membranes; with narrow, widely spreading or reflexed valves; diverging expanding keels with membranous, awn-like points; valve wings usually absent; closing bodies large.

CHARACTERS
None used.

NOTES
33 spp. Mostly Succulent Karoo Biome, also present in Desert and Fynbos biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

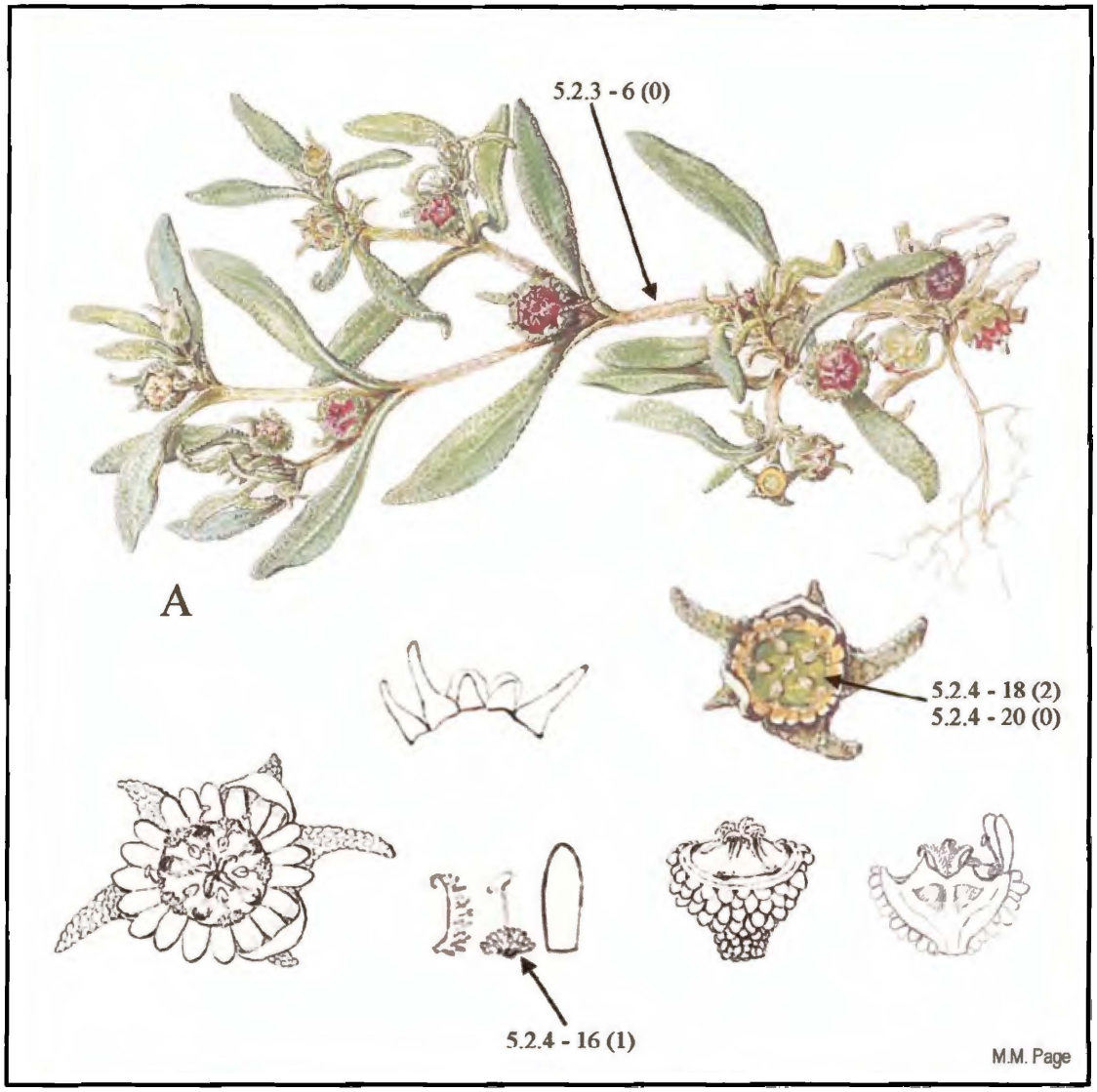


Fig. 6.28

TAXON
A. *C. papulosum subsp. papulosum*

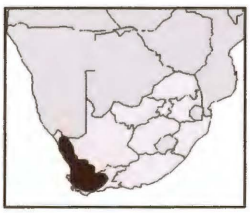
DISTINGUISHING CHARACTERS
Annual herbs with flat leaves; flowers white or yellow, sometimes cleistogamous; upper surface of fruit ridged.

Fruit a 5(6)-locular capsule, close to *Cleretum*-type; upper part of capsule distinctly ridged; with large expanding sheets; expanding keels parallel, large; valve wings broad; covering membranes small or absent; closing bodies absent.

CHARACTERS
5.2.3 - 6 (0): Stem surface texture - Papillate with large easily visible water cells.
5.2.4 - 16 (1): Filaments - Papillate.
5.2.4 - 18 (2): Floral nectaries - Broad, flat meronectary.
5.2.4 - 20 (0): Shape of nectary surface - Flat.
5.2.4 - 21 (0): Nectary colour - Green (as surrounding tissue).

NOTES
3 spp. 2 subspp. Succulent Karoo and Fynbos biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

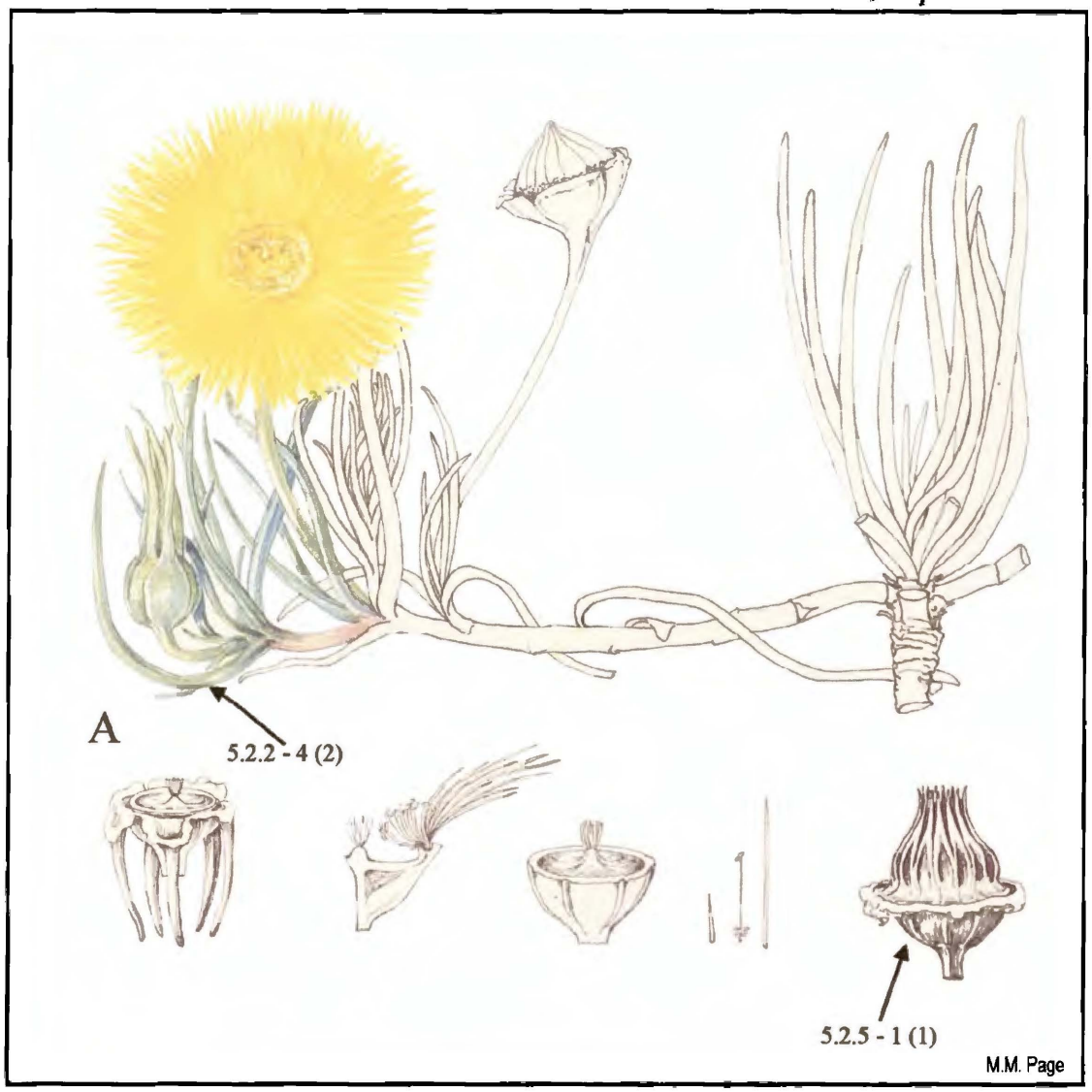


Fig. 6.29

TAXON
A. *C. pugioniformis* subsp. *pugioniformis*

CHARACTERS
5.2.2 - 4 (2): Leaf shape - Linear, mesophytic.
5.2.5 - 1 (1): Fruit type and dehiscence - Xerochastic, dehiscent when dry (schizocarpic).

DISTINGUISHING CHARACTERS
Perennial or biennial; leaves elongated; flowers yellow or whitish-yellow; fruit distinctive, cone-shaped, 10–25-locular, without expanding keels, with seed pockets.

Fruit a 10–25-locular capsule, large, ± xerochastic; seed dispersal dependent on separation of valves by desiccation; with two parietal seed pockets per locule; without expanding keels; each valve with a pair of thin, submembranous, wing-like, locular partitions on inner face.

NOTES
2 spp. 3 subspp. Fynbos and Succulent Karoo biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

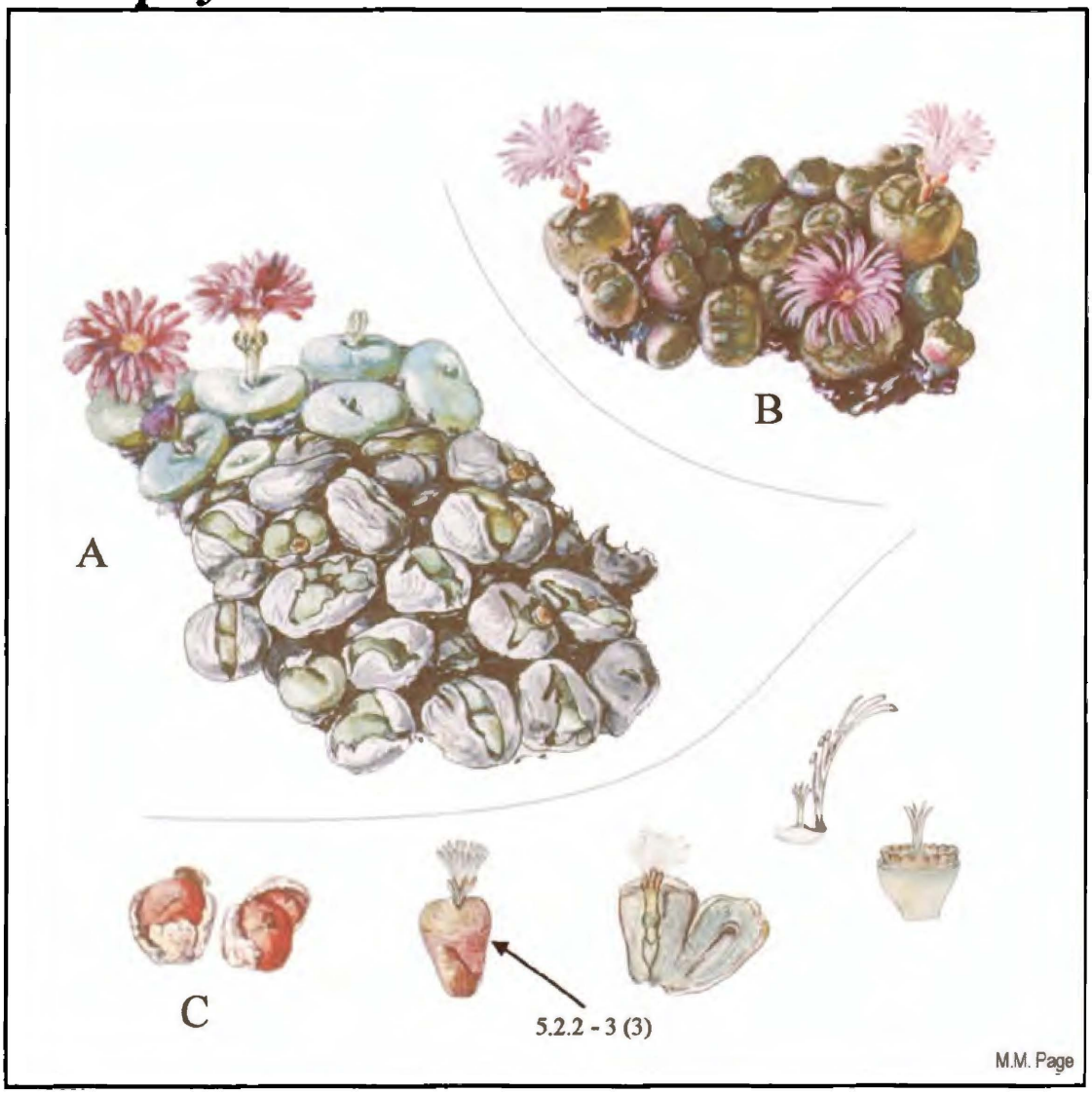


Fig. 6.30

TAXA
A. *C. wettsteinii* subsp. *wettsteinii*
B. *C. ficiforme*
C. *C. truncatum* subsp.*truncatum*

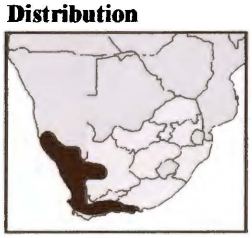
CHARACTERS
5.2.2 - 3 (3): Leaf pairs (degree of fusion) - Entirely fused.

DISTINGUISHING CHARACTERS
Cushion-forming or single-bodied perennials; leaf pairs entirely fused; flowers with petals fused into a tube, pedicels with bracts.

Fruit a 3–8-locular capsule, of *Delosperma*-type; without covering membranes or closing bodies; very fragile, but often held together by leaves.

NOTES
104 spp. 88 subspp. Mostly Succulent Karoo Biome, also present in Fynbos, Nama-Karoo and Savanna biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

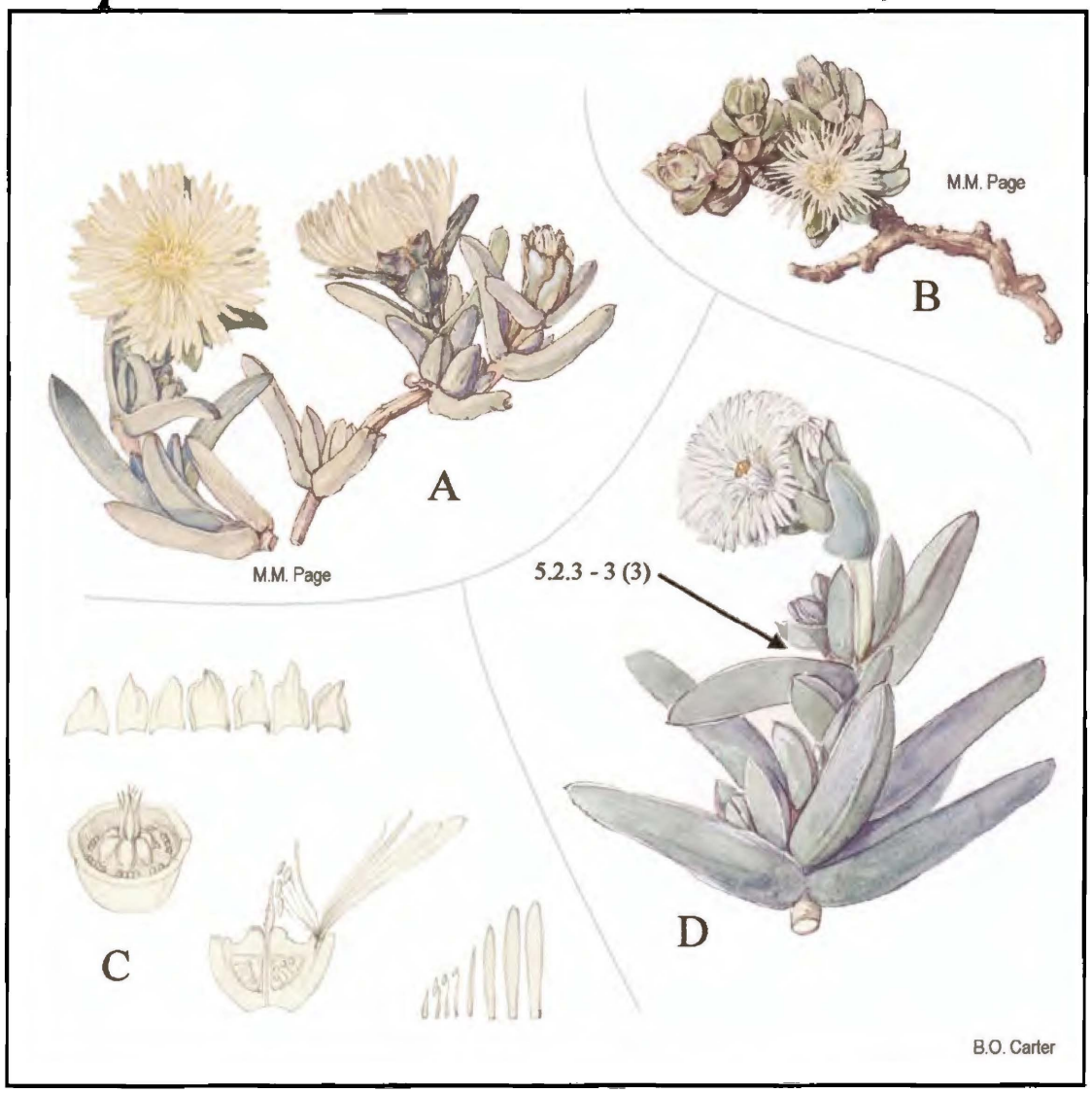


Fig. 6.31

TAXA
A. *C. lehmannii*
B. *C. angustipetala*
C. *C. britteniae*
D. "*C. algoense* ined." still in *Delosperma*

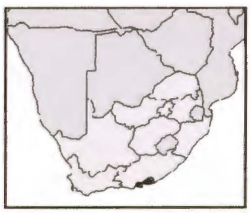
CHARACTERS
5.2.3 - 3 (3): Stem (internodes) - Visible, very short, hidden by densely packed leaves along branches.

DISTINGUISHING CHARACTERS
shrublets with pale grey-green, triquetrous, dotless leaves; flowers white with stiff petals and 6 sepals; old petals persist on the developing fruit.

Fruit a 6-locular capsule, of *Delosperma*-type; robust, whitish, with dark persistent petal remains, not closing completely after first opening; expanding keels parallel; valve wings broad; covering membranes 0; closing bodies 0.

NOTES
8 spp. Endemic to Albany Centre.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

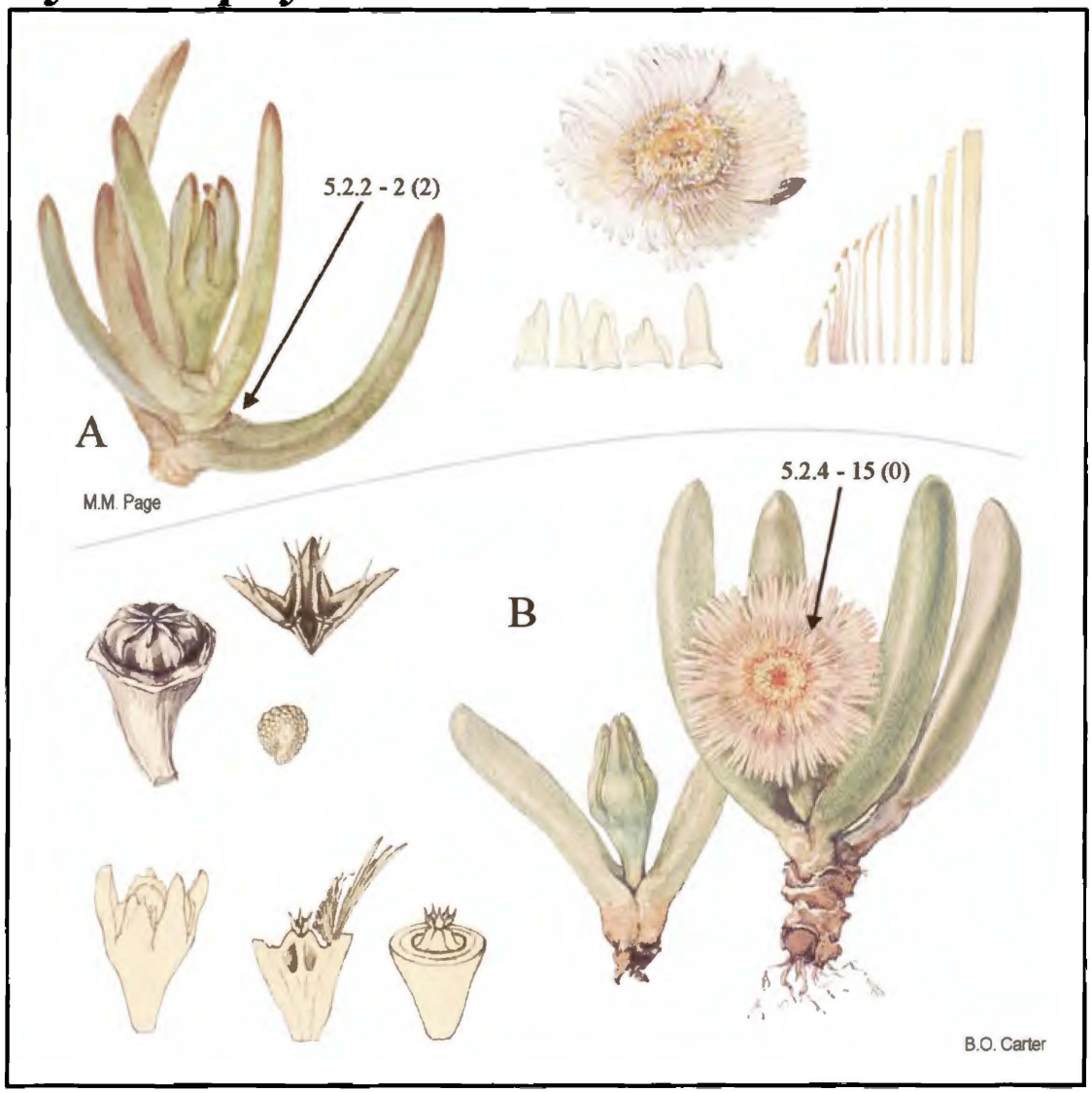


Fig. 6.32

TAXA
A. *C. comptonii*
B. *C. tugwelliae*

CHARACTERS
5.2.2 - 2 (2): Leaf arrangement - Leaves opposite.
5.2.4 - 15 (0): Filamentous staminodes - Present, spreading.

DISTINGUISHING CHARACTERS
tufted perennials, with cylindrical leaves; flowers large, yellowish with many stamens; fruit with toothed parallel expanding keels and long, awn-like valve wings; placentation partially axile.

Fruit a 5–11-locular capsule; of firm consistency, locules deep, and placenta parietal as in *Ruschia*-type; with long, narrow, awn-like valve wings (not awn-like in *C. tugwelliae* L.Bolus); expanding keels toothed, parallel; covering membranes present; closing bodies small.

NOTES
5 spp. Little Karoo Centre in Succulent Karoo Biome with outlier populations in Albany Centre.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

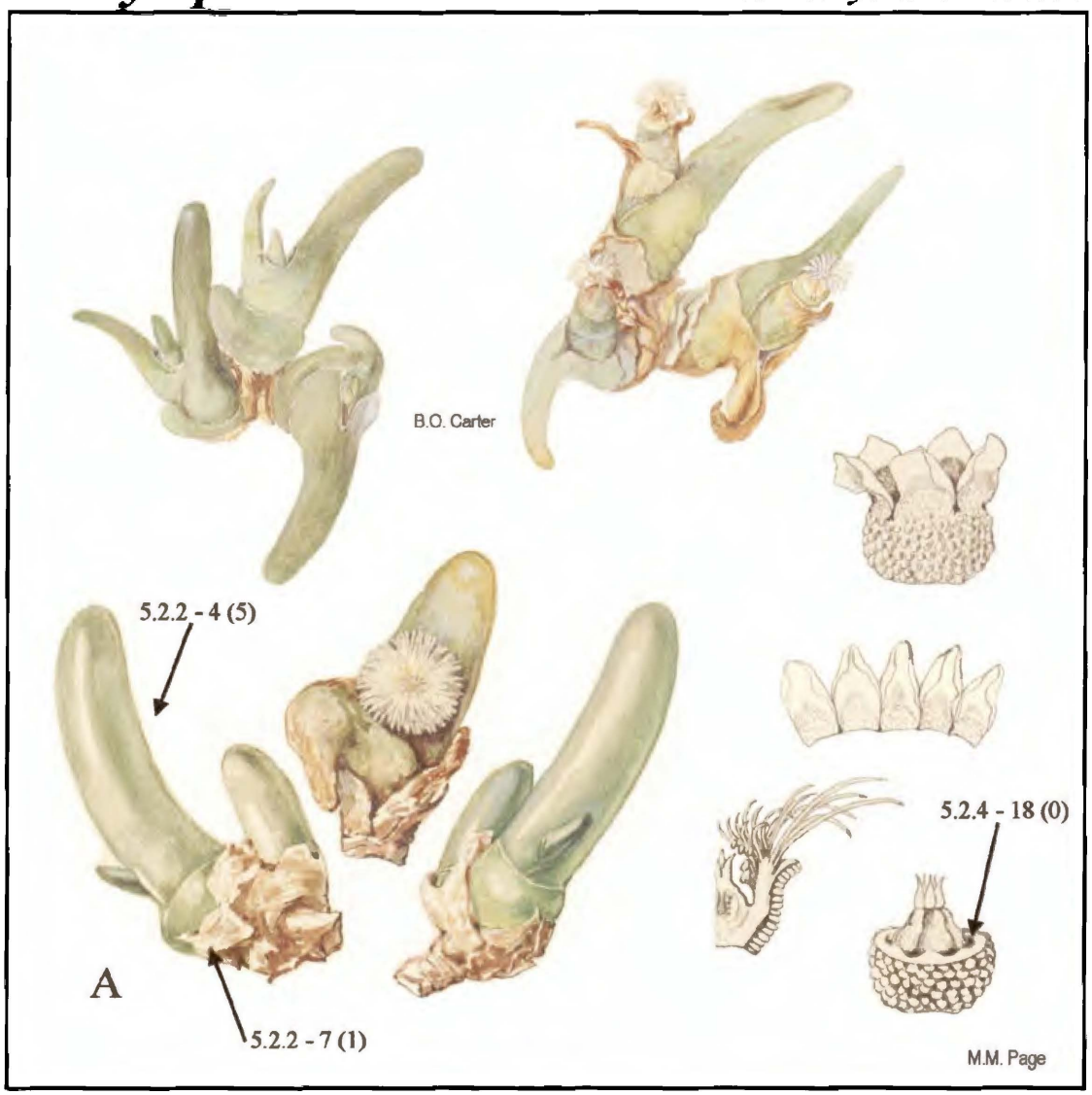


Fig. 6.33

TAXON
A. *D. digitata*

DISTINGUISHING CHARACTERS
Compact, highly succulent perennials; leaves sheathing, finger-like, cylindrical; flowers solitary, terminal, remaining open for ± 3 weeks.

Fruit a capsule, 5-locular, of *Mesembryanthemum*-type; expanding keels parallel, diverging slightly distally; valves with membranous marginal wings or flaps.

CHARACTERS
5.2.2 - 4 (5): Leaf shape - Cylindrical, semi cylindrical.
5.2.2 - 7 (1): Leaf sheaths - Old leaf sheaths persistent, papery or parchment-like.
5.2.4 - 18 (0): Floral nectaries - Koilomorphic meronectary.

NOTES
2 spp. Endemic to Knersvlakte Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

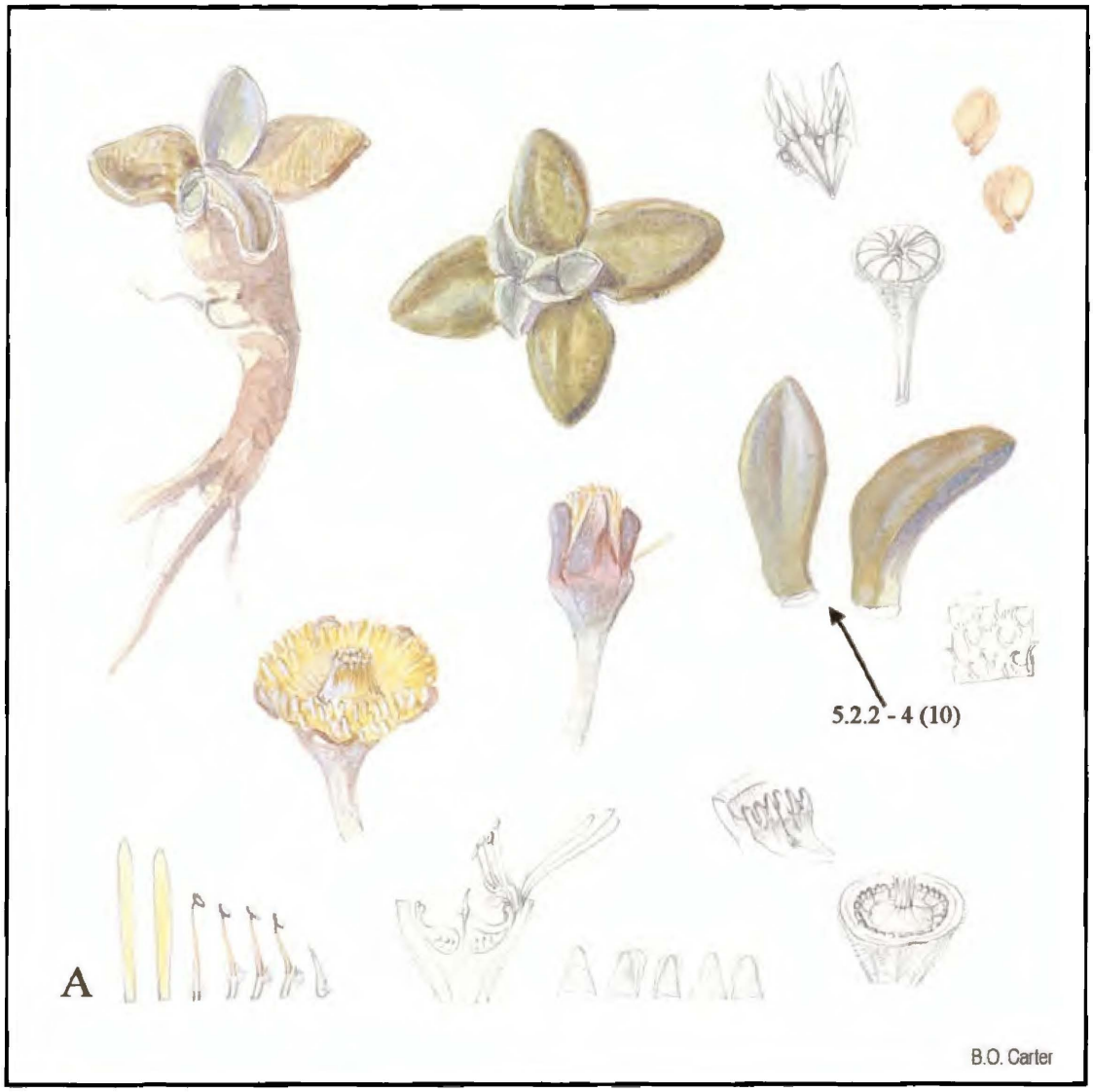


Fig. 6.34

TAXON
A. *D. peersii*

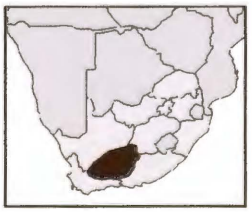
CHARACTERS
5.2.2 - 4 (10): Leaf shape - Spatulate.

DISTINGUISHING CHARACTERS
Rosette-forming perennials with tuberous roots; leaves spatulate-ovate or spatulate-lanceolate, velvety and often dust-covered; flowers deep yellow to salmon-coloured, opening in the afternoon.

Fruit an 8–12-locular capsule, shortly obconic, flattish at top, with raised sutures; valves narrowly deltoid, with a very prominent, acute keel on inner face; expanding keels diverging from base, ± half as long as valve, each tipped with a pallid awn reaching nearly to tips of valves, and with short, broad, membranous marginal wings at base united in pairs between valves; covering membranes rather stiff, closing bodies small.

NOTES
3 spp. Mostly Succulent Karoo Biome with populations extending into Nama-Karoo.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

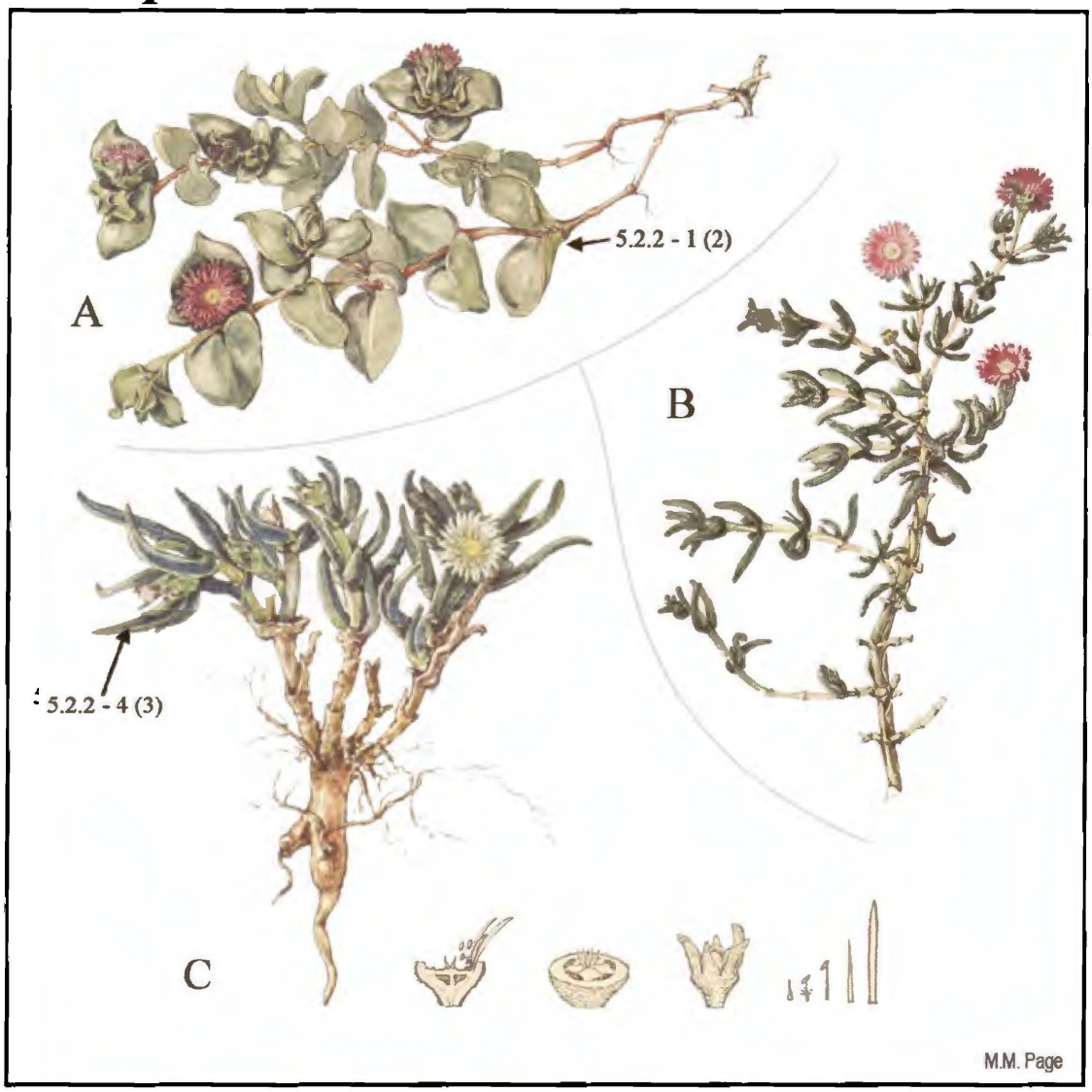


Fig. 6.35

TAXA
A. *D. tradescantioides*
B. *D. pageanum*
C. *D. framesii*

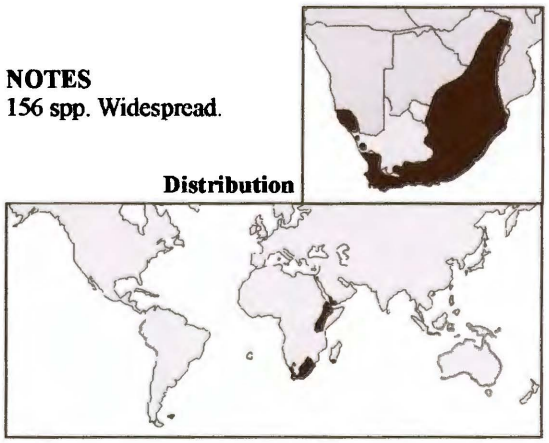
DISTINGUISHING CHARACTERS
creeping or shrubby perennials; leaves soft, glistening or hairy; fruit without covering membranes.

Fruit a (4)5(6)-locular capsule of *Delosperma*-type; expanding keels parallel; valve wings ± rectangular; covering membranes mostly absent; closing bodies absent.

CHARACTERS
5.2.2 - 1 (2): Attachment of leaves to stem - Without petiole.
5.2.2 - 4 (3): Leaf shape - Flattish, grooved upper surface, semi-succulent.

NOTES
156 spp. Widespread.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

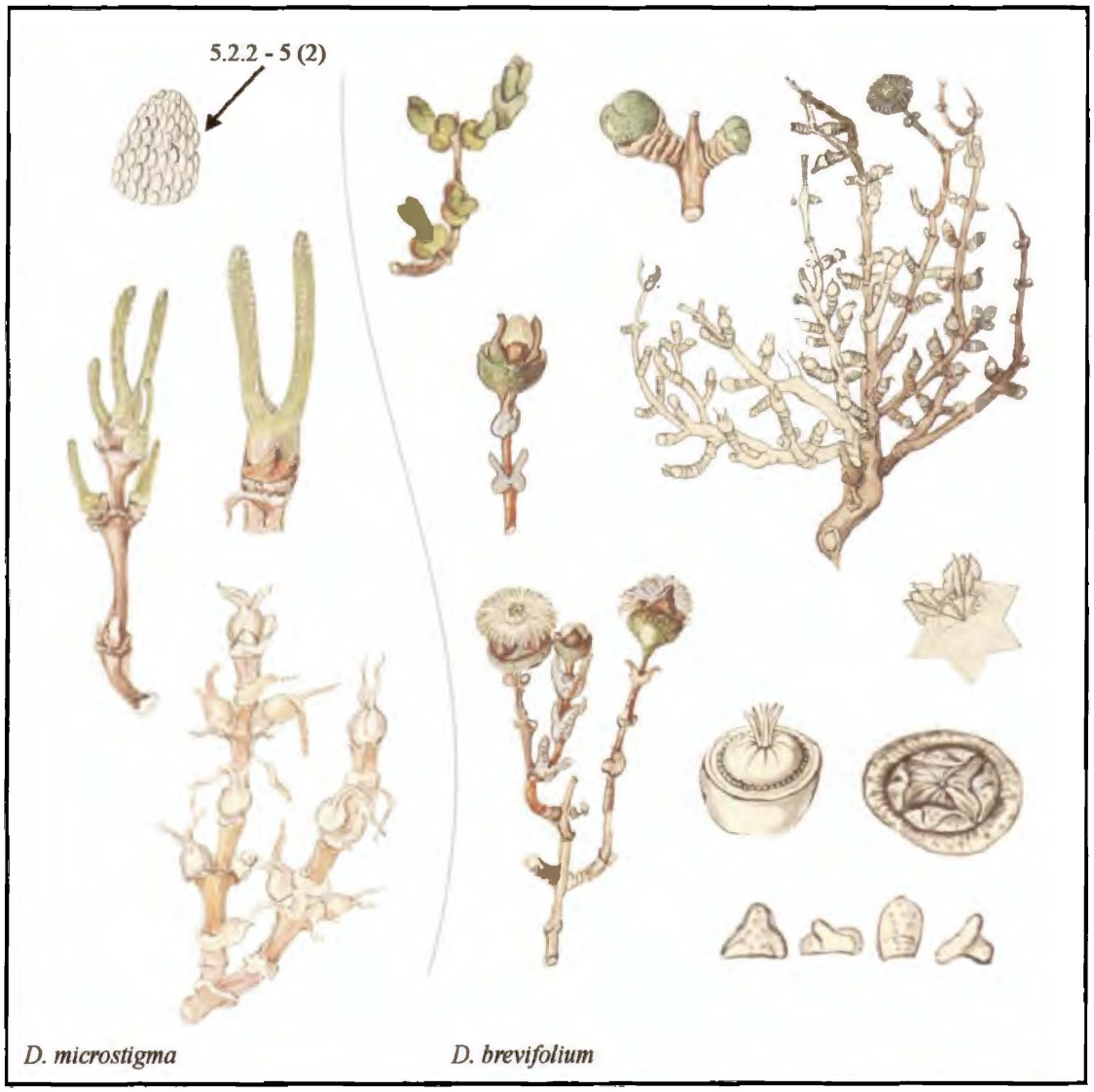


Fig. 6.36

TAXA
A. *D. microstigma*
B. *D. brevifolium*

CHARACTERS
5.2.2 - 5 (2): Leaf surface - Visible bladder cells, glistening and shiny in the light.

DISTINGUISHING CHARACTERS
Shrublets with two different kinds of leaf pairs and woody, hard, thin stems; resting leaf bodies inconspicuous.

Fruit a (4)5(6–9)-locular capsule, of *Mitrophyllum*-type; flat with high rims on the valves; closing bodies absent; expanding sheets merging into prominent, contiguous expanding keels, with broad, membranous margins; covering membranes membranous.

NOTES
7 spp. Near endemic to Knersvlakte Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

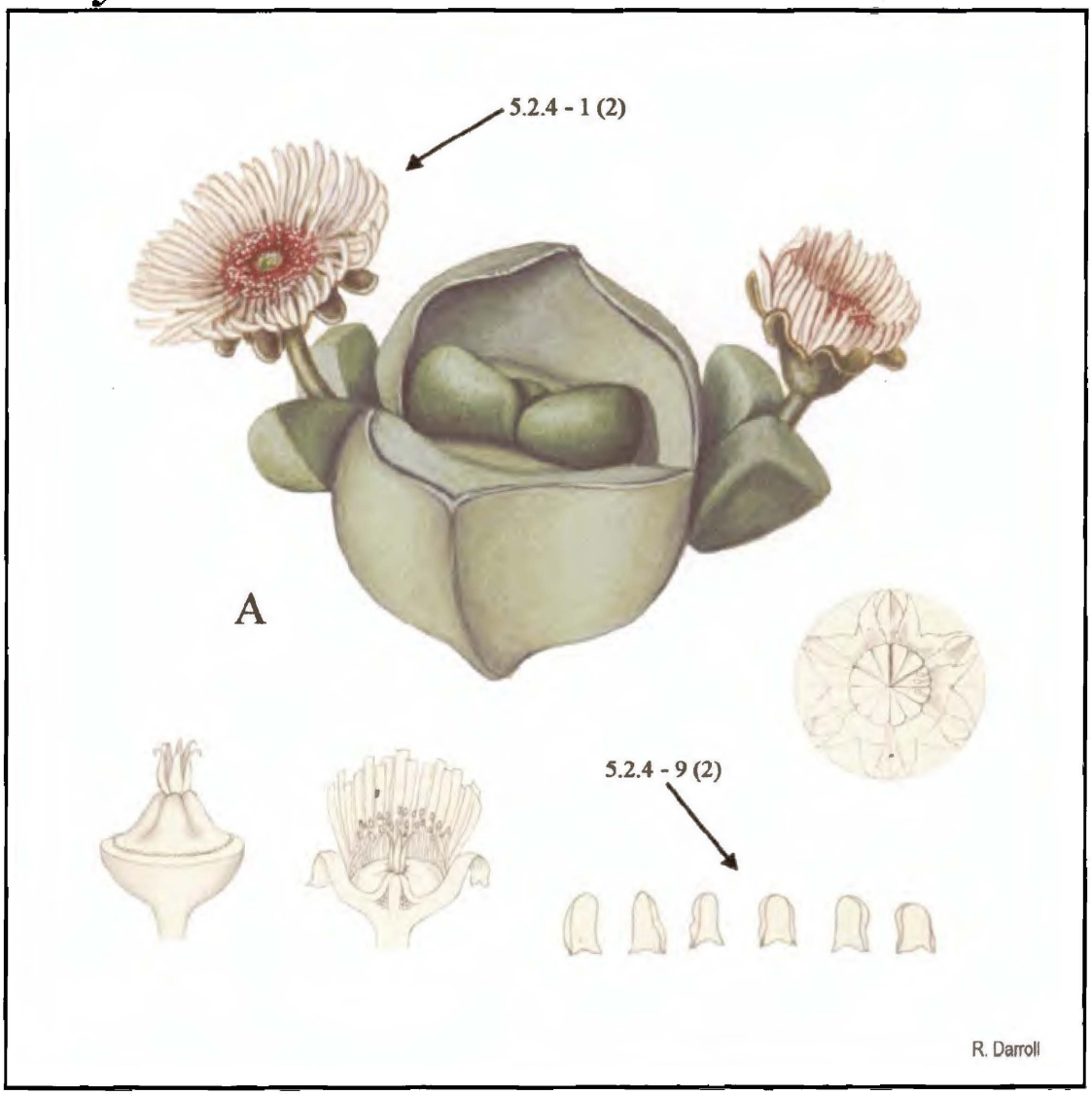


Fig. 6.37

TAXON
A. *D. lapidiformis*

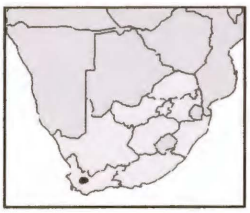
CHARACTERS
5.2.4 - 1 (2): Inflorescence characteristics - Paired, 2 flowers produced simultaneously on either side of plant body.
5.2.4 - 9 (2): Number of sepals - 6.

DISTINGUISHING CHARACTERS
Single-bodied or developing into small clumps; producing two flowers simultaneously, one on each side of the leaf pair, leaves keeled, waxy.

Fruit a 6-locular capsule, of *Drosanthemum*-type; covering membranes present; closing bodies absent.

NOTES
1 sp. Endemic to the Tanqua Karoo, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

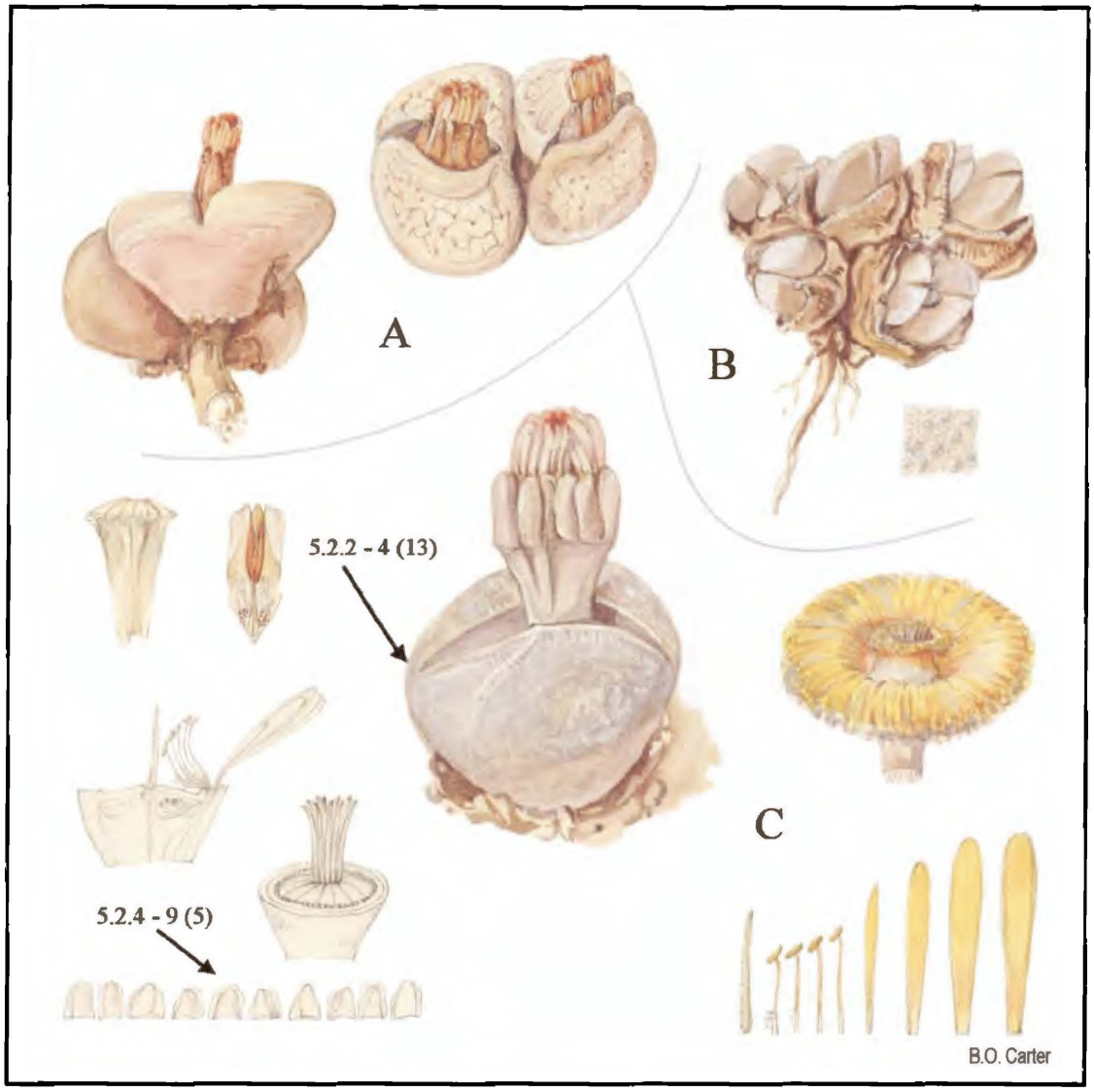


Fig. 6.38

TAXA
A. *D. vanzylii*
B. *D. puberulus*
C. *D. pole-evansii*

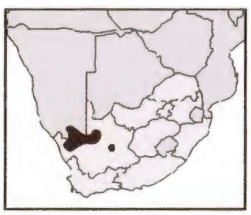
CHARACTERS
5.2.2 - 4 (13): Leaf shape - Globose, forming a rounded body and only fused basally.
5.2.4 - 9 (5): Number of sepals - 9 or more.

DISTINGUISHING CHARACTERS
Single-bodied or as small clumps; leaves often with distinct keel; pedicels short and stout; sepals 6–8 (9).

Fruit a 6–15-locular capsule, of *Delosperma*-type; shortly and broadly obconic, flattish, with slightly raised sutures on top; valve wings well developed; expanding keels closely contiguous into a central keel; covering membranes reduced to a limb, narrow or absent; closing bodies absent.

NOTES
6 spp. Mostly Nama-Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

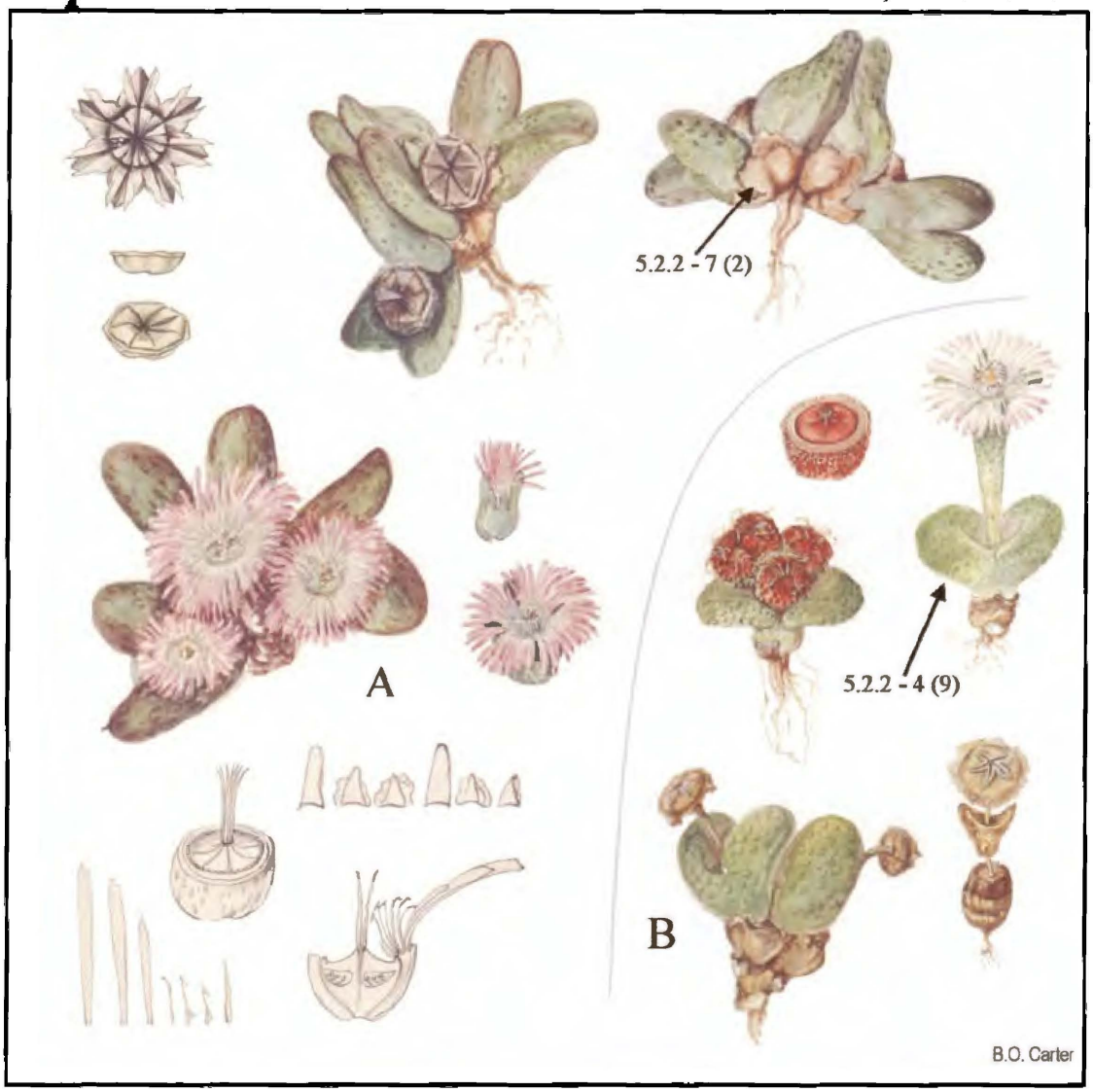


Fig. 6.39

TAXA
A. *D. retroversum*
B. *D. luckhoffii*

CHARACTERS
5.2.2 - 4 (9): Leaf shape - Ovate in outline, succulent.
5.2.2 - 7 (2): Leaf sheaths - Leaves, enclosed by brown to black sclerotic sheaths.

DISTINGUISHING CHARACTERS
Compact dwarf plants forming clumps with age; leaves soft, often reddish, with large micro-windows; flowers sessile.

Fruit a 5–7-locular capsule, of *Mitrophyllum*-type; flat; without any closing devices; expanding keels broad, dark brown, ending either in an awn or a wing; covering membranes present; closing bodies absent.

NOTES
2 spp. One species (*D. retroversum*) endemic, in limestone, near Piquetberg, Fynbos Biome and the other, (*D. luckhoffii*) endemic to Knersvlakte Centre, Succulent Karoo Biome..

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021



Fig. 6.40

TAXON
A. *D. crassifolium*

CHARACTERS
5.2.5 - 6 (2): Open fruit closing devices at exits of locules - Present, bifid or two-lobed.

DISTINGUISHING CHARACTERS
Mat-forming perennials; fruit spongy, closing bodies bilobed.

Fruit a 5-locular capsule, near *Mitrophyllum*-type; pale yellow, spongy; valves becoming reflexed; closing bodies large, bifid, spongy, rarely absent; expanding keels diverging, with lacerate margins; valve wings ± oblong, as long as valves; covering membranes present.

NOTES
5 spp. 2 subspp. Coastal in Fynbos Biome, also occurs Australia. Seabirds may be agents for long distance dispersal.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

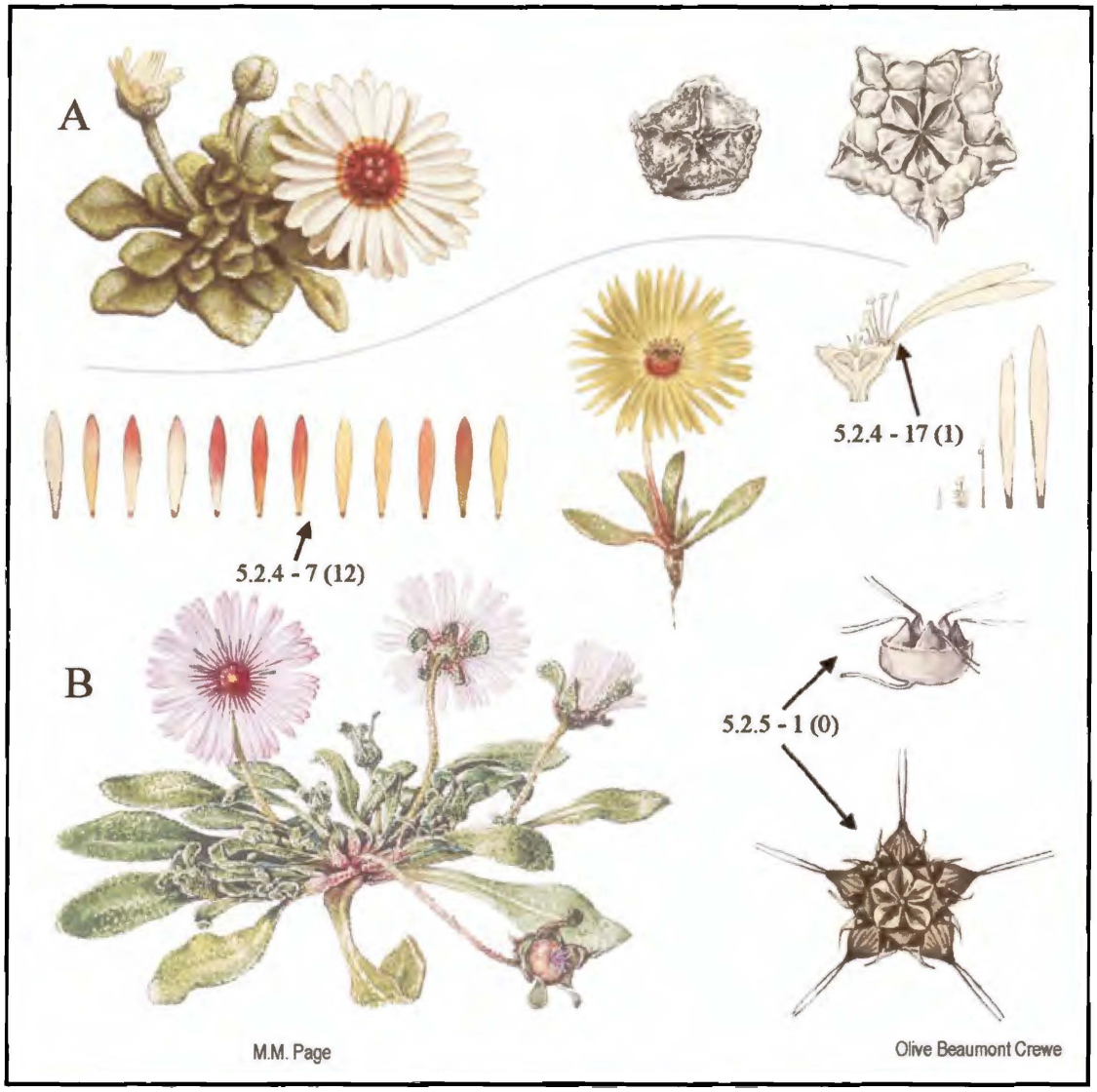


Fig. 6.41

TAXA
A. *D. maughanii*
B. *D. bellidiformis*

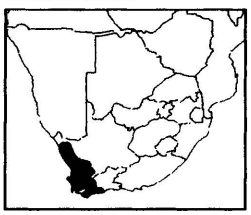
CHARACTERS
5.2.4 - 7 (12): Flower colour - Multi-coloured.
5.2.4 - 17 (1): Fusion of petals - Free.
5.2.5 - 1 (0): Fruit type & dehiscence - Hygrochastic, opening when wet.

DISTINGUISHING CHARACTERS
annuals, with glistening bladder cell idioblasts; flowers multicoloured; fruit often with persistent stigmas.

Fruit a 5-locular capsule, of *Mitrophyllum*-type; with persistent stigmas; expanding sheets large; expanding keels diverging; valve wings narrow, acute; covering membranes present or 0.

NOTES
7 spp. 2 subspp. Fynbos and Succulent Karoo biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

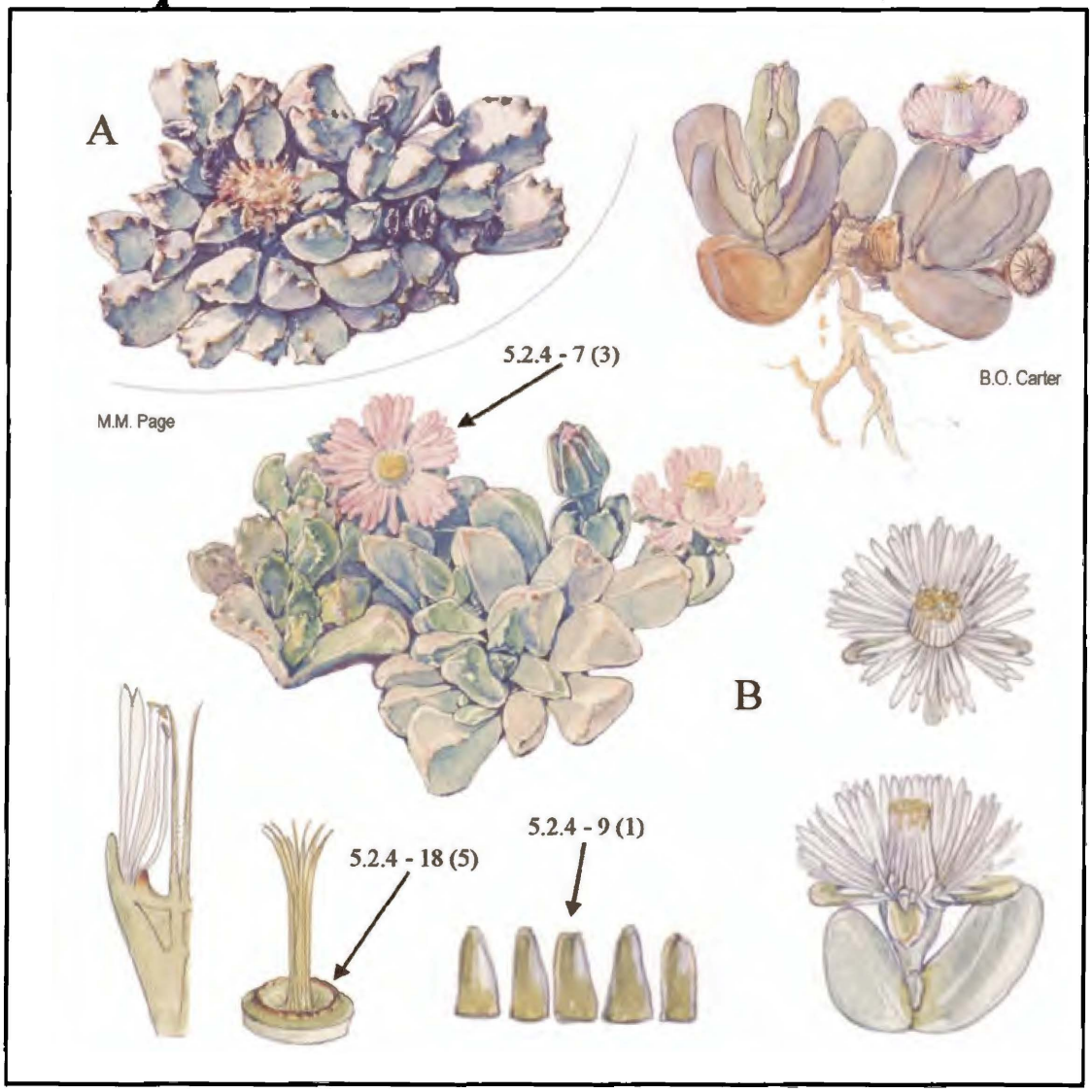


Fig. 6.42

TAXA
A. *D. delaetianus*
B. *D. dealbatus*

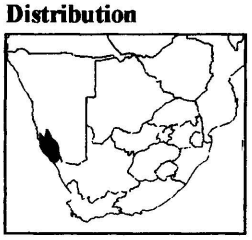
CHARACTERS
5.2.4 - 7 (3): Flower colour - Pale pink.
5.2.4 - 9 (1): Number of sepals - 5.
5.2.4 - 18 (5): Floral nectaries - Lophomorphic holonectary.

DISTINGUISHING CHARACTERS
perennials with smooth or slightly toothed, finely textured, grey-green leaves; sepals 5 (*Juttadinteria* has 4); pedicels bracteate, flowers opening in the evening; fruit with covering membranes.

Fruit a 8–11(14)-locular capsule, of *Titanopsis*-type; closing bodies absent; valve wings present, large; expanding keels parallel, lacerate, ending in an awn; covering membranes present, covering ²/₃ of locule, flattish, translucent.

NOTES
2 spp. Mostly Succulent Karoo Biome with extensions into Desert Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

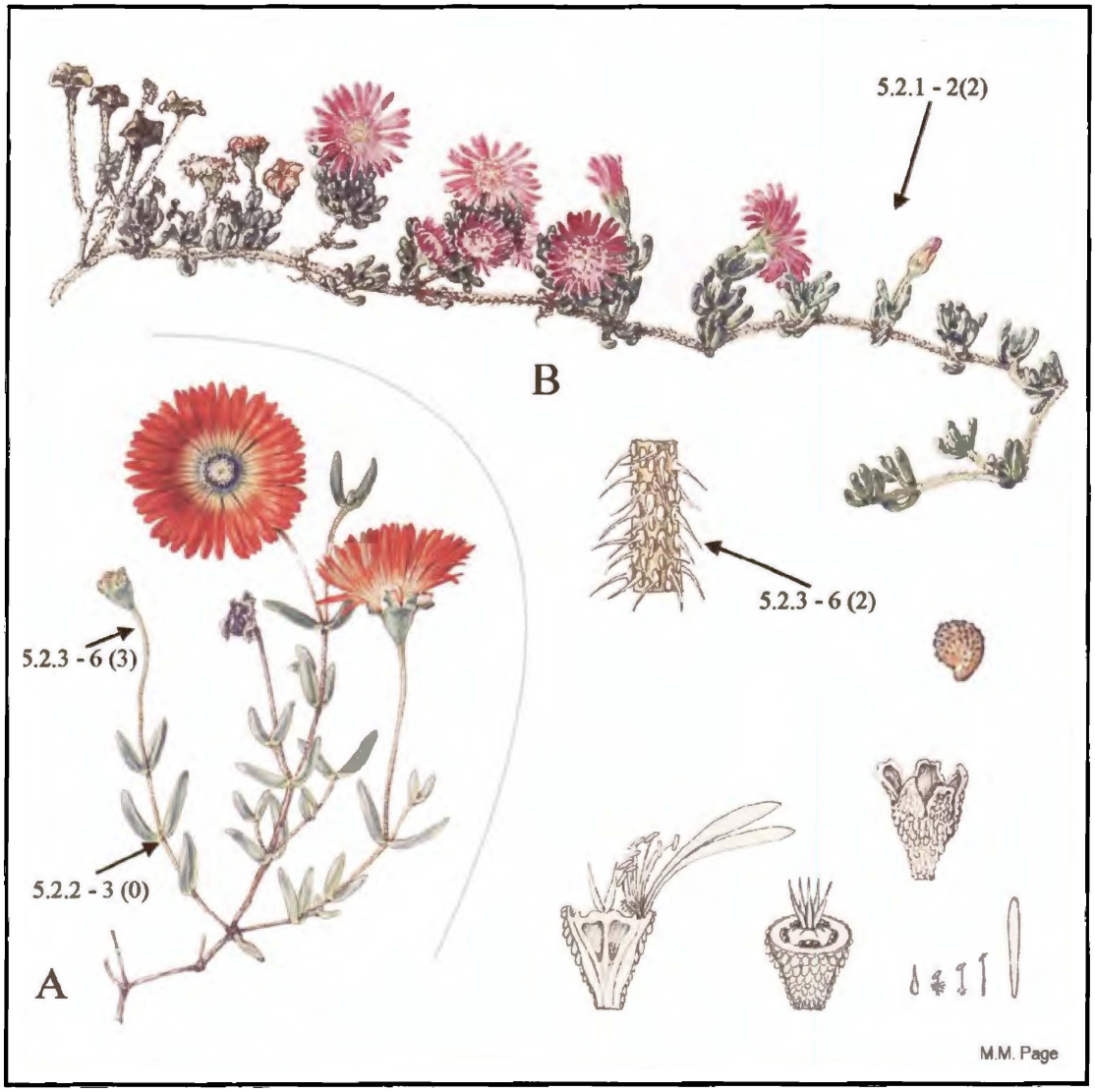


Fig. 6.43

TAXA
A. *D. speciosum*
B. *D. floribundum*

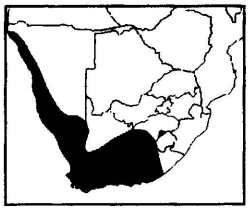
DISTINGUISHING CHARACTERS
Creeping or shrubby perennials with visible bladder cell idioblasts on the leaves; fruit with valve wings and covering membranes. Leaves (mostly) basally free.

Fruit a 5(6)-locular capsule, of *Drosanthemum*-type; sometimes with seed-pockets; valve wings present; expanding keels contiguous, parallel or divergent; covering membranes present; closing bodies very small or absent; capsule often turning from light grey to blackish when wet.

CHARACTERS
5.2.1 - 2(2): Overall appearance - Creeping succulent.
5.2.3 - 6 (2): Stem surface texture and ornamentation - Hairy.
5.2.3 - 6 (3): Stem surface texture and ornamentation - Papillate in young stems.
5.2.2 - 3 (0): Leaf pairs (degree of fusion) - Free.

NOTES
110 spp. Widespread in Fynbos and Succulent Karoo biomes, also present in Nama-Karoo and Albany Thicket.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

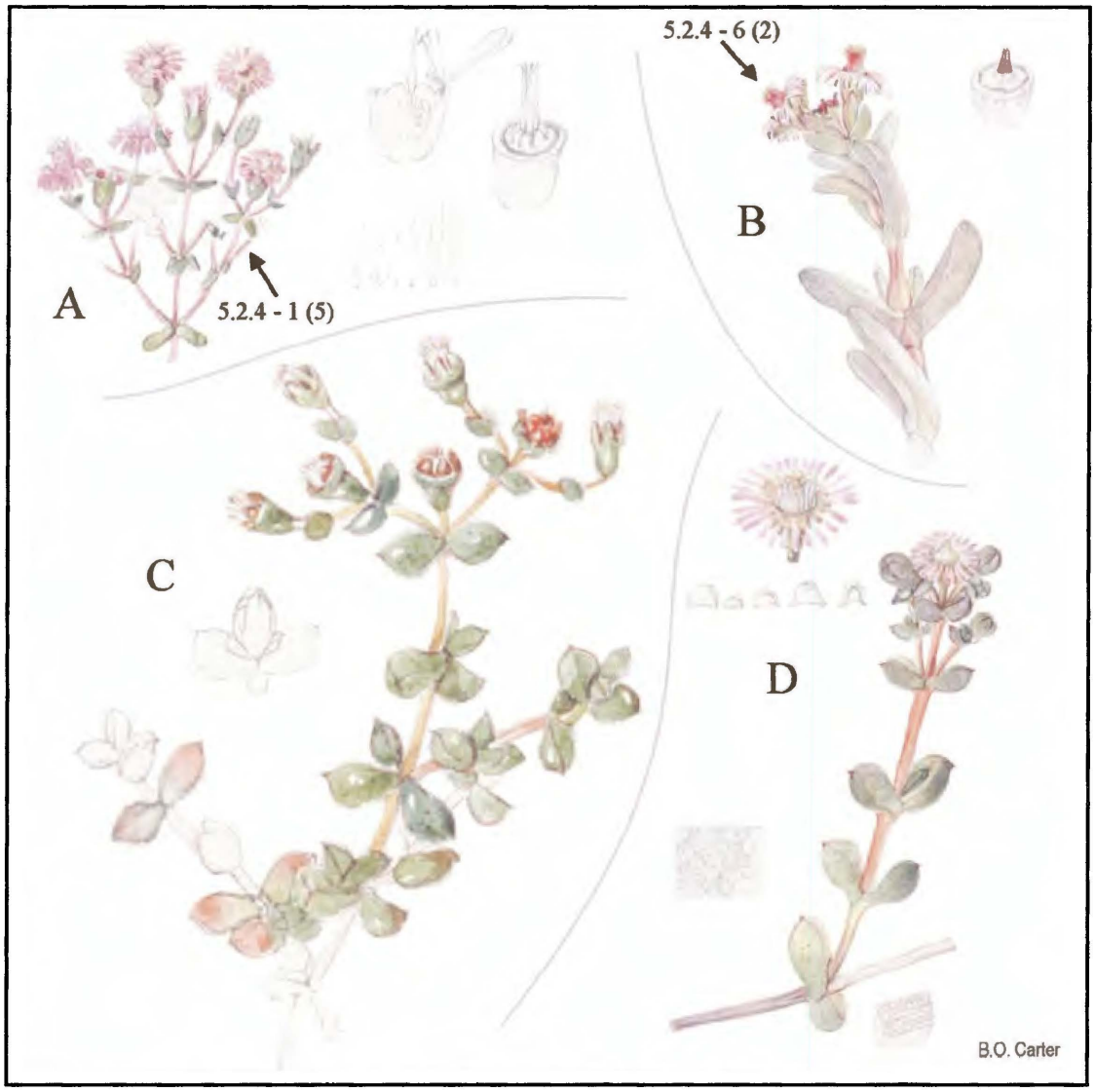


Fig. 6.44

TAXA
A. *E. cyathiformis*
B. *E. gravida*
C. *E. sedoides*
D. *E. schneideriana*

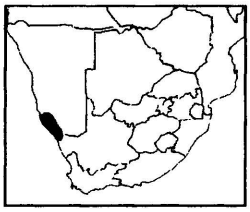
CHARACTERS
5.2.4 - 1 (5): Inflorescence characteristics - Many-flowered dichasia or compound cymes.
5.2.4 - 6 (2): Diurnal floral rhythm - Continuously open.

DISTINGUISHING CHARACTERS
Flat-growing to erect shrubs; leaves greyish green or reddish or bluish, textured; fruit with valves folding back entirely when expanded.

Fruit capsule close to the *Ruschia*-type; 5-locular; bottom bell-shaped, top convex, valve rims high; valves opening completely, valve wings broad and rectangular; closing bodies white; covering membranes complete with distal closing rodlets and low rims.

NOTES
8 spp. *E. gravida* probably belongs with *Antimima pilosula* in a separate genus in which flowers remain open continuously. Succulent Karoo Biome with extensions into Desert Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

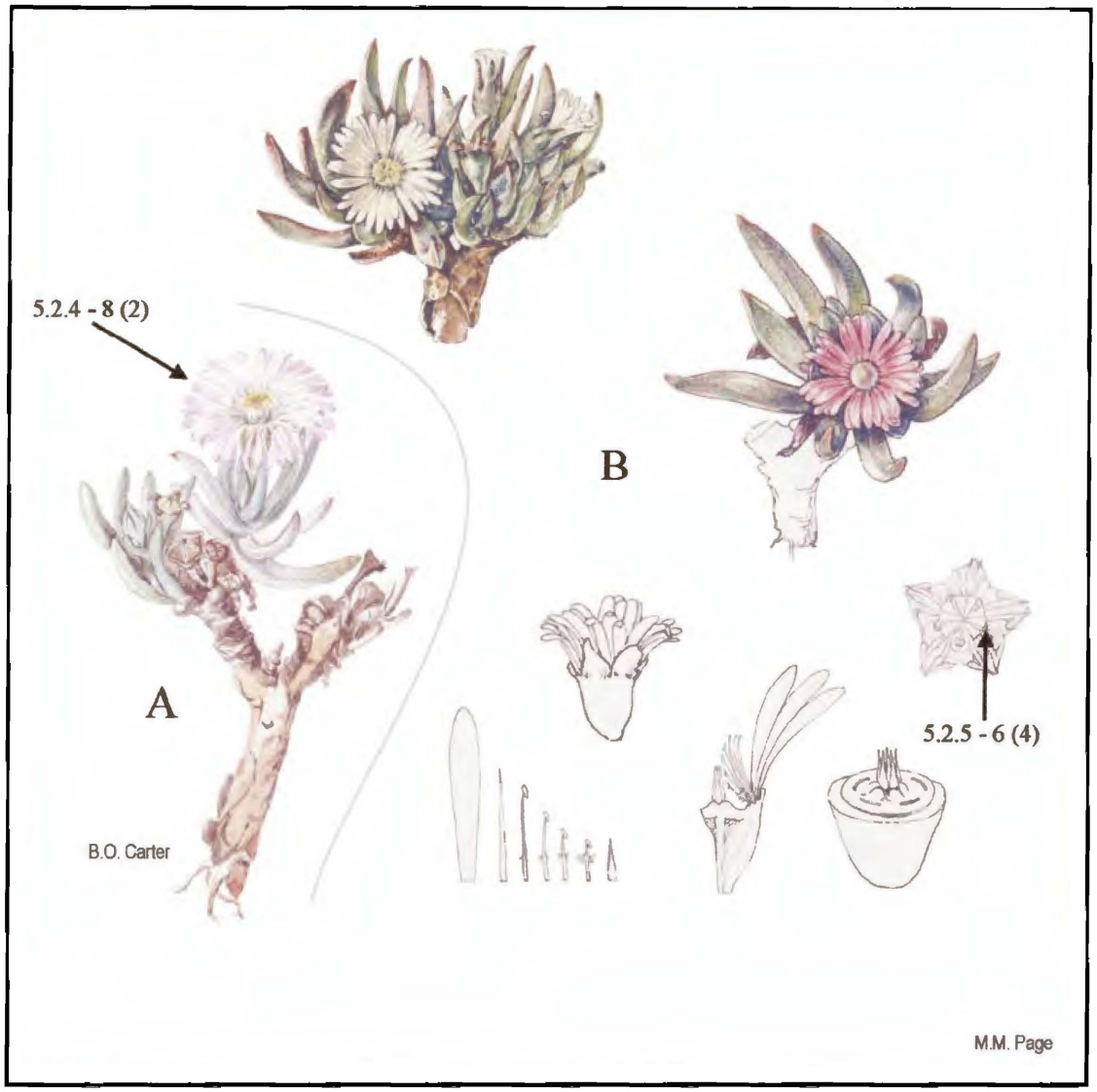


Fig. 6.45

TAXA
A. *E. fulleri*
B. *E. wilmaniae*

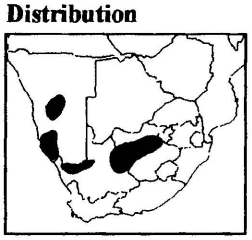
CHARACTERS
5.2.4 - 8 (2): Flower size - Medium (20–40 mm).
5.2.5 - 6 (4): Open fruit, closing devices at exits of locules - Present, small, white.

DISTINGUISHING CHARACTERS
Tufted perennials with thickened rootstock; leaves bluish green; flowers purple fading to pink or white towards centre, or white.

Fruit a 5-locular capsule, persisting for many years on plants; broad expanding keels and broad valve wings indicate a relation to *Titanopsis*-type of fruit, but deep locules and hook-shaped closing bodies agree with *Ruschia*-type; valve wings narrow; expanding keels broad, sheet-like, toothed; covering membranes stiff; closing bodies small, often crenulate as in *Hereroa*.

NOTES
4 spp. Two different nectary types (holonectary and meronectary) occur in this genus, suggesting that the group may need to be split up following detailed morphological investigation.

Distribution
Nama-Karoo, with extensions into other biomes.



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021



Modified from Smith *et al.* (1998).

Fig. 6.46

TAXON
A. *E. alpina*

CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Minute tufted perennials; leaves with visible bladder cell idioblasts; flowers solitary, white, without staminodes and with few petals.

Fruit an extremely fragile 5-locular capsule of the *Delosperma*-type, small and thin, and extremely fragile; valve wings reduced; covering membranes and closing bodies absent.

NOTES
1 spp. Highly restricted distribution in Albany Centre. The species grows on rocks amongst mosses in damp places near Hogsback. It may be closely related to *Delosperma*.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

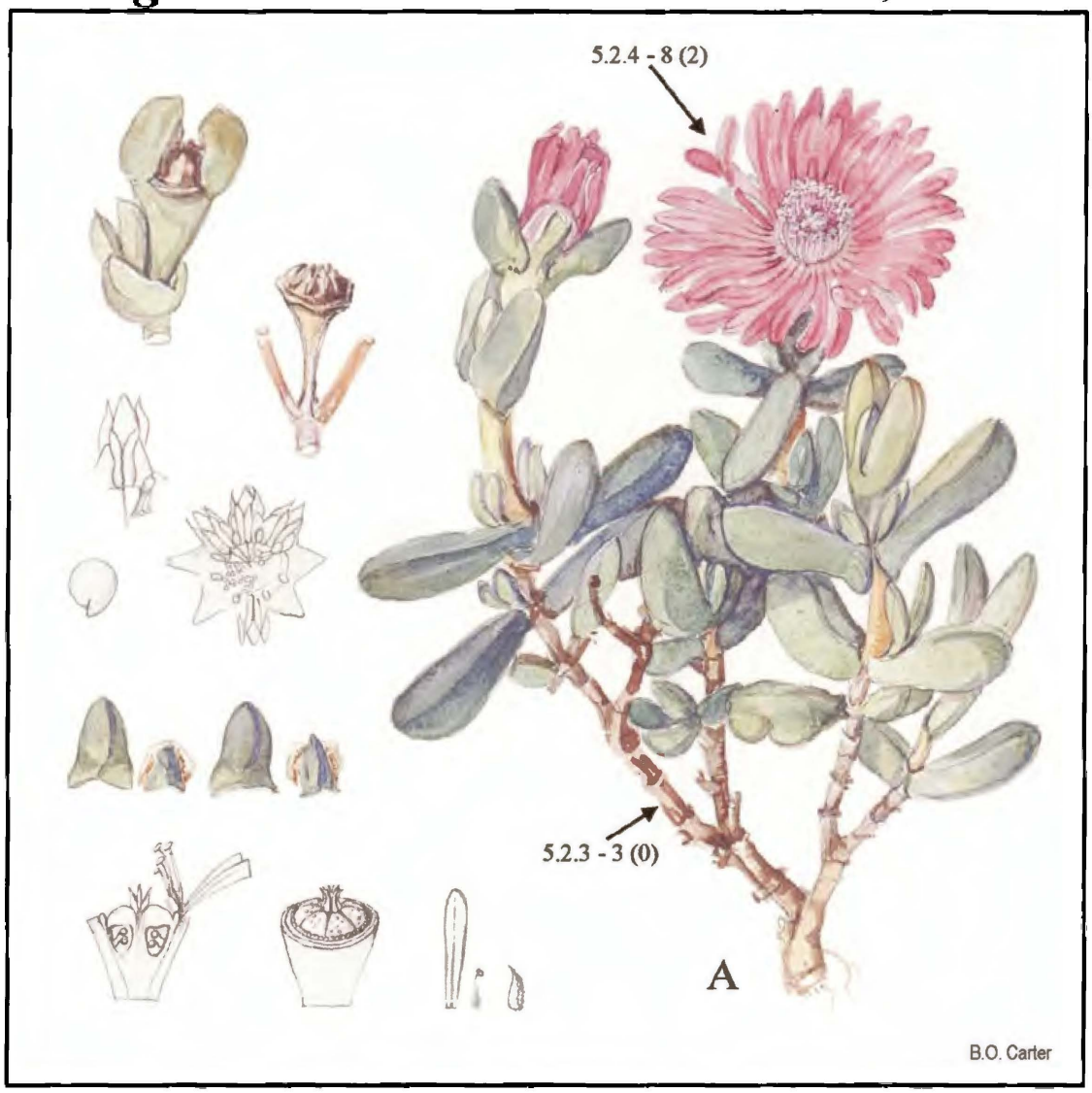


Fig. 6.47

TAXON
A. *E. octonaria*

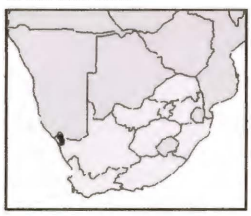
CHARACTERS
5.2.3 - 3 (0): Stem (internodes) - Visible, internodes easily seen.
5.2.4 - 8 (2): Flower size - Large (>40 mm).

DISTINGUISHING CHARACTERS
Erect perennials with woody branches; flowers magenta; fruit 8-locular, with small closing bodies.

Fruit a 8-locular capsule, of *Lampranthus*-type but with narrow valve wings; fairly large and woody; expanding keels diverging; covering membranes present, small, not covering entire locule; closing bodies small (unusual in a *Lampranthus*-type capsule).

NOTES
1 spp. Endemic to Gariep Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021



Fig. 6.48

TAXA
A. *E. bracteata*
B. *E. forficata*

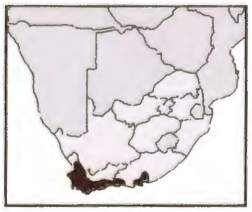
CHARACTERS
5.2.3 - 2 (2): Branches - Erect.

DISTINGUISHING CHARACTERS
Shrubs with sharp-tipped leaves; flowers with distinct hypanthium into which stamens bend.

Fruit a capsule of ± *Lampranthus*-type, usually 5-locular, rarely 9–13-locular, woody, base funnel-shaped; expanding keels ending in awns; valve wings variable; covering membranes with lateral-marginal closing ledges; closing bodies absent.

NOTES
31 spp. 2 hybrids. Nectary characters inconsistent, the genus needs to to be split into two genera. Endemic to Fynbos Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

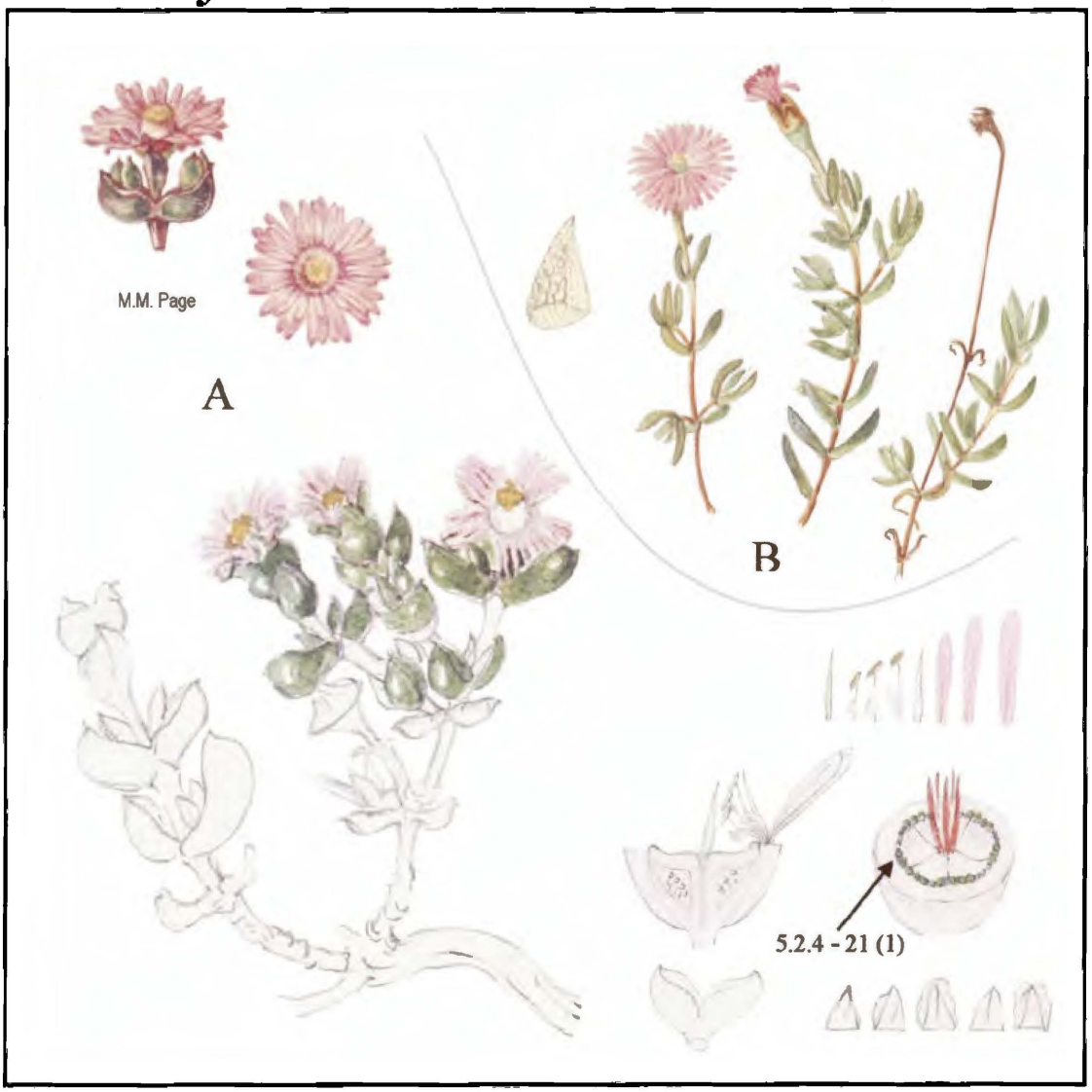


Fig. 6.49

TAXA
A. *E. drepanophylla*
B. *E. oxysepala*

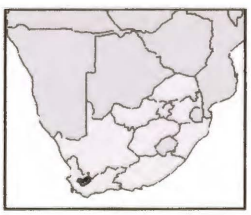
CHARACTERS
5.2.4 - 21 (1): Nectary colour - Dark green (distinct in colour from surrounding tissue).

DISTINGUISHING CHARACTERS
Dwarf shrublets with reddish stems; leaves often red-tipped, fruit flat on top, valve wings very narrow, often absent in old capsules.

Fruit a 5-locular capsule, of ± *Lampranthus*-type, obconical, woody; expanding keels parallel at base, divergent at points; valve wings very narrow, often absent in old capsules; covering membranes flexible, ± covering the locules; closing bodies absent.

NOTES
5 spp. *Lampranthus mucronatus* has recently been included in this genus although it would be better placed in *Braunsia*. Fynbos and Succulent Karoo, often at high altitude.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

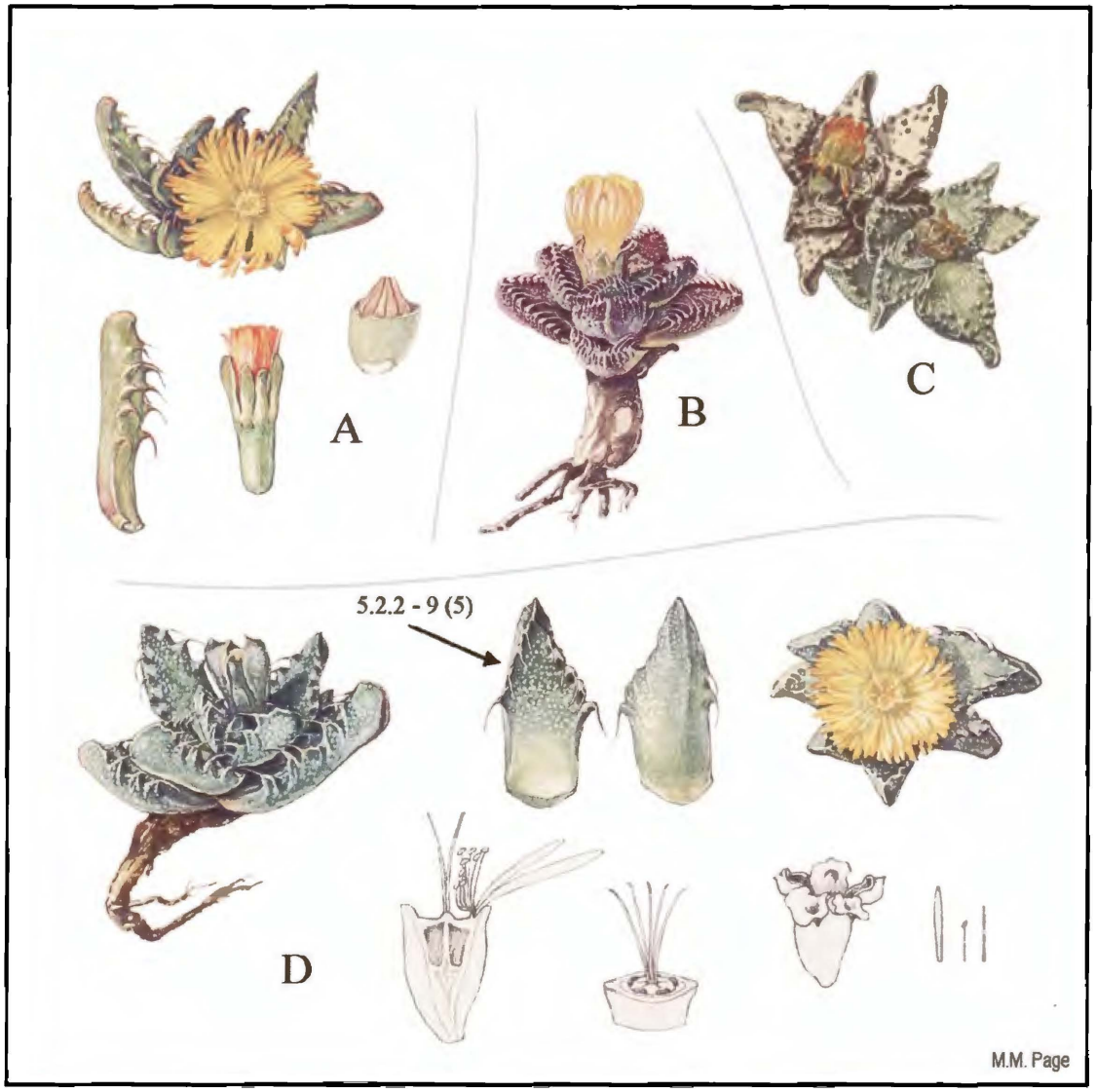


Fig. 6.50

TAXA
A. *F. lupina,* now sunk under *F. felina*
B. *F. tigrina*
C. *F. tuberculosa*
D. *F. felina*

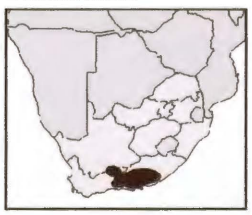
CHARACTERS
5.2.2 - 9 (5): Leaf margins and keel - Hard teeth or bristles on margins or keel.

DISTINGUISHING CHARACTERS
Compact perennial rosettes; leaves with distinct margins and rows of short to long teeth; flowers yellow, rarely white.

Fruit a 5- or 6-locular capsule, without closing bodies; appearing 10-locular and seedless: 5 empty hollows alternate with locules and seeds obscured by bent lamellae; valve wings firm, stout, connate with valves in their basal part only and standing rigidly above locules after opening of capsule; expanding keels ending in an awn, eventually capsules squeezed out by growth of new leaves.

NOTES
8 spp. Mostly confined to Albany Centre.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

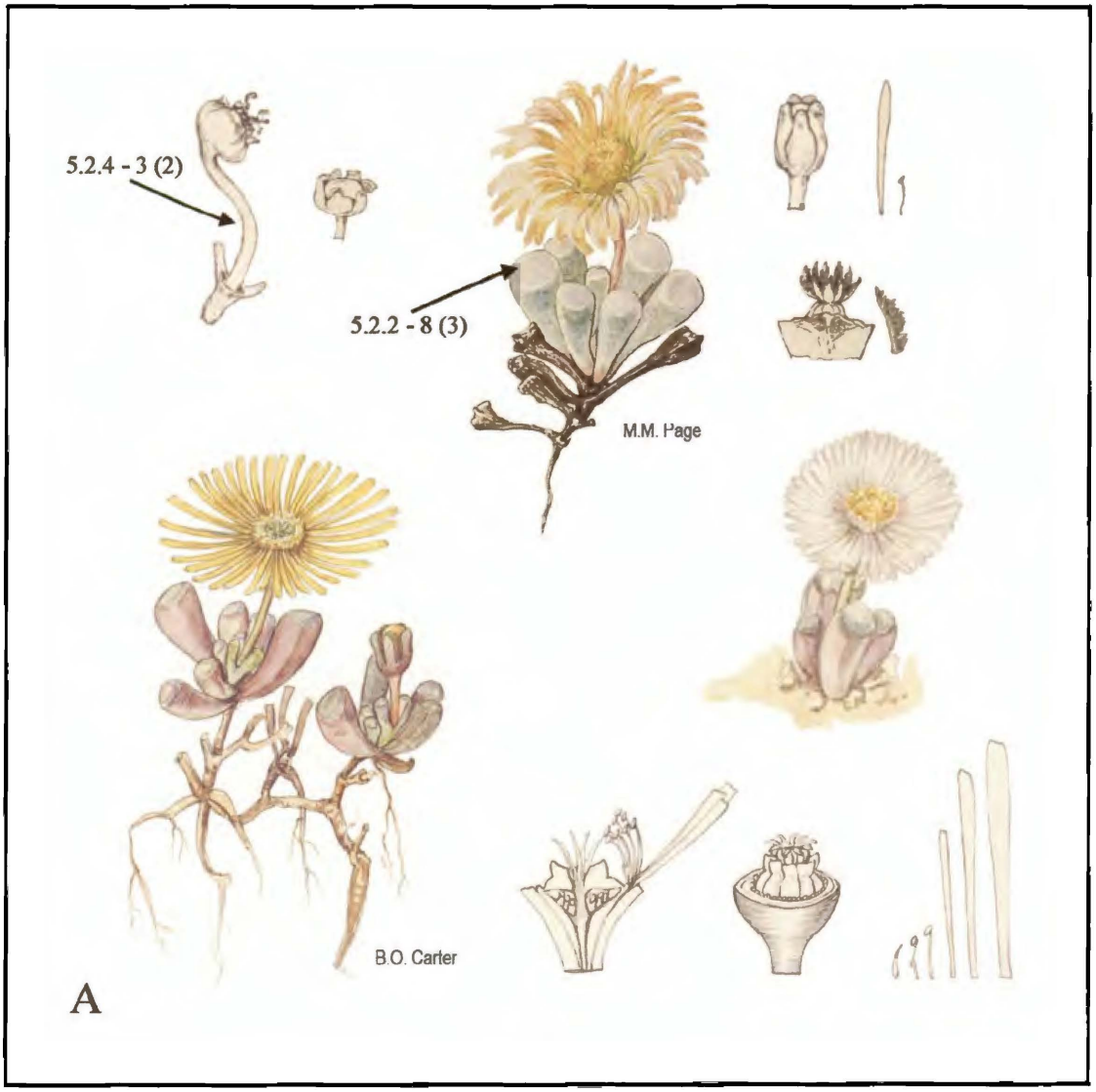


Fig. 6.51

TAXON
A. *F. rhopalophylla* **subsp.** *aurantiaca*

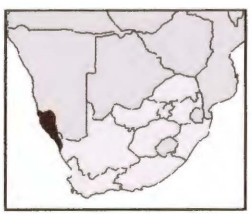
CHARACTERS
5.2.2 - 8 (3): Leaf tips - Windowed.
5.2.4 - 3 (2): Pedicel shape and behaviour - Pedicel S-shaped (sigmoid).

DISTINGUISHING CHARACTERS
Plants mostly underground with windowed tips visible; leaf surface smooth; capsule multi-locular; flowers yellow or white, without filamentous staminodes.

Fruit a 8–16-locular capsule of *Leipoldtia*-type, but with small closing bodies; becoming detached from plant and acting as tumble fruit; expanding keels parallel, diverging at tips, with teeth; valve wings small, with diverging tips; axile column firm; covering membranes well developed.

NOTES
1 spp. 2 subspp. Endemic to Gariep Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

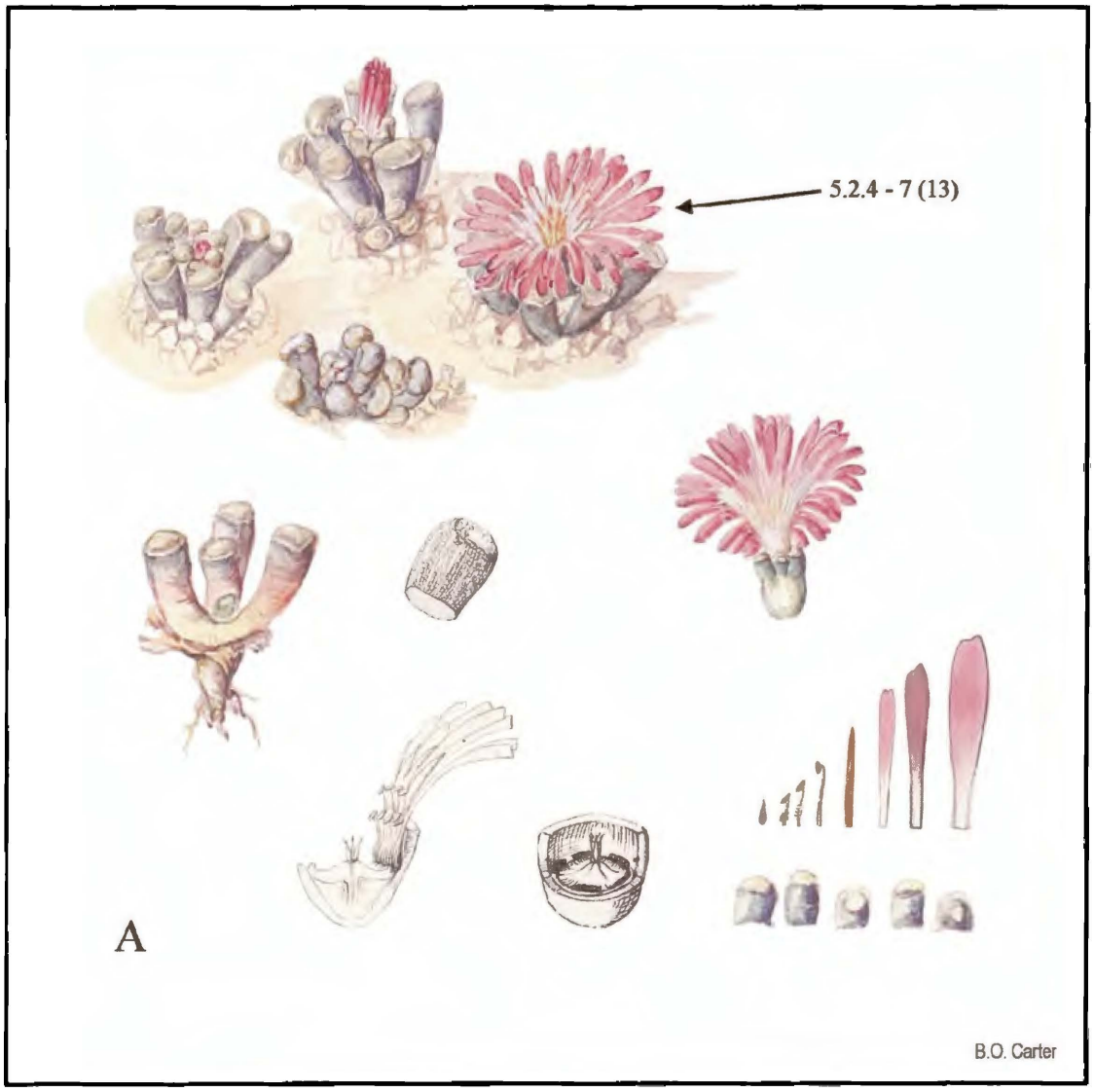


Fig. 6.52

TAXON
A. *F. pulchra*

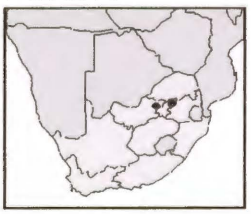
CHARACTERS
5.2.4 - 7 (13): Flower colour - Bicoloured, pink or magenta and white.

DISTINGUISHING CHARACTERS
Plants mostly underground with windowed tips visible; leaf surfaces with visible bladder cell idioblasts in rows; flowers with a series of filamentous staminodes; capsule 5- or 6-locular.

Fruit a 5- or 6-locular capsule, of *Delosperma*-type but without valve wings; valves only rising to a ± erect position, margins of valves recurved when open; expanding keels parallel and reduced, with small wings and diverging tips; very fragile, breaking up when wet, ripe or moistened or rolling as tumble fruit to disperse seeds.

NOTES
2 spp. Endemic to Grassland Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

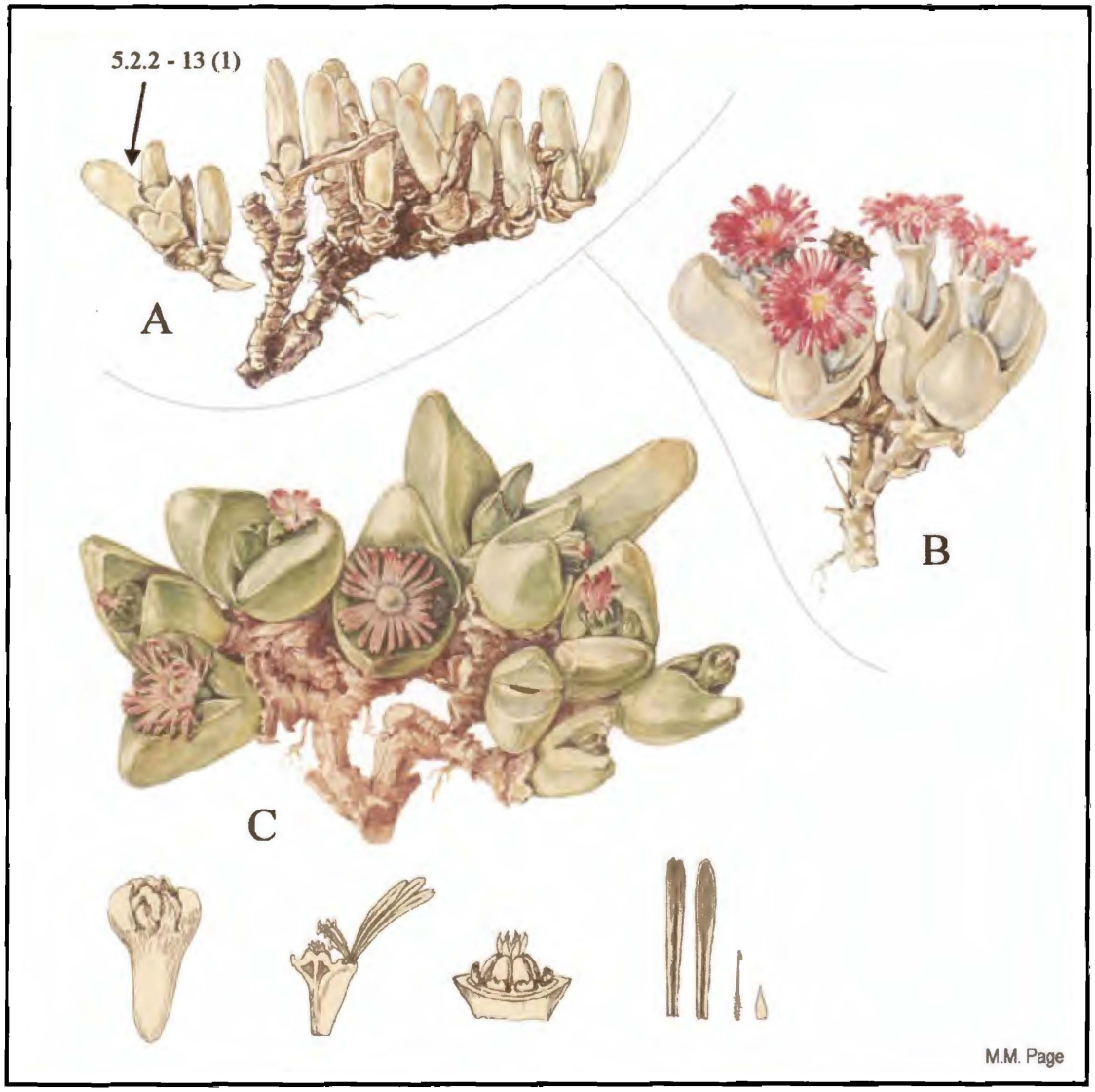


Fig. 6.53

TAXA
A. *G. geminum*
B. *G. pubescens*
C. *G. gibbosum*

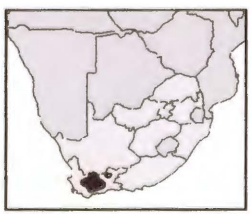
CHARACTERS
5.2.2 - 13 (1): Relative length of two leaves forming a pair - Leaves of a pair of distinctly different lengths (anisophyllous plant).

DISTINGUISHING CHARACTERS
Dwarf perennials with subequal to unequal leaves united into bodies with an oblique fissure separating the leaves of a pair, often velvety; flowers purple or white.

Fruit a 6–9-locular capsule, of *Drosanthemum*-type; convex or conical with prominent sutures; valves deltoid, spreading, reflexed when expanded; expanding keels parallel or diverging, rarely toothed, terminating in broad wings; covering membranes present; closing bodies absent.

NOTES
16 spp. Little Karoo Centre endemic, Succulent Karoo Biome with extension into Fynbos Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

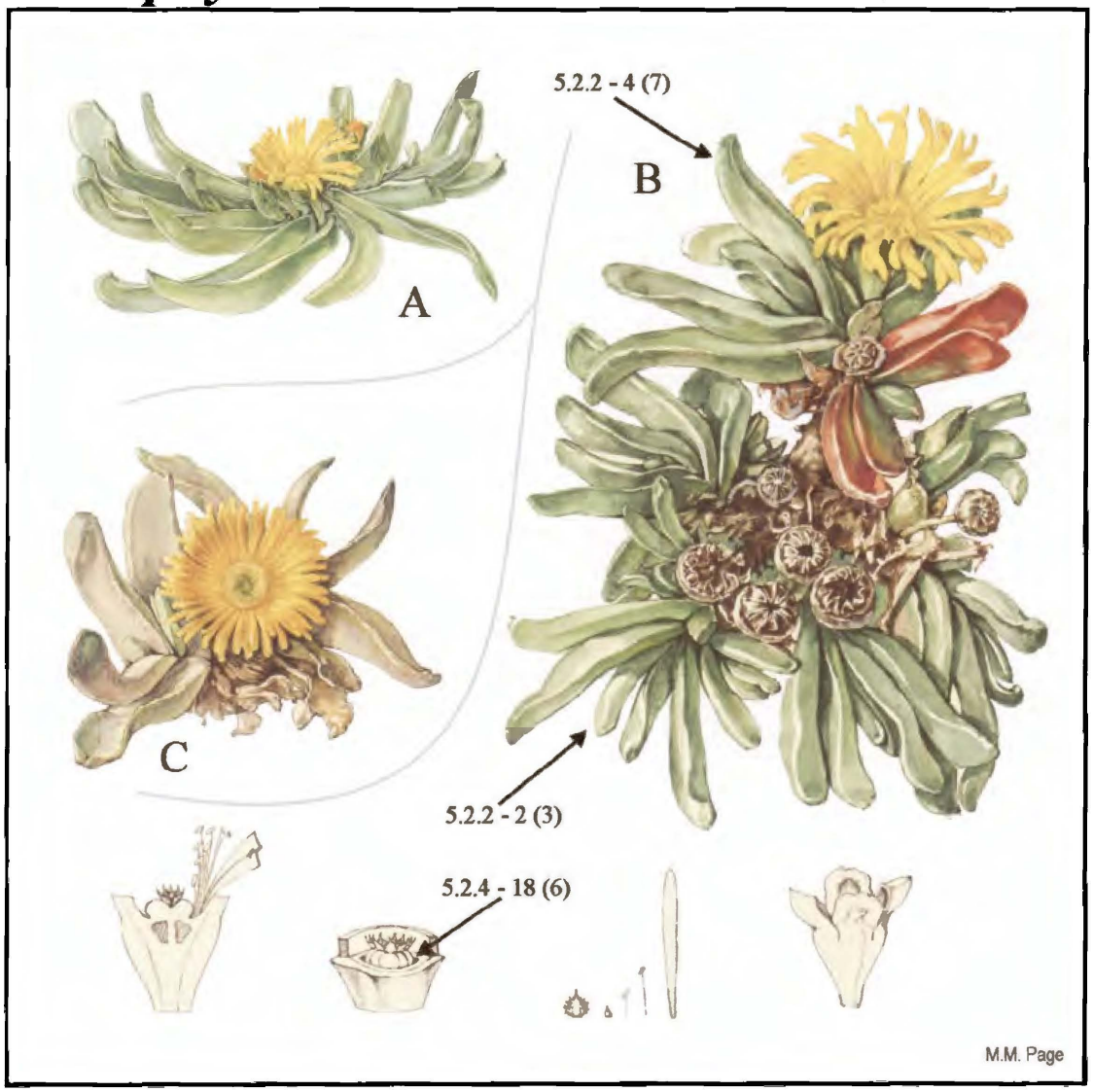


Fig. 6.54

TAXA
A. *G. depressum*
B. *G. longum*
C. *G. grandiflorum*

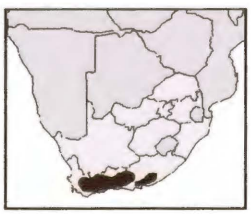
DISTINGUISHING CHARACTERS
Perennials with very succulent, mostly distichously arranged, tongue-shaped leaves; flowers large, sepals 4, petals yellow; fruit pale, multilocular with large closing bodies.

Fruit a 5–14-locular capsule; valve wings absent or very narrow; with broad-base and spongy-corky consistency of large closing bodies and mostly incomplete differentiation between expanding keel and expanding sheet; therefore tentatively placed with *Mitrophyllum*-type.

CHARACTERS
5.2.2 - 2 (3): Leaf arrangement - Leaves distichous.
5.2.2 - 4 (7): Leaf shape - Tongue, strap-shaped, succulent.
5.2.4 - 18 (6): Floral nectaries - Nectary inconspicuous, absent.

NOTES
16 spp. Mainly Succulent Karoo Biome with species in Fynbos and Albany Thicket biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

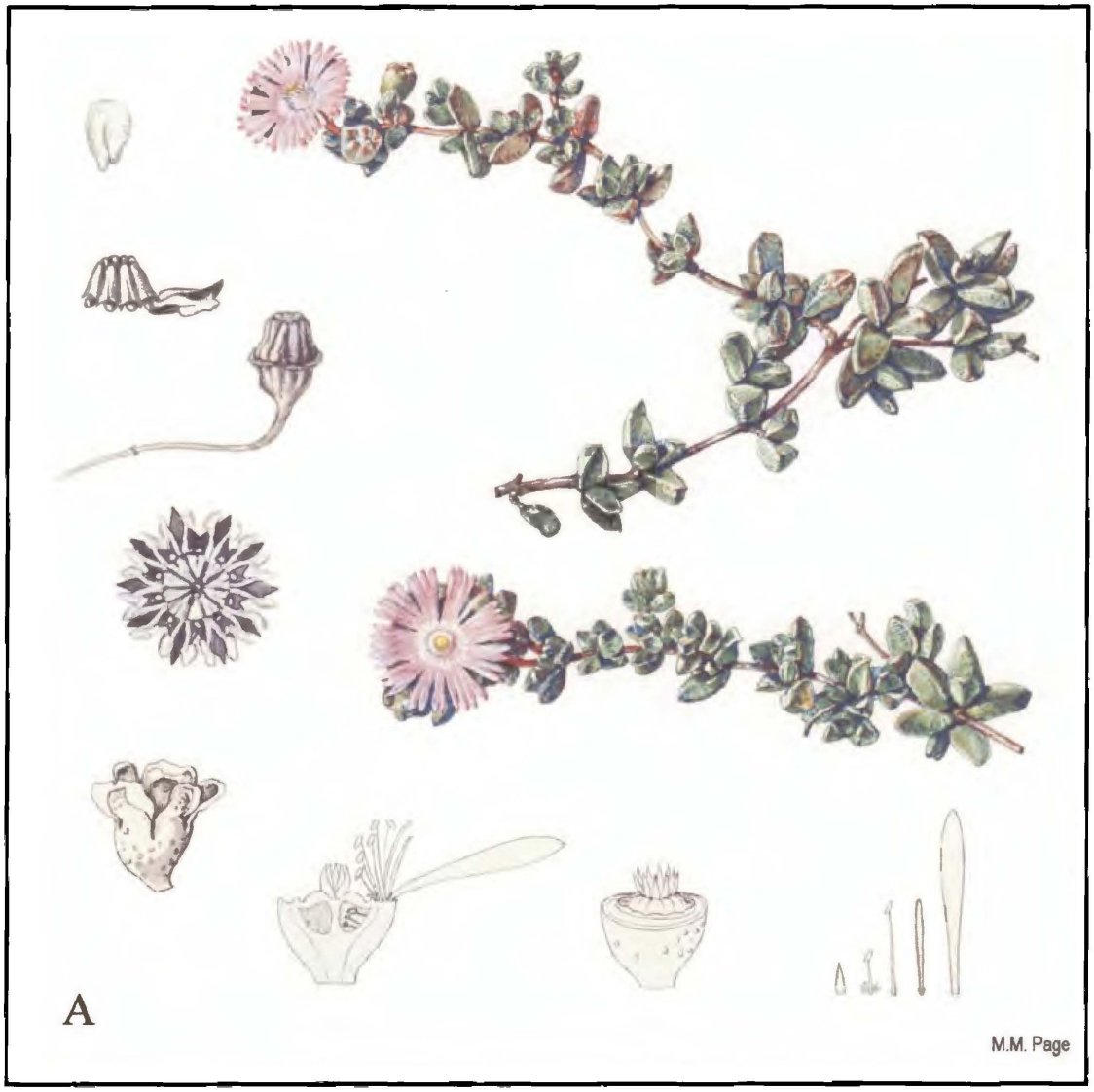


Fig. 6.55

TAXON
A. *H. planus*

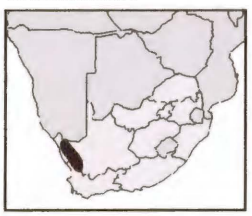
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
flat-growing perennials with long internodes; leaf pairs laterally flattened; fruit 10-locular, turret-shaped on top.

Fruit a 10-locular capsule, of *Leipoldtia*-type; turret-shaped with prominent subproximal elevations on covering membranes; expanding keels parallel; expanding sheets extensive.

NOTES
1 sp. Endemic to Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

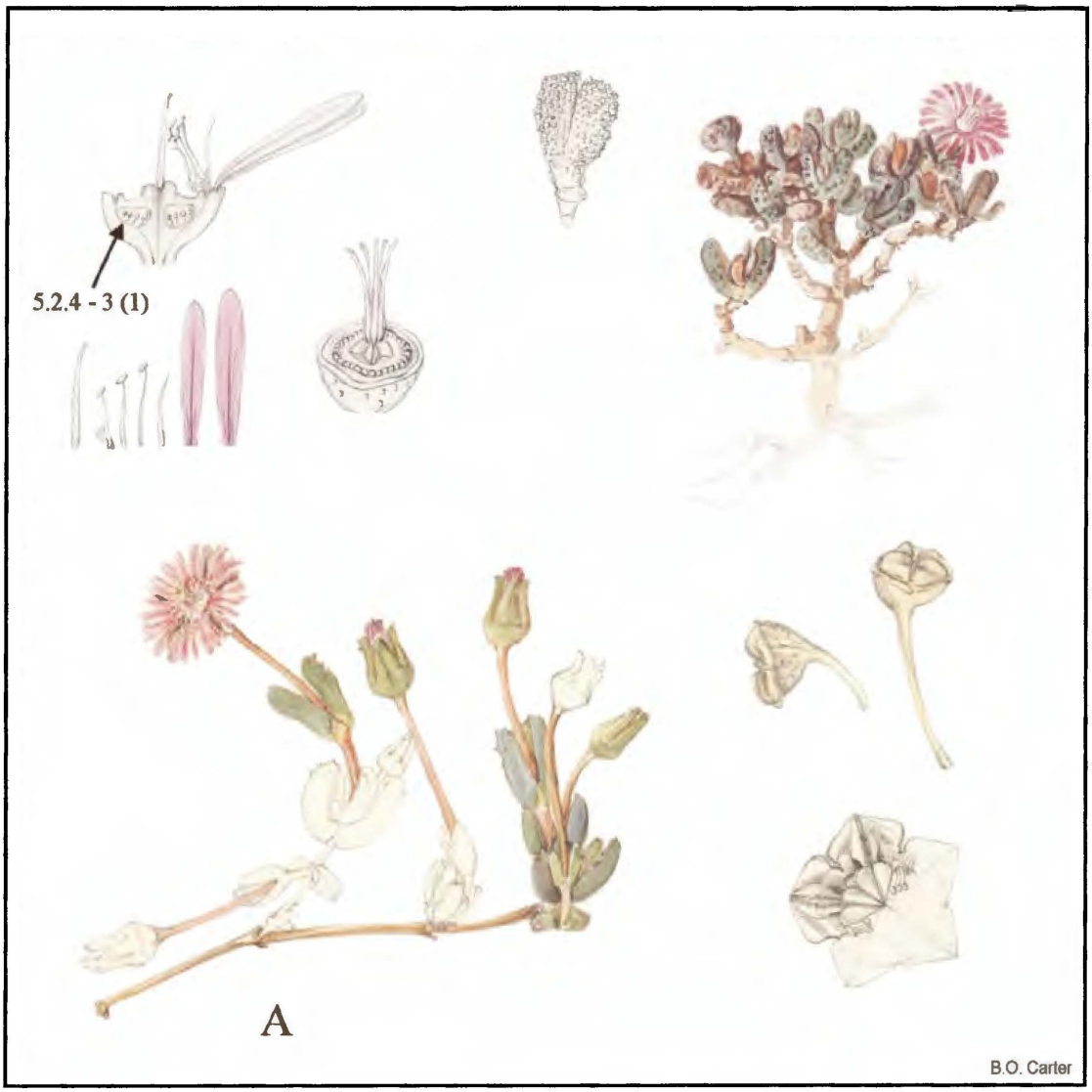


Fig. 6.56

TAXON
A. ***H. meleagris***

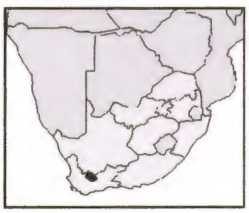
CHARACTERS
5.2.4 - 3 (1): Placentation - 'Basal' to parietal.

DISTINGUISHING CHARACTERS
Small shrublets, branches prostrate, rooting at the nodes; leaves toothed at tips.

Fruit a 5-locular capsule, close to *Mitrophyllum*-type; covering membranes ample; valves winged; expanding keels diverging and expanding sheets conspicuous; closing bodies absent or present as small bulges.

NOTES
2 spp. Hantam-Roggeveld Centre and Tanqua Karoo, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

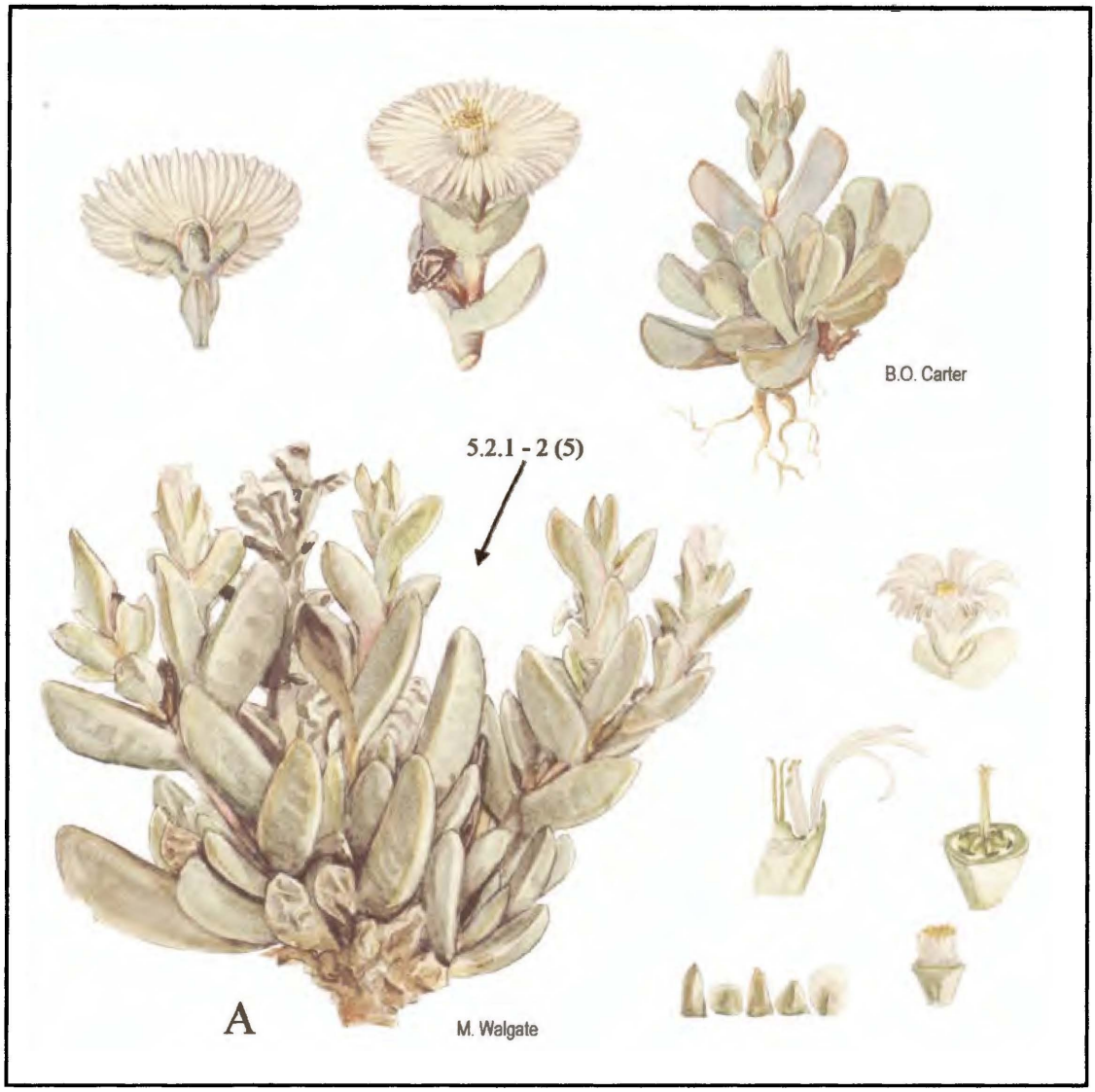


Fig. 6.57

TAXON
A. *H. pergamentaceus*

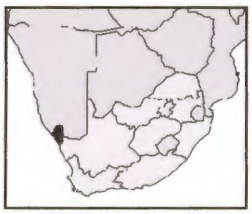
CHARACTERS
5.2.1 - 2 (5): Overall appearance - Succulent-leaved shrub (including dwarf shrubs).

DISTINGUISHING CHARACTERS
Compact shrublets; leaves greenish grey to silvery green, laterally flattened, sometimes rough, shrinking unevenly when dehydrated, leaf margins reddish purple; pedicel strongly flattened.

Fruit a 6-locular capsule, of *Delosperma*-type; whitish; expanding keels parallel, yellowish; valve wings large; covering membranes absent; closing bodies absent.

NOTES
2 spp. Endemic to the Gariep Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

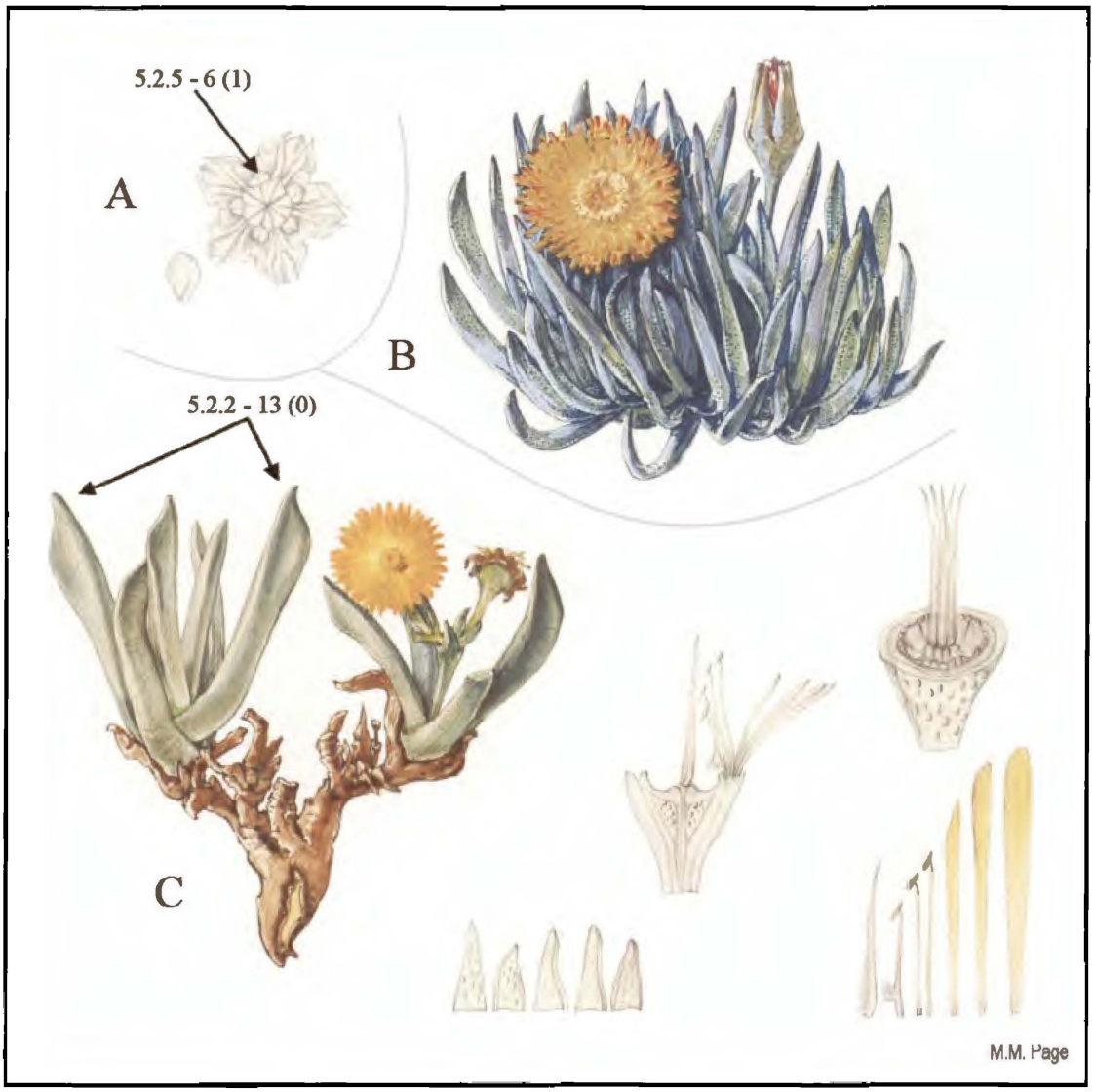


Fig. 6.58

TAXA
A. *H. fimbriata*
B. *H. concava*
C. *H. wilmaniae*

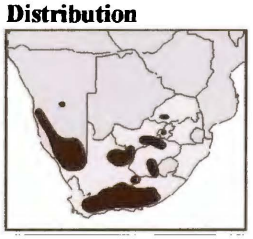
CHARACTERS
5.2.2 - 13 (0): Relative length of two leaves forming a pair - Leaves of a pair equal (isophyllous plant).
5.2.5 - 6 (1): Open fruit, closing devices at exits of locules - Absent, large, spongy closing ledge.

DISTINGUISHING CHARACTERS
Plants tufted, with tuberous roots; leaves dotted; flowers in cymes, on bracteate pedicels, petals yellow, flowers opening during the afternoon or evening.

Fruit a 5-locular capsule, close to *Mitrophyllum*-type but closing bodies small, variable in shape; locules either deep or shallow and with a raised placenta; expanding keels diverging, without wings or membranous points, often narrow; covering membranes present, translucent.

NOTES
28 spp. Widespread, mostly in Succulent Karoo Biome, also in Nama Karoo, Albany Thicket and Grassland biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

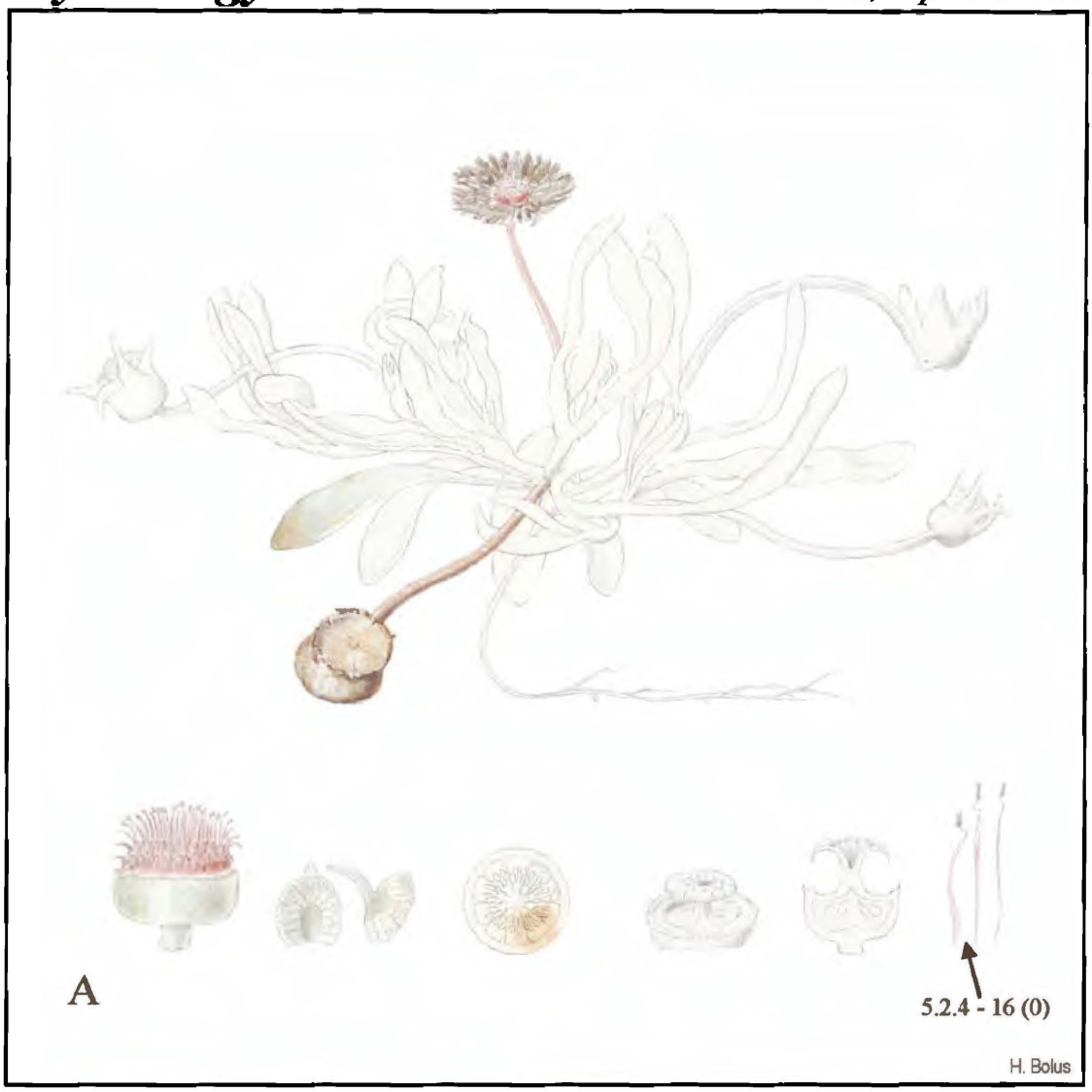


Fig. 6.59

TAXON
A. *H. glabra*

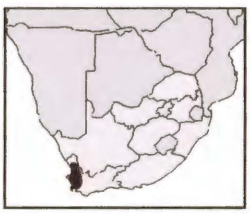
CHARACTERS
5.2.4 - 16 (0): Filaments - naked.

DISTINGUISHING CHARACTERS
Annual herbs with flat leaves; flowers solitary, petals ivory to yellow, fading to reddish with age, stigmas forming a central column; fruit schizocarpic.

Fruit a schizocarpic capsule, 8–12-locular; without opening devices but breaking up into flat, circular, broadly winged, 1-seeded units; dispersal by wind (anemochory).

NOTES
2 spp. Confined to Fynbos Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

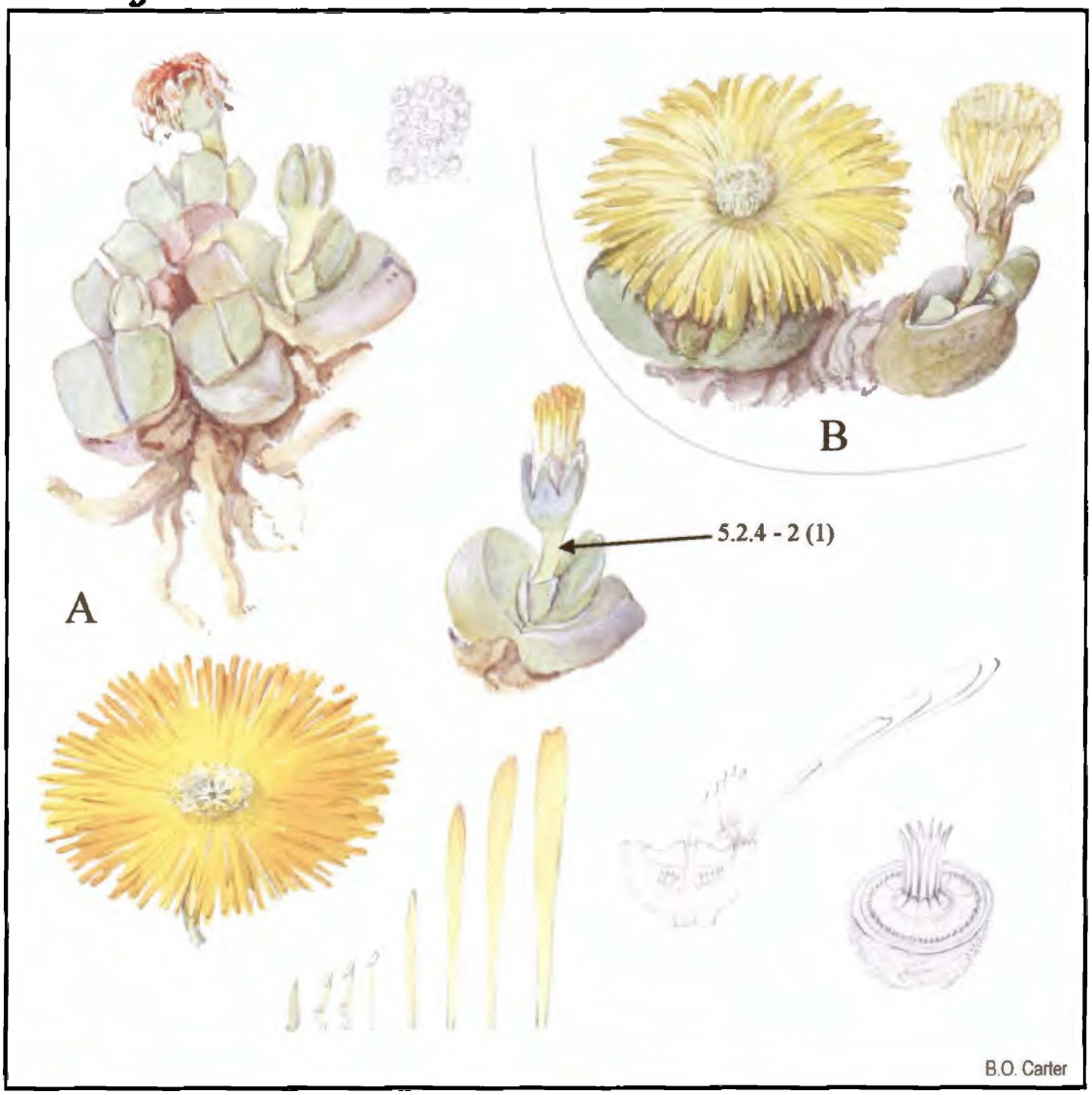


Fig. 6.60

TAXA
A. *I. excavata*
B. *I. vanzylii*

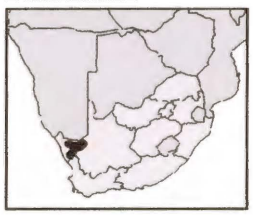
CHARACTERS
5.2.4 - 2 (1): Pedicel length - Flower subtended by short pedicel.

DISTINGUISHING CHARACTERS
Compact perennials with keeled leaves; flowers yellow, tinged with purple or red; fruit with robust stalks, closing bodies small or absent.

Fruit a 10–15-locular capsule, of *Titanopsis*-type; with tiny endocarpal closing bodies; covering membranes thin, flexible, collapsing into empty seed chambers once seeds have been dispersed; valve wings taper from broad bases to tips.

NOTES
2 spp. Nama Karoo and Succulent Karoo Biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

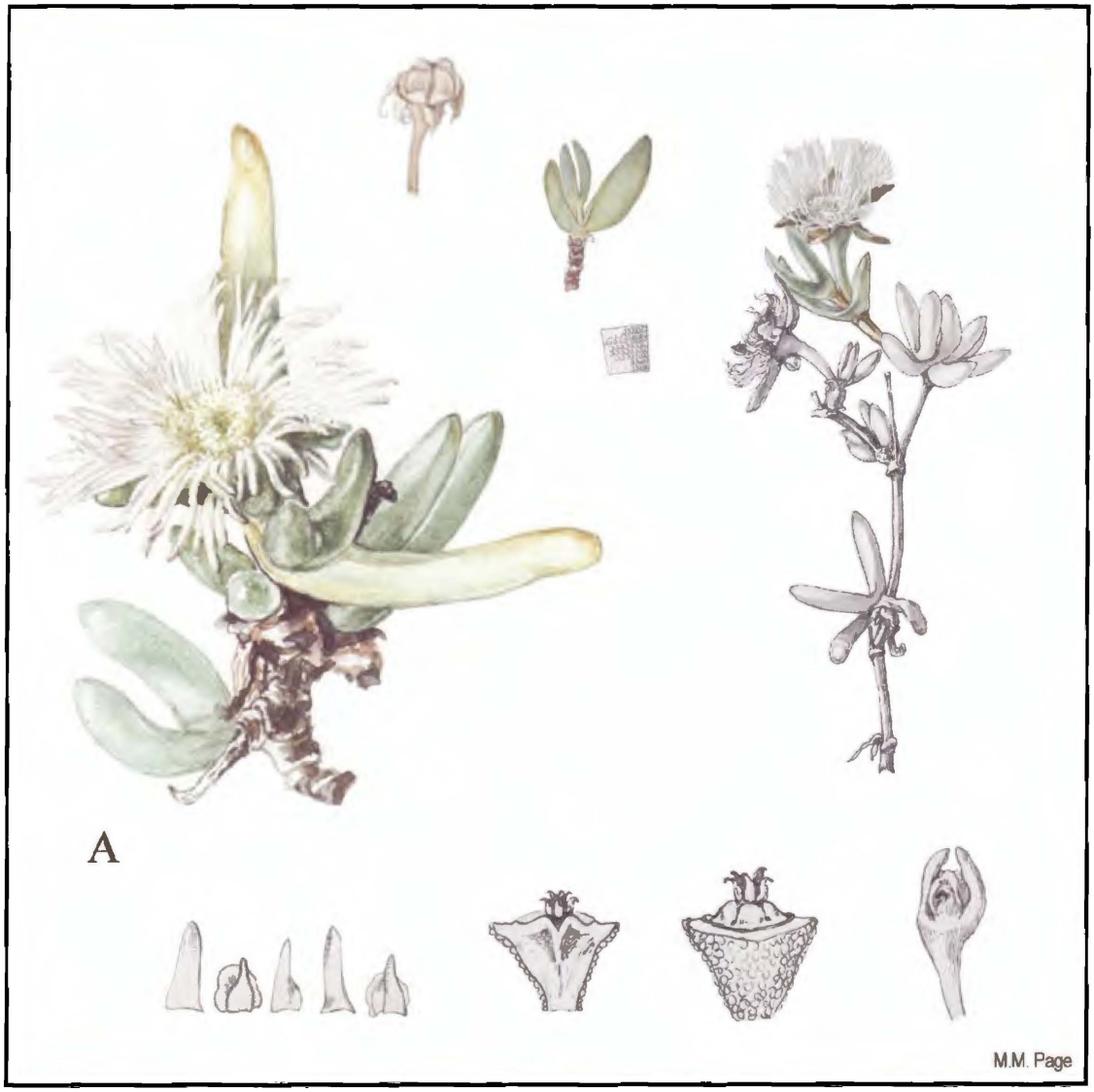


Fig. 6.61

TAXON
A. *J. kolbei*

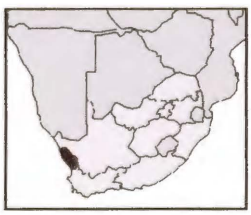
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Shrublets with long, erect branches bearing inflorescences; leaves of a pair forming plant bodies only in juvenile stage; flowers white, on long, red-brown, bare stems.

Fruit a 5-locular capsule, of *Mitrophyllum*-type; closing bodies absent; valve wings broad, recurved; expanding keels diverging, margins toothed, ending in awns; covering membranes covering ½ to ¾ of locule.

NOTES
3 spp. Endemic to Knersvlaktes Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

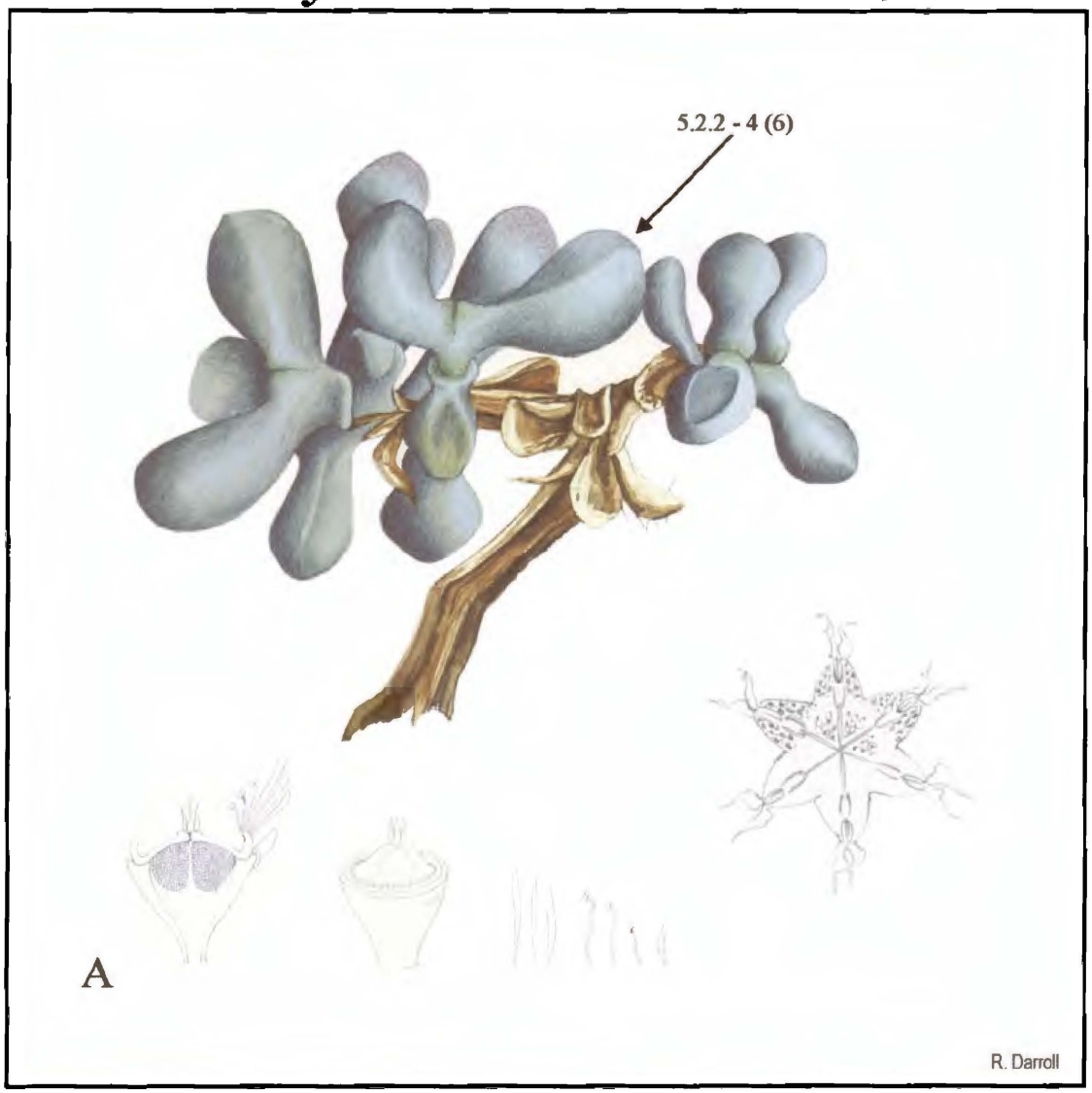


Fig. 6.62

TAXA
A. *J. lossowiana*

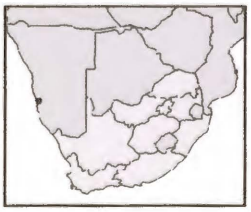
CHARACTERS
5.2.2 - 4 (6): Leaf shape - Clavate.

DISTINGUISHING CHARACTERS
Perennials with thick woody stems and leaves resembling grapes; highly localized in its distribution.

Fruit a 5(6)-locular capsule, of *Delosperma*-type; flat, basin-shaped, up to 12 mm in diameter with septa prominent, erect, arched towards central column; expanding keel contiguous towards base, diverging and excurrent into very long, narrow, pennant-like white wings; covering membranes absent; closing bodies absent.

NOTES
1 spp. Endemic to Dolphin Head, on the Skeleton Coast of Namibia, the only genus endemic to the Desert Biome. Probably closely related to *Stoeberia*.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

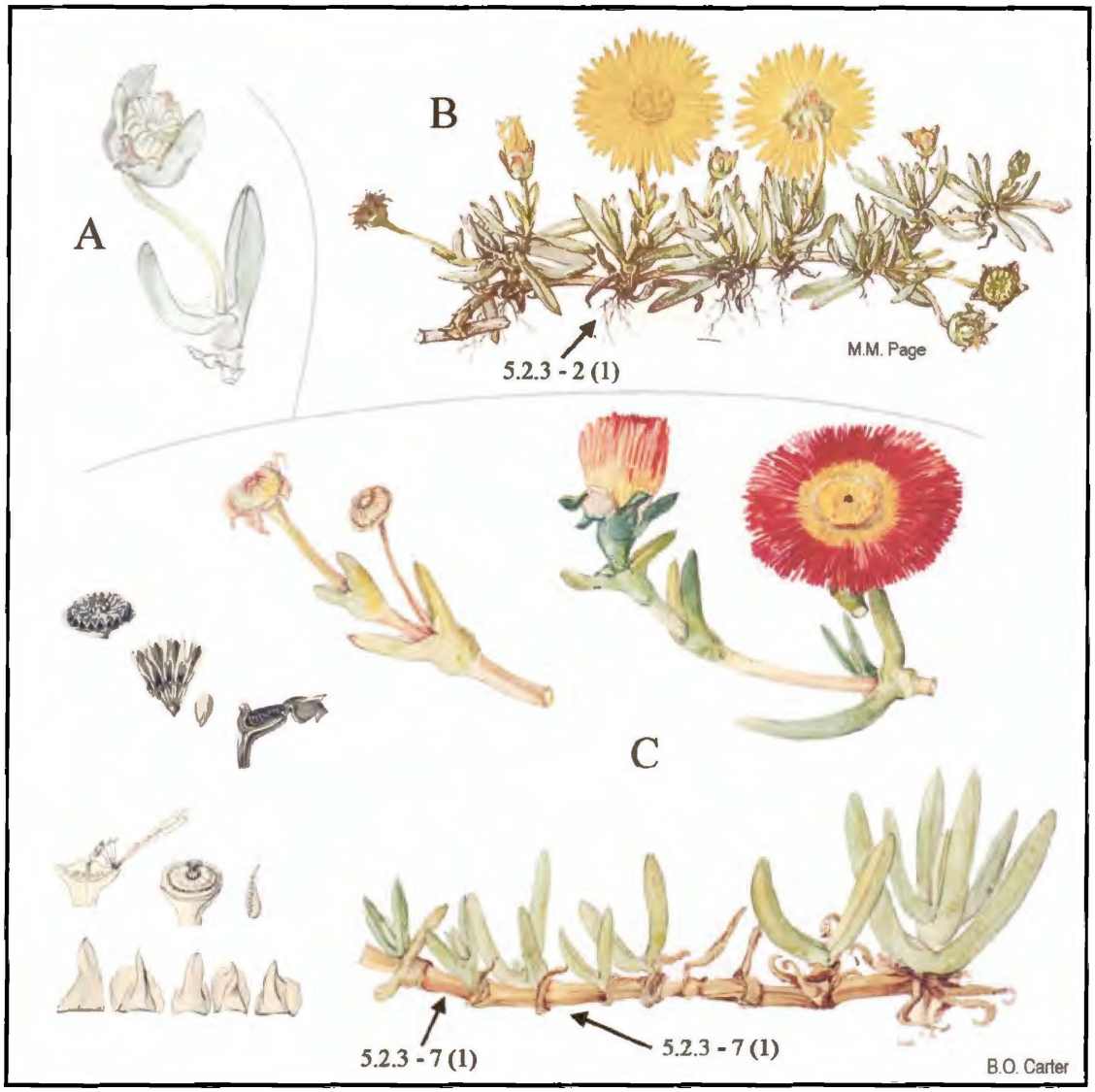


Fig. 6.63

TAXA
A. *J. cuprea*
B. *J. dubia*
C. *J. spongiosa*

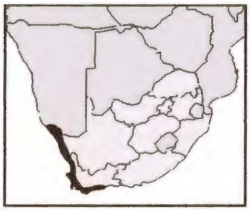
CHARACTERS
5.2.3 - 2 (1): Branches - Creeping or saltating (rooting at nodes).
5.2.3 - 4 (2): Stem consistency - Spongy or corky.
5.2.3 - 7 (1): Stem colour at maturity - Yellowish.

DISTINGUISHING CHARACTERS
Perennials with trailing stems; leaves tapering towards both ends; fruit 10–25-locular, with angular valves, appearing squarish on top.

NOTES
7 spp. Mostly coastal in the Fynbos and Succulent Karoo Biomes.

Fruit a 10–25-locular capsule, of *Leipoldtia*-type but with small closing bodies.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

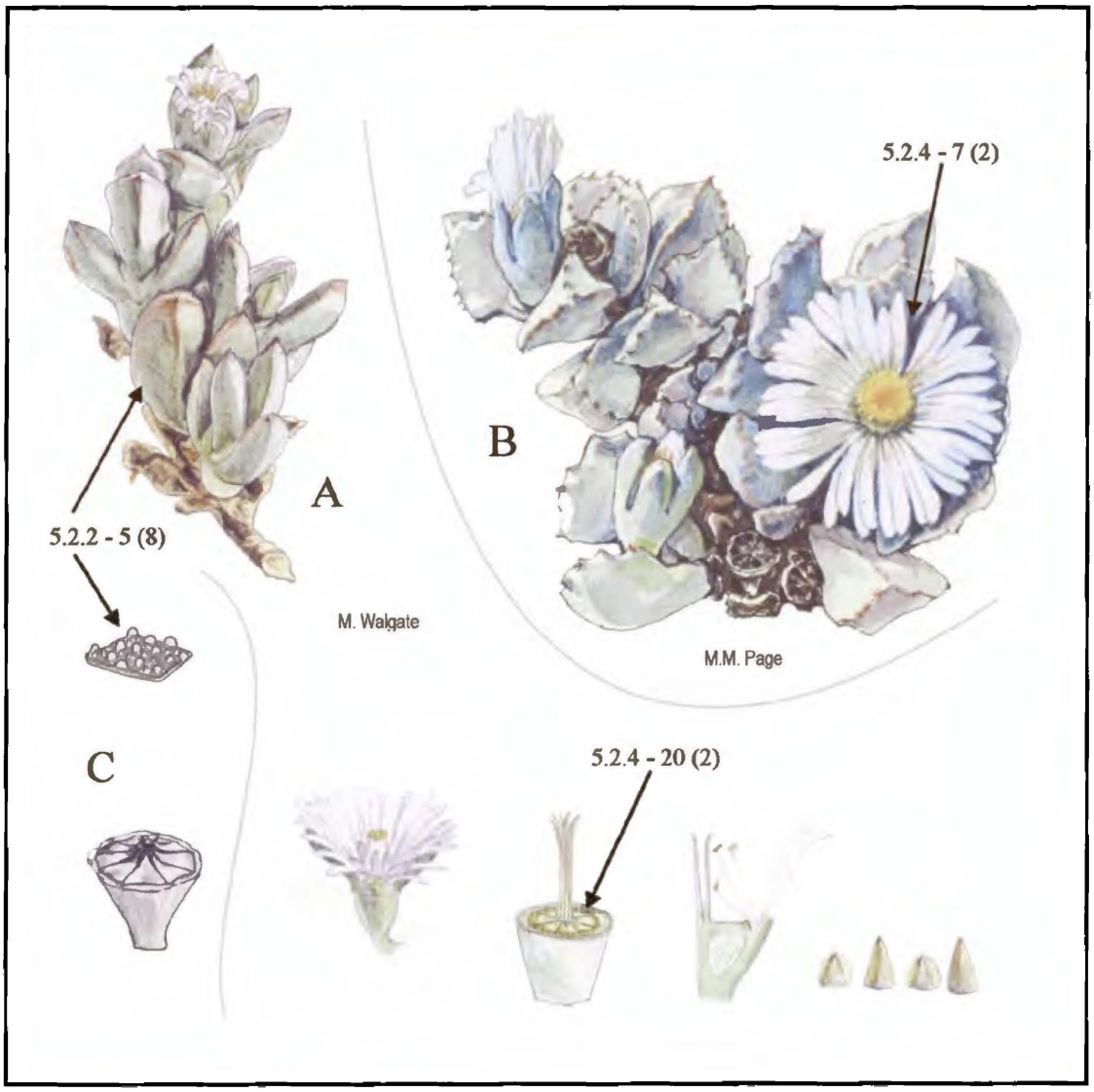


Fig. 6.64

TAXA
A. *J. deserticola*
B. *J. simpsonii*
C. *J. kovisimontana* (now sunk under *J. simpsonii*)

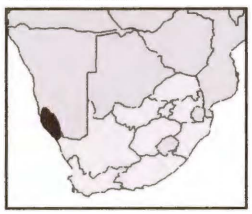
DISTINGUISHING CHARACTERS
Branches erect to spreading; leaves tuberculate; flowers with 4 sepals, petals white, stigmas 8(11), opening in the morning; pedicels ebracteate; fruit with rudimentary covering membranes.

Fruit a 8(11)-locular capsule, near *Delosperma*-type; with central column and thick septa between loculcs; valve wings long, narrow; expanding keels parallel, diverging slightly near tips; covering membranes rarely well developed, mostly reduced to a limb; closing bodies absent.

CHARACTERS
5.2.2 - 5 (8): Leaf surface - Papillate, rough to the touch.
5.2.4 - 7 (2): Flower colour - White.
5.2.4 - 20 (2): Shape of nectary surface - Raised and crested or lobed.

NOTES
5 spp. Endemic to Gariep Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

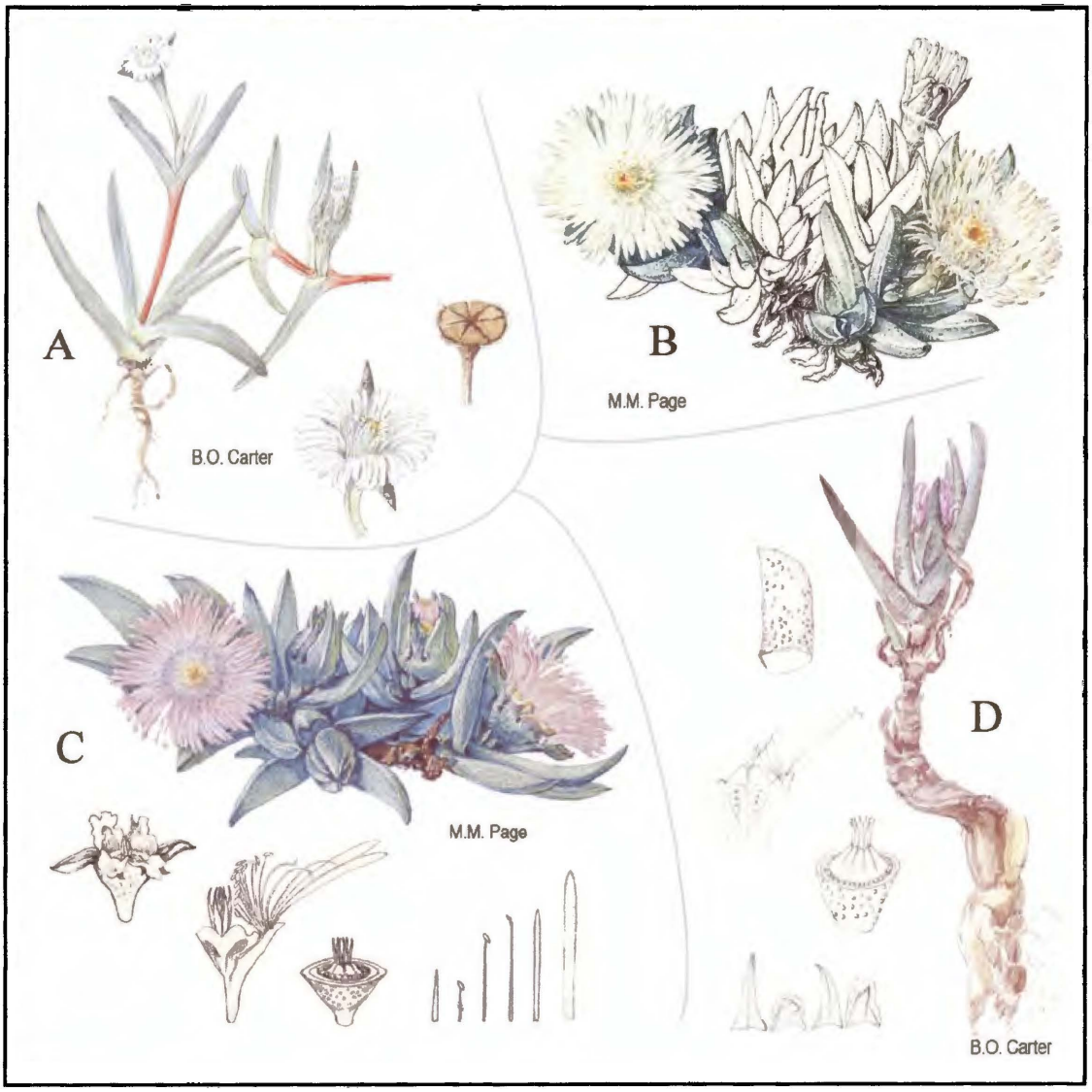


Fig. 6.65

TAXA
A. *K. borealis*
B. *K. carolinensis*
C. *K. carolinensis*
D. *K. acutipetala*

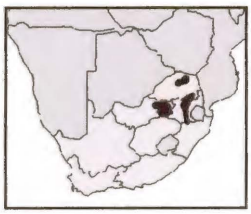
DISTINGUISHING CHARACTERS
Perennials tufted with tuberous roots, often trailing and rooting at the nodes; flowers solitary.

Fruit a (4)5- to 11-locular capsule, reddish when young, dark brown later; pedicel persistent or breaking off, resulting in a tumble fruit; valves without wings but with enlarged rims; bases of expanding keels widely separated; covering membranes complete, rather firm, filled ± with a whitish spongy tissue, with low rims at distal ends; closing device at distal rim of capsule reduced to a tiny bud or knob formed by placenta or by an outgrowth of expanding sheet over some protrusion from endocarp.

CHARACTERS
None used.

NOTES
6 spp. The genus may comprise two genera. Found in Grassland and Savanna biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

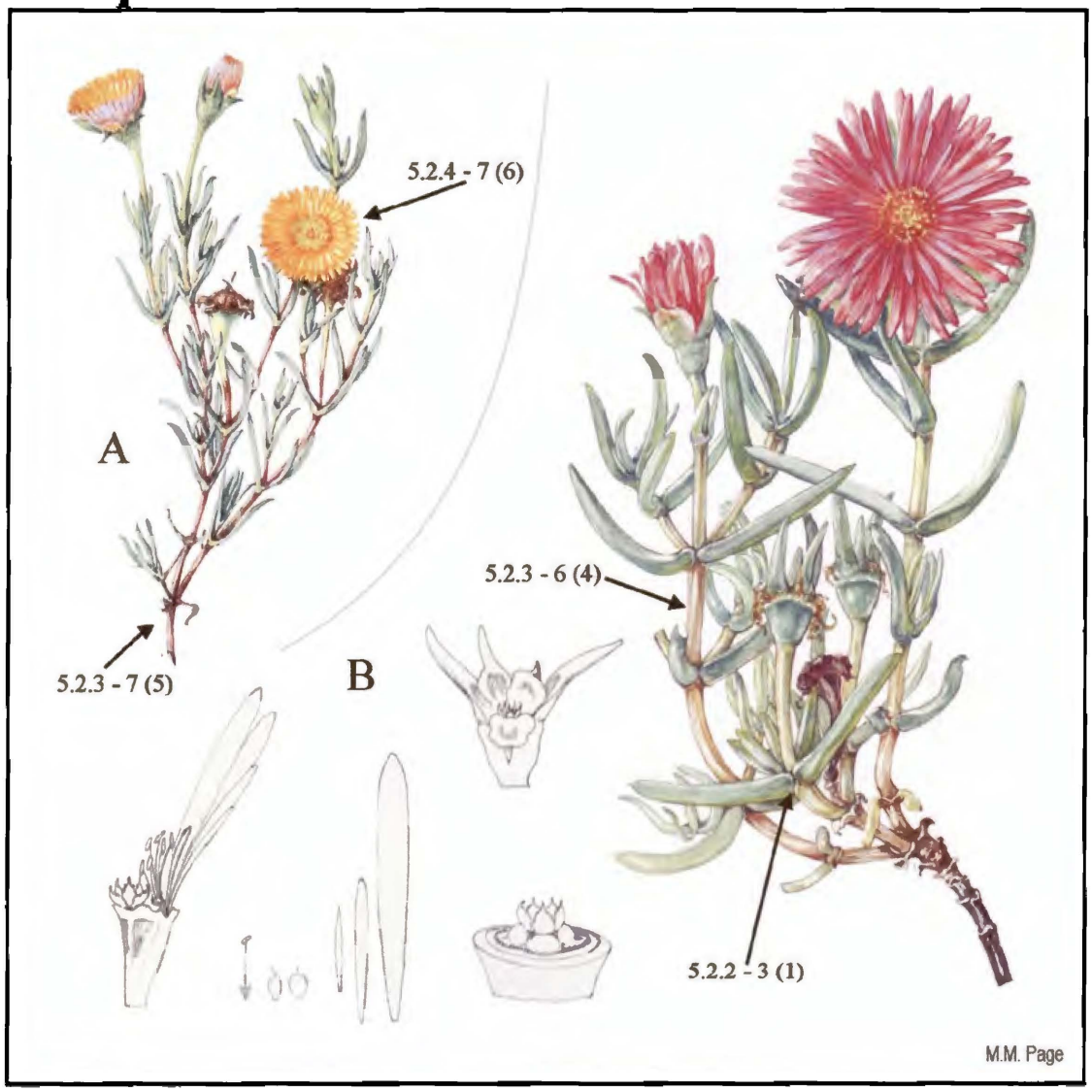


Fig. 6.66

TAXA
A. *L. glaucoides*
B. *L. saturatus*

DISTINGUISHING CHARACTERS
Creeping to erect shrubs or shrublets; leaves smooth, cylindrical; fruit with funicular hairs at distal exits of locules, covering membranes and valve wings present.

Fruit a capsule of *Lampranthus*-type, usually 5-locular, woody, base funnel-shaped, occasionally with seed pockets; valve wings large, or rarely absent; expanding keels diverging; covering membranes stout; closing bodies absent but sterile funicles blocking exits of loculcs.

CHARACTERS
5.2.2 - 3 (1): Leaf pairs (degree of fusion) - Basally connate.
5.2.3 - 6 (4): Stem surface texture and ornamentation - Smooth .
5.2.3 - 7 (5): Stem colour at maturity - Reddish.
5.2.4 - 7 (6): Flower colour - Orange.

NOTES
211 spp. Mostly in the Fynbos Biome, with species in the Succulent Karoo, Albany Thickets and Coastal Belt biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

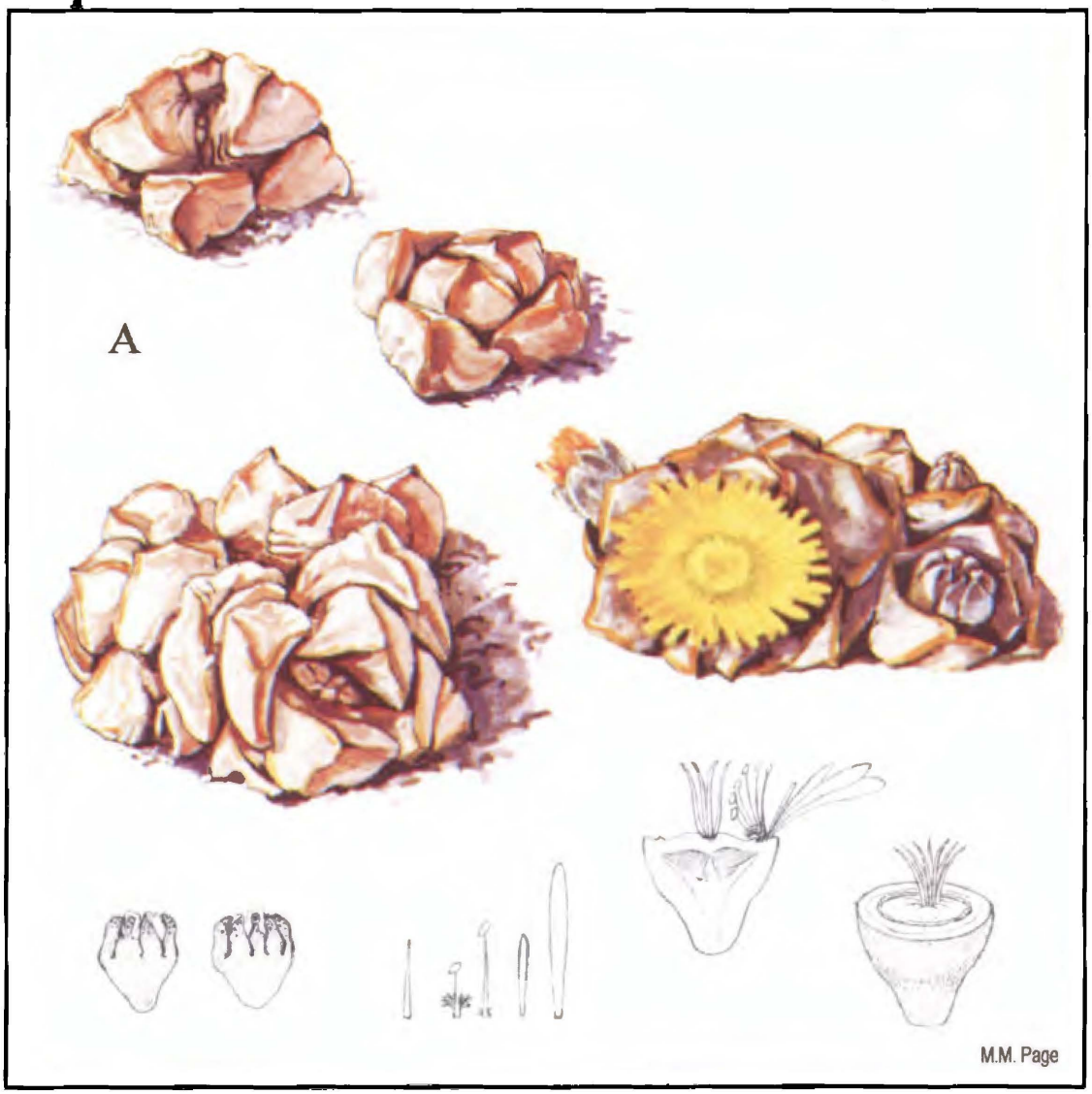


Fig. 6.67

TAXON
A. *L. margaretae*

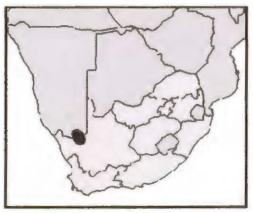
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Compact, stemless perennials with keeled leaves, often appearing somewhat shrunken; flowers yellow; pedicels winged.

Fruit a 6–8-locular capsule, of *Titanopsis*-type, flat with raised sutures; valves widely spreading or recurved when expanded; expanding keels contiguous towards base, diverging towards apex with broad, membranous margins; covering membranes present; closing bodies absent.

NOTES
1 spp. Distribution in Nama Karoo and Succulent Karoo biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

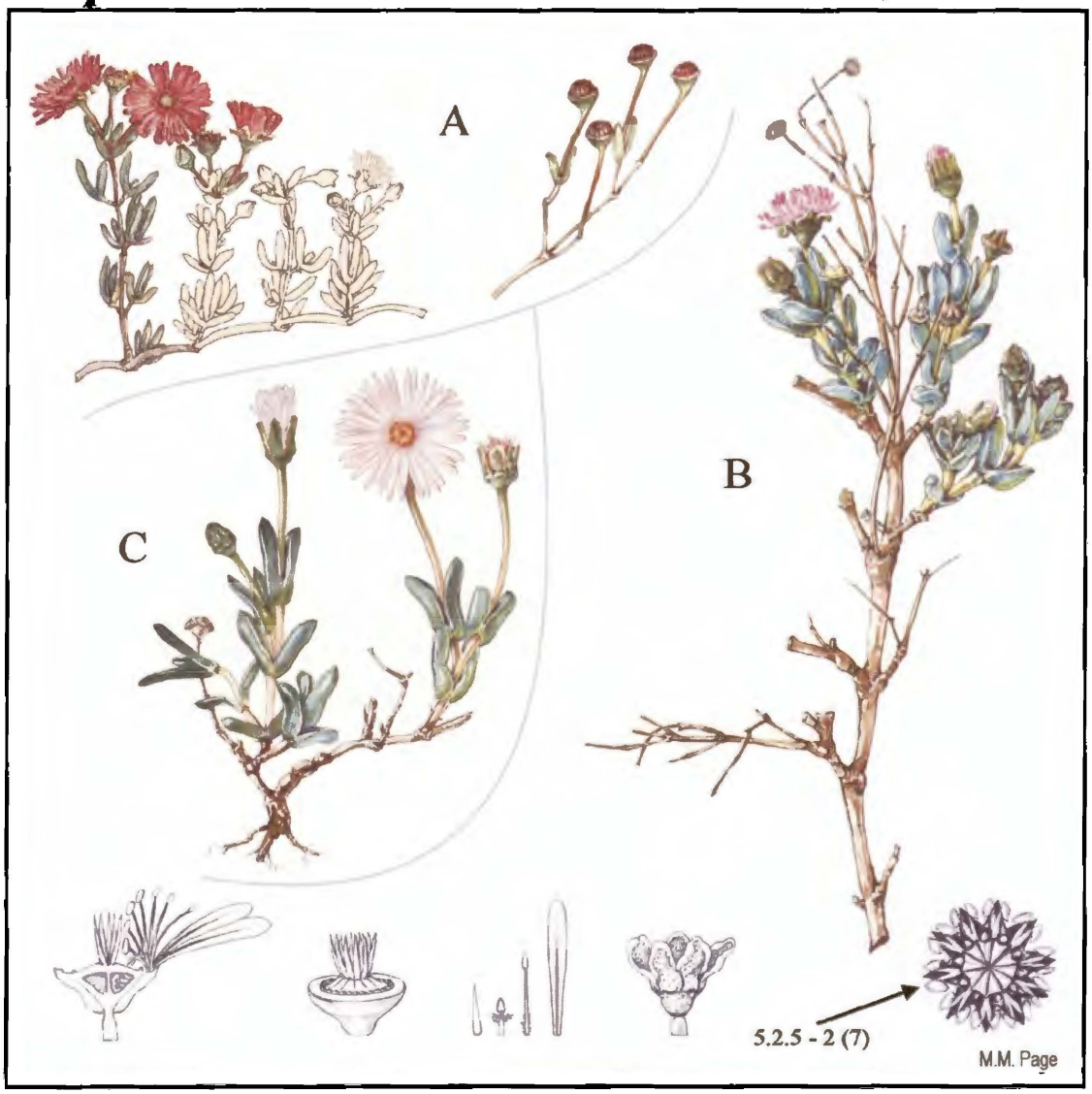


Fig. 6.68

TAXA
A. *L. britteniae*
B. *L. schultzei*
C. *L. calandra*

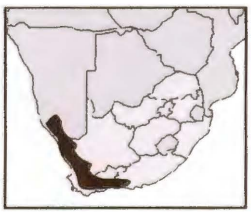
CHARACTERS
5.2.5 - 2 (7): Number of locules - 10.

DISTINGUISHING CHARACTERS
Sparse shrubs; fruit 10(16)-locular; whitish grey when closed.

Fruit a 10(16)-locular capsule, of *Leipoldtia*-type; covering membranes wavy with closing rodlets at distal end; expanding keels radially spreading, contiguous towards base; valve wings broad; closing bodies large and white.

NOTES
11 spp. 3 subspp. Mostly confined to the Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

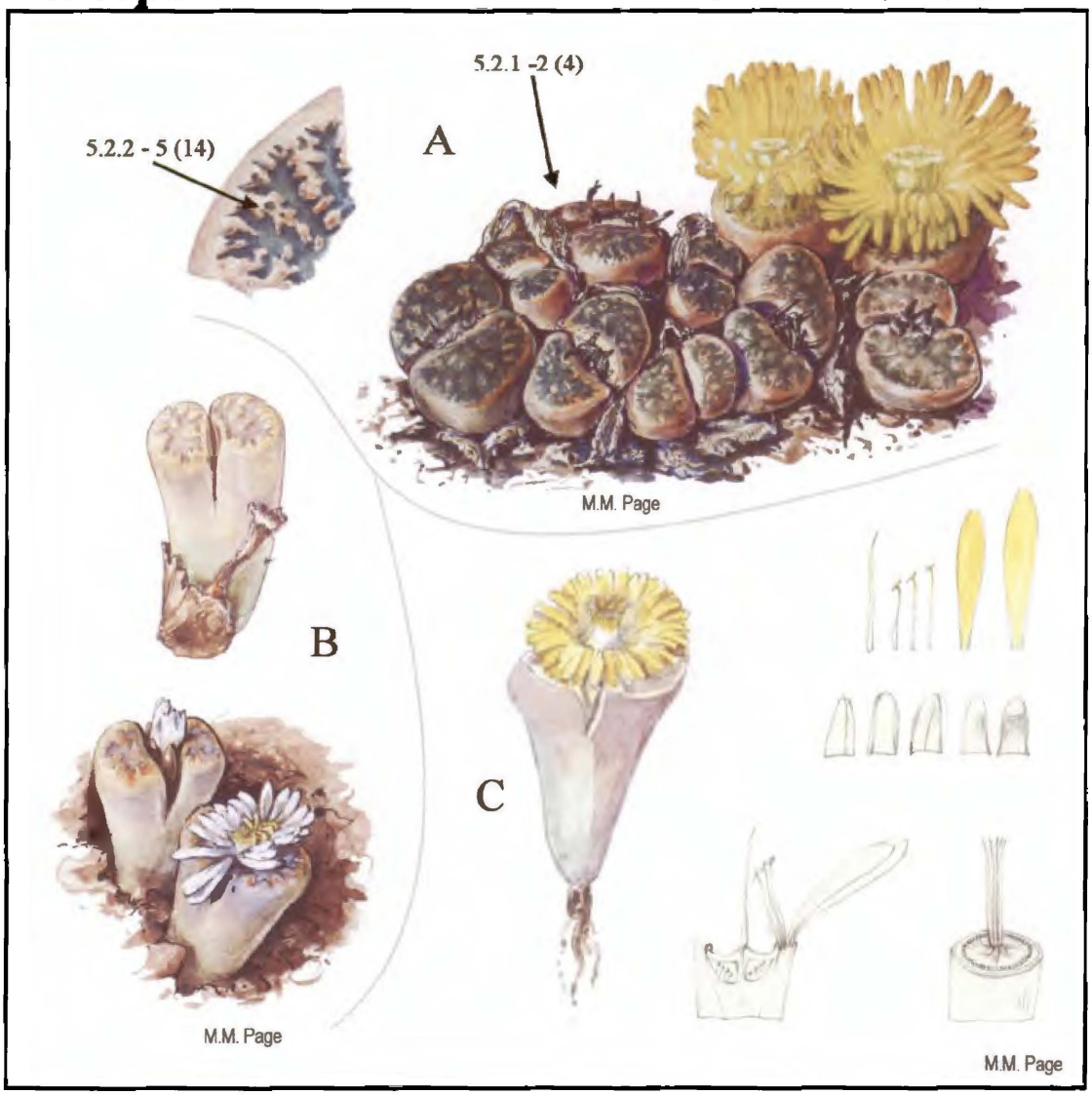


Fig. 6.69

TAXA
A. *L. lesliei*
B. *L. karasmontana* subsp. *karasmontana*
C. *L. schwantesii* subsp. *schwantesii*

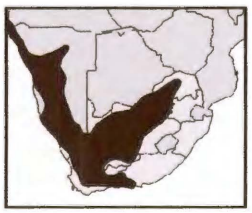
DISTINGUISHING CHARACTERS
Compact dwarf perennials, mostly underground with paired leaves fused to form ± obconic bodies with flat or rounded, often windowed and ornamented tops; fruit 4–7(9)-locular; pedicels ebracteate.

Fruit a 4–7(9)-locular capsule, of *Delosperma*-type; small; valves with broad valve wings; expanding keel single, stout, central on valve, divided at apex; covering membranes reduced to a limb or absent; closing bodies absent.

CHARACTERS
5.2.1 -2 (4): Overall appearance - Stone plants. consisting mostly of succulent leaves (stems not visible, miniatures).
5.2.2 - 5 (14): Leaf surface - Textured with ridges and markings.

NOTES
38 spp, 24 subspp. Widespread, mostly in Succulent Karoo, Nama-Karoo, Savanna, Desert and Grassland Biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Machairophyllum *Ruschioideae; Ruschieae*

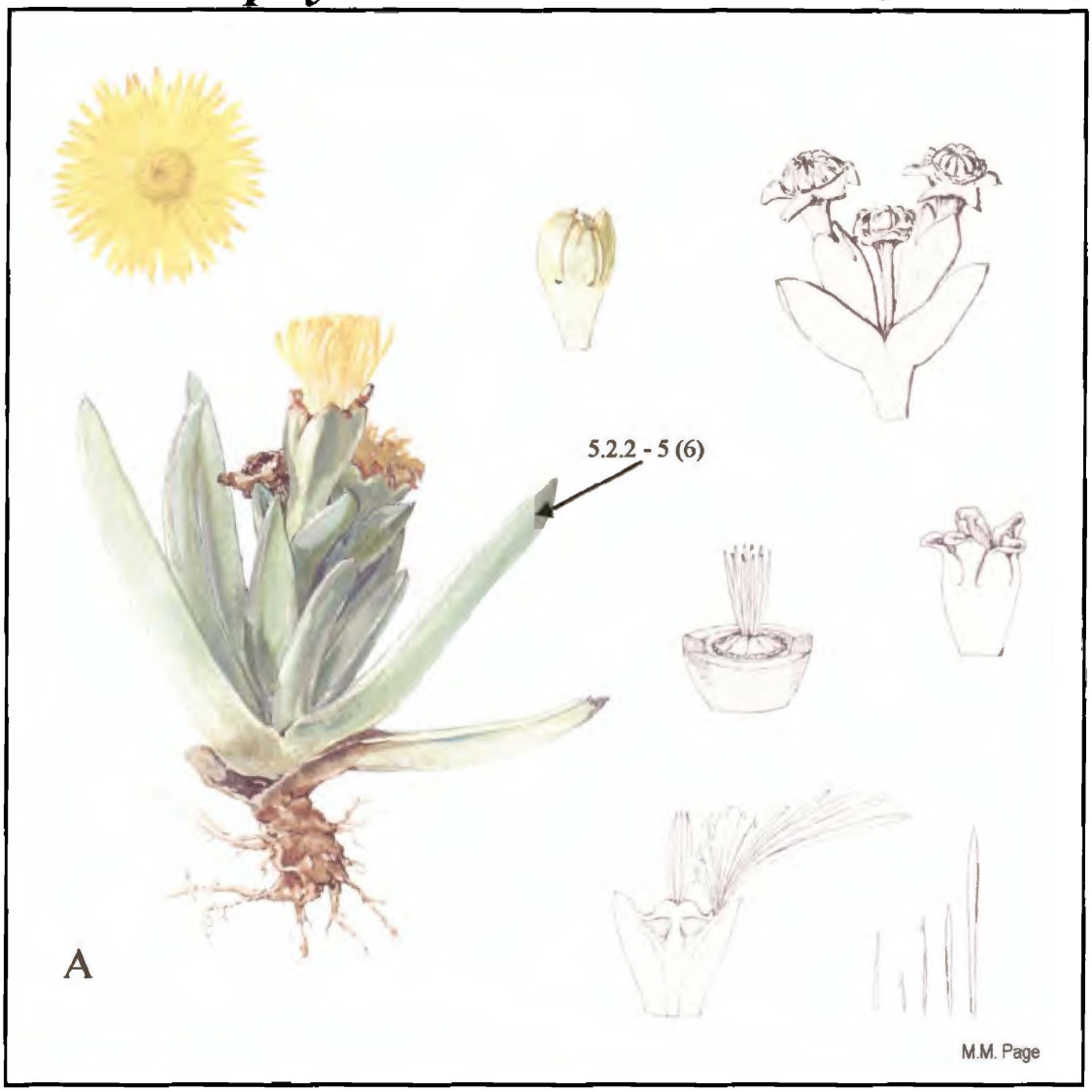


Fig. 6.70

TAXON
A. *M. albidum*

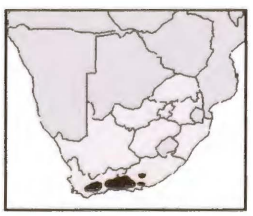
CHARACTERS
5.2.2 - 5 (6): Leaf surface - Smooth and untextured.

DISTINGUISHING CHARACTERS
Tufted, robust perennials; leaves smooth, hard; flowers large to very large with many petals and staminodes, usually nocturnal; pedicels long, bracteate.

Fruit a 5–15-locular capsule; resembling capsule of *Cylindrophyllum* and therefore perhaps close to *Leipoldtia*-type, but with a ± spongy tissue in covering membrane; small closing bodies and no additional closing devices at distal opening.

NOTES
4 spp. Mostly in Succulent Karoo and Albany Thicket biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

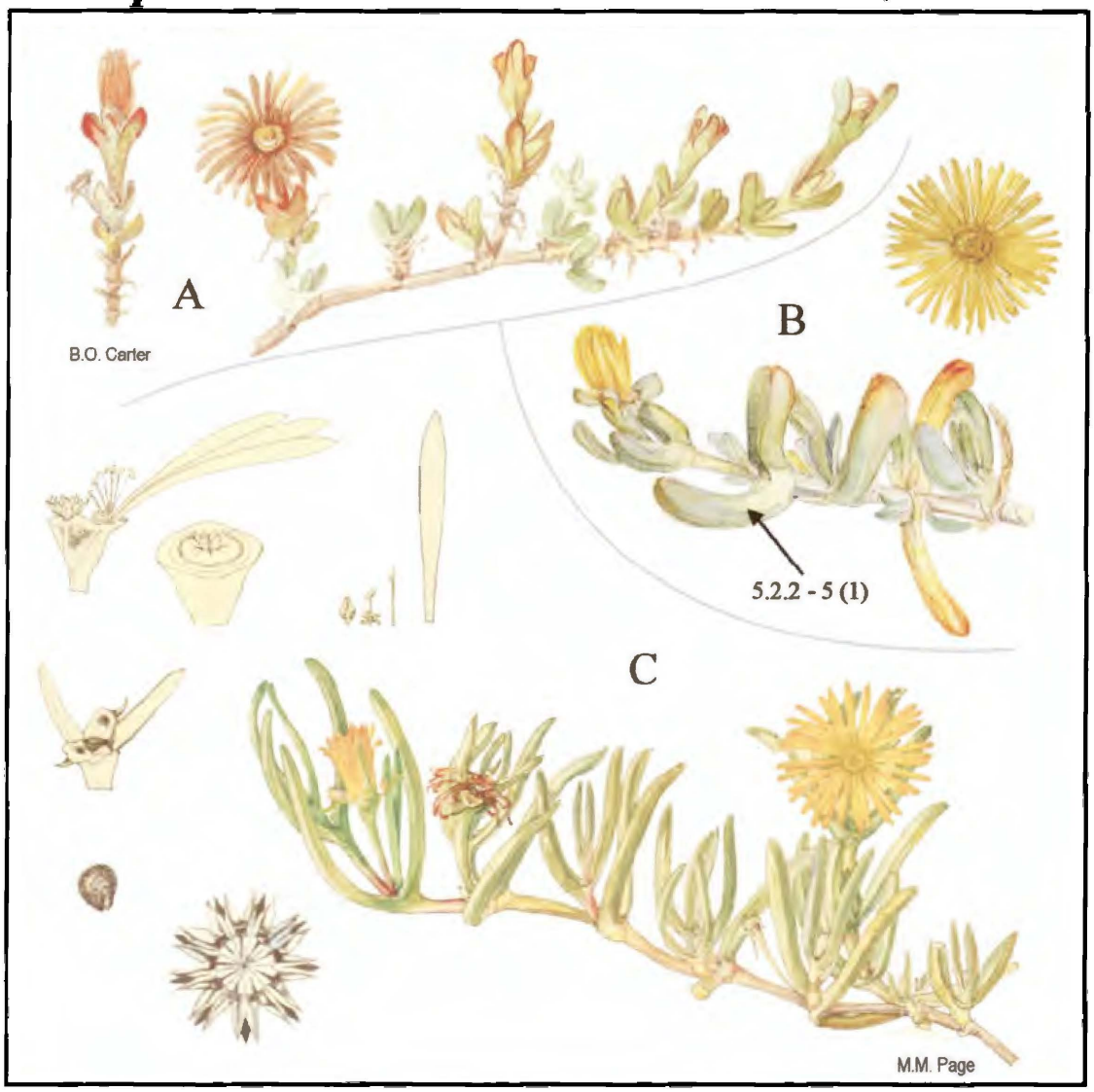


Fig. 6.71

TAXA
A. *M. uitenhagensis*
B. *M. framesii*
C. *M. lutea*

CHARACTERS
5.2.2 - 5 (1): Leaf surface - distinctly waxy.

DISTINGUISHING CHARACTERS
Creeping to rarely upright perennials; leaves waxy; flowers yellow to red; capsule 8–12-locular, sometimes with bifid closing bodies.

Fruit a 8–12-locular capsule, of *Drosanthemum*-type; parietal placentas often ending distally in prominent, sometimes bipartite knobs acting as closing bodies; base of locules divided by false septum which, together with splitting proper septa, forms pockets containing 1 or 2 seeds; these schizocarpous units are then dispersed.

NOTES
17 spp. Widespread in Succulent Karoo, Nama-Karoo, Grassland, Fynbos, Desert biomes and in the Albany Centre.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

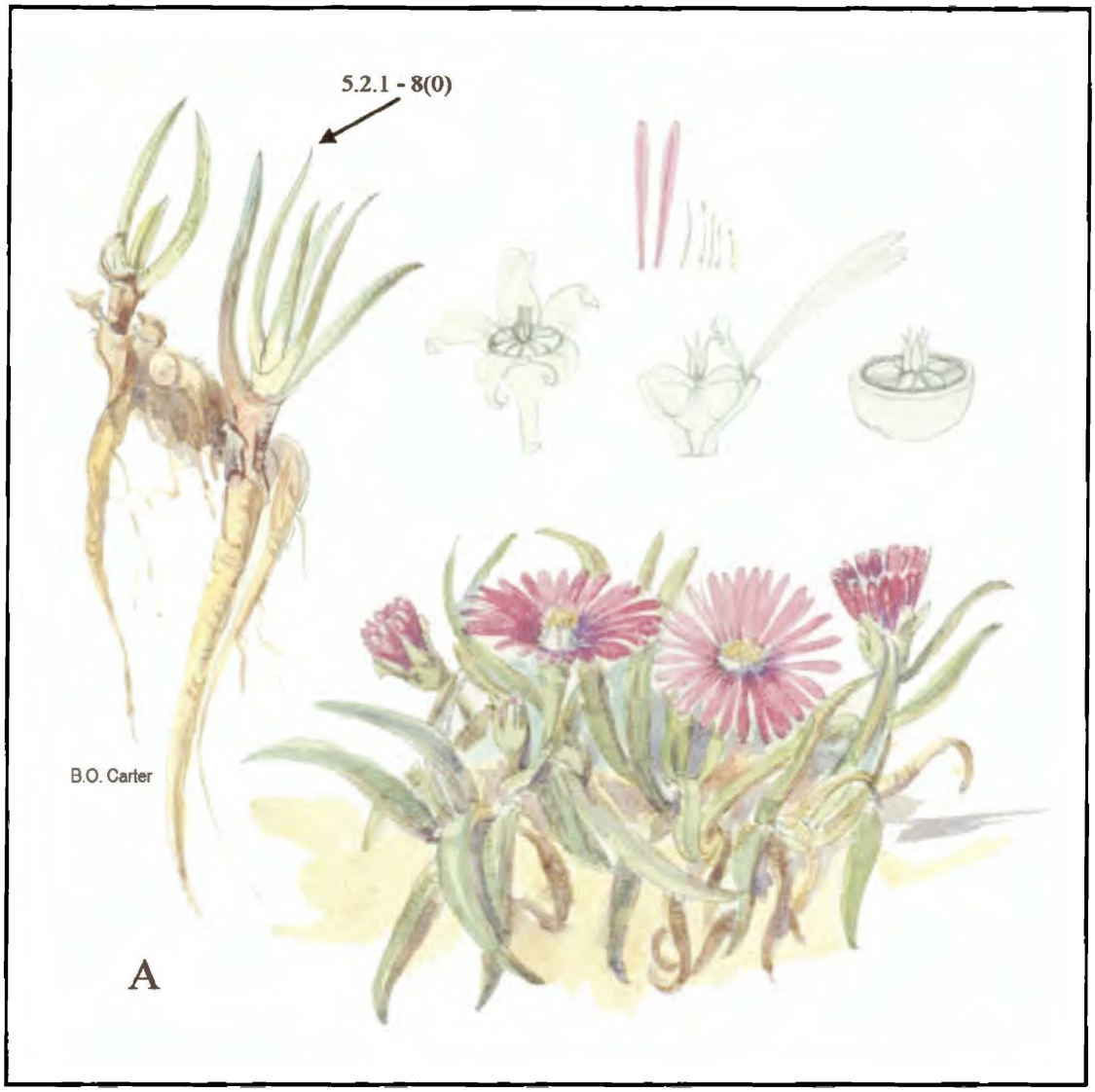


Fig. 6.72

TAXON
A. *M. stenophylla*

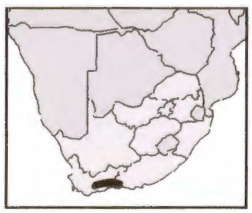
CHARACTERS
5.2.1 - 8(0): Leaf tips - pointed (or rounded).

DISTINGUISHING CHARACTERS
Tufted perennials with tuberous roots; flowers solitary, large, with purple, striped petals; fruit 5-locular with large, white closing bodies.

Fruit a 5-locular capsule; covering membranes stiff, translucent; expanding keels widely divergent, reddish; closing bodies very large, whitish; valve wings absent.

NOTES
2 spp. In Fynbos and Succulent Karoo biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

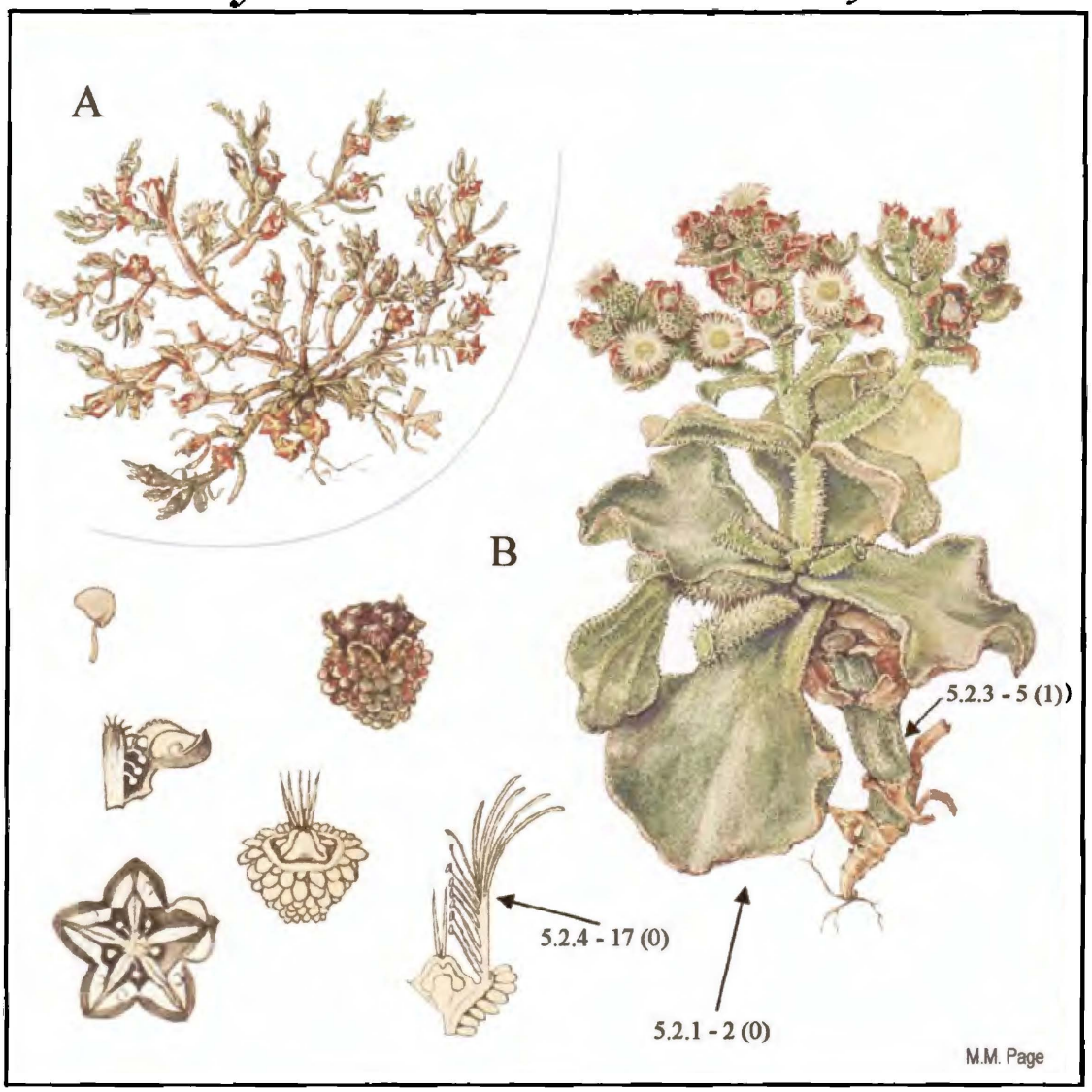


Fig. 6.73

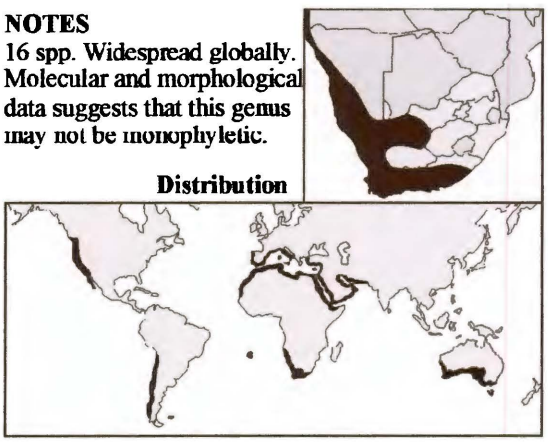
TAXA
A. *M. nodiflorum*
B. *M. crystallinum*

CHARACTERS
5.2.1 - 2 (0): Overall appearance - Semi succulent, fleshy herb, often soft-leaved, glistening.
5.2.3 - 5 (1): Stem shape - Winged.
5.2.4 - 17 (0): Fusion of petals - Fused at base for a few millimetres.

DISTINGUISHING CHARACTERS
Stems herbaceous, surfaces conspicuously covered with bladder cells.

NOTES
16 spp. Widespread globally. Molecular and morphological data suggests that this genus may not be monophyletic.

Distribution



Fruit a 5-locular capsule, of *Mesembryanthemum*-type; expanding keels extending to centre of fruit; covering membranes absent; valve wings present, either inflexed over valves or reflexed and fused in pairs.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

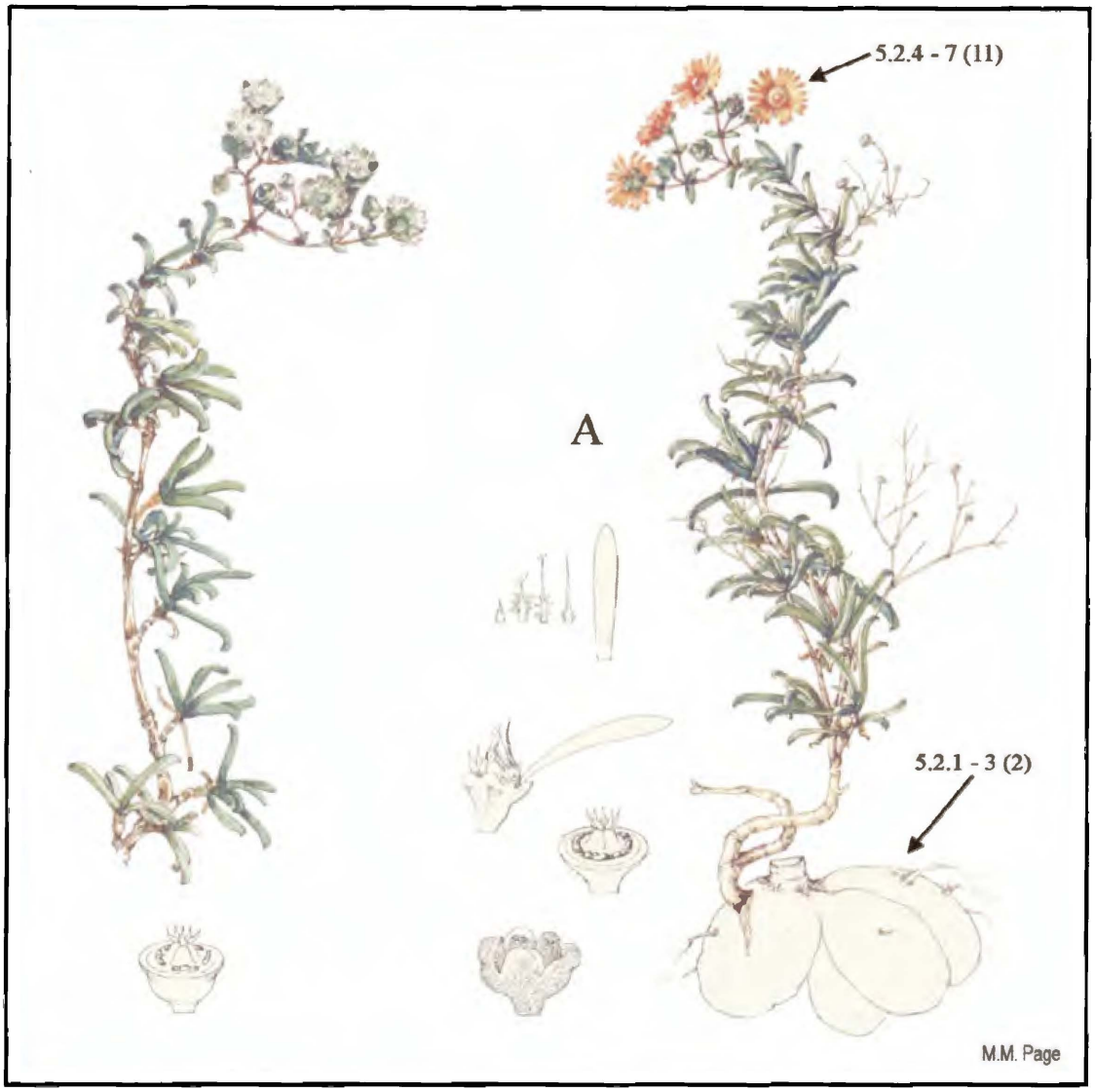


Fig. 6.74

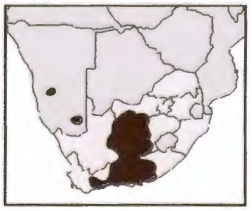
TAXON
A. *M. tuberosum*

CHARACTERS
5.2.1 - 3 (2): Roots - Single or multiple swollen tubers (potato-like).
5.2.4 - 7 (11): Flower colour - Copper-coloured.

DISTINGUISHING CHARACTERS
Densely branched shrubs, with tuberous roots; flowers often in coppery shades, without filamentous staminodes; fruit with covering membranes which may be reduced

Fruit a 5-locular capsule, of *Drosanthemum*-type; small, valves recurved when expanded; expanding keels contiguous and diverging towards tips, with narrow, membranous, acute wings; covering membranes present, but sometimes reduced by half; closing bodies absent.

NOTES
6 spp. Mostly in Albany Centre and Nama-Karoo Biome. Possibly tribe Ruschieae, some taxa may be in Drosanthemeae, molecular investigation is required to confirm tribal classification. **Distribution**



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

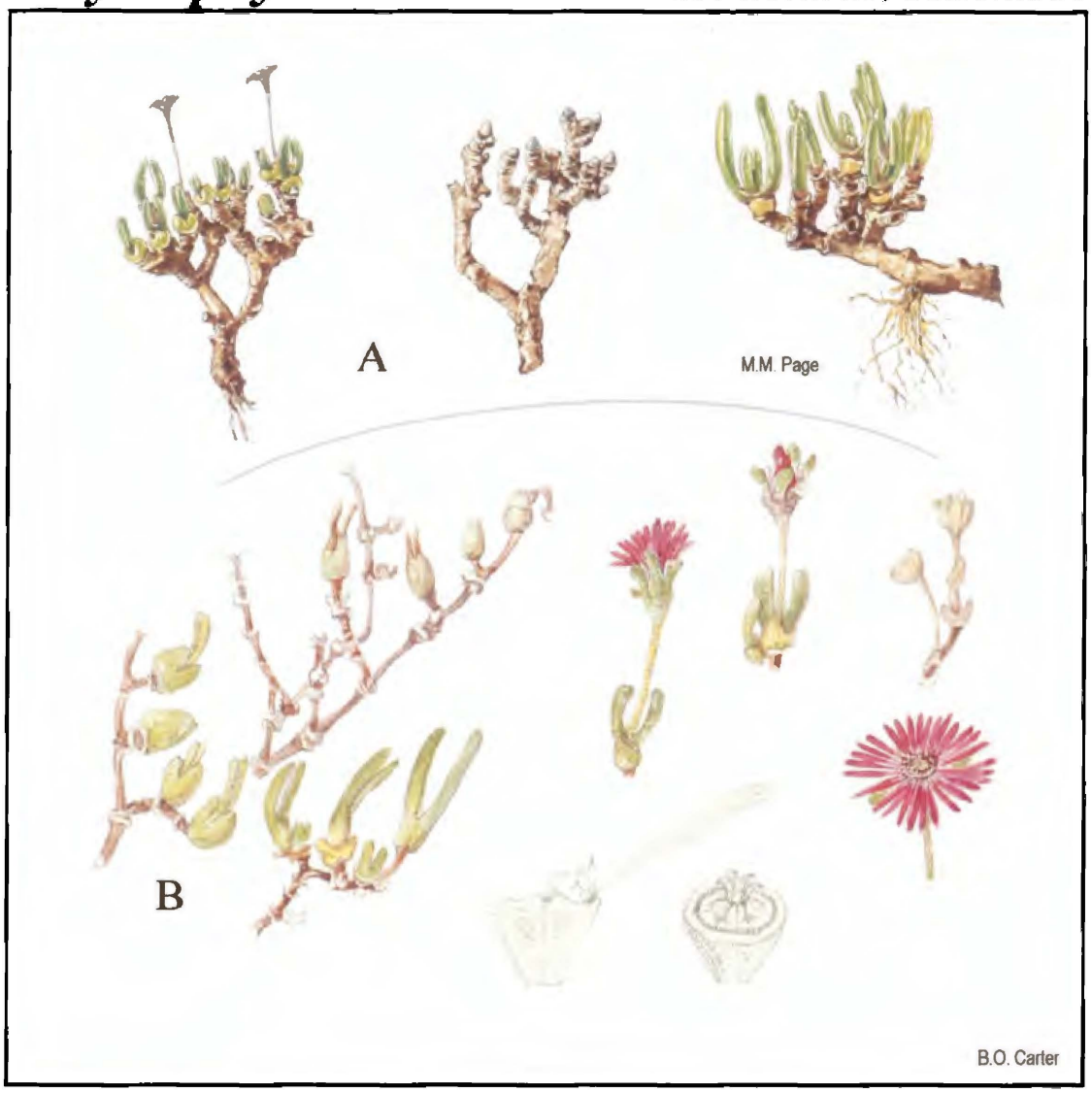


Fig. 6.75

TAXA
A. *Meyerophytum* sp.
B. *M. meyeri*

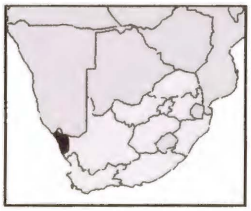
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Compact shrublets with weak, repeatedly branching stems; resting leaf bodies conspicuous

Fruit a 5-locular capsule, of *Mitrophyllum*-type but with deeply concave covering membranes with a prominent distal bulge touching the protuberance reaching from base of expanding sheet into locule; closing bodies absent; valve wings ample; expanding keels flat.

NOTES
2 spp. Confined to Gariep Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

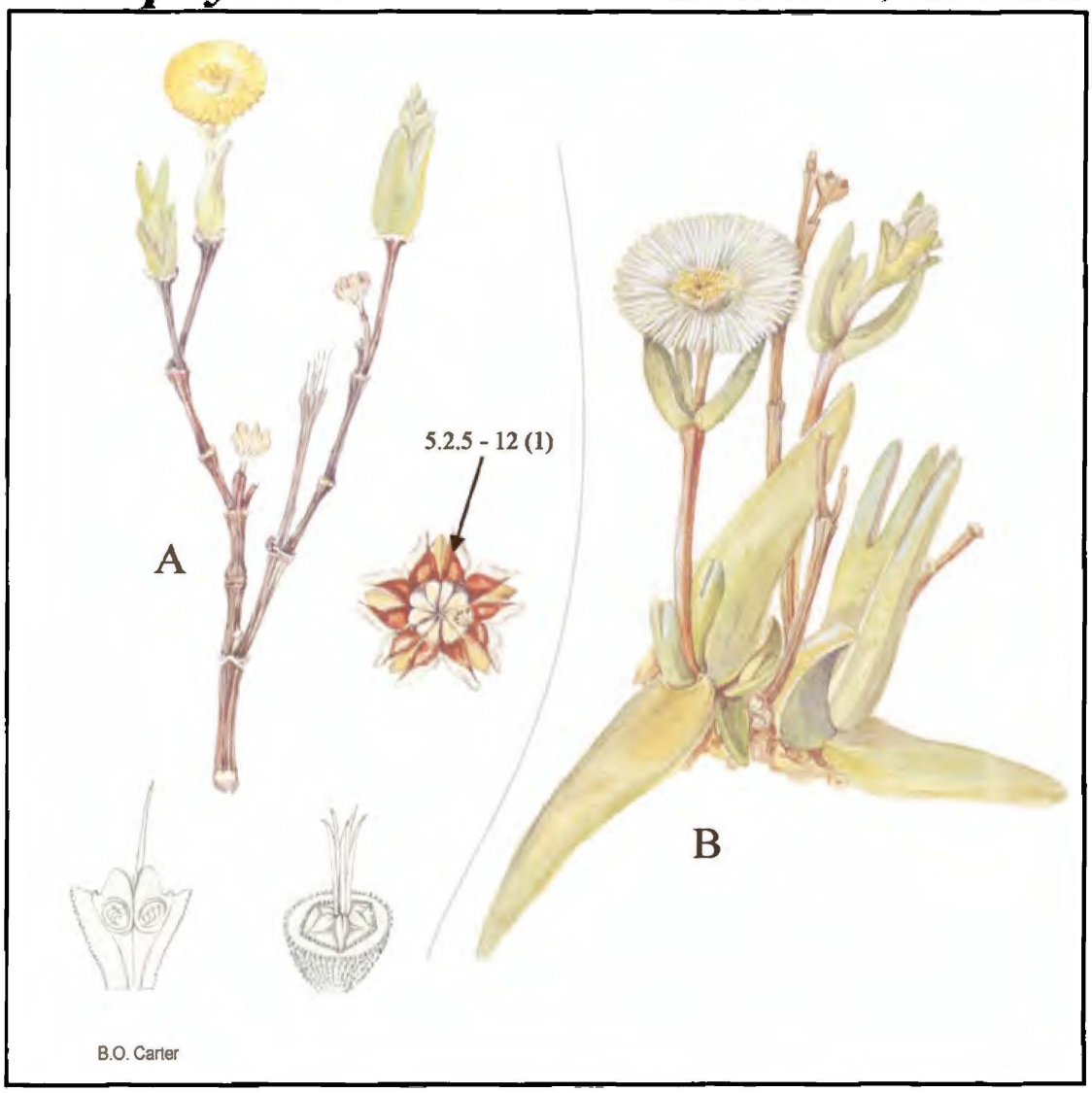


Fig. 6.76

TAXA
A. *M. dissitum*
B. *M. grande*

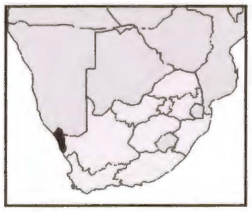
CHARACTERS
5.2.5 - 12 (1): Expanding keels - Curved, merged with expanding sheets, ± restricted to valves.

DISTINGUISHING CHARACTERS
Shrubs with very large, oblong, floppy leaf pairs with papery leaf sheaths, borne on erect woody stems.

Fruit a 5(7)-locular capsule, of *Mitrophyllum*-type with or without covering membranes; with or without closing ledges or bosses.

NOTES
6 spp. In Gariep Centre and southwards in Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

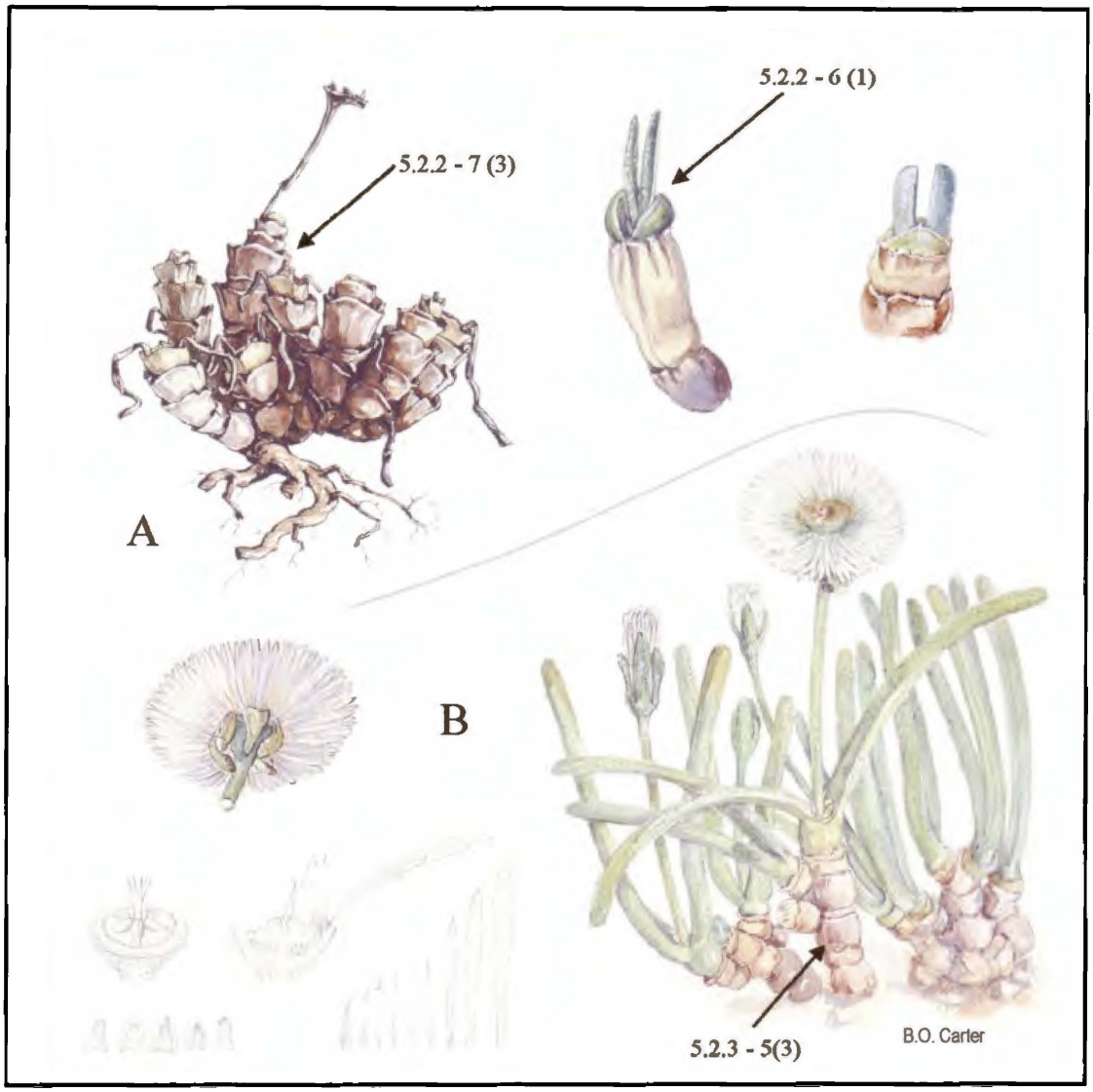


Fig. 6.77

TAXA
A. *M. scutata* **subsp.** *scutata*
B. *M. moniliformis*

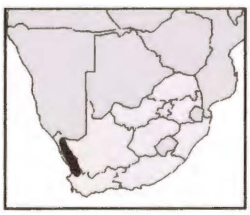
CHARACTERS
5.2.2 - 6 (1): Leaf pair types - Differently shaped leaves at different seasons (heterophyllous plant).
5.2.2 - 7 (3): Leaf sheaths - Internodes enclosed by sclerotic bases of old leaf sheaths.
5.2.3 - 5 (3): Stem shape - Articulated, beaded.

DISTINGUISHING CHARACTERS
Small shrublets with succulent constricted stems and persistent leaf bases, resembling a string of large beads.

NOTES
5 spp. 2 subspp. Namaqualand including Knersvlakte Centre, Succulent Karoo Biome.

Fruit a 5(7)-locular capsule, of *Mitrophyllum*-type, with prominent sutural ridges; valves widely spreading or reflexed; expanding keels ± widely diverging, broad at base, with inner ridges raised and with narrow, marginal wings; loculcs shallow, with or without covering membranes; closing devices absent.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

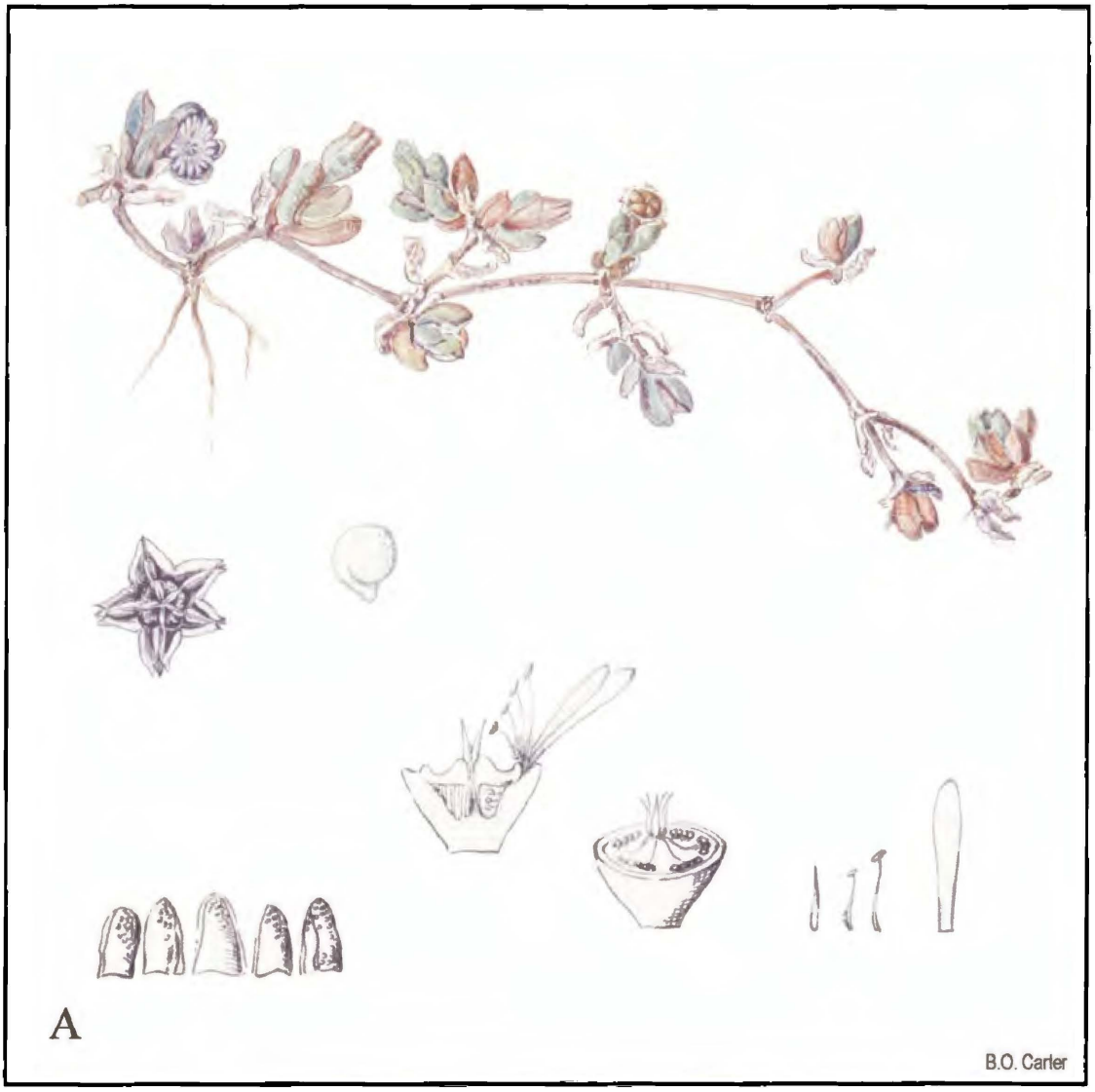


Fig. 6.78

TAXON
A. *M. intervallaris*

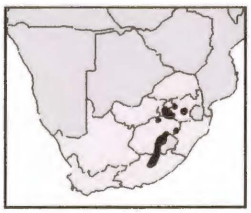
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Creeping, very small perennials; flowers with hypanthium, white, opening at night.

Fruit a 5(6) locular capsule, ± of *Delosperma*-type but without valve wings; expanding tissue composed of radial, contiguous keels to apex of each valve and expanding sheet; covering membranes absent but ledges of deeply split septa may cover locules slightly; closing bodies absent but funicles conspicuous, swelling when wet.

NOTES
1 sp. Endemic to the Grassland Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

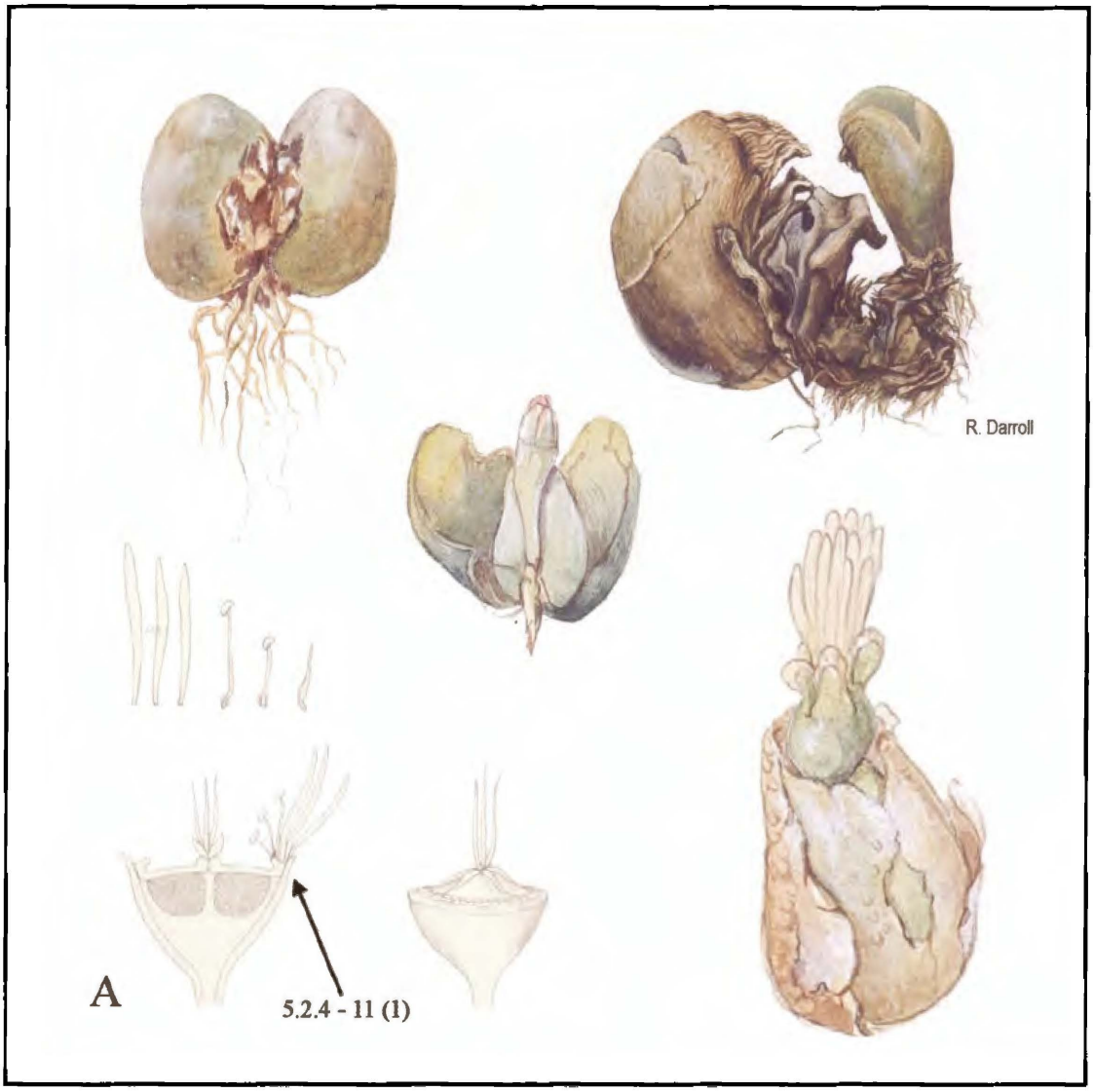


Fig. 6.79

TAXON
A. *M. hortenseae*

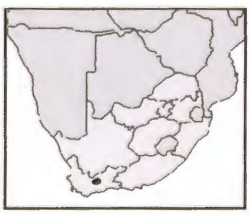
CHARACTERS
5.2.4 - 11 (1): Position of the ovary - Inferior.

DISTINGUISHING CHARACTERS
Single-bodied perennials with leaf pairs entirely fused, hairy; flowers rupturing tips of bodies when emerging.

Fruit a 6-locular capsule, of *Delosperma*-type; placenta prominent; forming pockets; valves deltoid, expanding horizontally; expanding keels contiguous with broad, marginal valve wings as long as valves; valve wings connate at base, forming pockets; covering membranes or closing devices absent.

NOTES
1 sp. Endemic to Little Karoo Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

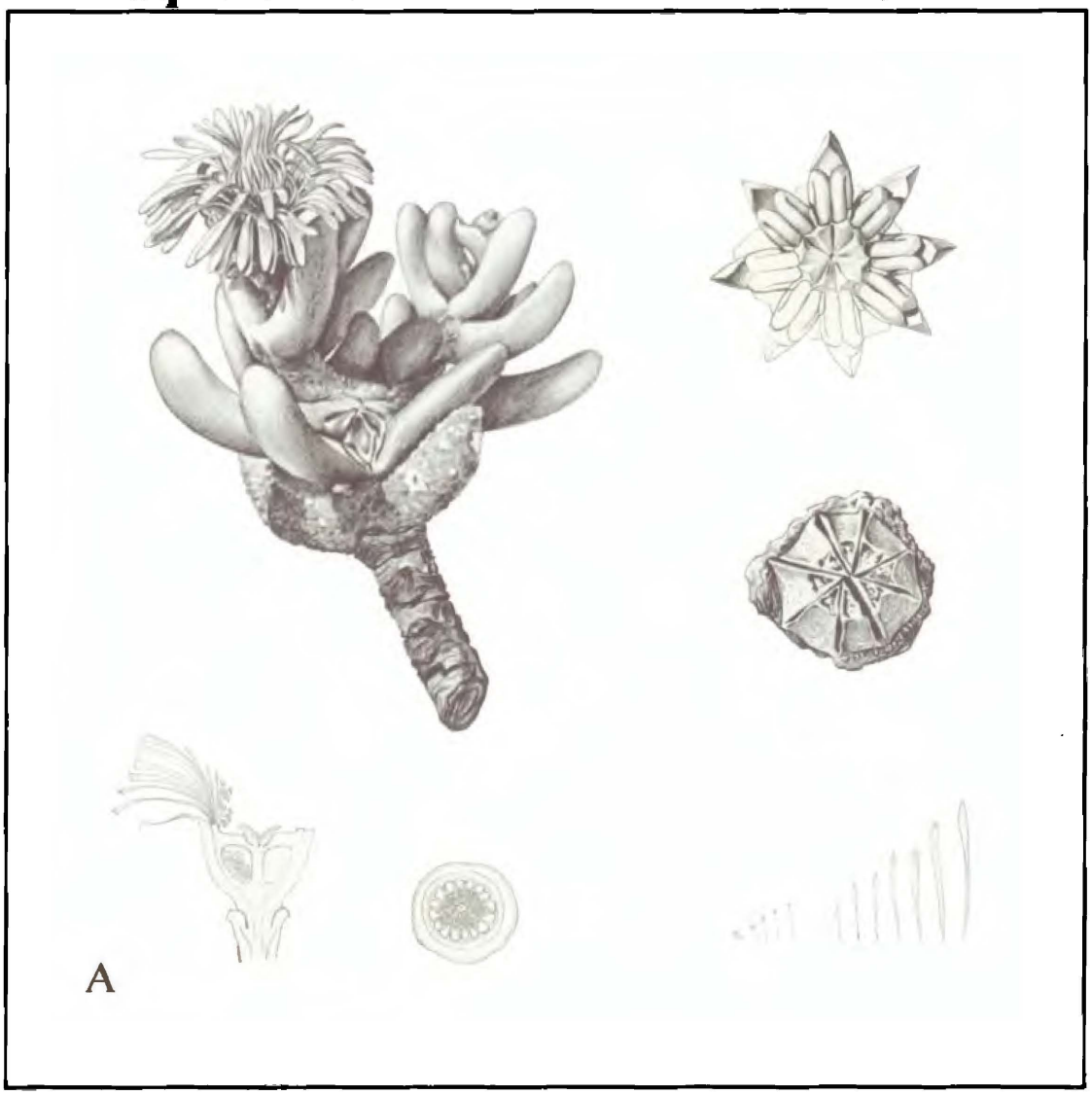


Fig. 6.80

TAXON
A. *N. vanheerdei*

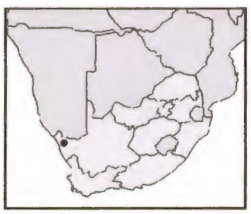
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Compact perennials; leaves cylindrical, fused at the bases; flowers magenta with spoon-shaped outer petals; seeds echinate.

Fruit a (8)12(16)-locular capsule, of *Lampranthus*-type, woody and rounded; valve wings present, narrow; covering membranes radially thickened; expanding keels parallel, diverging at tips; closing bodies absent.

NOTES
1 sp. Local endemic in Namaqualand, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

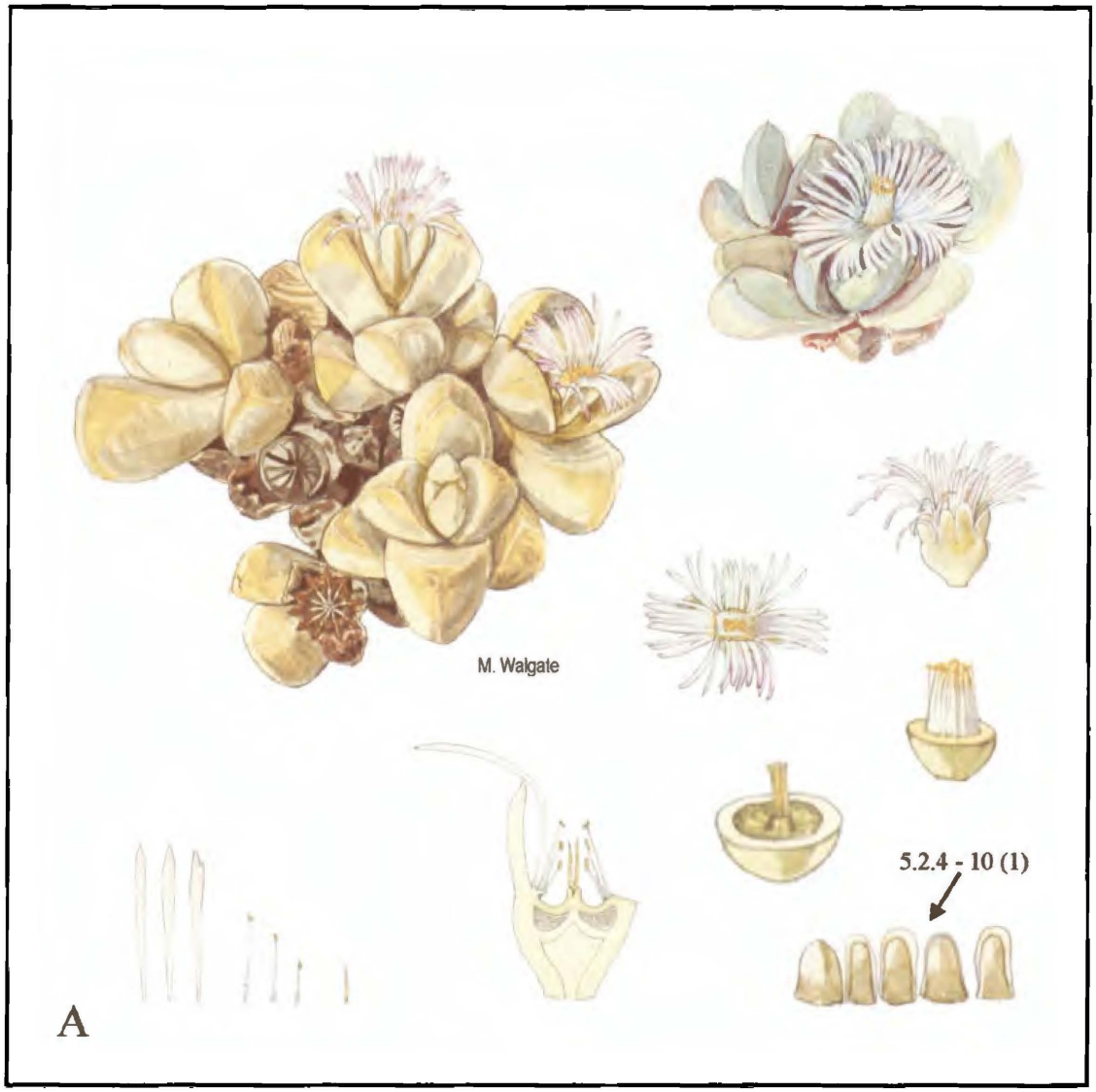


Fig. 6.81

TAXON
A. *N. cinerea*

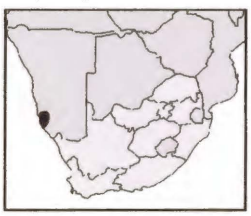
CHARACTERS
5.2.4 - 10 (1): Relative length of sepals - Almost equal in length.

DISTINGUISHING CHARACTERS
Dense, compact perennials; leaves thick, basally fused, velvety, waxy; flowers solitary, pink or white, square-looking; opening in the morning or perpetually open.

Fruit a (9–)12(–28)-locular capsule, close to *Delosperma*-type; convex; expanding keels parallel along base and diverging and lacerate towards tips, with oblong valve wings; covering membranes reduced to limb or absent; closing devices absent.

NOTES
2 spp. Endemic to small area in Succulent Karoo Biome, Namibia.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

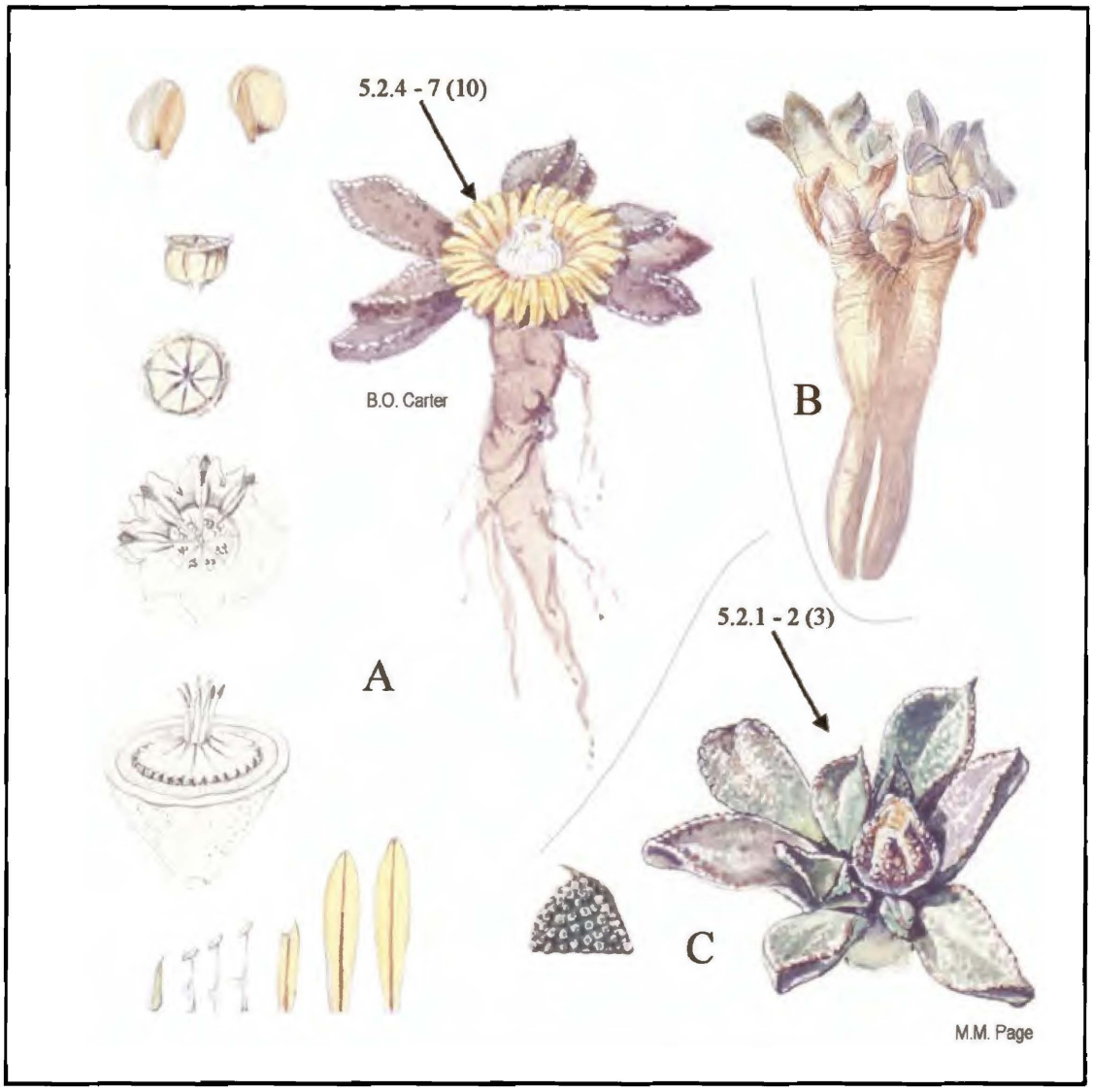


Fig. 6.82

TAXA
A. *N. pole-evansii*
B. *N. vittatus*
C. *N. aloides*

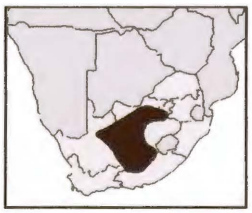
CHARACTERS
5.2.1 - 2 (3): Overall appearance - Tufted, or clump-forming or rosette-leaved succulent.
5.2.4 - 7 (10): Flower colour - Yellowish-orange with stripe.

DISTINGUISHING CHARACTERS
Small rosette-forming perennials with tuberous roots; leaves pointed at tips, with almost concave upper surfaces and pale dots; flowers in shades of yellow, often with striped petals.

Fruit a 6–10-locular capsule, resembling *Delosperma*-type, but the rounded, semiglobose base of capsule differs from typical form, sometimes as tumble fruit; expanding keels strictly radial; closing bodies absent; rims of septa very narrow.

NOTES
6 spp. Present in Grassland, Nama Karoo and Savanna biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

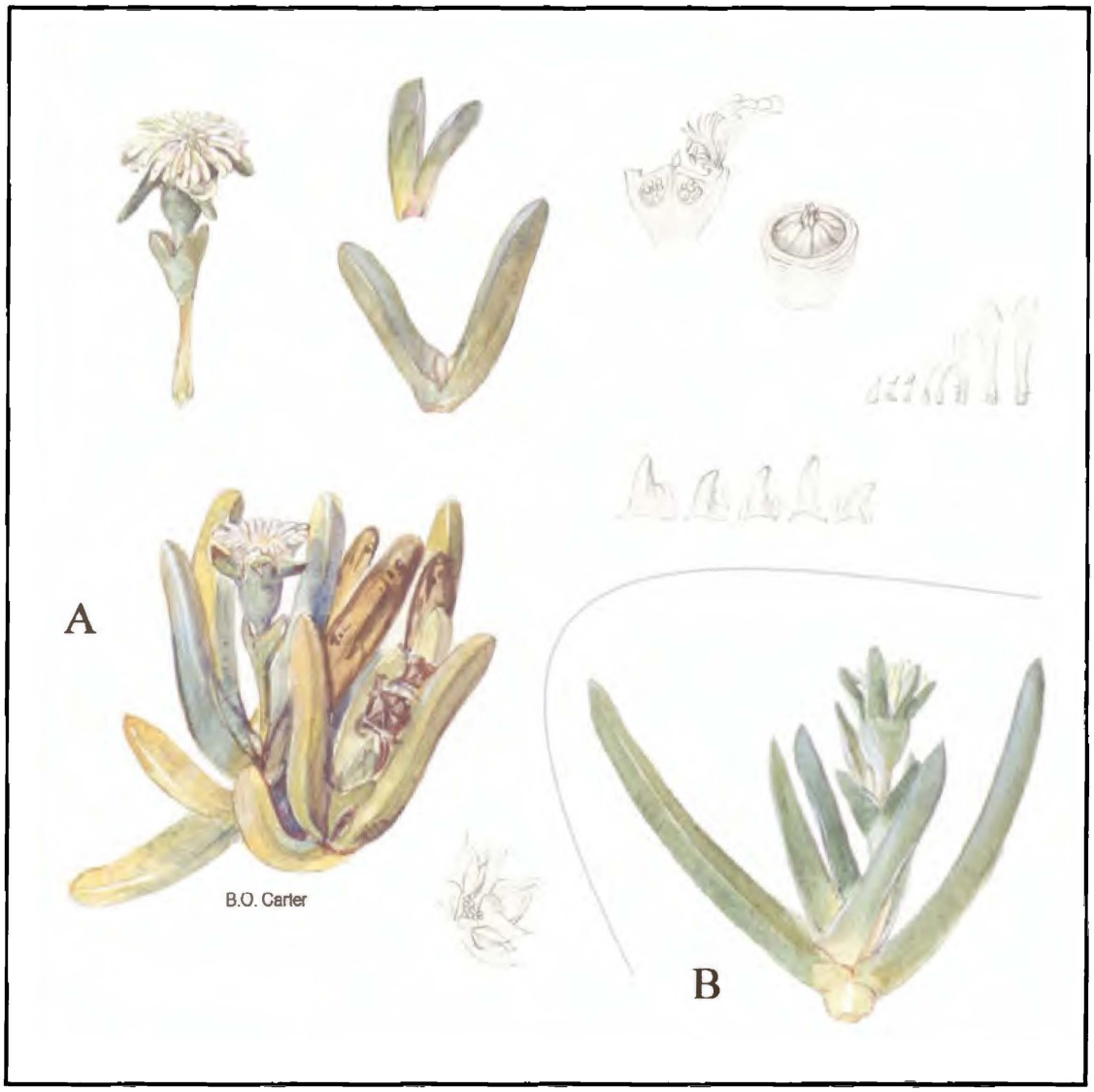


Fig. 6.83

TAXA
A. *N. pillansii*
B. *Nelia* sp.

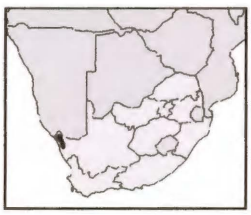
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Compact, clump-forming perennials; leaves smooth; petals stiff; flowers, once open, do not close again.

Fruit a 5-locular capsule, of *Delosperma*-type, but expanding keels parallel, stout, yellow, diverging distally; covering membranes vestigial, developed as rather broad rectangular rims of septa; sutures slightly raised in centre; valves recurved when expanded; valve wings broad; closing devices absent.

NOTES
2 spp. Endemic to Northern Namaqualand, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

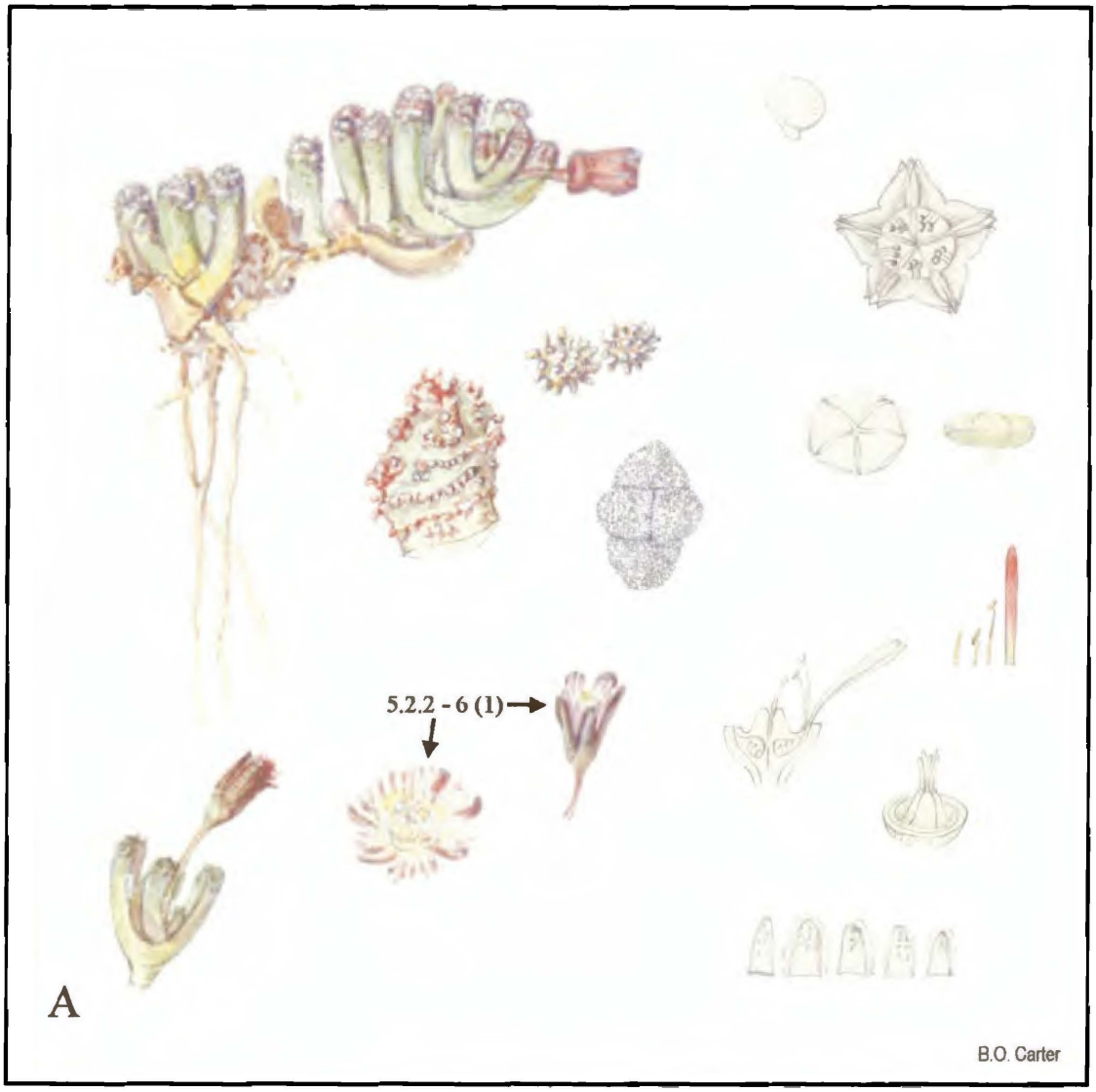


Fig. 6.84

TAXON
A. *N. sibbettii*

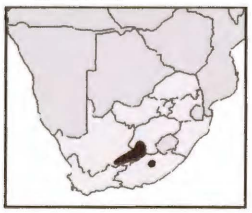
CHARACTERS
5.2.2 - 6 (1): Diurnal floral rhythm - Opening in the evening or at night.

DISTINGUISHING CHARACTERS
Minute perennials with strongly textured leaves; pedicels long and slender; flowers nocturnal, highly scented.

Fruit a 4–6-locular capsule, of *Delosperma*-type with erect septa; expanding keels parallel, diverging slightly at tips; valve wings absent; covering membranes sometimes well developed, otherwise reduced to a limb; closing devices absent.

NOTES
2 spp. Present in Nama-Karoo and Grassland biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

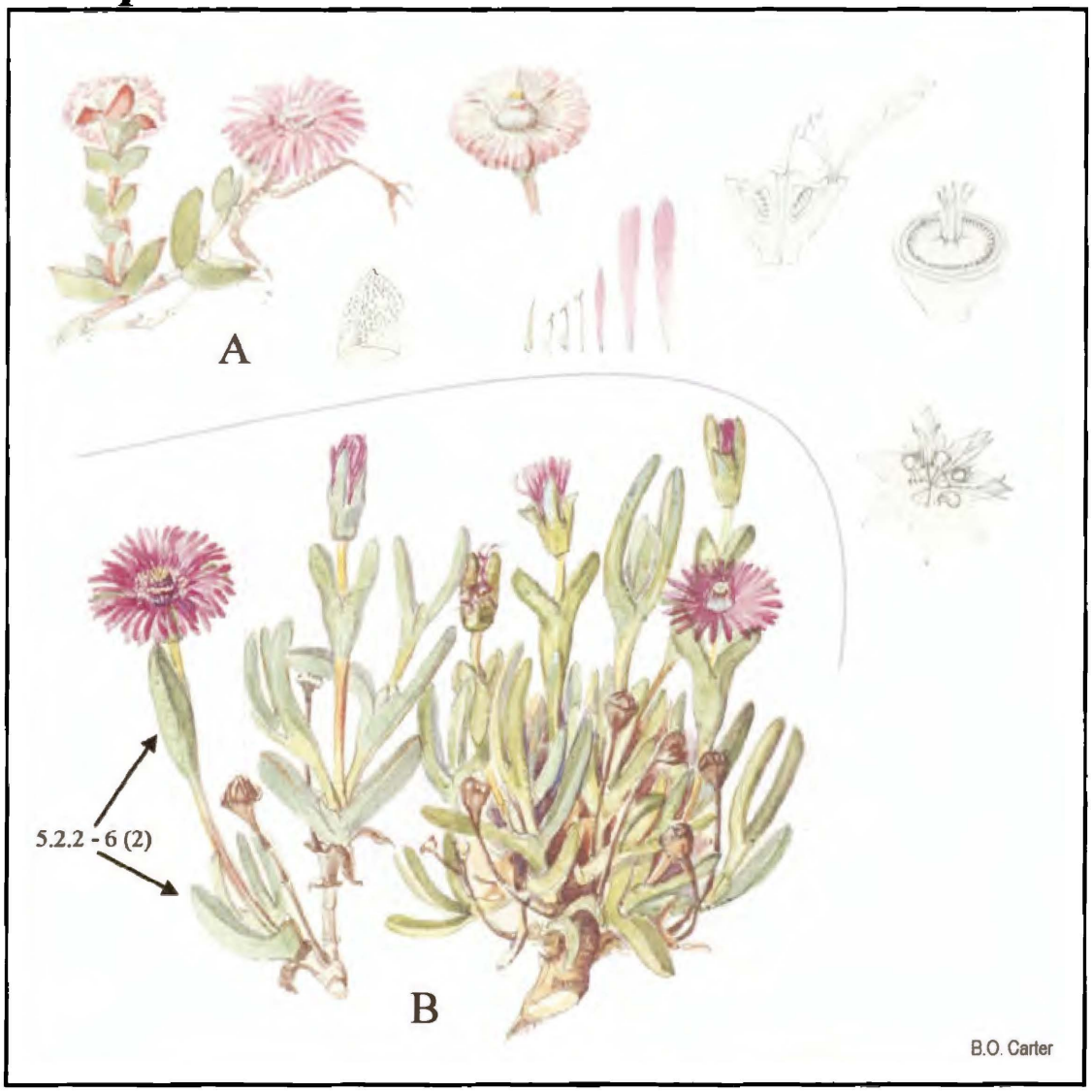


Fig. 6.85

TAXA
A. *O. rupigenum*
B. *O. connatum*

CHARACTERS
5.2.2 - 6 (2): Leaf pair types - Differently shaped leaves on different parts of the plant.

DISTINGUISHING CHARACTERS
Fruit firm, brown, 6–8-locular.

Fruit a 6–8-locular capsule, close to *Leipoldtia*-type, brown, markedly convex on top in most cases; expanding keels diverging, lacerate towards tips; valve wings absent or narrow, broadest in middle; closing bodies large, white, flat; covering membranes rising towards centre; distal closing devices absent.

NOTES
8 spp. The genus need revision and may be subdivided into more than one genus. Present in Succulent Karoo and Fynbos biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

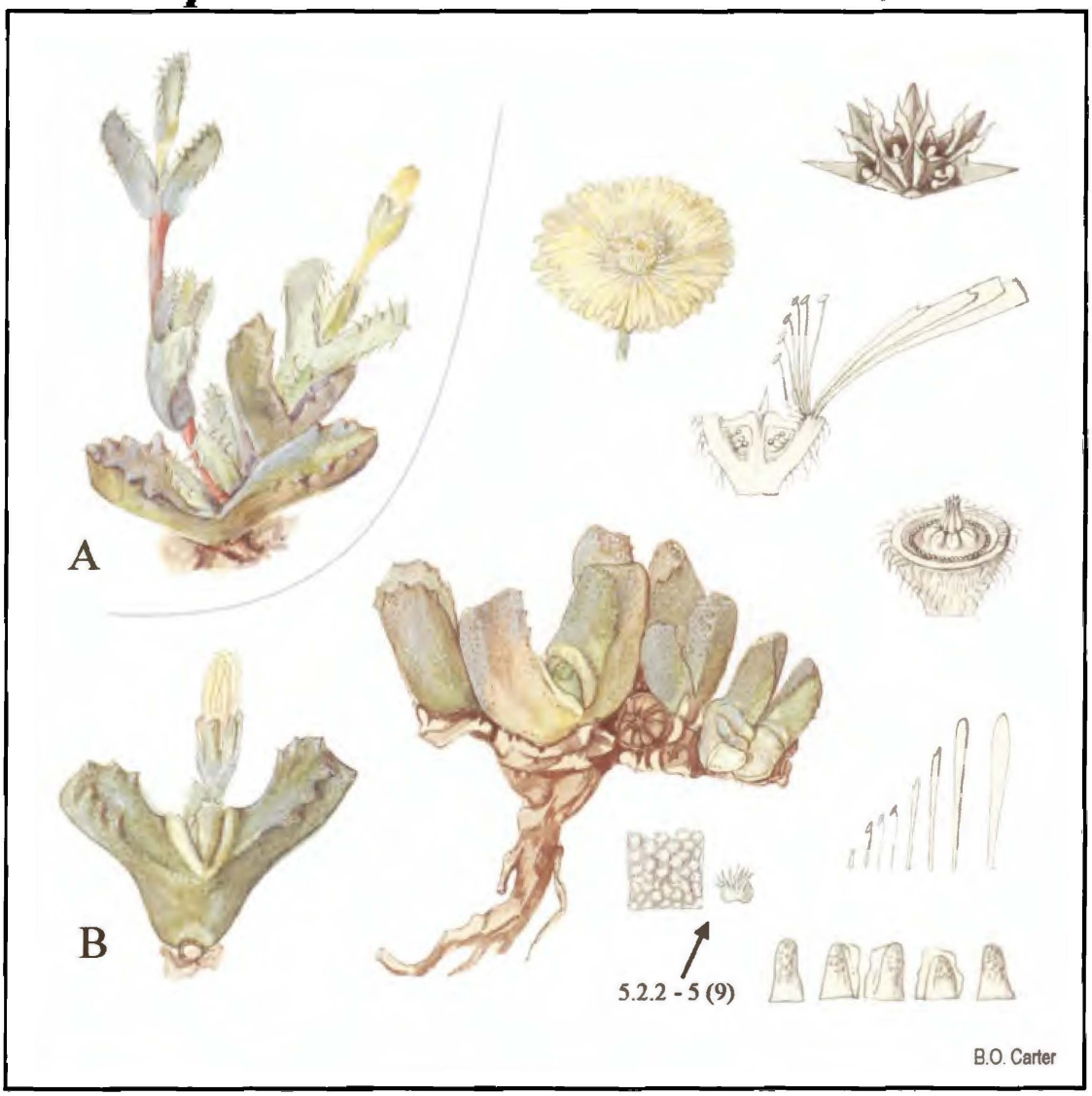


Fig. 6.86

TAXA
A. *O. marlothii*
B. *O. nanus*

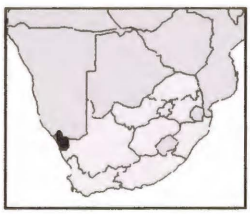
CHARACTERS
5.2.2 - 5 (9): Leaf surface - Velvety from soft hairs.

DISTINGUISHING CHARACTERS
Perennials forming small clumps or mats; leaves keeled, greyish green, often hairy, dentate; flowers yellow to orange.

Fruit a (8–)10(11)-locular capsule, of *Leipoldtia*-type with a thick semiglobose hairy base; expanding keels parallel, toothed, terminating in diverging membranous points; covering membranes stiff; closing bodies large, nearly closing the opening.

NOTES
4 spp. 2 subspp. Endemic to Gariep Centre and northern Namaqualand, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

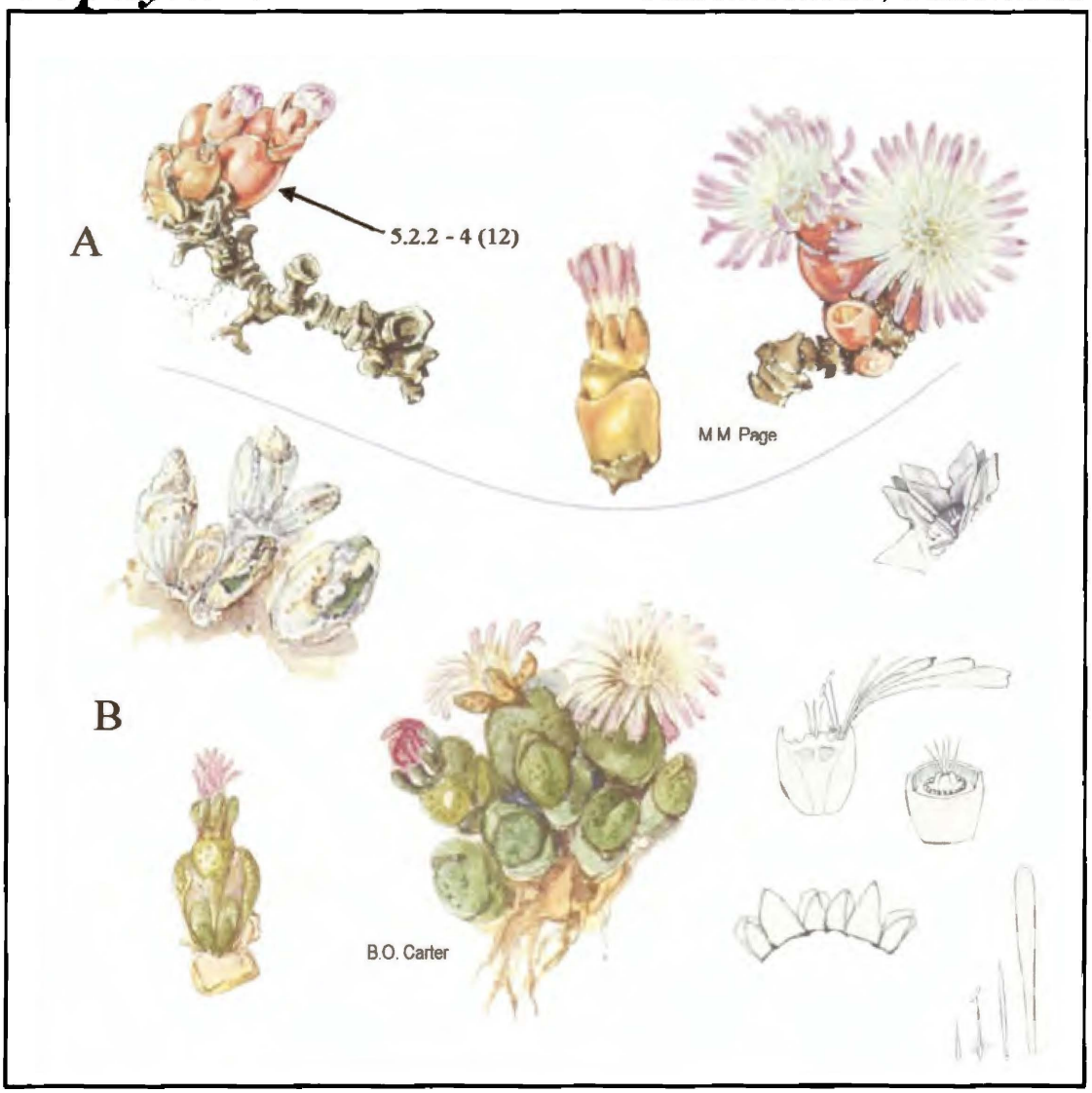


Fig. 6.87

TAXA
A. *O. oviforme*
B. *O. nanum*

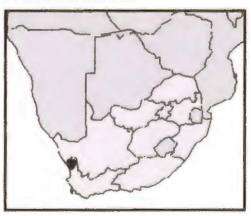
CHARACTERS
5.2.2 - 4 (12): Leaf shape - Fused to form conical, oblong, or spherical bodies.

DISTINGUISHING CHARACTERS
Stemless perennials, with clusters of ovoid, papillate leaves; old leaves forming papery sheaths enclosing the emerging young leaf pair.

Fruit a (5)6-locular capsule, of *Delosperma*-type; developing directly on top of drying plant body; valve wings broad; covering membranes rarely present as narrow rims over locules; closing bodies absent.

NOTES
2 spp. Endemic to the Knersvlakte Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021



Fig. 6.88

TAXON
A. *O. coeganum*

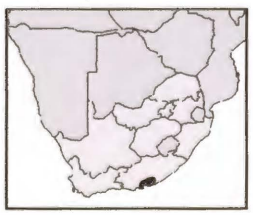
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Plants cushion-forming; leaves smooth, soft, unmarked; flowers yellow; fruit with septa arching over expanded capsules; fruit open and close repeatedly (unlike *Faucaria*).

Fruit a 5- or 6-locular capsule; septa of fruit separated into two, their upper part not flat as in *Faucaria* but arching on top of capsule; valve wings basally connate with valves, moving upwards into an erect position when fruit opens and valves fold back.

NOTES
2 spp. Endemic to Albany Thicket.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

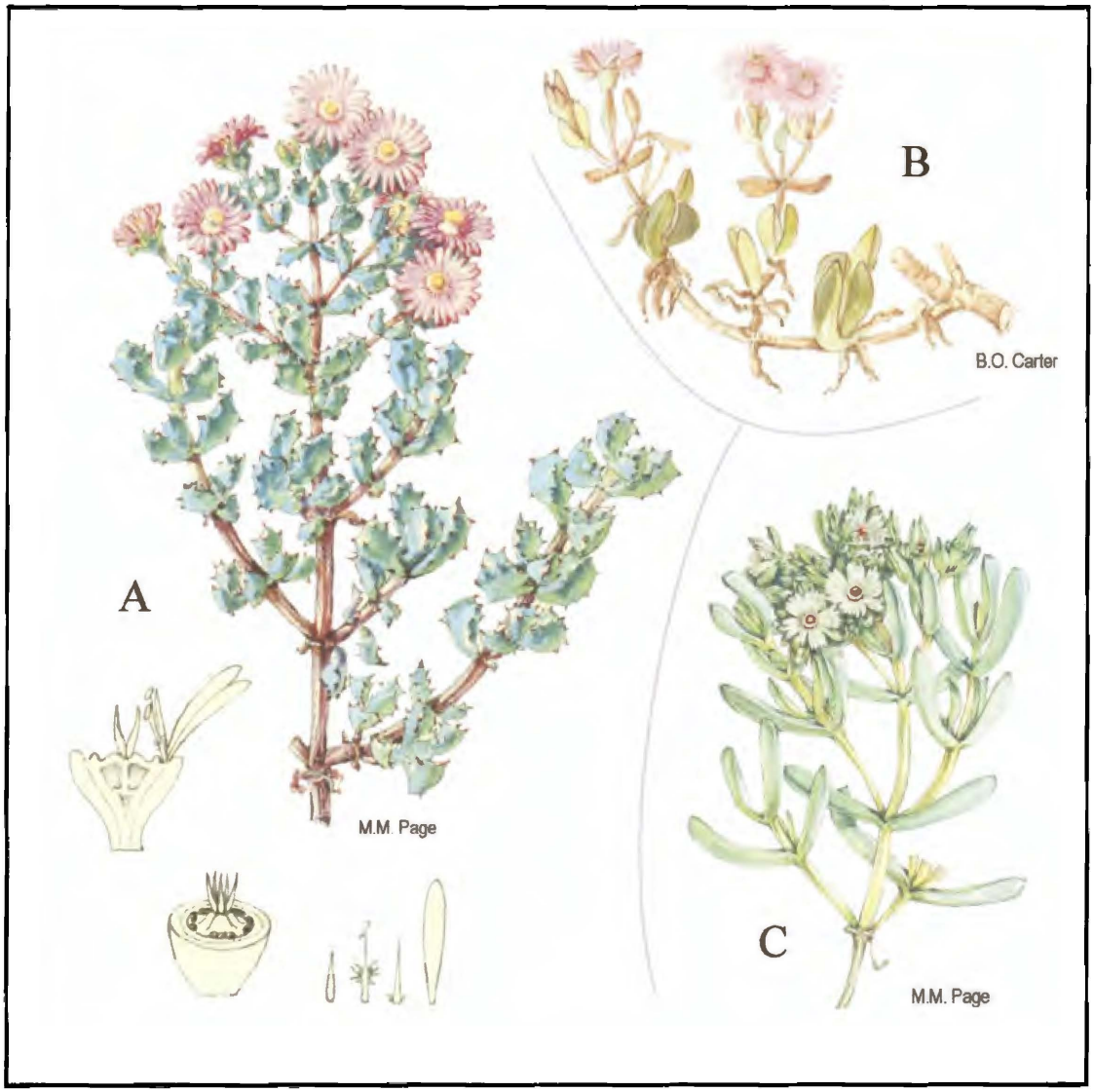


Fig. 6.89

TAXA
A. *O. deltoides*
B. *O. paardebergensis*
C. *O. comptonii*

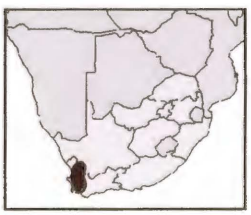
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Small shrubs with greyish green, waxy, sometimes dentate leaves; flowers scented; stamens and staminodes collected into a cone.

Fruit a 5-locular capsule, of *Lampranthus*-type; grey to brown; expanding keels diverging from base, more than half as long as valves; valve wings very broad and rectangular; covering membranes with inconspicuous closing ledges at distal ends; closing devices absent, but placenta ending in a tiny to small knob.

NOTES
22 spp. Extremely diverse near Piquetberg, Fynbos Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

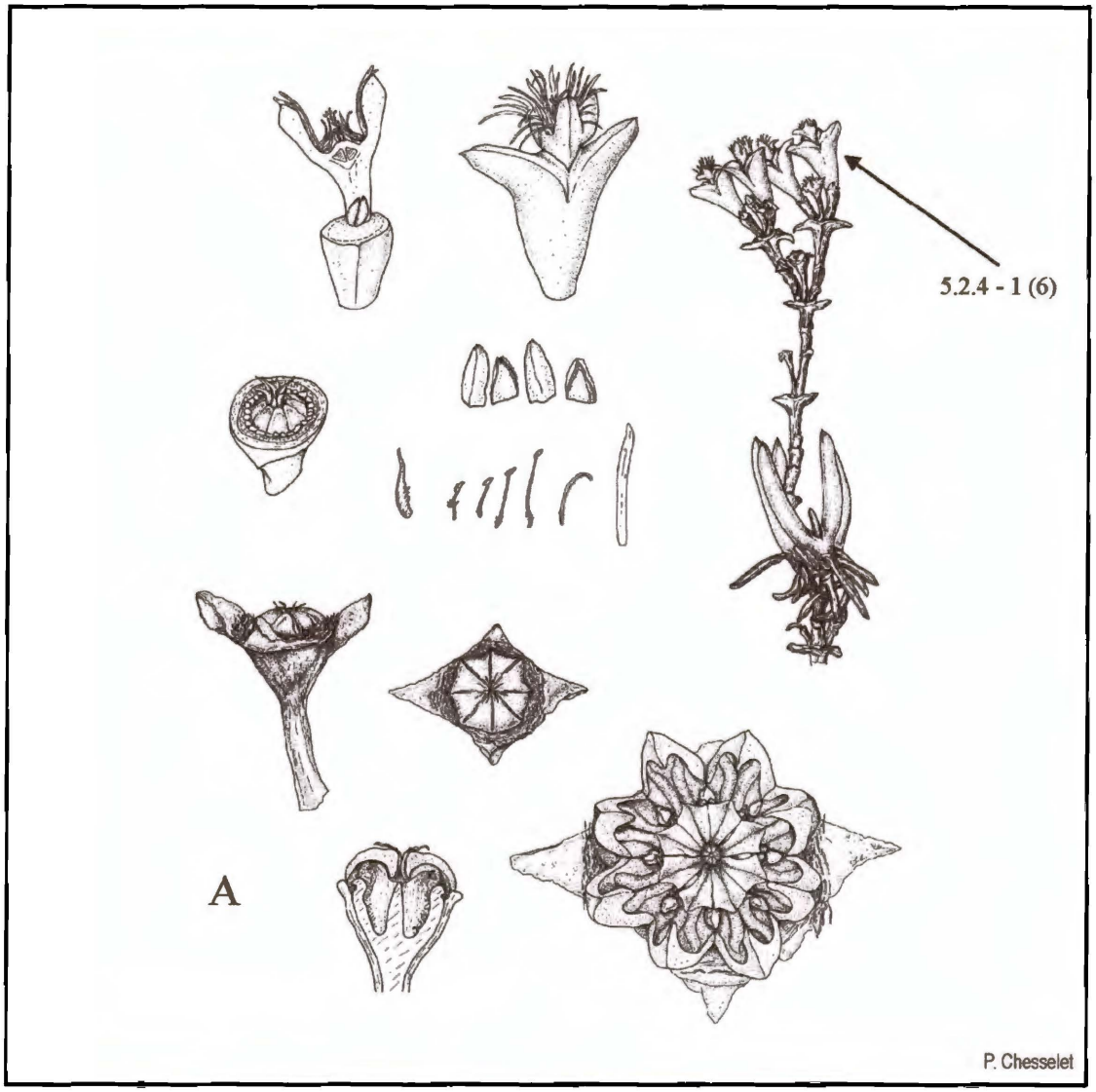


Fig. 6.90

TAXON
A. *O. monticola* (inflorescence)

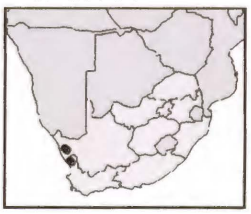
CHARACTERS
5.2.4 - 1 (6): Inflorescence characteristics - Succulent cymose inflorescence (persistent, highly succulent).

DISTINGUISHING CHARACTERS
Perennials with compact vegetative growth and elongated reproductive parts; inflorescences persistent.

Fruit a (6–)8-locular capsule, close to *Ruschia*-type but valves with low rims, yet forming a rounded dome, valves erect when open, without wings; expanding keels erect, thick; covering membranes well developed; closing bodies large.

NOTES
2 spp. Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

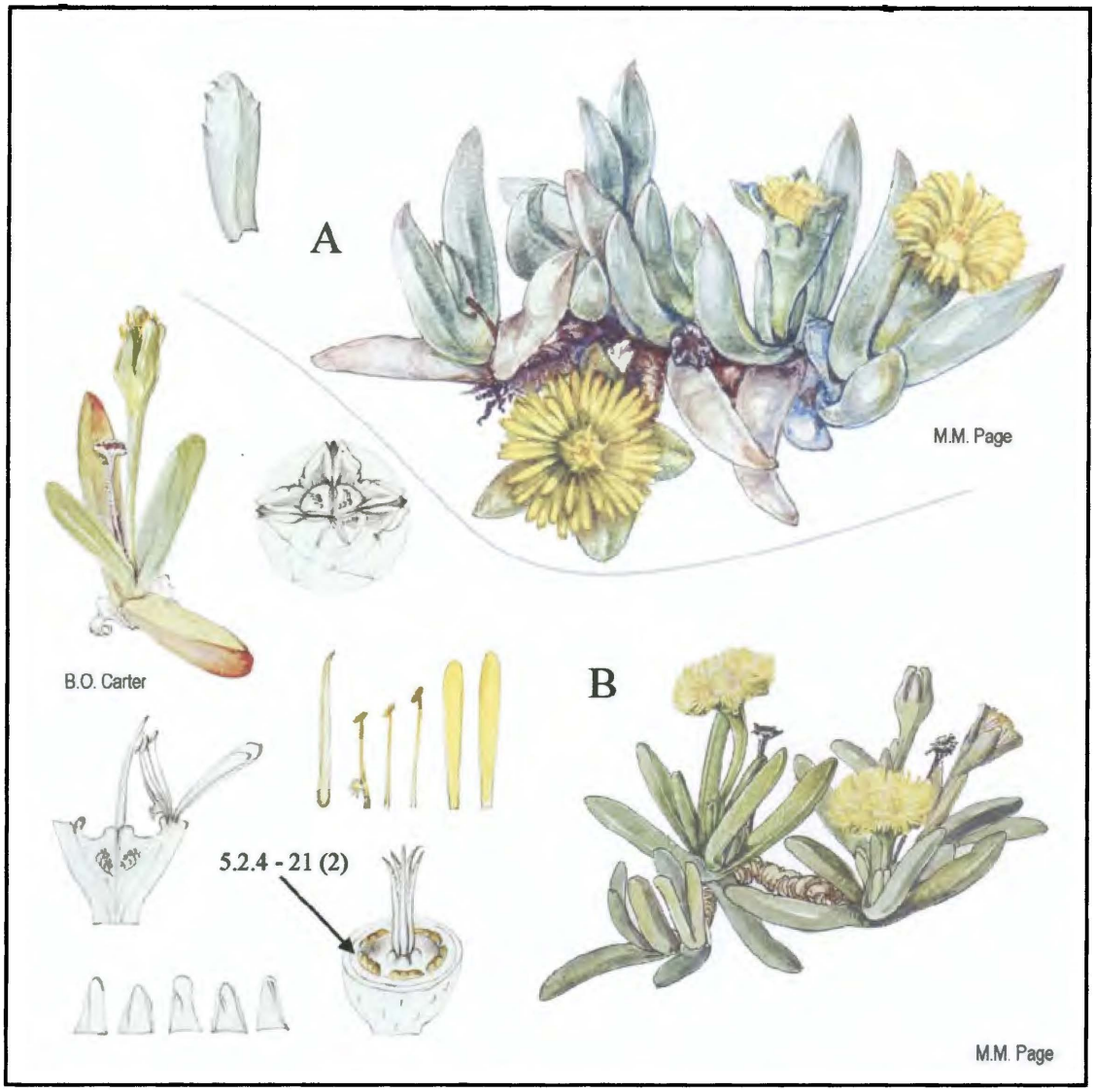


Fig. 6.91

TAXA
A. *P. frithii*
B. *P. macradenia*

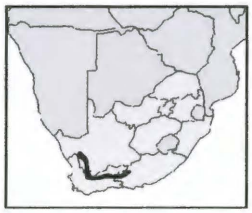
CHARACTERS
5.2.4 - 21 (2): Nectary colour - Yellowish.

DISTINGUISHING CHARACTERS
Tufted perennials, sometimes forming cushions; old leaves persistent for several years, blackened; leaves trigonous, smooth, greyish green; flowers solitary, petals yellow, without filamentous staminodes, fruit funnel-shaped with valves raised in centre.

Fruit a 5-locular capsule close to the *Delosperma*-type, with almost parallel expanding keels; covering membranes reduced to a narrow ledge; closing bodies absent or as tiny bumps; valve wings broad.

NOTES
3 spp. Confined to Ecca Group shales in the Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

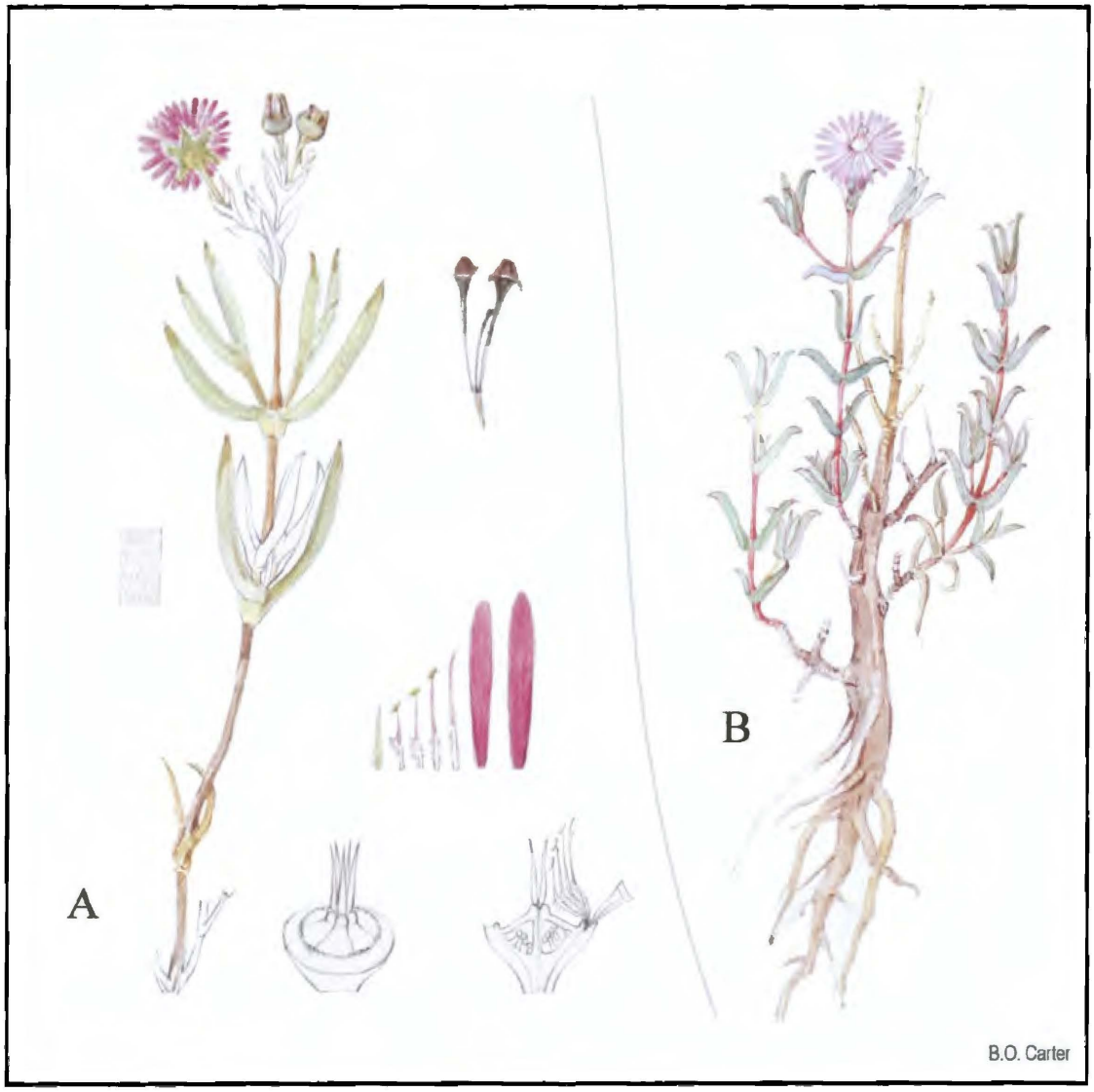


Fig. 6.92

TAXA
A. *P. gydouwensis*
B. *P. unca*

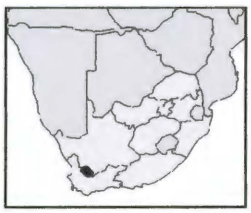
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Erect perennial shrubs with smooth brown stems. Leaves apically recurved, mucronate and basally fused into distinct short sheath. Leaf surfaces rough from small papillae. Flowers solitary or in cymes, bracteate, petals pink or white, nectary annular.

Fruit capsule 5-locular, without closing bodies, with long expanding keels and rectangular valve wings. Upper part dome-shaped.

NOTES
7 spp. Tanqua Karoo in Succulent Karoo Biome and Fynbos Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

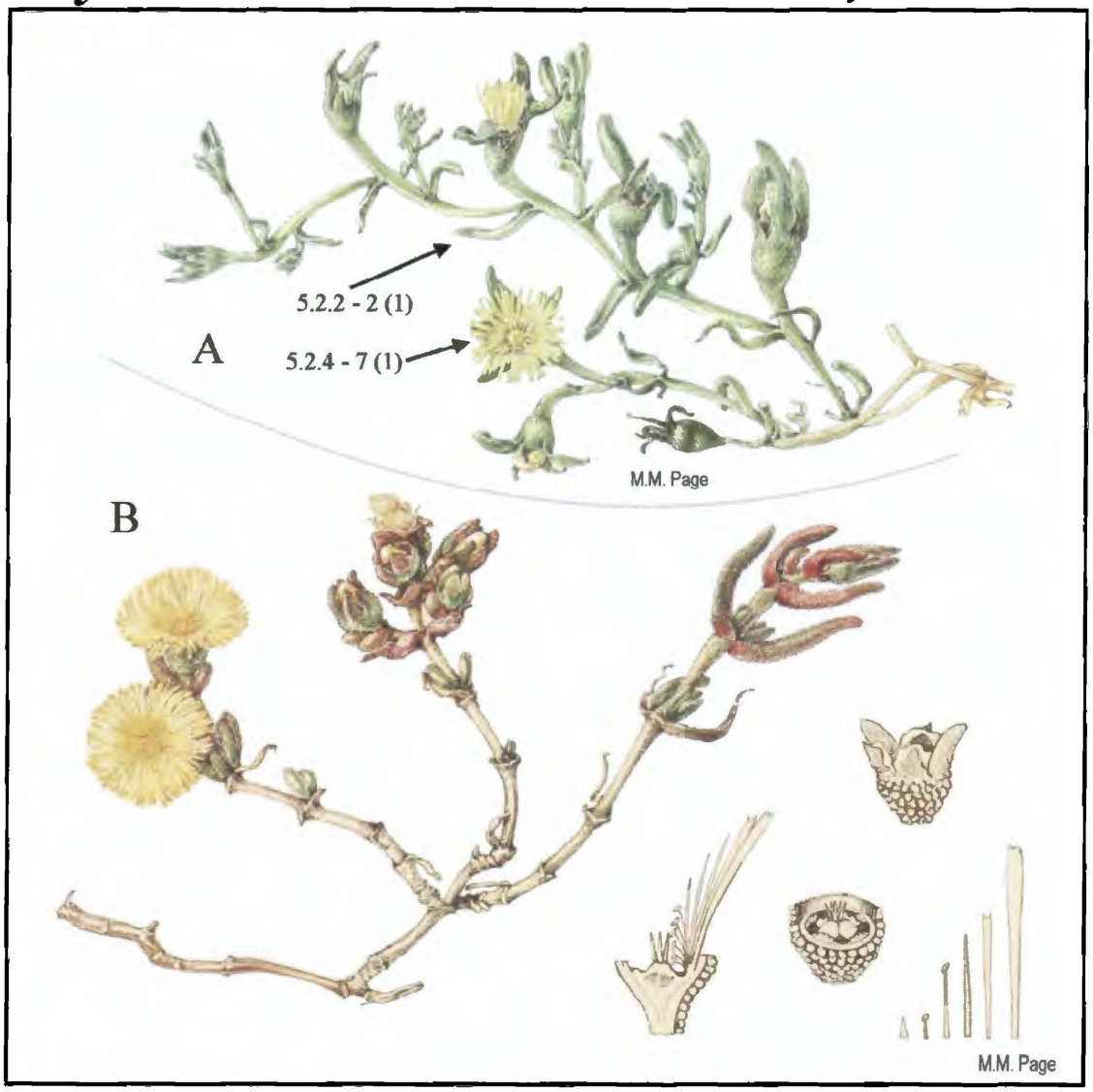


Fig. 6.93

TAXA
A. *P. sinuosus*
B. *P. nitidus*

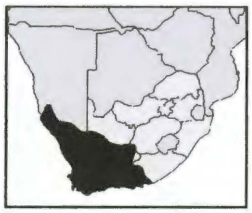
CHARACTERS
5.2.2 - 2 (1): Leaf arrangement - Leaves alternate in the inflorescence.
5.2.4 - 7 (1): Flower colour - Greenish.

DISTINGUISHING CHARACTERS
Perennials, with conspicuous bladder cell idioblasts on leaves; if rootstock is tuberous, leaves are summer-deciduous.

Fruit a 4- or 5-locular capsule, of *Mesembryanthemum*-type; expanding keels extending to centre of fruit; covering membranes absent; valve wings mostly present and inflexed over valves or rarely reflexed and fused in pairs or absent.

NOTES
31 spp. 2 subspp. The genus is polyphyletic as shown by molecular data. Mostly in Succulent Karoo Biome, also Fynbos, Grassland and Nama-Karoo biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

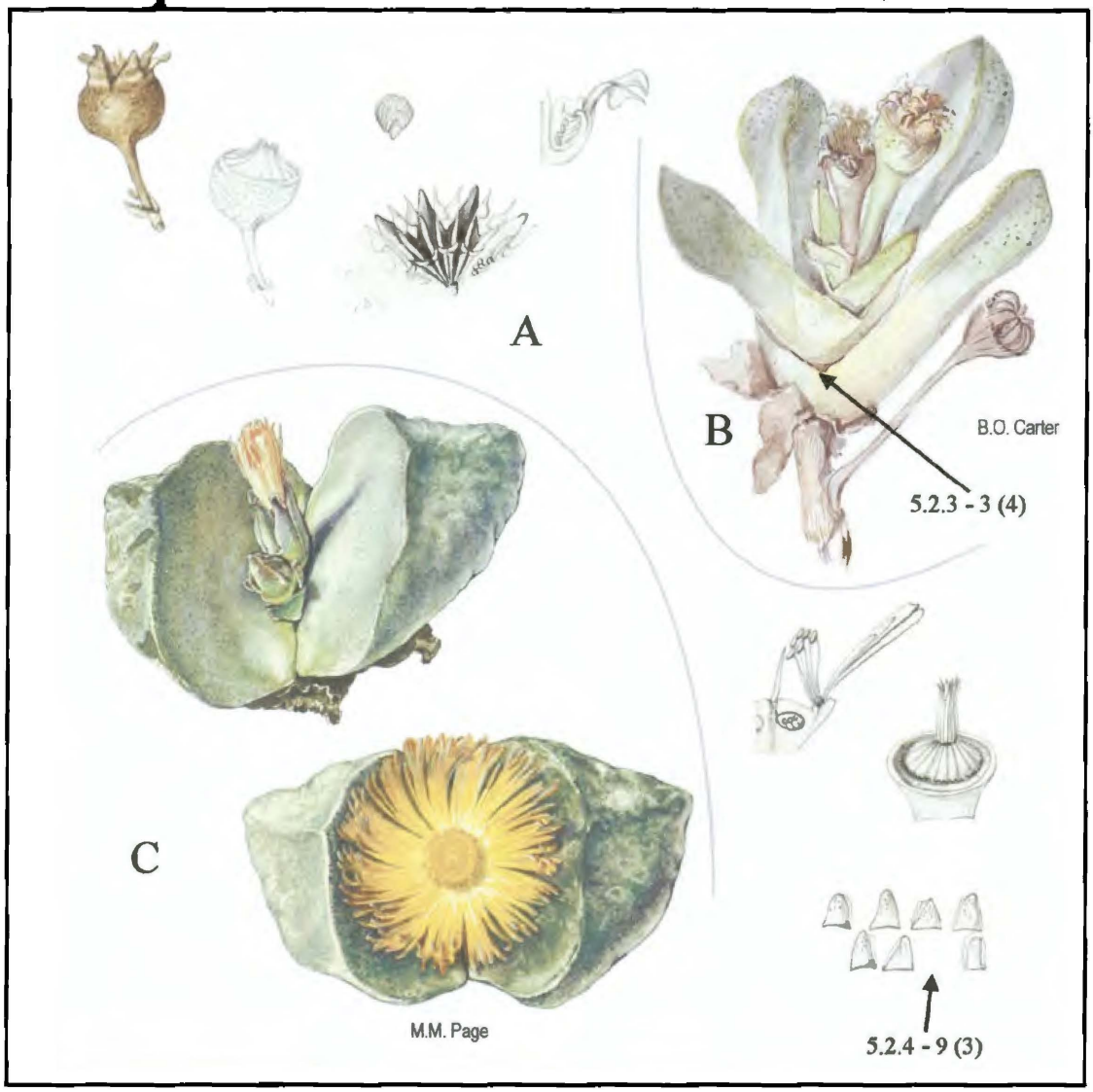


Fig. 6.94

TAXA
A. *P. nelii*
B. *P. compactus* subsp. *fergusoniae*
C. *P. bolusii*

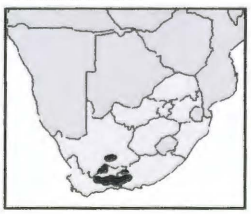
CHARACTERS
5.2.3 - 3 (4): Stem internodes - Not visible (internodes abbreviated).
5.2.4 - 9 (3): Number of sepals - 7.

DISTINGUISHING CHARACTERS
Compact perennials; leaves keeled, resembling stones, distinctly pellucid-dotted, waxy.

Fruit a 10–12-locular capsule, a derived version of *Leipoldtia*-type with broad, apically tapering valve wings; very firm covering membranes; large white to brown closing bodies of endocarpal or placental origin.

NOTES
4 spp. 5 subspp. 1 hybrid. Present in Albany Centre as well as Nama-Karoo and Succulent Karoo biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

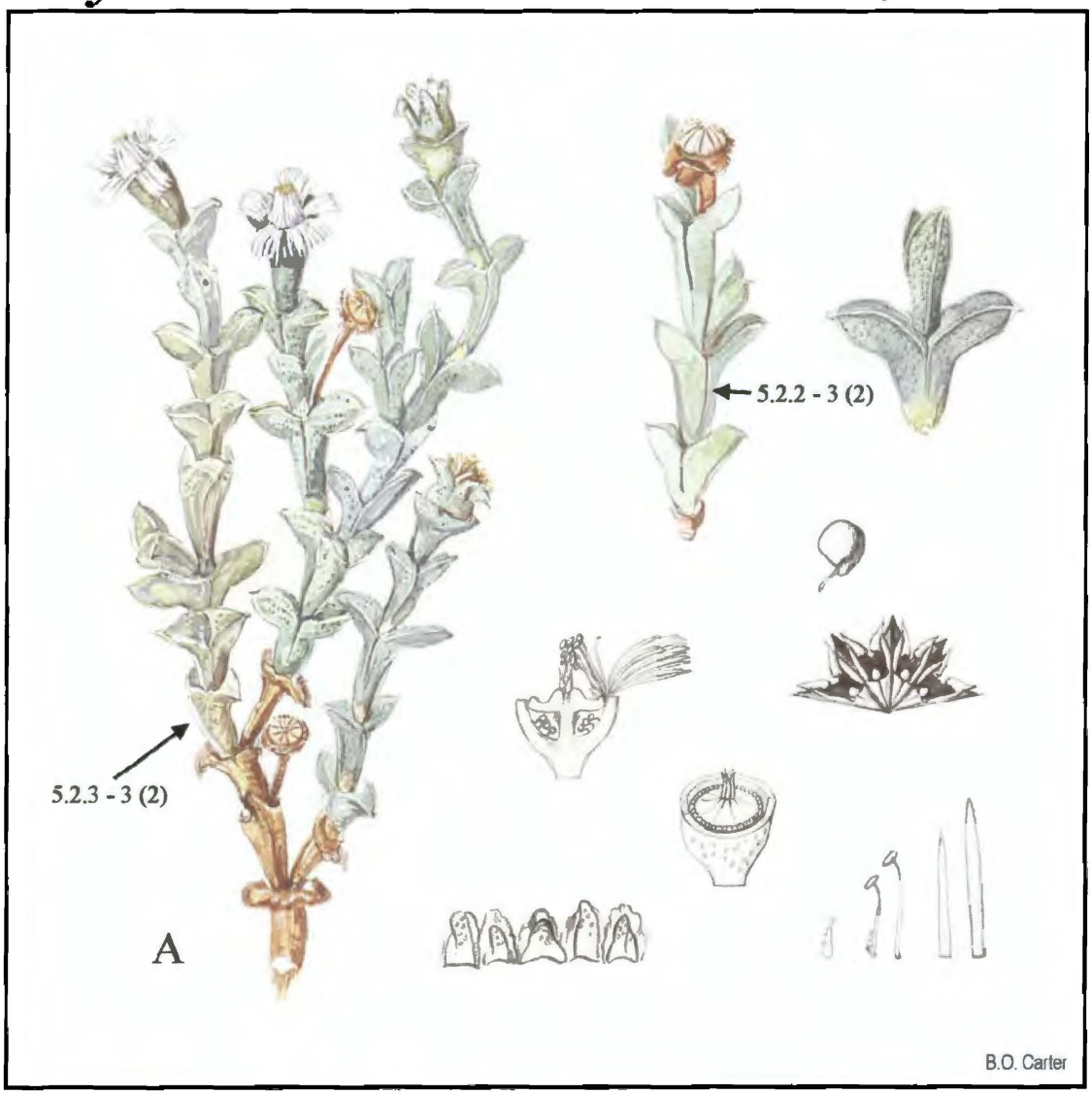


Fig. 6.95

TAXON
A. *P. albiflora*

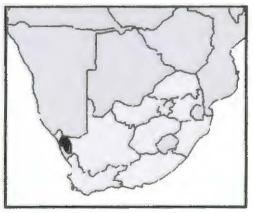
CHARACTERS
5.2.2 - 3 (2): Leaf pairs (degree of fusion) - Partly fused.
5.2.3 - 3 (2): Stem (internodes) - Present, but hidden by highly fused sheathing leaves.

DISTINGUISHING CHARACTERS
Shrubby perennials with leaves fused at their bases, stem-sheathing, diverging at tips; flowers white; fruit 8–18-locular.

Fruit a (8–)10(–18)-locular capsule, with top elevated and white, and base ± funnel-shaped; close to *Ruschia*-type, but with valve wings and rather shallow locules; expanding keels abruptly diverging towards apex, with broad, terminal wings; covering membranes straight, without a rim at top; closing bodies large and white (*P. albiflora*) or smaller and dark (*P. steenbokensis*).

NOTES
2 spp. Northern Namaqualand including Kamiesberg, mostly Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

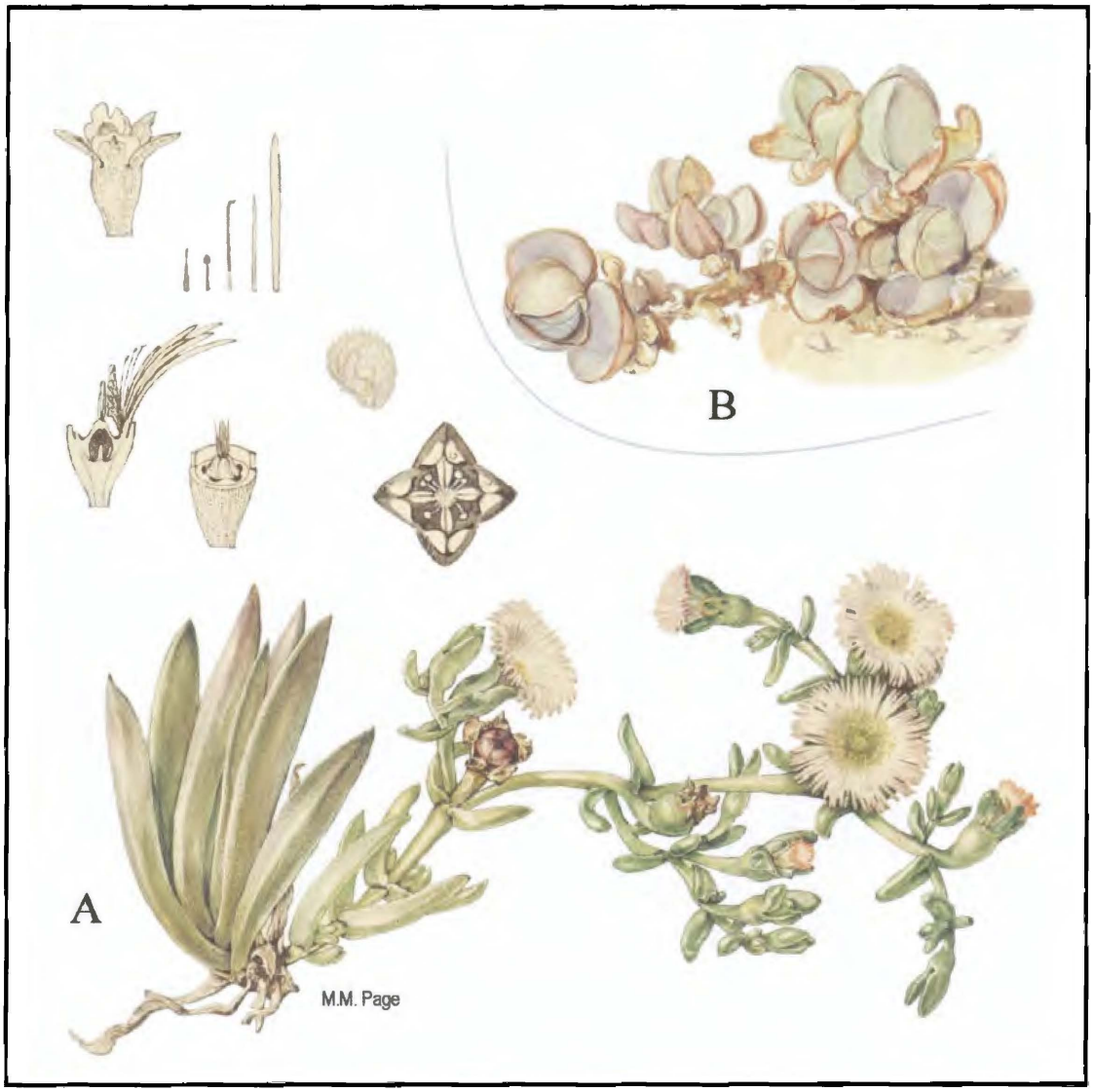


Fig. 6.96

TAXA
A. *P. pallens* subsp. *pallens*
B. *P. sladeniana*

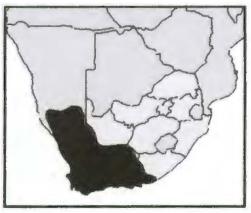
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Soft, smooth, creeping stems (except *P. sladeniana*).

Fruit a 4-locular capsule of *Mesembryanthemum*-type, lower part funnel-shaped with deep locules; expanding keels extending to centre of fruit; covering membranes absent; valve wings present.

NOTES
6 spp. 4 subspp. In Fynbos, Nama-Karoo and Succulent Karoo biomes, and Albany Centre.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

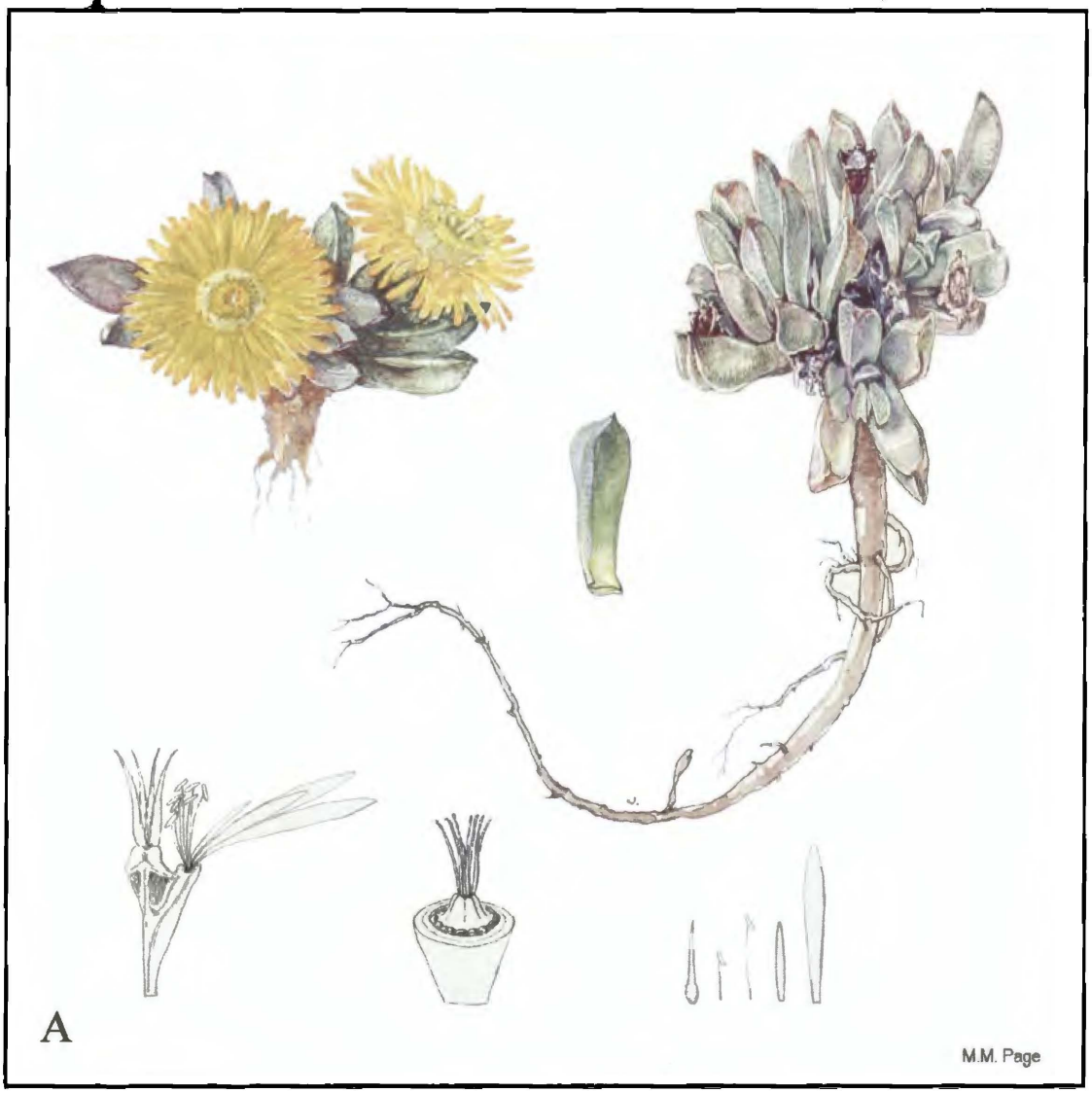


Fig. 6.97

TAXON
A. *P. orpenii*

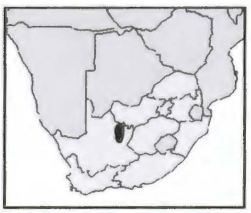
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Compact tufted perennial without swollen rootstock; leaves trigonous and mucronate with pellucid dots; flowers solitary with leaf-like bracts, yellow with whitish or pinkish hues outside; stamens gathered in a cone; opening in the afternoon between 15:00 and 18:00; fruit persistent on long pedicels.

Fruit mostly 7-locular capsules, close to the *Titanopsis*-type, with straight covering membranes, closing bodies absent; valve wings present, narrowing at base and tip.

NOTES
1 sp. The only genus endemic to the Nama-Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

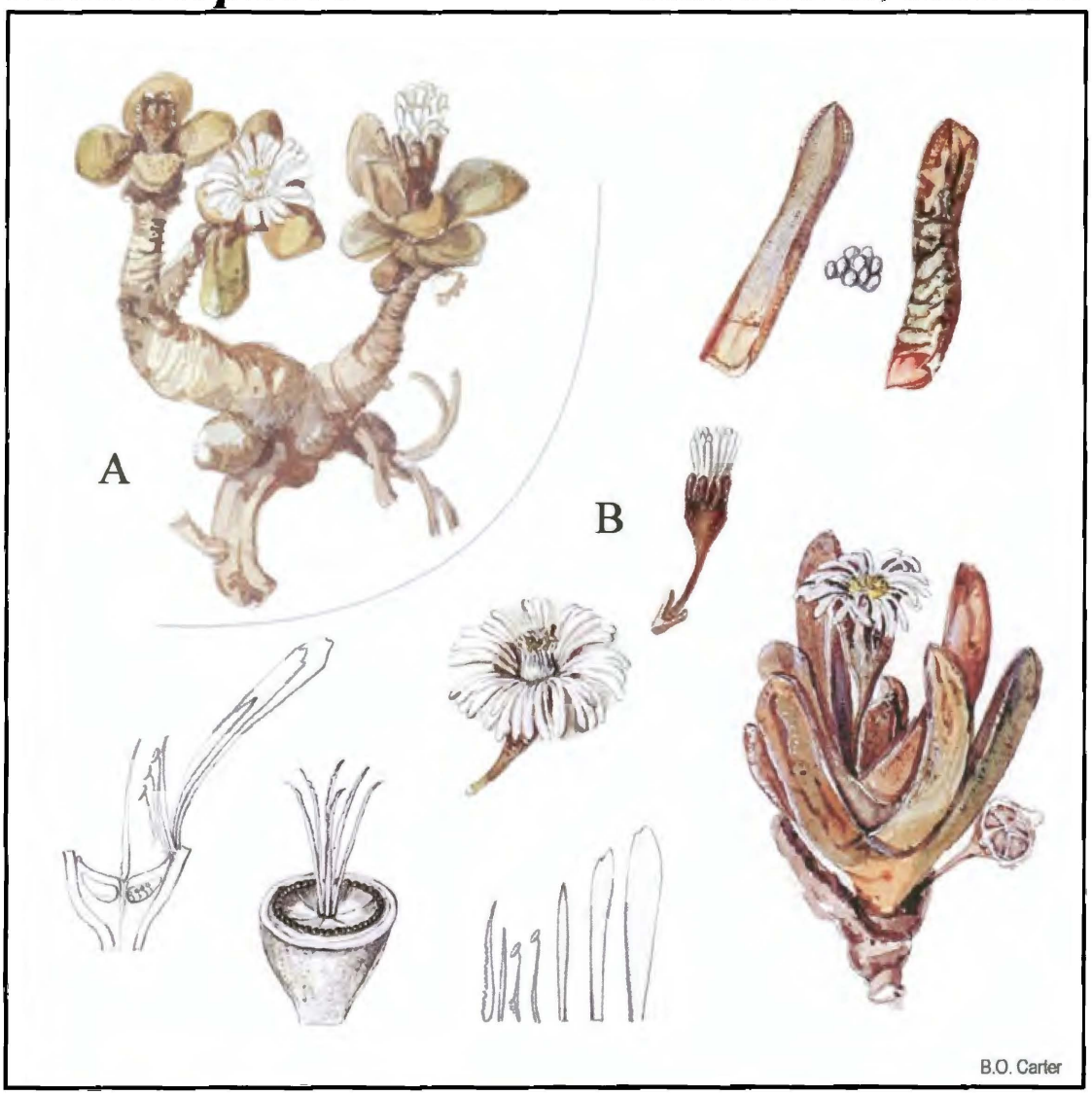


Fig. 6.98

TAXA
A. *P. nissenii*
B. *P. longifolia*

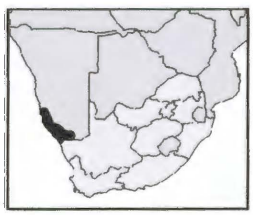
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Tufted or shrubby perennials; leaves with sticky epidermis to which sand adheres.

Fruit a 5- or 6(7)-locular capsule, of *Delosperma*-type; flattish; expanding keels parallel, ending in rather long, rounded, light yellow, crenulate wings, lacerate at apex; covering membranes vestigial; closing bodies absent.

NOTES
4 spp. Endemic to the Gariep Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Psilocaulon *Ruschioideae*

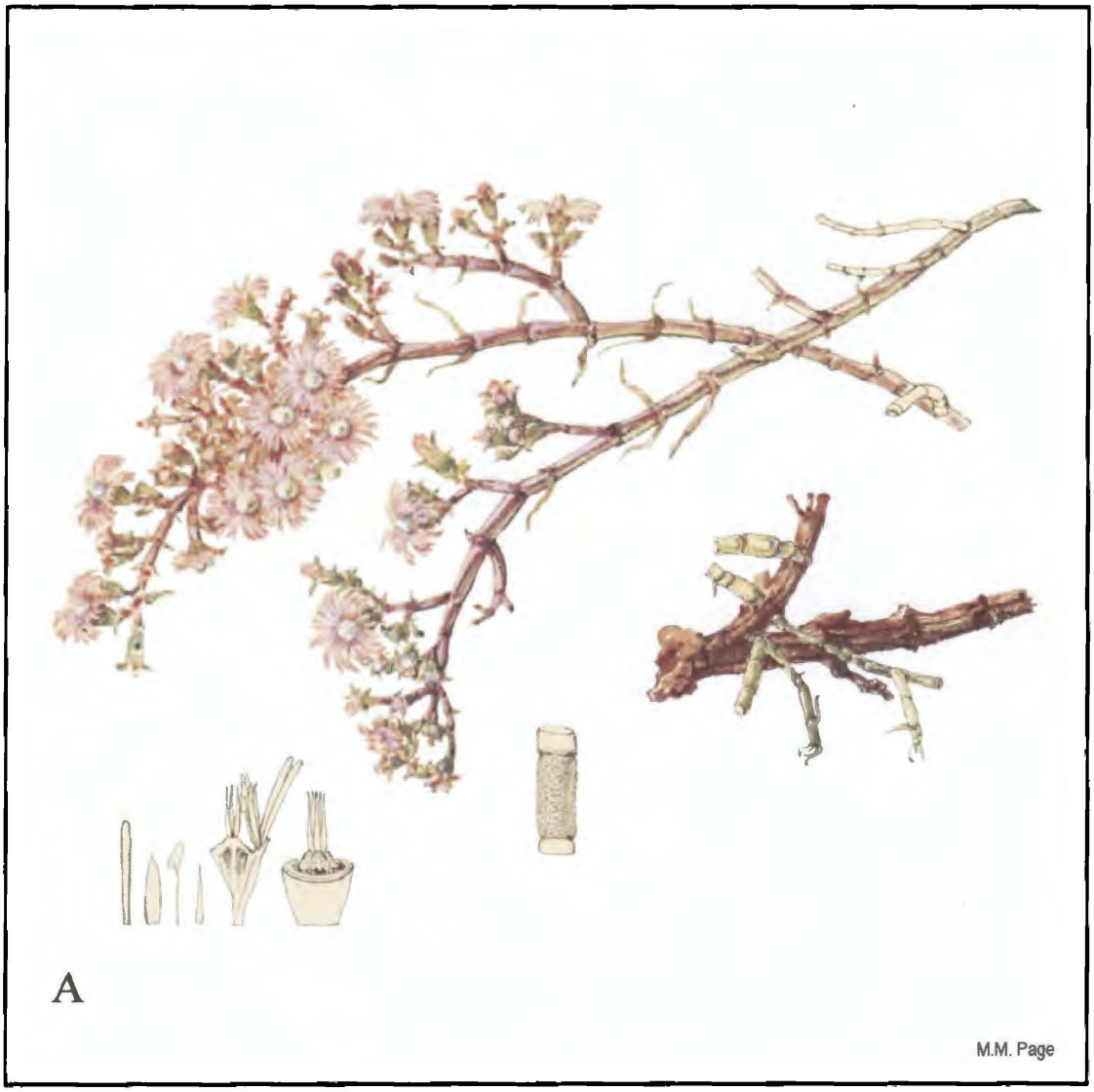


Fig. 6.99

TAXON
A. *P. dinteri*

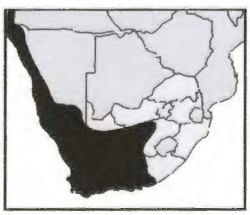
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Stems succulent, smooth or with minute bladder cell idioblasts; flowers with broad filamentous staminodes which are ragged at tips, transparent and gathered into a cone.

Fruit a 4- or 5-locular capsule, of *Mesembryanthemum*-type, expanding keels extending to centre of fruit; valve wings inflexed over valves.

NOTES
14 spp. Mostly in Succulent Karoo Biome, also in Fynbos and Nama-Karoo biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

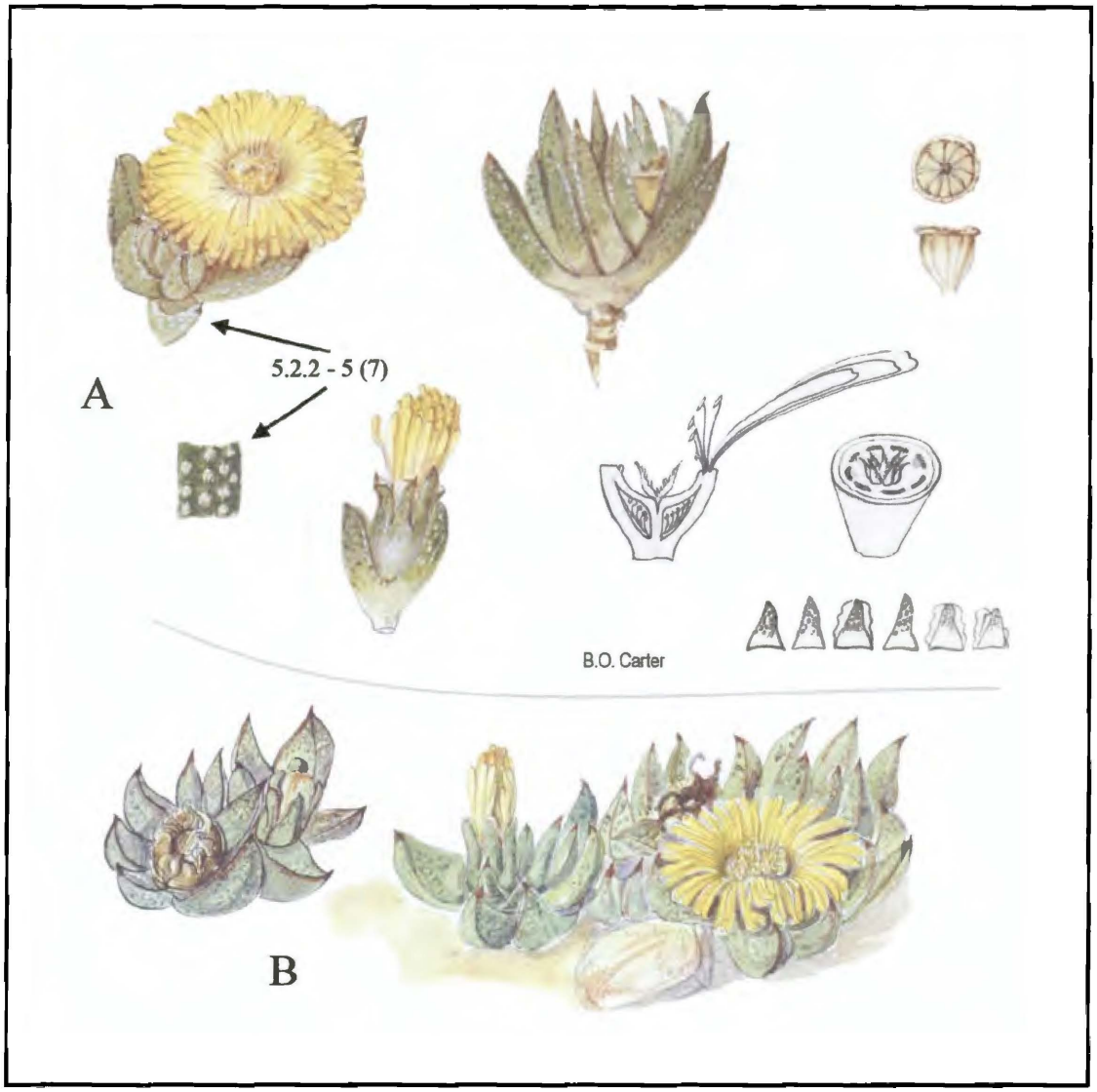


Fig. 6.100

TAXA
A. *R. difformis*
B. *R. albinota*

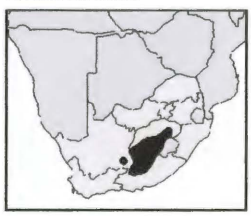
CHARACTERS
5.2.2 - 5 (7): Leaf surface - Pellucid dots (subepidermal tannin idioblasts).

DISTINGUISHING CHARACTERS
Compact perennials, forming rosettes; leaves dotted; flowers yellow.

Fruit a 7–10-locular capsule, close to *Titanopsis*-type but with a rather rounded top and base, also browner and firmer than typical form; valves with wings reaching above halfway up; expanding keels contiguous in basal section, then diverging widely, shortly aristate, almost reaching apex of valve; covering membranes present; closing bodies absent.

NOTES
6 spp. Present in Grassland and Albany Centre.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

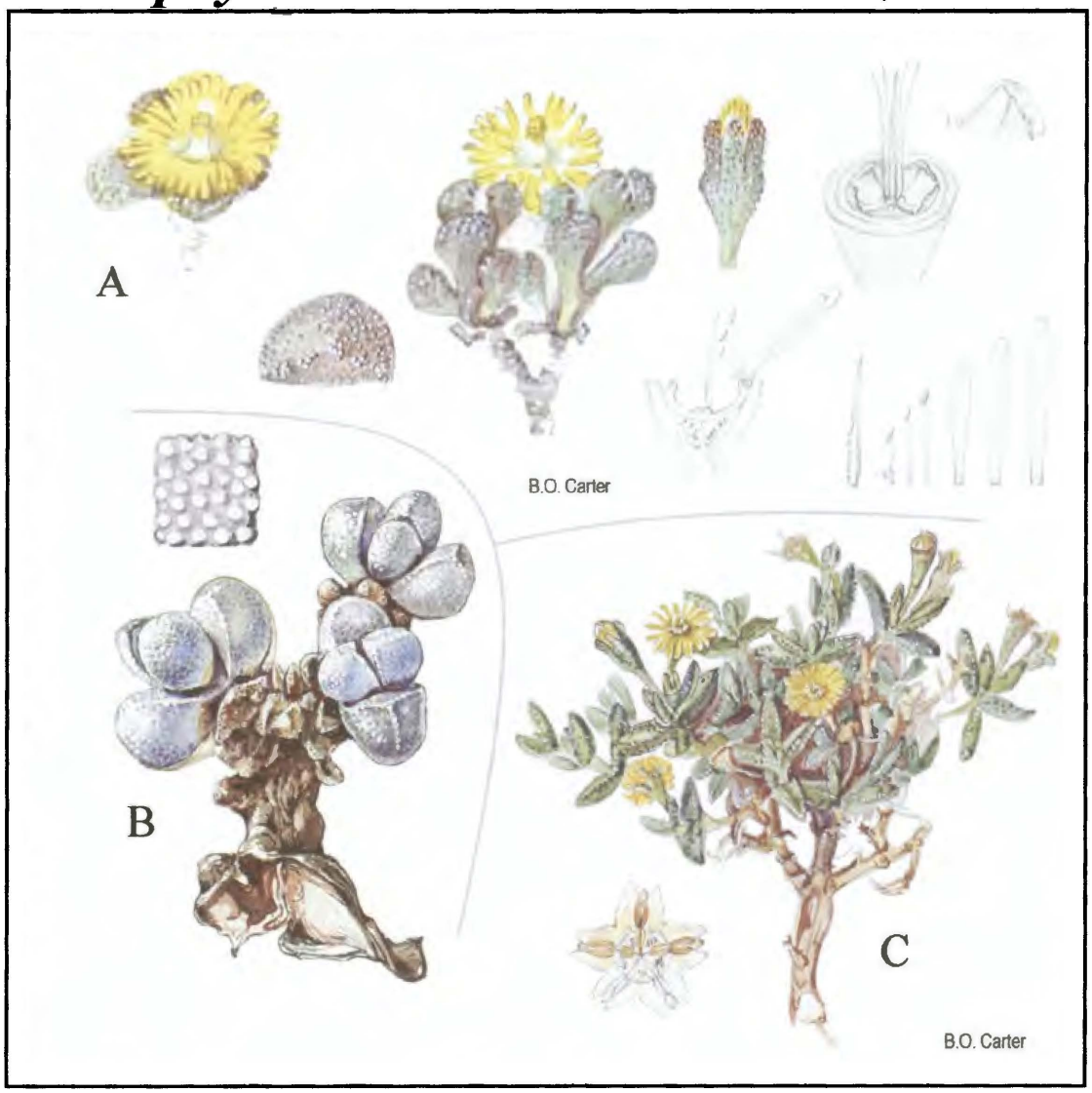


Fig. 6.101

TAXA
A. *R. broomii*
B. *R. comptonii*
C. *R. luteum*

CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Dwarf succulents, often with textured leaves; flowers white to yellow; pedicels ebracteate.

Fruit a 5-locular capsule, small, with sutures slightly raised and gaping; valves deltoid, reflexed when expanded; of *Delosperma*-type but with diverging expanding keels and marginal valve wings; covering membranes often absent or much reduced; closing bodies absent.

NOTES
10 spp. Present in Succulent Karoo and Nama-Karoo biomes, and Albany Centre.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

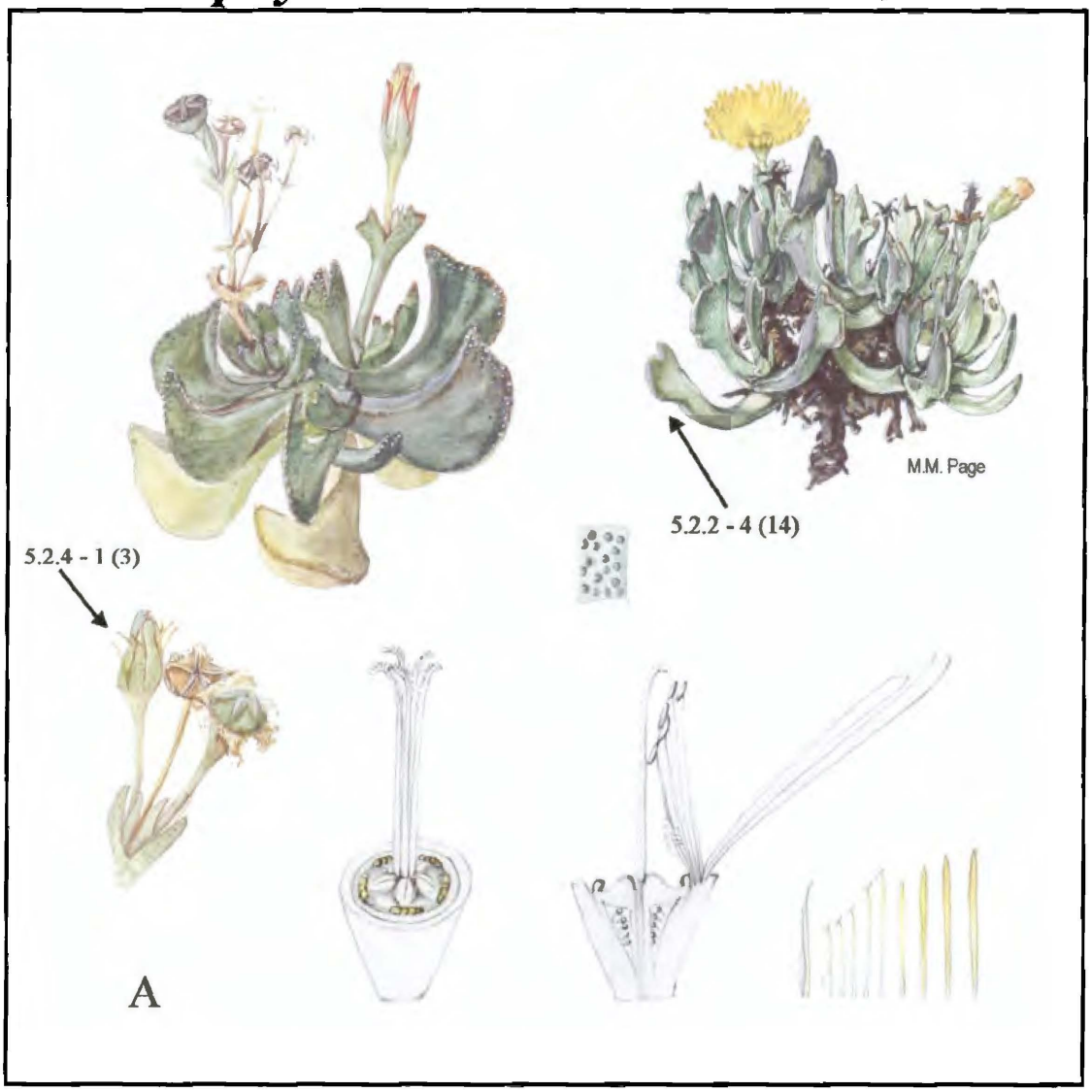


Fig. 6.102

TAXON
A. *R. dolabriforme*

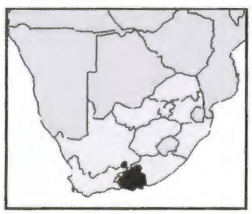
CHARACTERS
5.2.2 - 4 (14): Leaf shape - Rhomboid.
5.2.4 - 1 (3): Inflorescence characteristics - Cymose, mostly in threes.

DISTINGUISHING CHARACTERS
Tufted perennials; leaves sickle- or boat-shaped.

Fruit a 5-locular capsule, valves with high rims; close to *Mitrophyllum*-type but with bipartite, flat, large closing bodies; locules deep; covering membranes complete with closing ledges at distal lower surfaces; expanding keels mostly basally separate; valve wings very narrow.

NOTES
5 spp. Endemic to Albany Centre.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

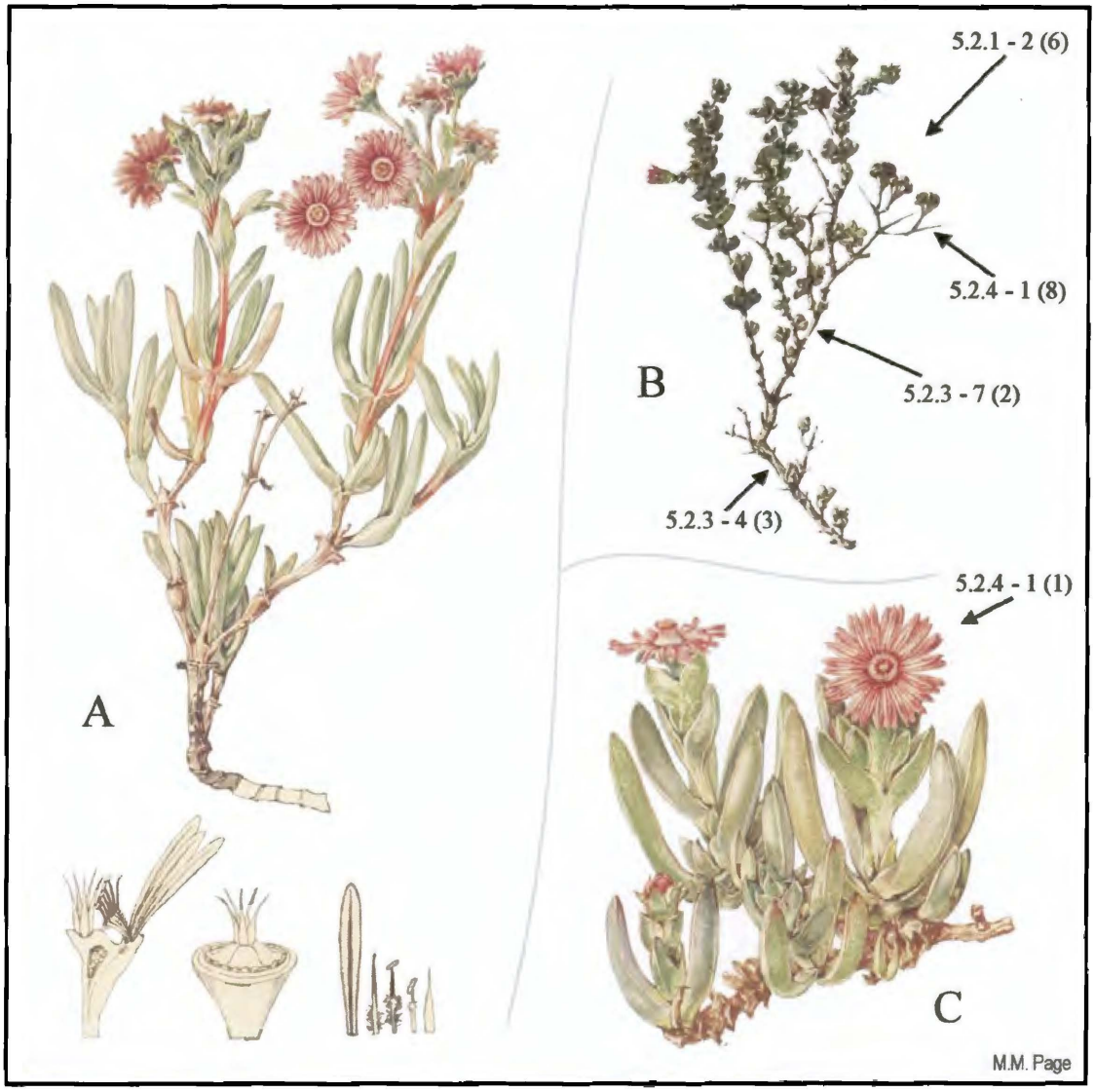


Fig. 6.103

TAXA
A. *R. caroli*
B. *R. cradockensis* subsp. *triticiformis*
C. *R. schollii*

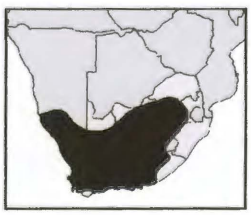
DISTINGUISHING CHARACTERS
Mostly shrubby, sometimes creeping perennials; fruit with small hook-shaped closing bodies, short tangentially arranged expanding keels.

Fruit a 5(6)-locular capsule, of *Ruschia*-type; with a deep base and no valve wings; valves opening into upright position; closing bodies small, hook- hood- or rodlet-shaped, rarely larger and sometimes absent; expanding keels short, widely diverging; additional closing rodlets at distal lower surfaces of covering membranes.

CHARACTERS
5.2.1 - 2 (6): Overall appearance - Spiny succulent-leaved shrub or subshrub.
5.2.3 - 4 (3): Stem consistency - Woody.
5.2.3 - 7 (2): Stem colour at maturity - Brown.
5.2.4 - 1 (1): Inflorescence characteristics - Cymose, mostly solitary.

NOTES
216 spp. 2subspp. A widespread and diverse genus that may need further subdivision.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

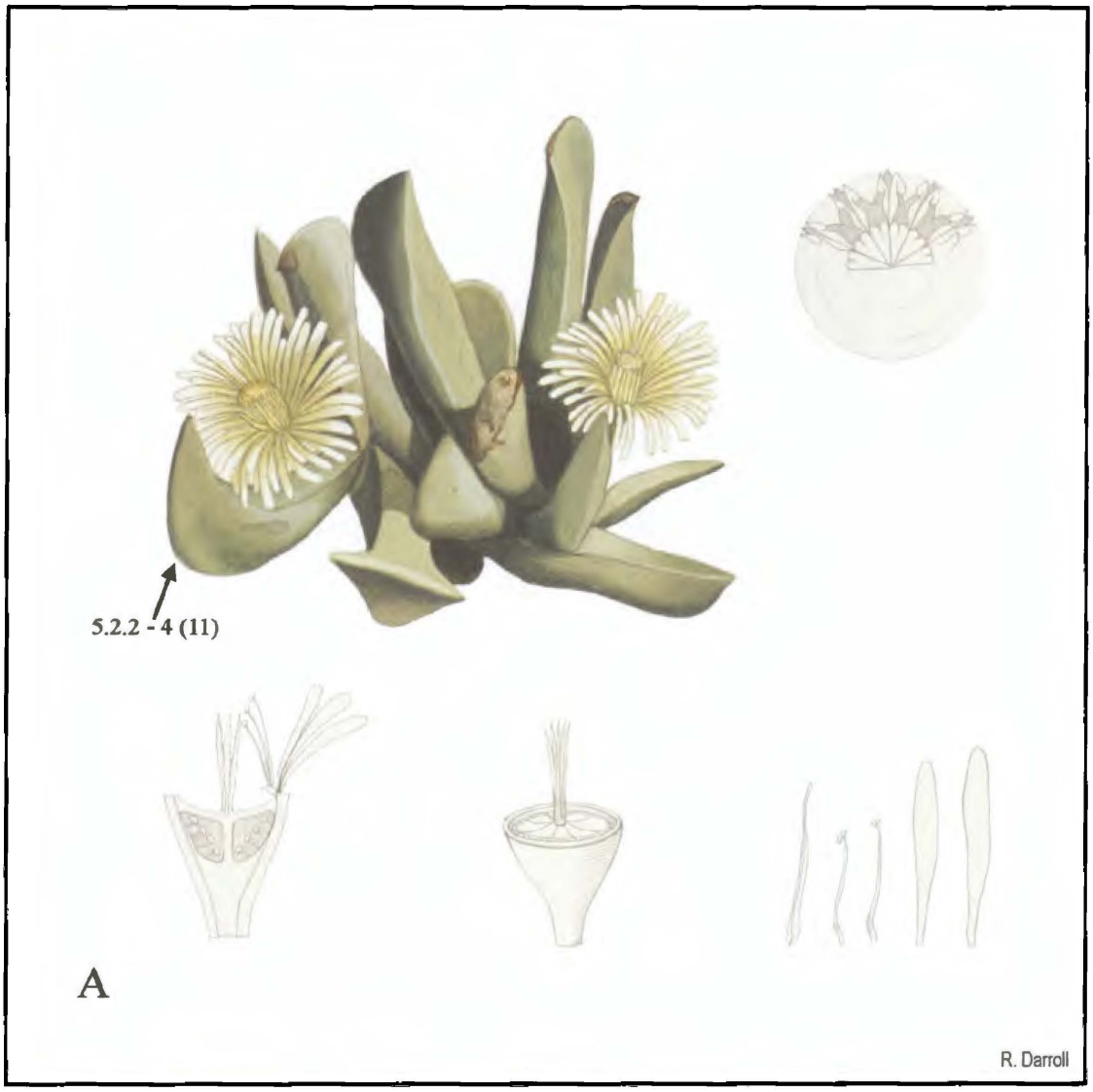


Fig. 6.104

TAXON
A. *R. falcatus*

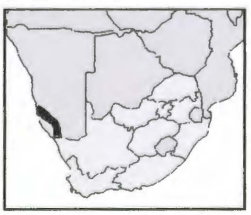
CHARACTERS
5.2.2 - 4 (11): Leaf shape - Falcate or lunate.

DISTINGUISHING CHARACTERS
Compact perennials with sickle-shaped, smooth leaves; flowers with hypanthium; petals greenish white.

Fruit a capsule of *Delosperma*-type; with a slightly raised basal placenta; with narrow valve wings; covering membranes absent; closing bodies absent; stalk elongates as fruit ripens.

NOTES
1 sp. In Richtersveld and southern Namibia, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

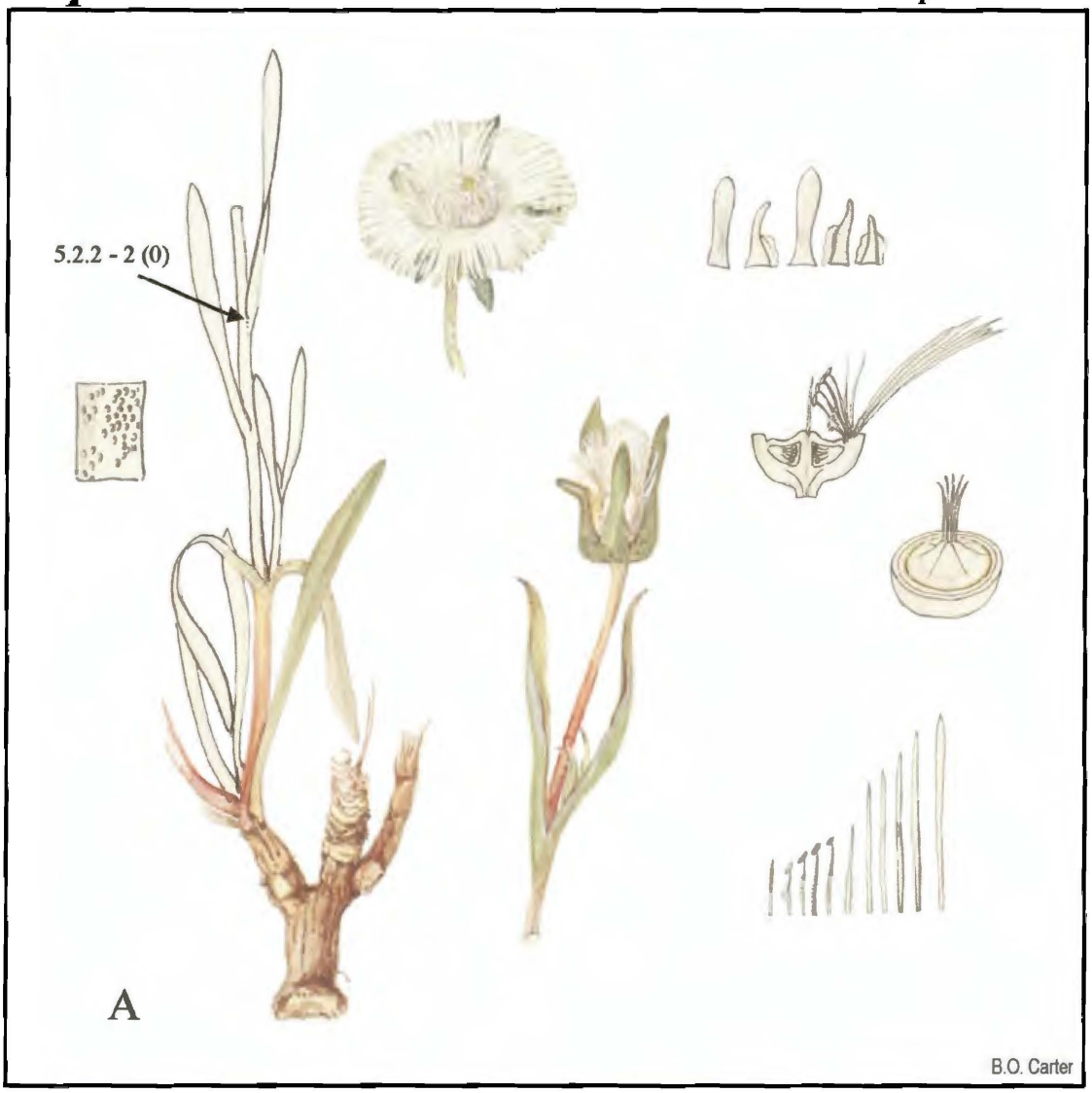


Fig. 6.105

TAXON
A. *S. flaccida*

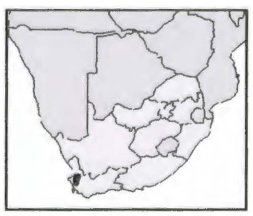
CHARACTERS
5.2.2 - 2 (0): Leaf arrangement - Leaves alternate.

DISTINGUISHING CHARACTERS
Perennial herbs with tubers; leaves alternate, flat; flowers white; seeds dimorphic.

Fruit a 5-locular capsule; opening apically when drying (xerochastic); floor of capsule distally widened to form a covered ring of semipockets.

NOTES
1 sp. Confined to Fynbos Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Sarcozona *Ruschioideae; Ruschieae*



Fig. 6.106

TAXON

CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Perennial succulent with visible internodes; branches erect, lower ones prostrate, seldom rooting at nodes; leaves acutely triquetrous, pellucid-dotted, edges and keel verrucose or denticulate, connate bases persist on branches, uppermost leaves partly enclosing flower; flowers solitary, sessile, magenta to white, filaments white; sepals persistent, 4 or 5.

Fruit a 4- or 5-locular indehiscent berry containing numerous seed in a sticky mucelage and topped by persistent sepals.

NOTES
2 spp. The suggested close relationship between *Sarcozona* and *Carpobrotus* is not supported here.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

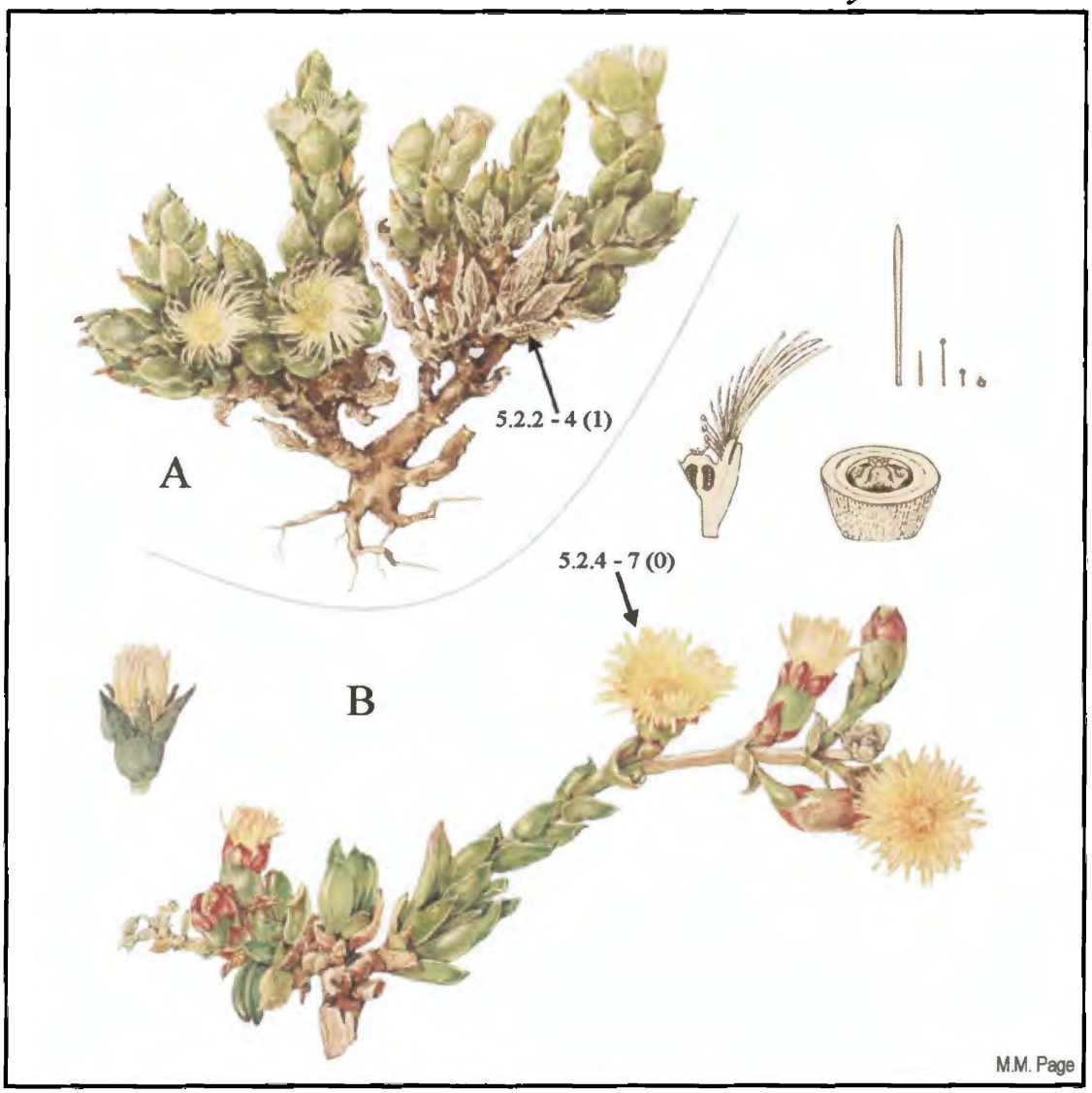


Fig. 6.107

TAXA
A. *Sceletium* sp.
B. *S. crassicaule*

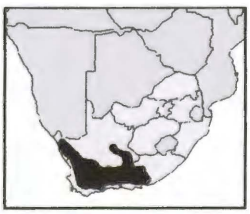
CHARACTERS
5.2.2 - 4 (1): Leaf shape - Flattish, withering to skeleton.
5.2.4 - 7 (0): Flower colour - Cream, yellowish.

DISTINGUISHING CHARACTERS
Persistent dry leaves which become skeletonized with only veins remaining.

Fruit a 4- or 5(6)-locular capsule, of *Mesembryanthemum*-type; expanding keels extending to centre of fruit; valve wings present or absent; breaking off readily to be dispersed by wind as tumble fruit.

NOTES
8 spp. Widespread, mostly in Fynbos and Succulent

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

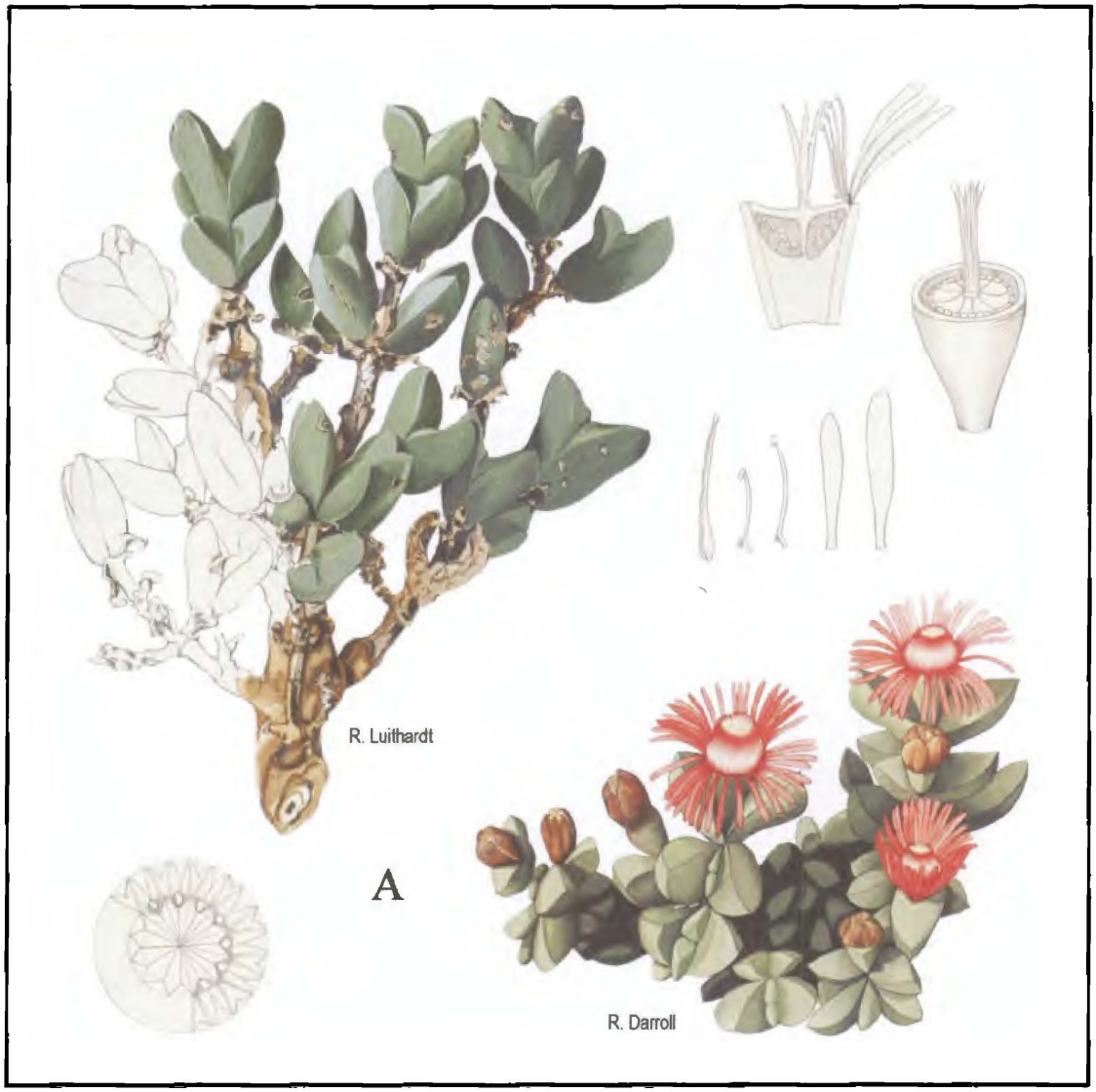


Fig. 6.108

TAXON
A. *S. maximiliani*

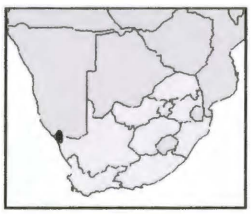
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Compact perennials, with grey-green short leaves; flowers white or pink to purple, with staminodes collected in a cone.

Fruit a 10–12-locular capsule close to *Leipoldtia*-type but with a variable and sometimes complete recurving of covering membranes, with spur-like processes which nearly close opening; expanding keels parallel, diverging towards acute apex; closing bodies present.

NOTES
2 spp. Confined to the Gariep Centre, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

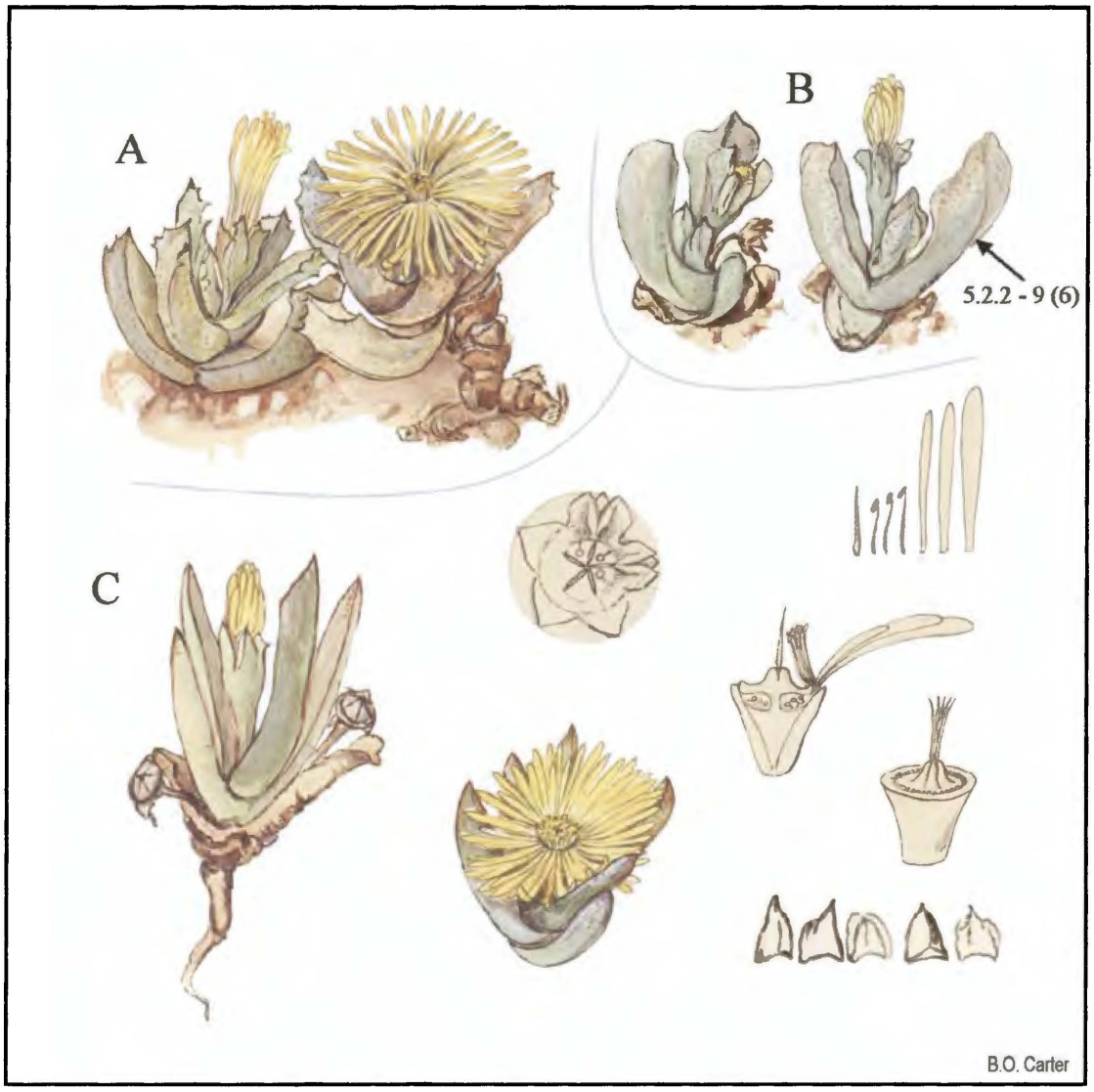


Fig. 6.109

TAXA
A. *S. ruedebuschii*
B. *S. borcherdsii*
C. *S. pillansii*

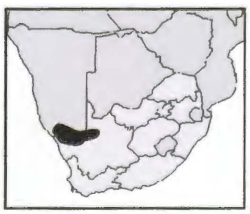
CHARACTERS
5.2.2 - 9 (6): Leaf margins and keel - Keel oblique or twisted.

DISTINGUISHING CHARACTERS
Compact perennials with internodes enclosed by leaves which are asymmetric, toothed, erect, sometimes whitish.

Fruit a 5-locular capsule of *Delosperma*-type; covering membranes vestigial, as narrow ledges spreading from septa, with weak, central column; expanding keels parallel but not touching, yellowish, broadening towards tips; valve wings broad; closing bodies absent.

NOTES
11 spp. Confined mainly to Gariep Centre; Succulent Karoo, with slight extensions into Nama-Karoo

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

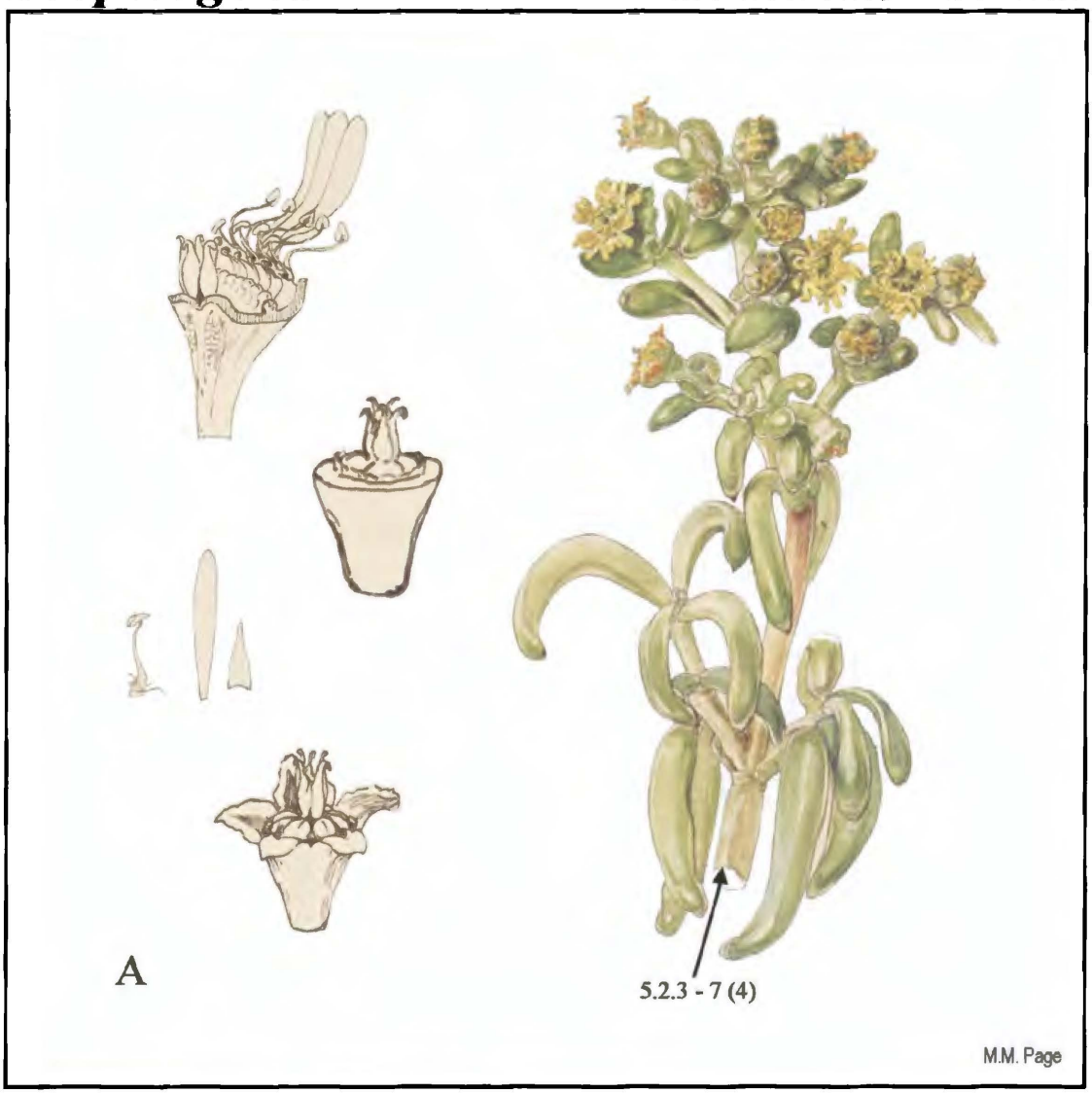


Fig. 6.110

TAXON
A. *S. verruculata*

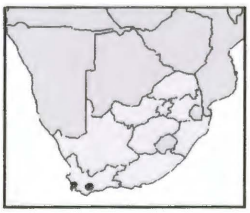
CHARACTERS
5.2.3 - 7 (4): Stem colour at maturity - Bluish green.

DISTINGUISHING CHARACTERS
Shrubs with smooth, cylindrical leaves; flowers yellow.

Fruit a 5-locular capsule, probably close to *Drosanthemum*-type, woody, top convex; valves once opened do not close again; valve wings absent; expanding keels diverging from base; covering membranes short; closing bodies absent.

NOTES
2 spp. Confined to Fynbos Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

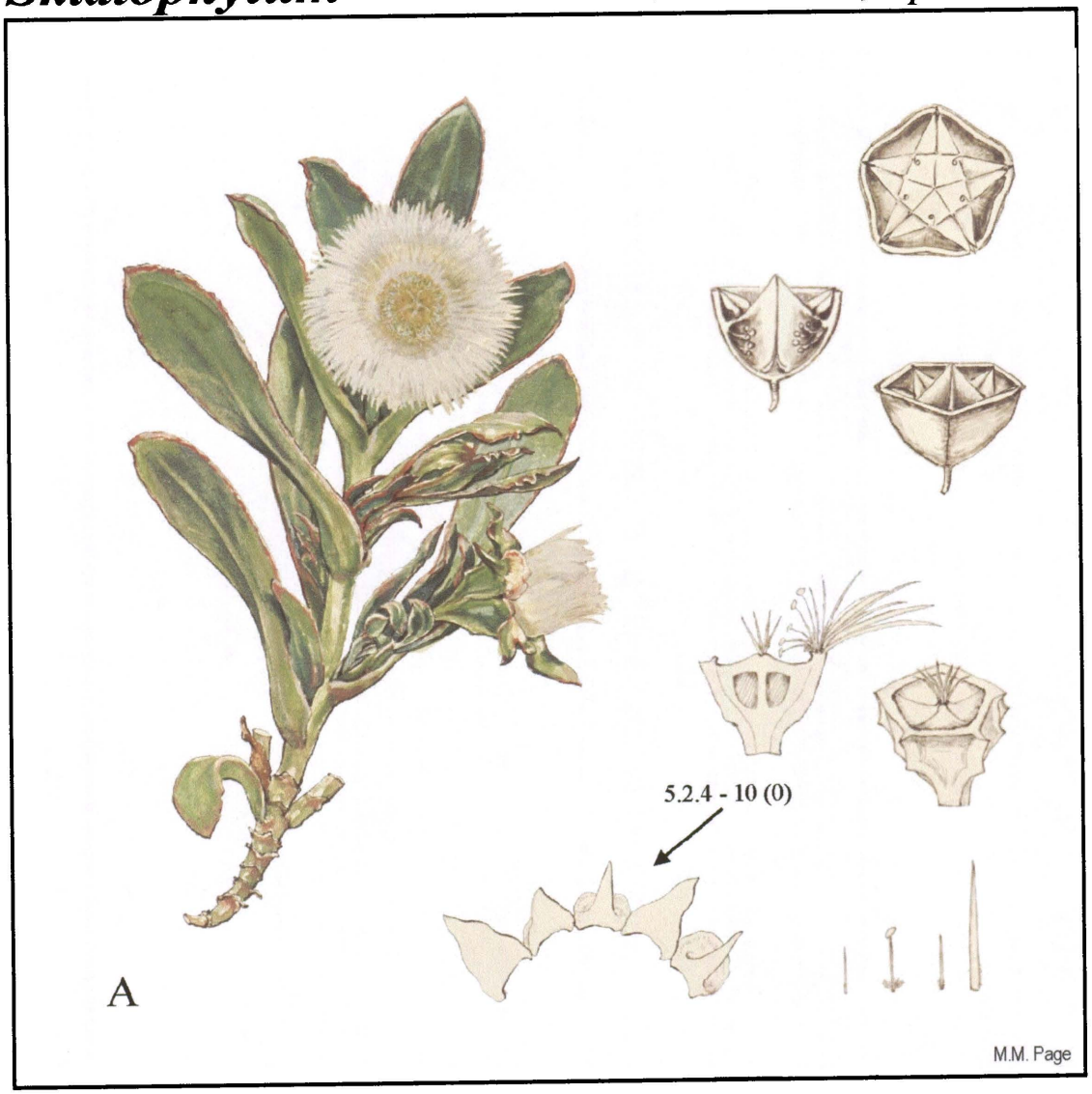


Fig. 6.111

TAXON
A. *S. tripolium*

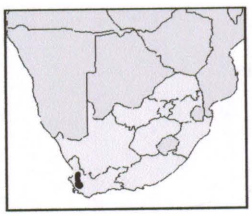
CHARACTERS
5.2.4 - 10 (0): Relative length of sepals - Unequal in length.

DISTINGUISHING CHARACTERS
Annuals or perennials with flat, alternate leaves which have undulated margins when young and may appear opposite; flowers white.

Fruit a (4)5–7-locular capsule, large, obconic; valves without expanding keels or marginal wings, with upper distal seed chambers; valves open on drying (xerochastically) and remain open.

NOTES
1 sp. Confined to Fynbos Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

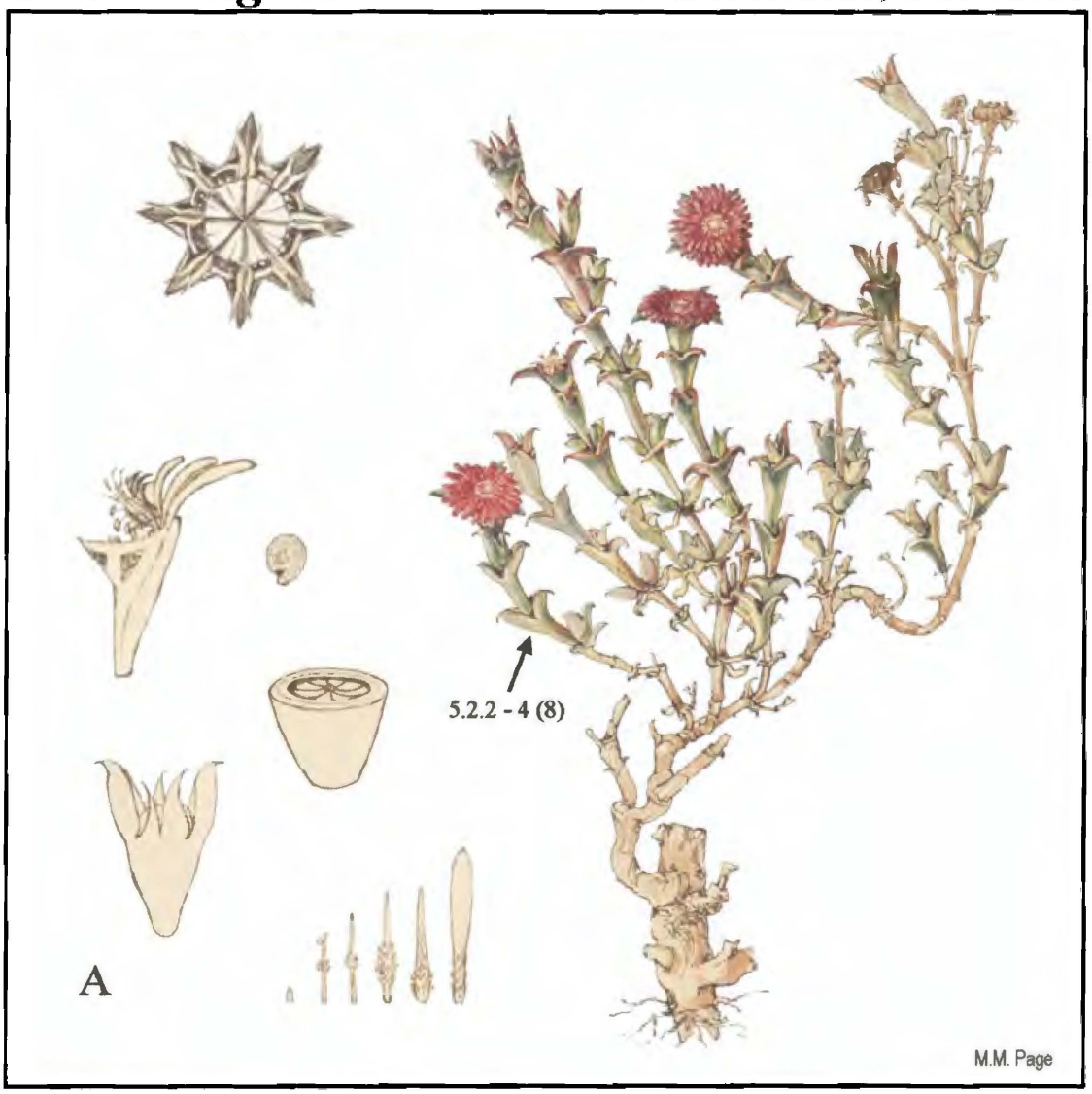


Fig. 6.112

TAXA
A. *S. viride*

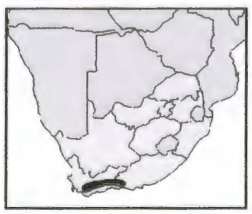
CHARACTERS
5.2.2 - 4 (8): Leaf shape - Fused and stem-sheathing at base, diverging at tips, highly succulent.

DISTINGUISHING CHARACTERS
Shrubs with stem-sheathing, partially fused leaf pairs.

Fruit a 7–10-locular, woody capsule, of *Lampranthus*-type but valves with very narrow wings; expanding keels parallel at base, with diverging awned tips; covering membranes stout; closing bodies absent.

NOTES
1 sp. Confined to Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

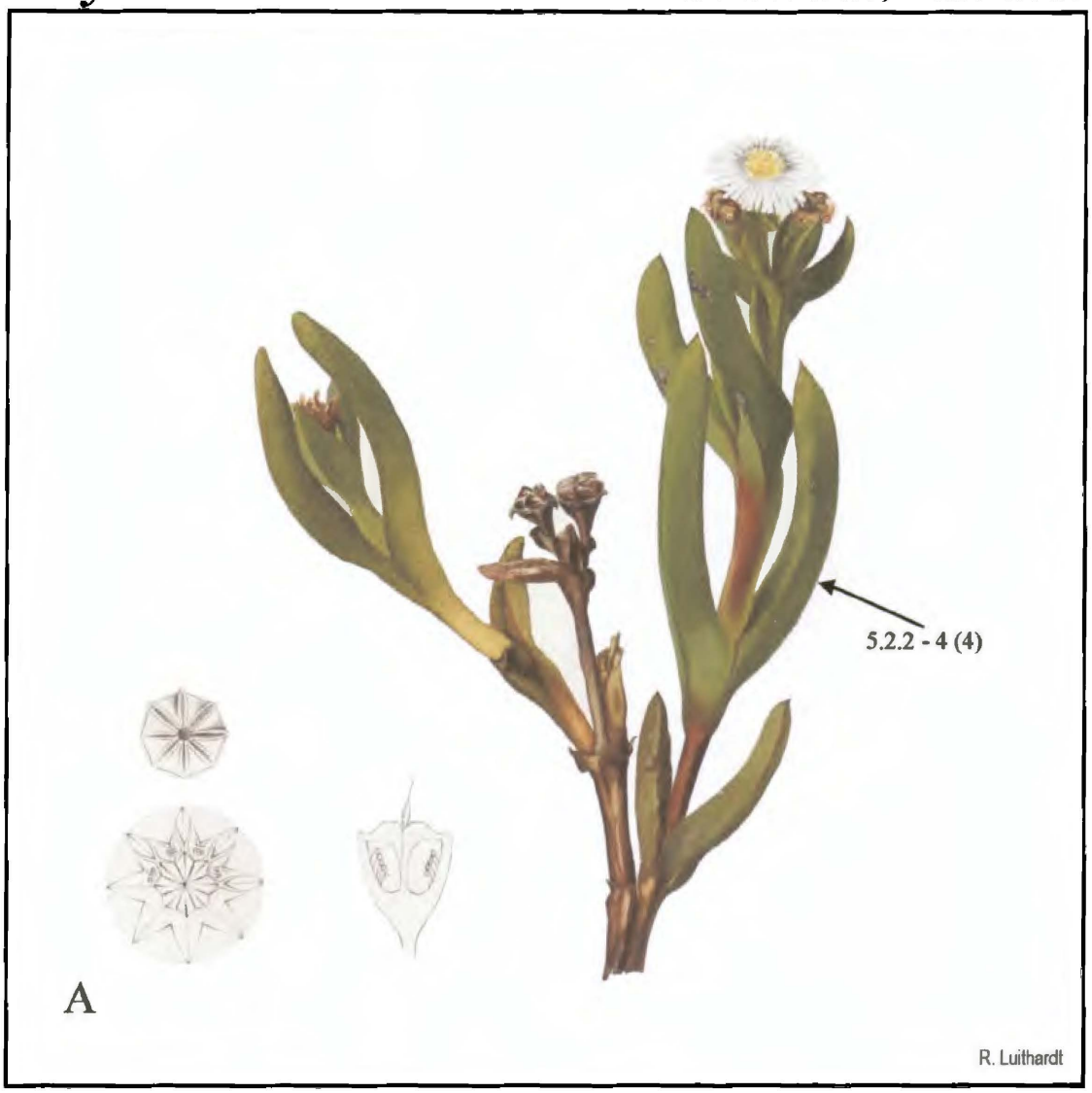


Fig. 6.113

TAXON
A. *S. neilii*

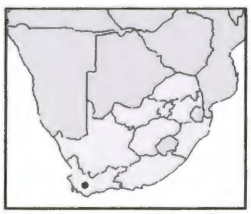
CHARACTERS
5.2.2 - 4 (4): Leaf shape - Trigonous or triquetrous.

DISTINGUISHING CHARACTERS
Erect and woody shrubs with long internodes and stem-sheathing cylindrical leaves with a ridged bottom edge; flowers pink or white with stamens and staminodes collected in a cone; fruit 6–9-locular; once open, remaining so.

Fruit a (6)7- or 8(9)-locular capsule, obconic-globose; close to *Ruschia*-type, but valves connate at base, therefore opening only partially and remaining open; expanding keels contiguous at base, widely diverging, without wings; covering membranes well developed; closing bodies absent.

NOTES
1 sp. Narrow endemic in Succulent Karoo.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

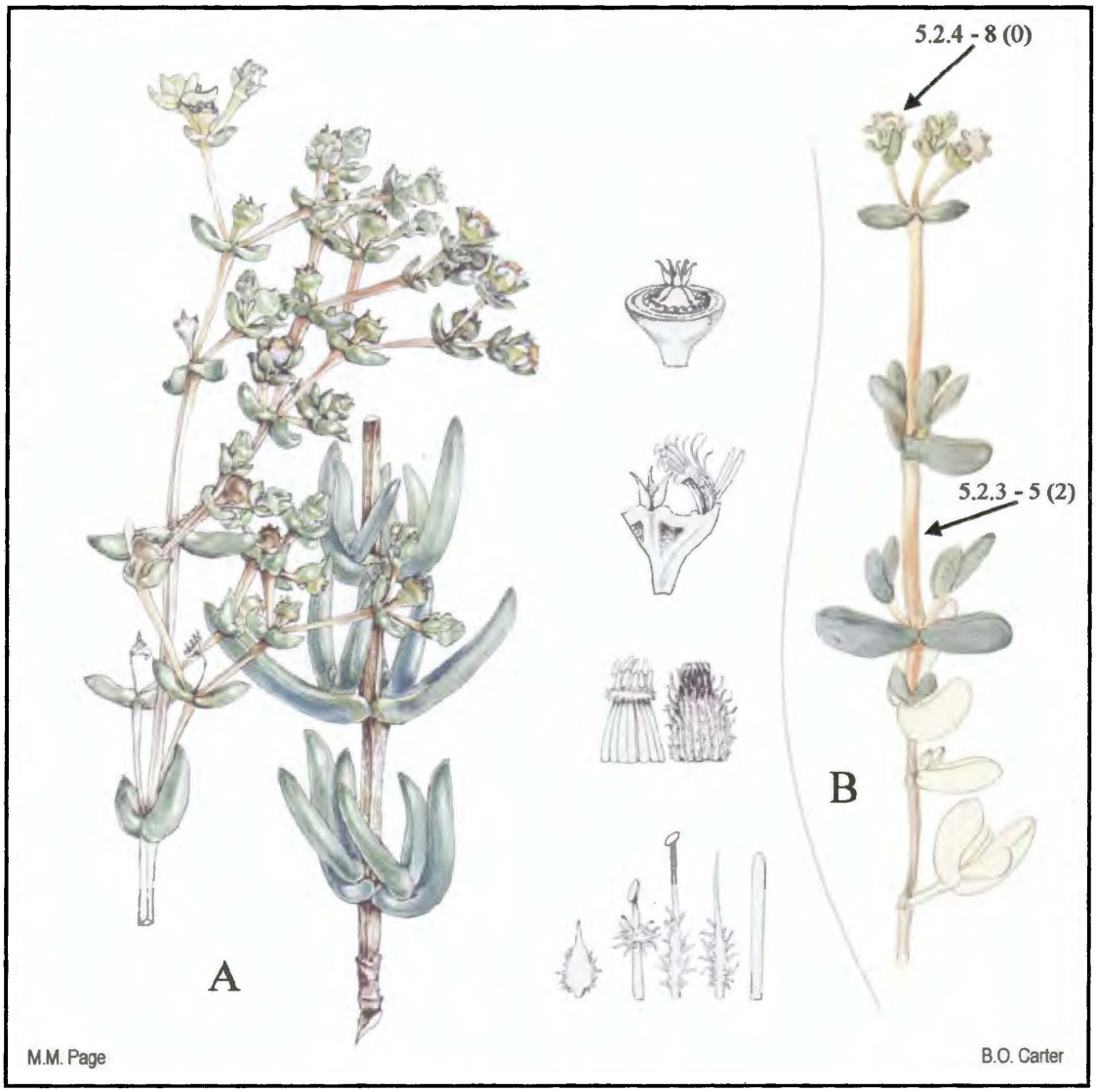


Fig. 6.114

TAXA
A. *S. frutescens*
B. *S. gigas*

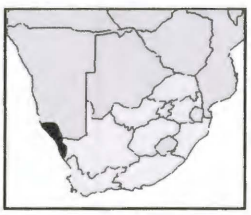
CHARACTERS
5.2.3 - 5 (2): Stem shape - Cylindrical.
5.2.4 - 8 (0): Flower size - Small (<20 mm).

DISTINGUISHING CHARACTERS
shrublets or large bushes; fruit with hard valve wings, and recurved valve rims, not closing completely once they have opened.

Fruit a 5(6)-locular capsule, nearest *Ruschia*-type, top-shaped, upper part domed; valve margins slightly raised in most species; locules deep and wide; valves opening once; valve wings broad, sclerotinised; closing bodies absent or present. In *S. gigas*, a capsular schizocarp, breaking into nutlets each enclosing one seed, persistent dorsal and apical connecting bundles forming a fibrous, basket-like skeleton remaining on plant.

NOTES
6 spp. Confined to Succulent Karoo Biome, South Africa and Namibia.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

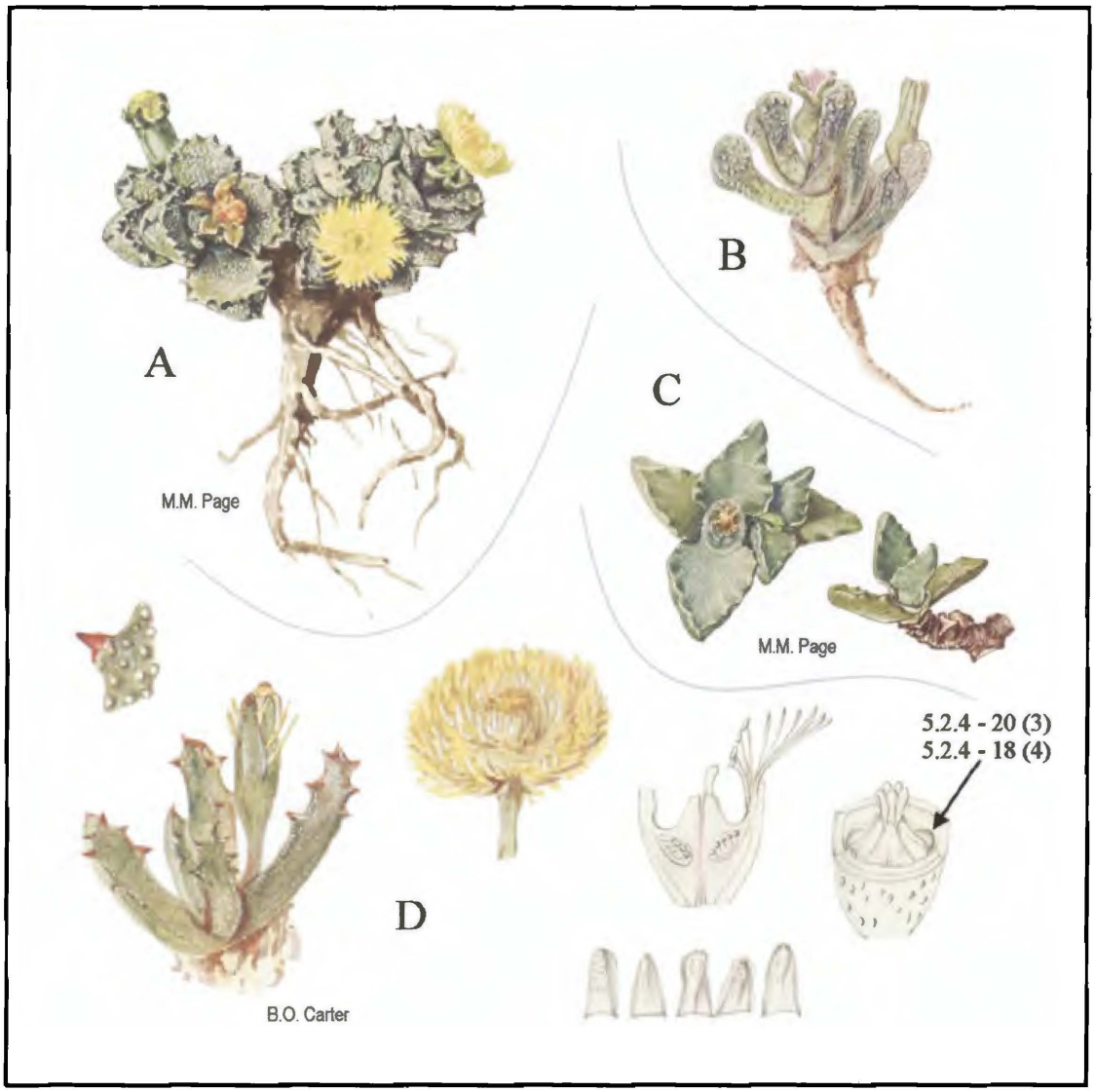


Fig. 6.115

TAXA
A. *S. difforme*
B. *S. alboroseum*
C. *S. agninum*
D. *S. murinum*

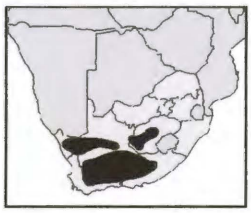
DISTINGUISHING CHARACTERS
Small perennial clumps; leaves with many marginal short teeth; leaf surfaces highly textured.

Fruit a 5(6)-locular capsule, of *Delosperma*-type; with very narrow rims along septa and with seed pockets derived from basal false septa; locules deep; expanding keels parallel, thick, yellowish, diverging at tips; valve wings narrow or broad; covering membranes vestigial; closing bodies absent.

CHARACTERS
5.2.4 - 18 (4): Floral nectaries - Specialized nectary of the *Stomatium*-type.
5.2.4 - 20 (3): Shape of nectary surface - Smooth nectariferous tissue, raised as droplet-like structures on inner walls of shallow hypanthium.

NOTES
39 spp. Broad distribution in Nama Karoo, Succulent Karoo and Grassland biomes, also present in Albany Centre.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

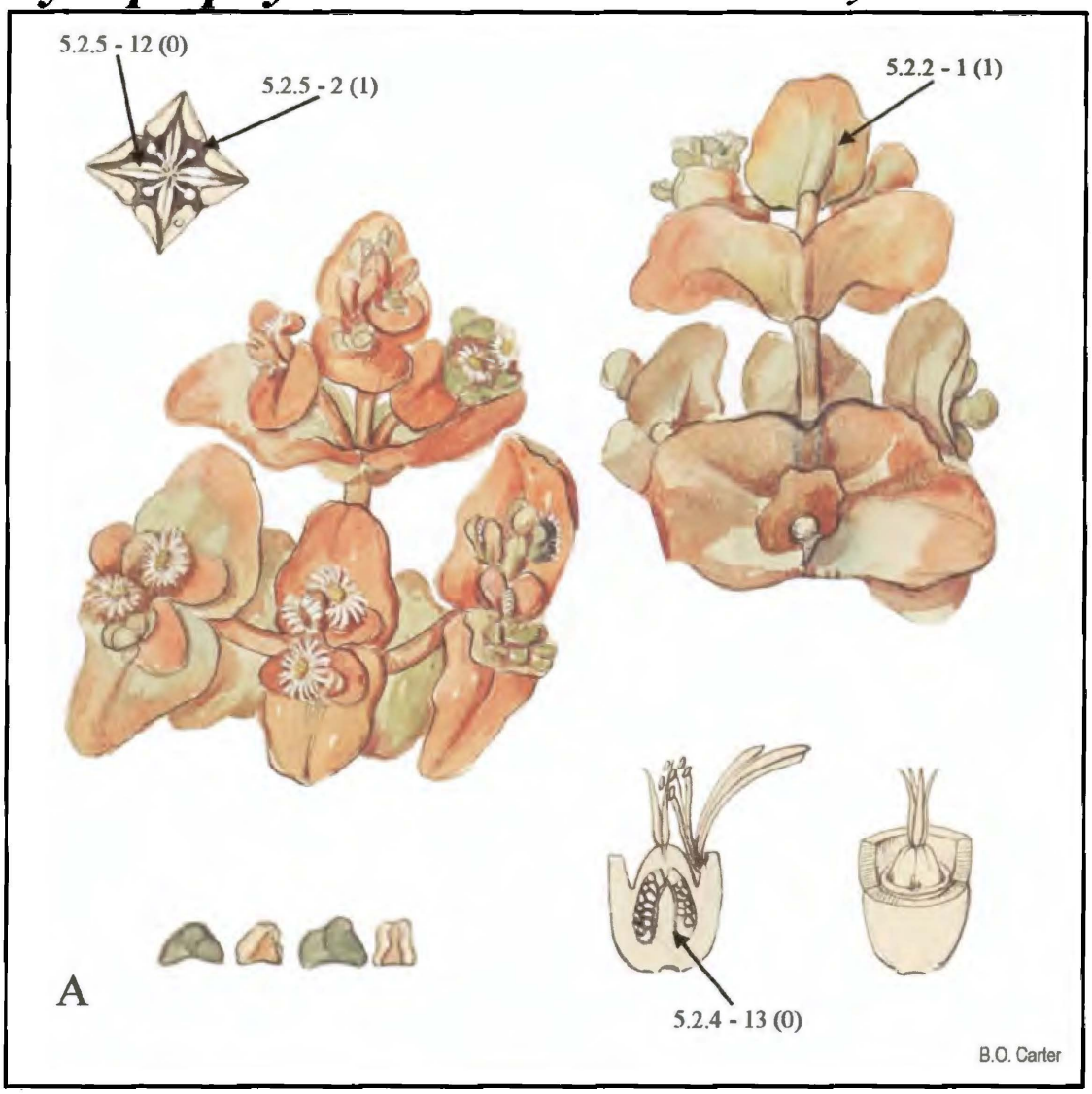


Fig. 6.116

TAXON
A. *S. juttae*

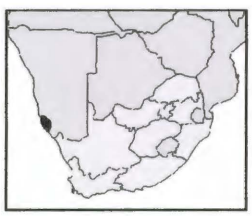
DISTINGUISHING CHARACTERS
Paired leaves flat, roundish, stem-clasping; size and shape differences between basal and upper leaves.

Fruit a 4-locular capsule, of *Mesembryanthemum*-type; expanding keels extend to centre of fruit; covering membranes absent; valves with large, erect, incurved wings.

CHARACTERS
5.2.2 - 1 (1): Attachment of leaves to stem - Stem clasping.
5.2.4 - 13 (0): Pacentation - Axile.
5.2.5 - 2 (1): Number of locules - 4.
5.2.5 - 12 (0): Expanding keels - Radial, from central axis of fruit to valves.

NOTES
1 sp. Confined to Gariep Centre, Succulent Karoo Biome, southern Namibia.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

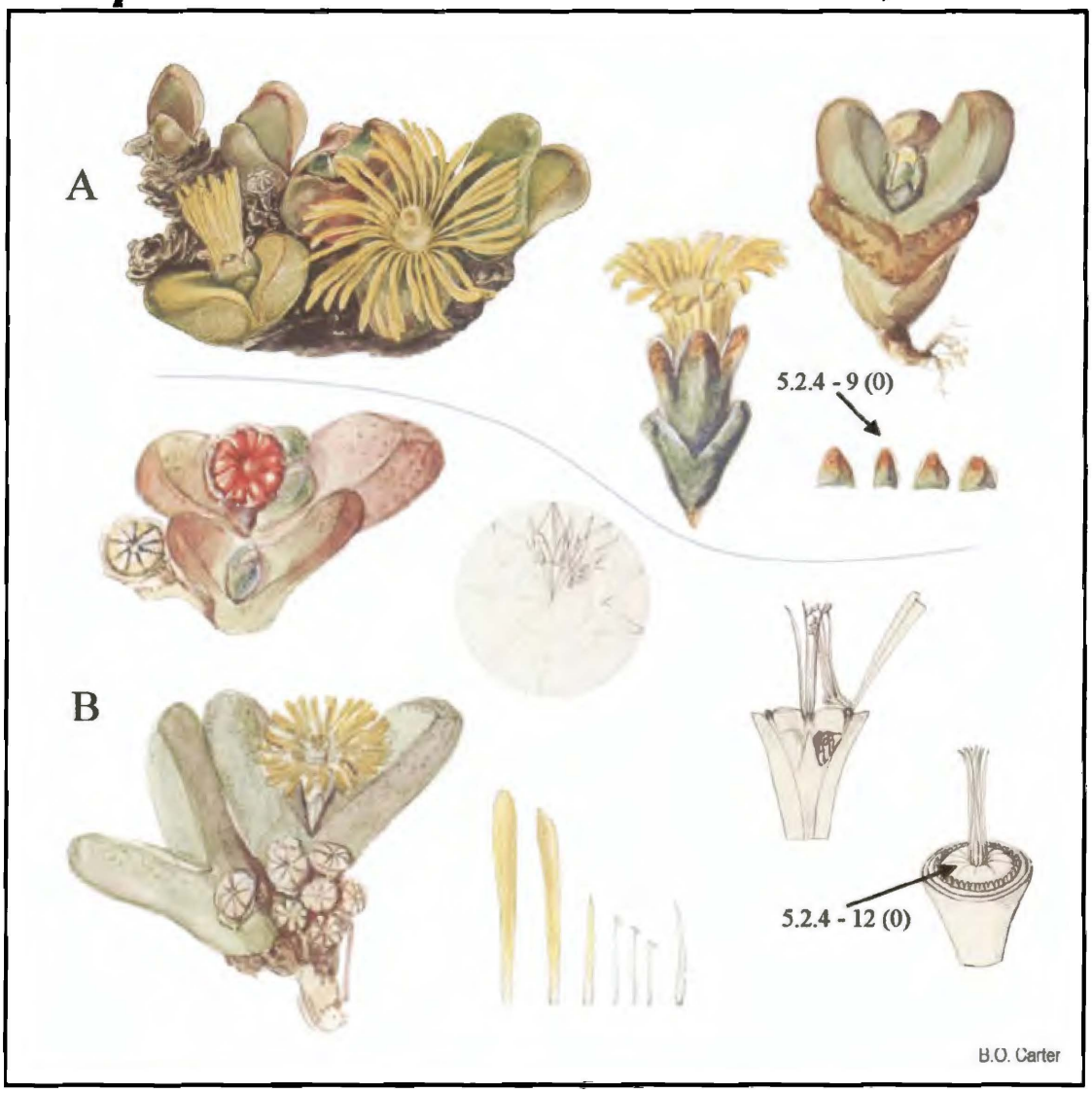


Fig. 6.117

TAXA
A. *T. prismatica*
B. *T. archeri*

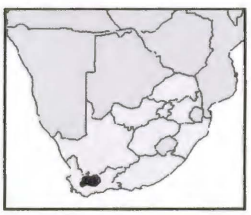
CHARACTERS
5.2.4 - 9 (0): Number of sepals - 4.
5.2.4 - 12 (0): Hypanthium - Absent.

DISTINGUISHING CHARACTERS
Compact perennials with smooth, unkeeled leaves.

Fruit a 9- or 10-locular capsule, of *Titanopsis*-type; convex on top; expanding keels parallel, diverging at tips, ending in aristate valve wings; covering membranes present; closing bodies tiny, endocarpal.

NOTES
3 spp. Confined to Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

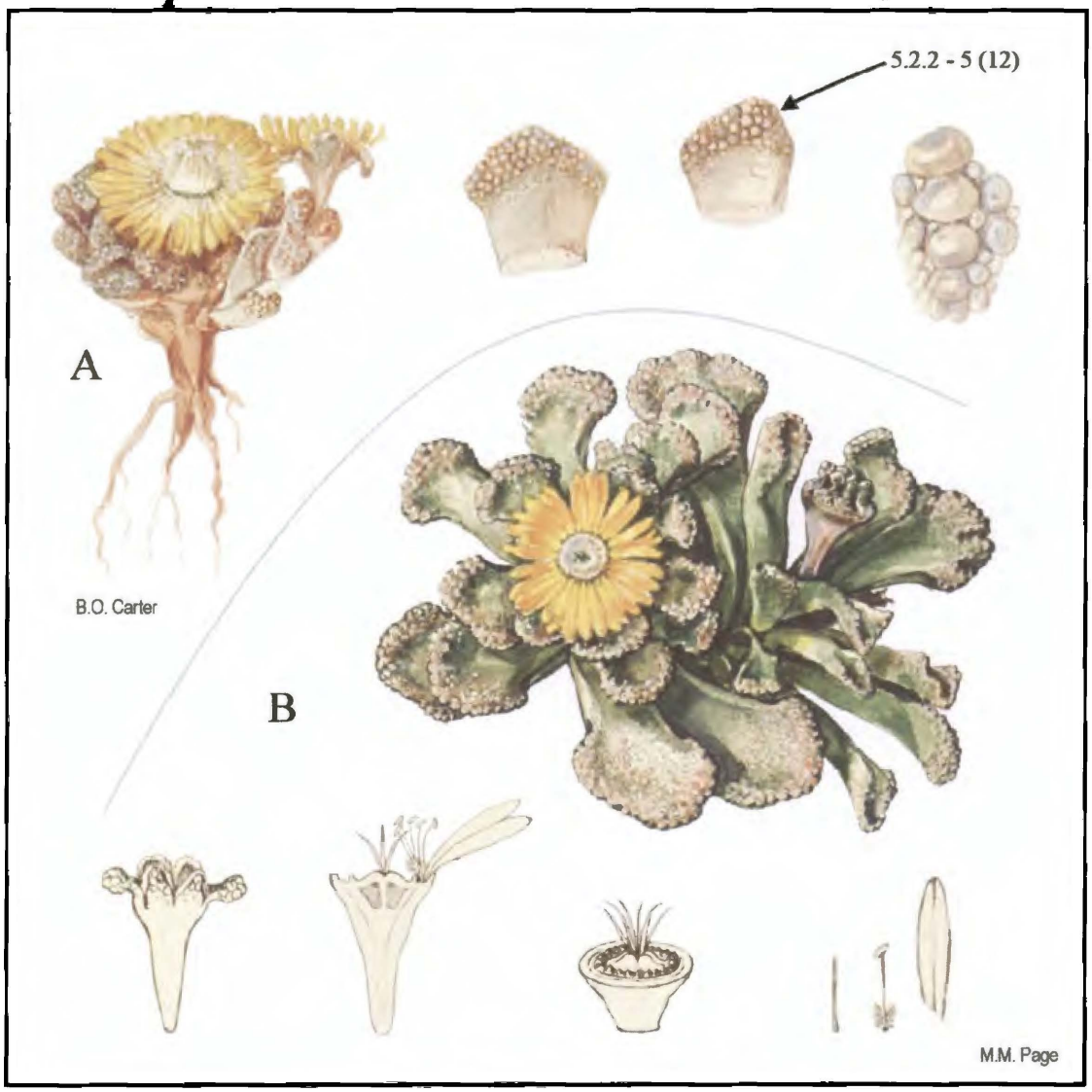


Fig. 6.118

TAXA
A. *T. schwantesii*
B. *T. calcarea*

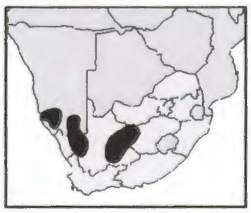
CHARACTERS
5.2.2 - 5 (12): Leaf surface - Rough with white bumps or pustules.

DISTINGUISHING CHARACTERS
Perennials forming rosettes of highly textured, pustulate, spoon-shaped leaves.

Fruit a (5)6(–10)-locular capsule, of *Titanopsis*-type; with prominent sutures; expanding keels subcontiguous and diverging towards awn-like apex, minutely toothed on inner, membranous margin; covering membranes membranous, semitransparent, not entirely covering locules; closing bodies absent.

NOTES
3 spp. Wide distribution across a number of biomes including Succulent Karoo, Nama-Karoo and Grassland biomes.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

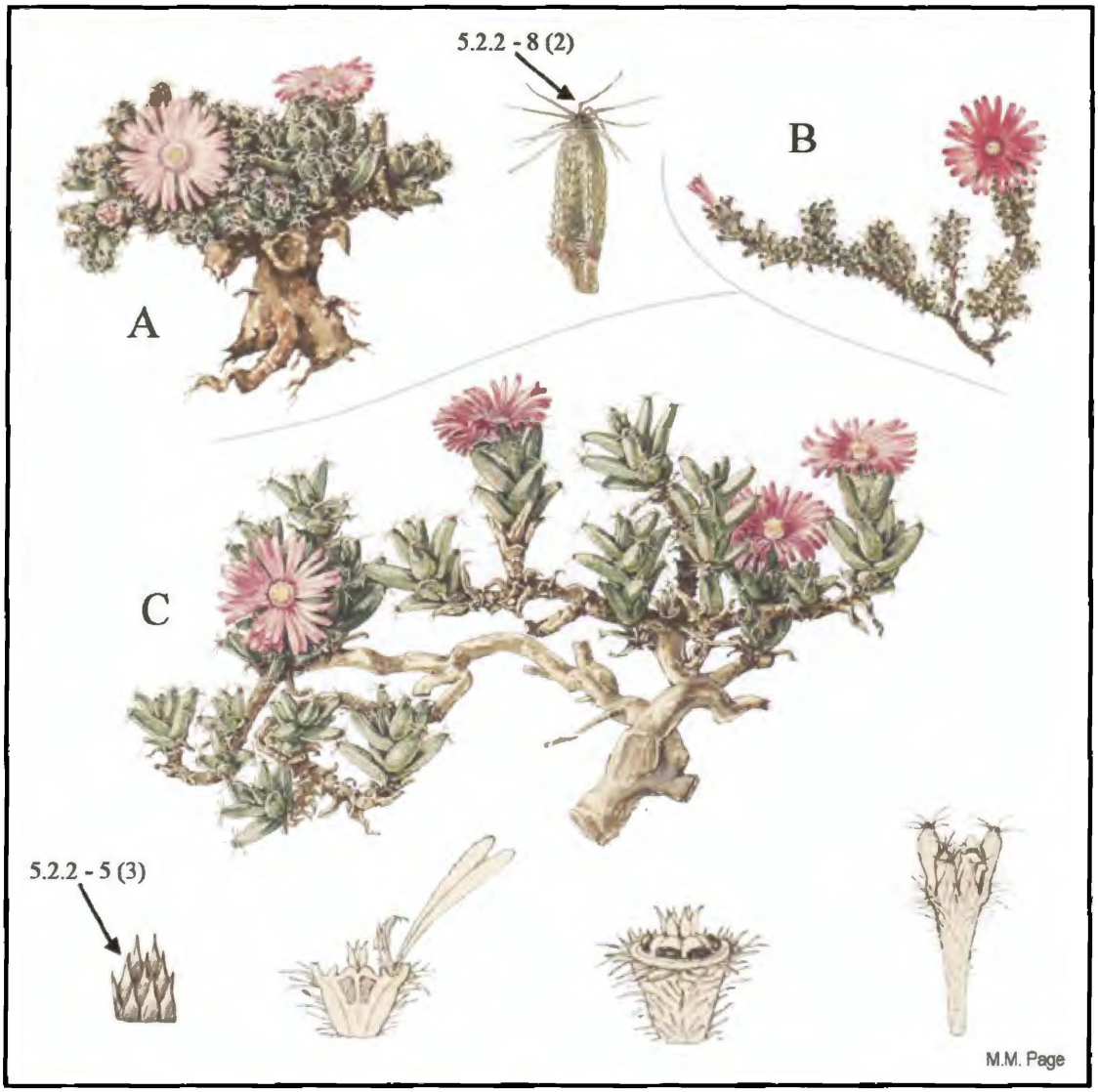


Fig. 6.119

TAXA
A. *P. stellatum*
B. *T. bulbosum*
C. *T. marlothii*

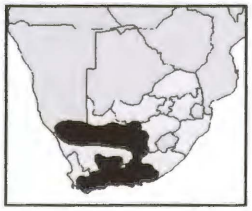
CHARACTERS
5.2.2 - 5 (3): Leaf surface - Bladder cells elevated and pointed at one or both ends.
5.2.2 - 8 (2): Leaf tips - Tipped with diadem of hairs.

DISTINGUISHING CHARACTERS
Short- or long-stemmed shrubs; leaves crowned with a diadem of bristles; fruit with well-developed covering membranes.

Fruit a 5–8-locular capsule, of *Drosanthemum*-type; expanding keels contiguous, winged, diverging towards tips; valve wings broad and rounded; covering membranes present or reduced to a limb; closing bodies absent.

NOTES
34 spp. Widespread across a number of biomes including Fynbos, Succulent Karoo, Nama-Karoo, and Grassland biomes, as well as Albany Centre.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

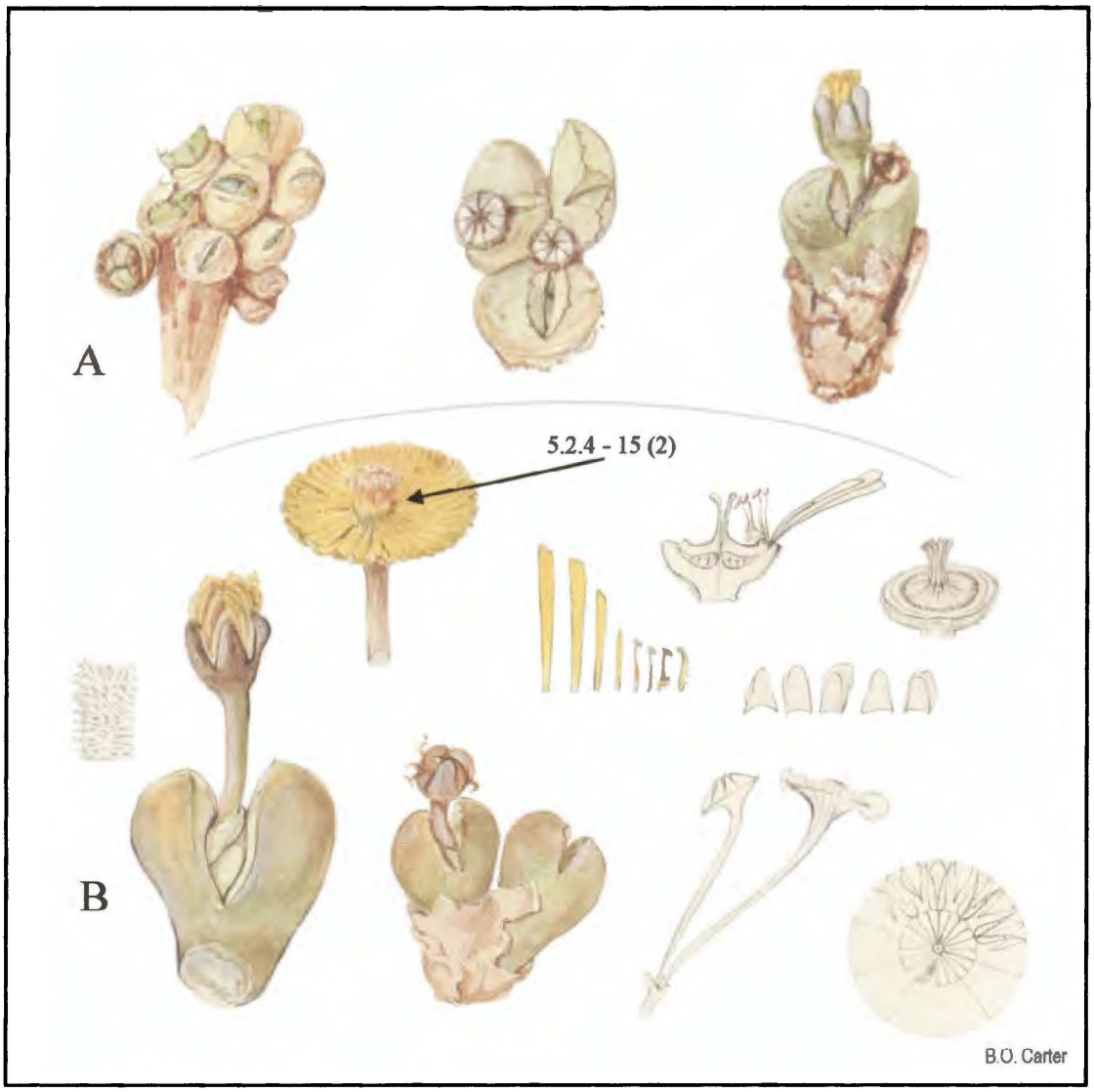


Fig. 6.120

TAXA
A. *V. primosii*
B. *V. roodiae*

CHARACTERS
5.2.4 - 15 (2): Filamentous staminodes - Absent (0 to few).

DISTINGUISHING CHARACTERS
Compact perennials; leaf pairs often forming bodies; leaves thick, yellowish green, with short, stout teeth on margins and keel; flowers single or up to three together, yellowish orange.

Fruit a 7–15-locular capsule, of *Titanopsis*-type; conical, not closing entirely after seeds have been released; expanding keels ± diverging, fringed with broad membranous valve wings; covering membranes with flat, flexible membranous wings; closing bodies absent.

NOTES
2 spp. In Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

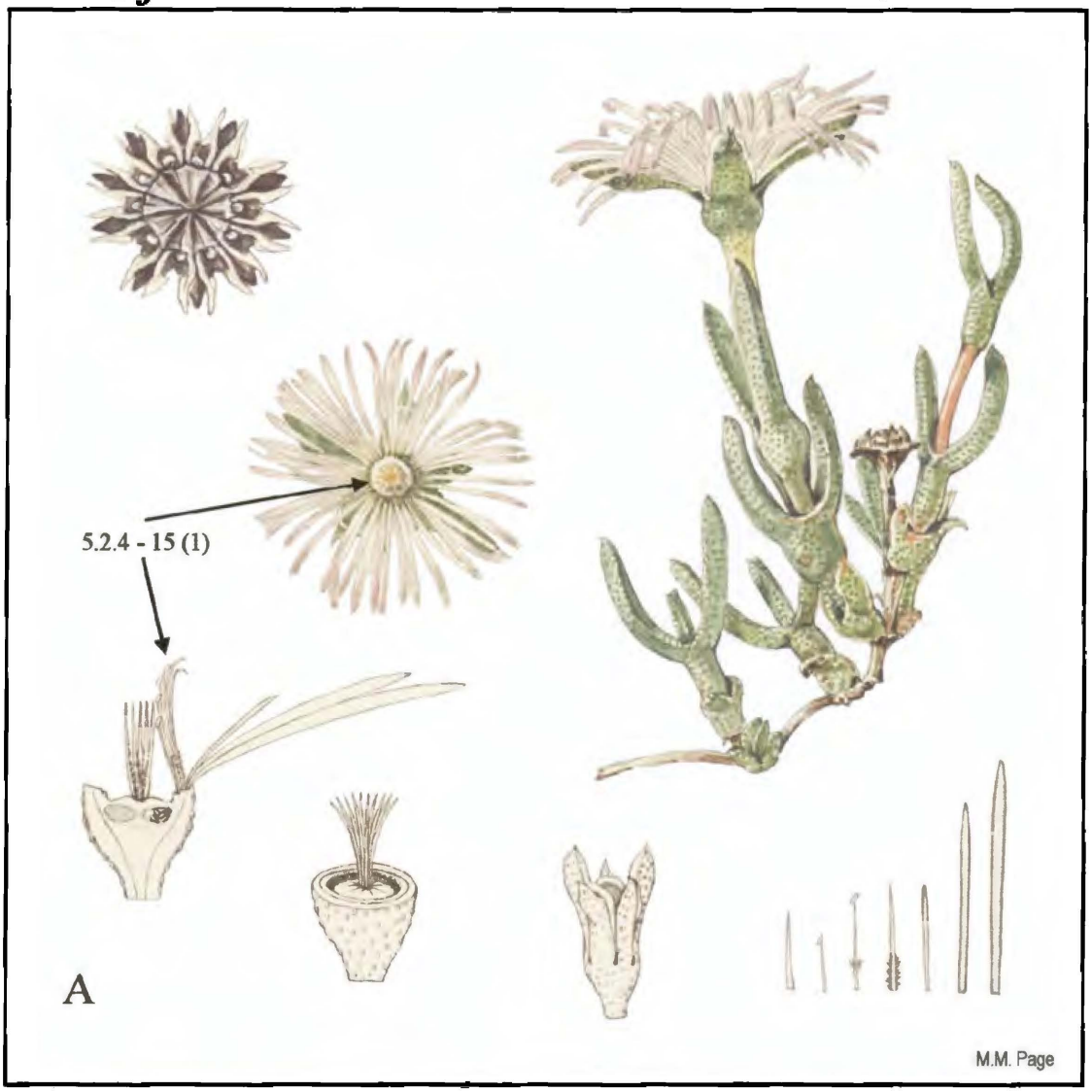


Fig. 6.121

TAXON
A. *V. annulata*

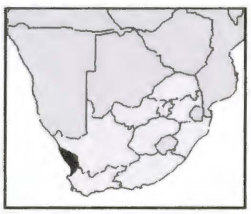
CHARACTERS
5.2.4 - 15 (1): Filamentous staminodes - Present, gathered with stamens in a central cone.

DISTINGUISHING CHARACTERS
Compact perennial clumps with trailing or climbing long shoots; leaf pairs dimorphic; flowers with distinctly elongating filamentous staminodes.

Fruit a 10-locular capsule of *Leipoldtia*-type, with additional closing devices such as inconspicuous ledges or bulges; expanding keels diverging, with wings; covering membranes present; closing bodies present, large, white.

NOTES
1 sp. Confined to Namaqualand, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021



Modified from Smith *et al.* (1998).

Fig. 6.122

TAXON
A. *V. ater*

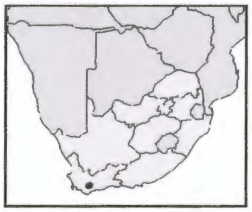
CHARACTERS
None used.

DISTINGUISHING CHARACTERS
Perennials with persistent trailing stems; old persistent leaves blackish; capsules blackish.

Fruit a 5–7-locular capsule of ± *Lampranthus*-type, up to 6 mm in diameter (up to 10 mm when expanded), firm, blackish, flat above, half globose below; expanding keels parallel at base, divergent towards tips; covering membranes present, flat; closing bodies absent; valve wings absent.

NOTES
1 sp. Narrow endemic to high altitudes in Fynbos Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

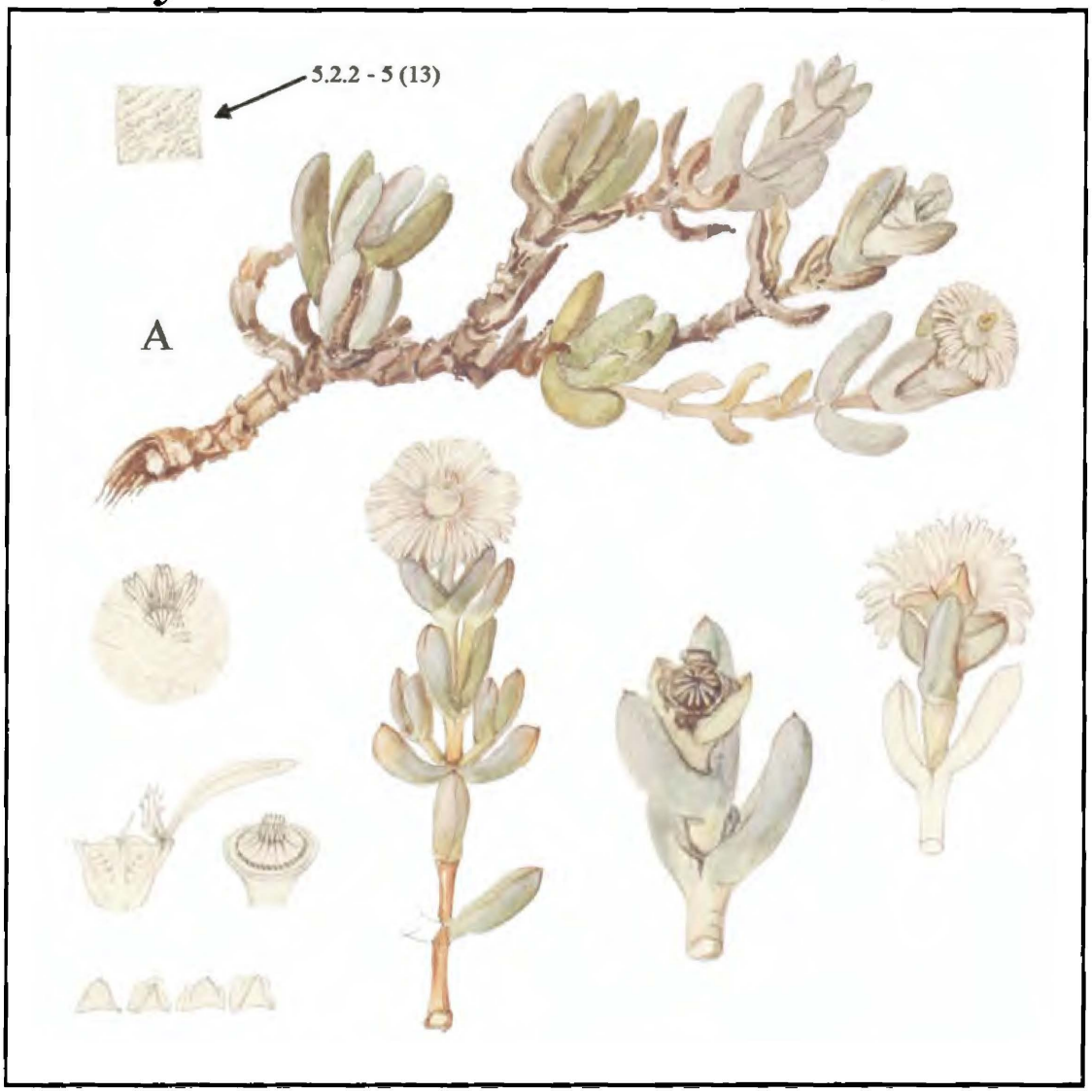


Fig. 6.123

TAXON
A. *W. farinosa*

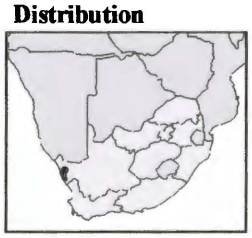
CHARACTERS
5.2.2 - 5 (13): Leaf surface - Ridges, woolly appearance.

DISTINGUISHING CHARACTERS
robust sprawling plants with leaves seemingly dusted with flour (hence the specific name *farinosa* = floury); flowers solitary, white.

Fruit a 11- or 12-locular capsule of *Lampranthus*-type, woody, reddish at first, convex on top; valves with spreading wings; expanding keels parallel at base, diverging slightly towards apex; covering membranes small, not covering entire locule; closing bodies absent.

NOTES
1 sp. Narrow endemic in Namaqualand, Succulent Karoo Biome.

Distribution



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

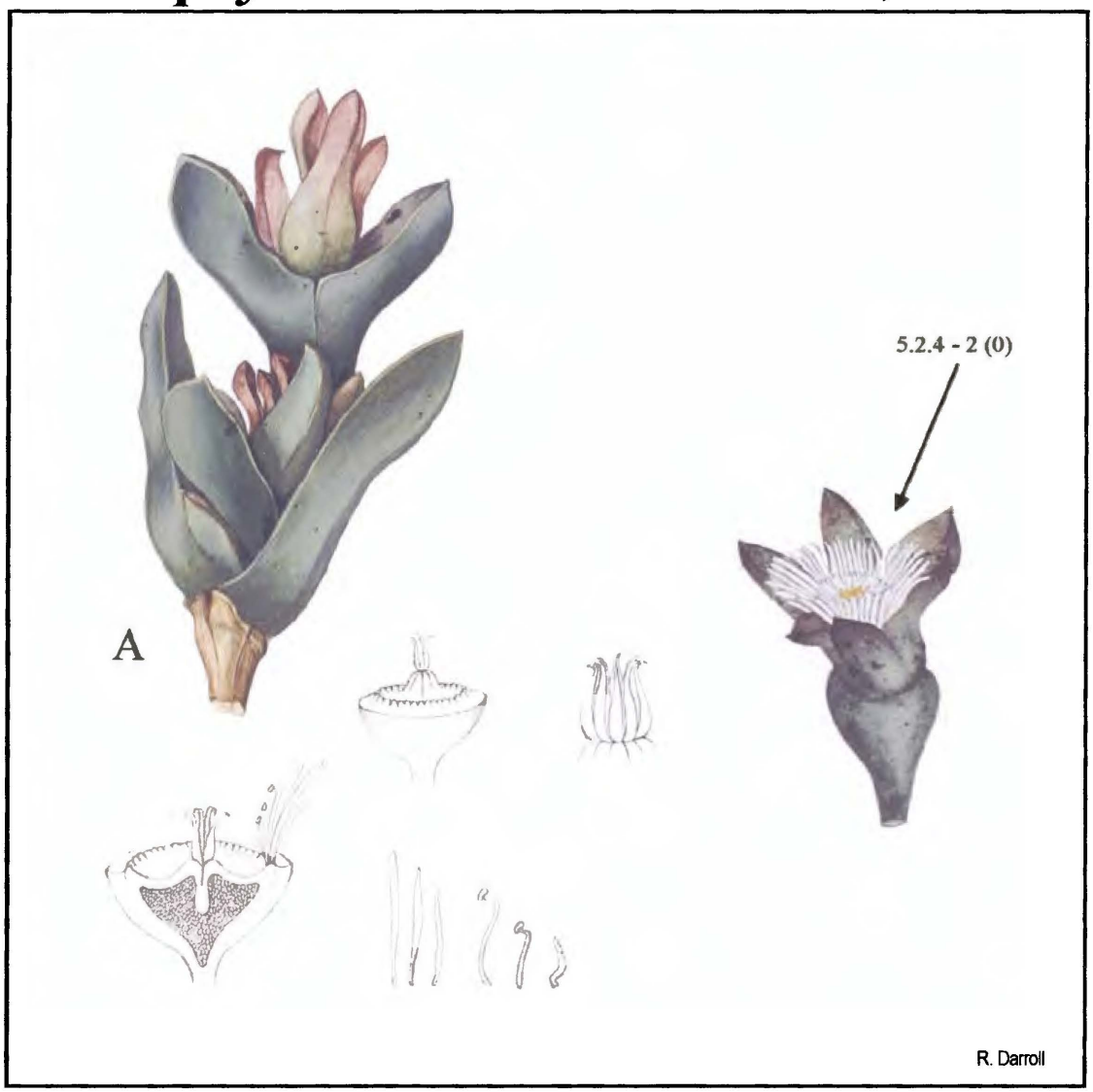


Fig. 6.124

TAXON
A. *Z. suppositum*

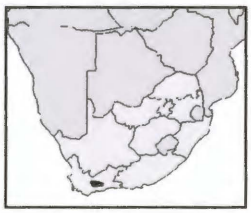
CHARACTERS
5.2.4 - 2 (0): Pedicel length - Flower sessile or sub-sessile.

DISTINGUISHING CHARACTERS
Compact shrublets with partially fused leaves; flowers solitary with short pedicels; fruit flat-topped, 10-locular.

Fruit a 10-locular capsule of *Lampranthus*-type, woody, top flat, expanding keels divergent, ending with a small stiff, aristate wing, covering membranes present, closing bodies absent.

NOTES
2 spp. Endemic to Little Karoo Centre, Succulent Karoo Biome.

Distribution

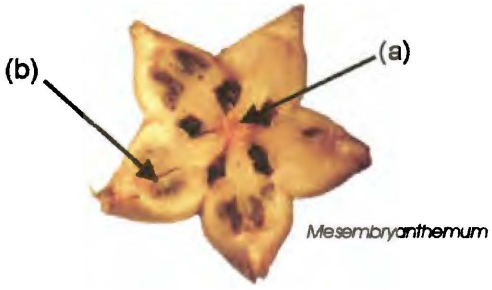


Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Fruit types and main features

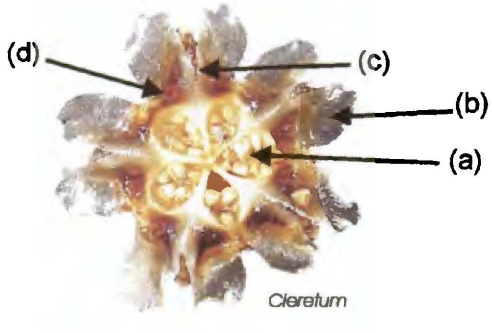
Mesembryanthemum-type

Axile placenta (a)
Flaps on valves (b)



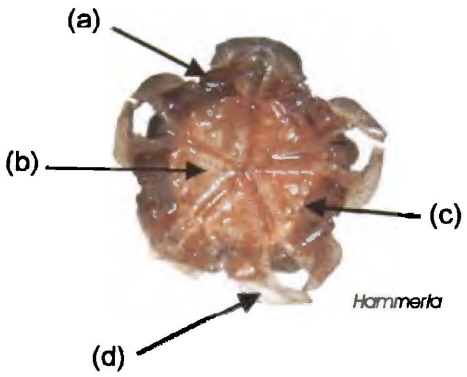
Cleretum-type

Covering membranes present or absent (a)
Large valve wings (b)
Expanding keels parallel (c),
merging into expanding sheets (d)



Mitrophyllum-type

Expanding sheets dominant (a)
Covering membranes compound (b)
Closing ledges or bosses (c)
Valve wings broad (d)



Apatesia-type

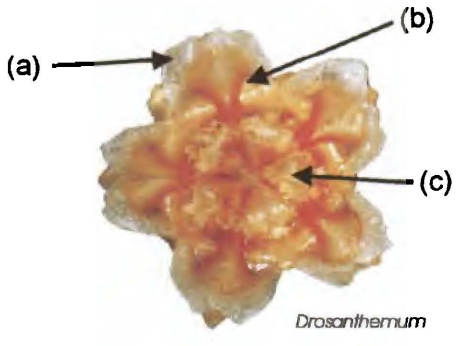
Placenta parietal (a) (except *Hymenogyne)*
Tendency towards schizocarpy (b)
Seed pockets (c)
Multilocularity





Drosanthemum-type

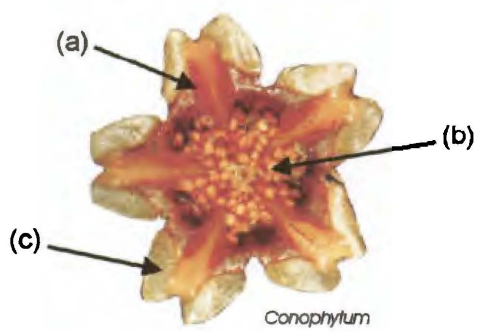
Valve wings broad (a)
Closing bodies usually absent
Basal seed chambers sometimes present
Expanding keels merging with or distinct (b)
from expanding sheets
Covering membranes compound (c)



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

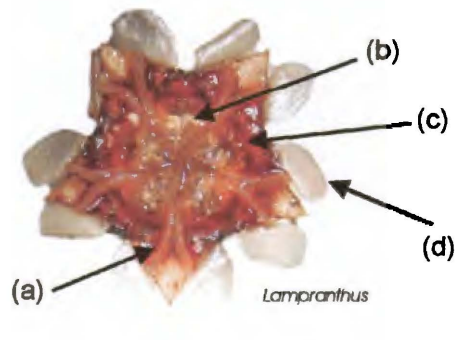
Delosperma-type

Expanding keels distinct from expanding keels, radial (a)
Covering membranes absent (b) or vestigial
Valve wings broad (c)



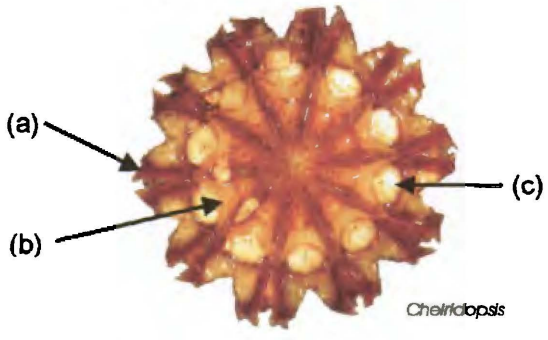
Lampranthus-type

Expanding keels divergent (a)
Covering membranes rigid, rim recurved (b) with closing ledges below
Bunches of sterile funicular hairs at distal exits of locules (c)
With valve wings (d)



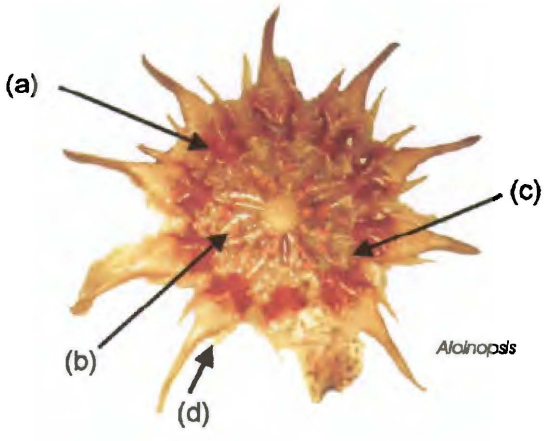
Leipoldtia-type

Expanding keels divergent (a) with radial awn
Covering membranes persistent, hard, concave, recurved (b)
Closing bodies large, stalked (c)
Valve wings



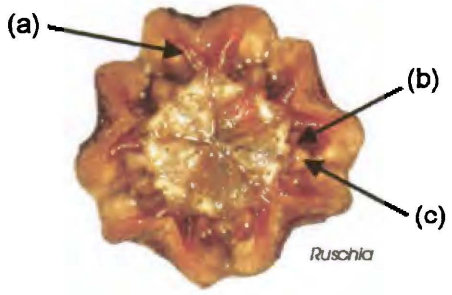
Titanopsis-type

Expanding keels distinct from expanding keels (a
Covering membranes compound, translucent, soft (b)
Closing bodies absent or small (c)
Valve wings present (d)



Ruschia-type

Expanding keels divergent, short (a)
Covering membranes persistent, hard, with closing rodlets below (b)
Closing bodies usually rod-shaped (c)
Without valve wings



Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

CHAPTER 7

GENERAL DISCUSSION

The approach to this study is embodied in the statement by Hershkowitz (1989): 'Higher level systematics is nothing more than a synthesis of the body of information available for lower level taxa'. The 'Interactive mesembs' dataset provides an up-to-date species-level inventory for the family Mesembryanthemaceae; the descriptive treatment of genera (Chesselet *et al.* 2000a) provides a baseline for character analysis at genus level; characters identified as fixed at genus level facilitate the formulation of hypotheses of relationship at tribal level.

New biogeographical information for mesembs was extracted from the comprehensive species list of the group (Chesselet *et al.* 2003b). Species and genus distribution data as well as numbers of species per biome and percentage of endemism are provided for the biomes of southern Africa for the first time. It is shown that basal tribes in the Ruschioideae most probably have their origins in the Fynbos Biome, supporting the hypothesis that the Fynbos Biome is older than the Succulent Karoo (Stuckenberg 1998), and that the two biomes can indeed be considered as part of a Greater Cape Mediterranean Region (Bayer 1984; Jürgens 1997; Midgley *et al.* 2001; Van Wyk & Smith 2001; Linder 2003).

The character analysis of mesemb genera provides hypotheses of supra-generic relationship, and together with published molecular data (Klak *et al.* 2003b), enabled critical assessment of the informal classification of Hartmann (1991, 1993), and its rendition at tribal level. Further detailed study would be required to establish cohesive subtribes. Some of Schwantes' higher taxa (Ihlenfeldt *et al.* 1962; Herre 1971) such as Mitrophyllinae are still currently accepted.

New data presented in this study lies in the demarcation of character states or character state recognition, the allocation of character states to different taxonomic

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

units or their taxonomic significance, the assessment of the taxonomic significance of character states, the polarization of characters and their phylogenetic significance, and in some cases, in the speculations relating to the functional significance of particular states or syndromes.

Analysis and atomization of variation into discrete character states is central to this study. Where possible, character polarities were established and these sequences represent hypotheses of evolution. In the character list, 36 characters are identified as useful in the interactive key, 19 for phylogenetic purposes and 7 are descriptive. The fact that most characters were not useful phylogenetically demonstrates the extremely adaptive flexibility of this diverse group. The most striking feature of the character analysis is that very few characters seem to be of phylogenetic significance. This may explain the species-rich nature of the group. Not many characters are fixed within a clade; those that are include stomatal types, epidermis types, wide-band tracheids, fusion of leaf pairs and nectary types. The characters of phylogenetic significance are useful in the delimitation of large groups. As soon as more conservative characters become available, better supra-specific taxonomy is possible as blueprint characters define higher categories.

Within a clade characters may be extremely variable. This may be indicative of a group in the process of diversification. In many characters used for identification purposes the variation was lumped into a few broadly defined states. The extreme evolutionary plasticity of an essentially simple ground-plan creates variation in morphology but with few tangible differences, or clear synapomorphies—probably one of the reasons why mesembs are so difficult to identify. Cladistic analysis of morphology thus becomes extremely challenging due to a lack of stable characters. A phylogeny based on a comprehensive morphological character set was not attempted. Ihlenfeldt (1994) viewed the reticulate distribution of characters considered to be taxonomically important as an impediment to cladistic analyses of mesembs. The present study supports his observation.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Numerous characters, particularly from the vegetative data set, are useful for identification, especially at species-level. They are taxonomic (flexible), not conservative and probably easily mutable. In the mesembs we may be dealing with a family that shows great flexibility potential. The family is not constrained by conservative characters and may therefore be predisposed to great adaptability. The extent of character flexibility may be linked to species, or to specific taxonomic groups. Hence the risk of applying techniques such as the so-called 'molecular clock' (Klak *et al.* 2004) as these necessarily make 'simplistic' assumptions about mutation rates.

Mesembs may belong to a relatively old lineage in the context of angiosperm evolution. They seem to have retained their evolutionary flexibility and may never acquire a 'baggage' of conservative characters. Such groups often speciate 'cryptically'; they may look very similar but differ physiologically or phenologically. In the absence of obvious morphological differences, some species may even be distinguished by flowering time, with 'chrono-genes' synchronizing phenology and imposing species boundaries. Liede & Hammer (1990) remark that the most striking division in floral characters in *Conophytum* runs between day- and night-flowering species.

In the mesembs, we are probably dealing with the very recent radiation—estimated at between 3.8 and 8.7 MA by Klak *et al.* (2004)—of an ancient group with a limited basic ground-plan. The colonization of the recently established Succulent Karoo is probably still an active process in some taxa. The exceptional richness and endemism demonstrated for the Succulent Karoo highlights its position as the most diverse winter-rainfall semi-desert in the world (Cowling *et al.* 1998, 1999). This may be partly attributable to its particular edaphic characteristics (mudstones, shales, granites and sandstones), and positioning juxtaposed to the species-rich Fynbos Biome. In both biomes levels of endemism are comparable to those of oceanic islands. Insularity due to topography and geological factors is an important explanatory factor in the high levels of endemism found in both Fynbos and Succulent Karoo. Nevertheless, the dominance of mesembs and their taxonomic

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

diversity in the vegetation of the Succulent Karoo are surely due also to factors inherent in the plants themselves.

Classification variables were used in a study by Ricklefs & Renner (1994) to show that proliferation of taxa in a colonizing lineage is related to what they term 'evolutionary flexibility'. They suggest that familial diversity is promoted by the presence of more than one state in any of four classification variables that include: geographical distribution (tropical, temperate, cosmopolitan, temperate high-altitude tropical), growth form (herbaceous, woody, both), pollination mode (abiotic, biotic, both) and dispersal mode (abiotic, biotic, both). These variables were subsequently found to be inadequate for testing variation in familial diversity.

Dodd *et al.* (1999) rejected the suggestion that character variability results in high net speciation rate. In a comparison of the common descendant state with species richness of lineages, Dodd *et al.* (1999) suggest that not all transitions stimulate diversification and that morphological or ecological transitions do not necessarily stimulate greater success of a lineage as measured by species proliferation. Commenting on morphogenetic genes with large phenotypic effect, Kadereit (1994) suggests: 'Although it seems certain that mutations of large phenotypic effect exist, it remains unclear how often large changes have contributed to evolutionary change....their significance may remain underestimated as the result of sampling problems when phylogenies are to be the guide to such mutations.'

Ricklef & Renner (2000) elaborate, suggesting that such transitions may often enable a lineage to occupy an unexploited, but restrictive ecological niche. The proliferation of mesemb taxa in the recently established ecological niche of Succulent Karoo may be just such a case. The inception of a Mediterranean climate in the southwestern parts of the African continent produced a brand new ecological niche (Ihlenfeldt 1994). Under such conditions, plants moving into the new climatic regime are subjected to a 'vacuum effect'. Through a shift in climatic variables the prevailing flora was eliminated and only the Mediterranean-adaptable groups explosively radiated to fill the void, e.g. *Conophytum.* In the case of the Succulent Karoo,

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

competition was not a major factor in the replacement of the prevailing flora, as climate probably caused the shifts. In addition, stress—in the form of water stress and limited access to nutrients—may have been an additional driving force in the adaptive radiation of mesembs. Jürgens (1990b) points out that those plant formations with a predominance of leaf succulent life forms are generally rare, and the prevalence of leaf succulence in Succulent Karoo is regarded as a zonal phenomenon.

Both studies by Ricklef & Renner (1994, 2000) show that biotic pollination and herbaceous growth forms are associated with higher diversity. In the mesembs, the colourful petals, nectaries and pollination syndromes enhanced biotic pollination in sometimes massive, or highly specialized (in terms of opening time) floral displays. The presence of petaloid staminodes in mesembs not only represents a major synapomorphy for the group, distinguishing them dramatically from sister taxa in Aizoaceae, but also represent a major morphological innovation promoting co-evolution with insect pollinators that may be scarce in an arid environment. In contrast to the observations of Ricklef & Renner (1994, 2000), herbaceous growth forms are limited to some Mesembryanthemoideae taxa and to the Dorotheantheae. The specialized succulent growth forms of most Ruschioideae present a special case.

In a comment on Dodd *et al.* 's (1999) critique, Ricklef & Renner (2000) highlight the relative performance of phylogenetic and nonphylogenetic analyses of comparative data and find them to be without substantial differences. Taxon size, however, complicates analyses of distribution of character variation among sister taxa. The key question raised by Dodd *et al.* (1999) is 'do evolutionary lineages possess traits that promote diversification?' Ricklef & Renner (2000) presume that many traits could potentially affect diversification rates, and that sister family pairs may have different contrasting characters that affect diversity in different ways, as in for example, the simple fruit of Mesembryanthemoideae in contrast to the complex fruit types (i.e. 2, 7, 8, 9 & 10 in Table 5.2.5.2.1) of many Ruschioideae. They suggest that if the number of species in a phylogenetic lineage is essentially haphazard (null hypothesis) then species richness may be affected by so many different factors in addition to character states that there is little hope of identifying key innovations or

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

key environmental conditions in a comparative analysis. Nevertheless, in contrast to taxa in Aizoaceae *sensu stricto*, mesembs show specialization of habit, succulent adaptations and a complex gynoecial morphology. The shift from the superior to the inferior ovary resulted in the evolution of deep and complex fruit capsules, with sometimes numerous locules and structures that enabled specialized hygrochastic and xerochastic dispersal mechanisms, as well as survival in and exploitation of new habitats.

The extreme succulent nature of most mesembs and the high degree of evolutionary convergence and consequent problems of homology in character analysis, make it difficult to identify synapomorphies that may have enabled the tremendous evolutionary success of mesembs. Convergence, due to the adaptive pressure of survival in desiccating, and often saline surroundings, is common among mesembs. Features such as multilocularity, heterophylly, neoteny, miniaturism, sunken growth and spinescence all have arisen several times in the evolution of the group. This high level of convergence may reflect a limited potential for adaptive responses in the light of the phylogenetic constraint which is the genetic baggage of mesembs. In the context of angiosperms, mesembs are a relatively basal group. They have greatly exploited their limited potential and, in contrast to many plants adapted to arid conditions, show a limited repertoire of specializations. The group contains few stem succulents, not many plants are hairy or silvery, most are small in stature and water storage is mostly confined to the leaves. Many have opted for minutism and mimicry of their surroundings (camouflage) as both water saving and defence strategies against herbivores.

Despite the paucity of phylogenetically useful characters, a new tribal classification has resulted from this study. Some kinds of characters are inherently more informative than others and different data sets do not always provide similar hypotheses of relationship. Systematic congruence, whereby different data sets are analysed by the same method, and classifications based on different character sets of the same organism postulate the same groupings (Mickevich 1978), serves as a measure of the stability of a classification as new sources of information are

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

considered. Problems of congruence of data sets have been encountered in the Mesembryanthemaceae. Groups established on the basis of capsule types (Hartmann 1988) do not coincide with groups postulated on the basis of combinations of vegetative and reproductive organs (Hartmann 1991, 1993; Hartmann & Bruckmann 2000; Rust *et al.* 2002). Delimitations based on ontogeny of seedlings do not match those provided by leaf epidermal characteristics (Dupont 1968).

This study has focused attention on the importance of features of the floral nectaries in higher-level classification of the group. Ultimately, the molecular phylogeny published by Klak *et al.* (2003b) has proved to be the most useful character set for testing congruence of morphological data. In many cases it is difficult to distinguish between synapomorphic reversals or sympleisiomorphies, or just the switching on and off of major genes. In terms of characters of the floral nectary, clarification of instances of convergence enabled the delimitation of the four tribes in Ruschioideae, and the identification of the major morphological synapomorphies associated with these higher-level groups. The character 'leaves basally fused' is the only obvious morphological synapomorphy for Ruschieae. The mostly free leaves of Drosanthemeae must be regarded as the morphological character that distinguishes it from Ruschieae. It is always the basal state that defines a group. Descriptors (Schmid 1982) such as 'mostly' and 'usually' have been used when describing Drosanthemeae.

Until recently Hartmann's (1988) detailed studies of fruits had provided a basis for supra-generic classification (Hartmann 1991, 1993). The focus on mesemb fruit has been important in the delimitation of genera since Brown's (1925) initial observations of their complex structure. In the light of some of the characters such as provided by floral nectaries, stomatal types, epidermal types and wide-band tracheids, fruit may not be as useful as previously thought, particularly at supra-generic levels.

Yet at genus level, fruit are important in diagnosis and a notable feature of mesemb fruit is the tendency towards multilocularity. An increased merosity is characteristic of most species in Apatesieae, and in some of the more advanced mesembs, typically those in the Leipoldtia group. In many other plant groups there is

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

a tendency towards simplification, and the reduction of parts. This reduction has a limit. However, in the mesembs the opposite trend exists, and to the proliferation of parts there is no limit. Proliferation of parts of the gynoecium and associated structures such as the sepals is more prevalent than reduction. This may have contributed to the proliferation of taxa at genus level.

Future morphological research on Mesembryanthemaceae would require a greater understanding of the functional significance of so-called adaptive features. There is a paucity of autecological studies and a limited knowledge of the ecophysiology of this group. Interpretation of morphological syndromes and their functional significance would greatly facilitate the formulation of hypotheses and understanding of the succulent strategies, dispersal modes and flowering behaviour of mesembs. At present there is insufficient evidence to reflect upon the functions of many of the characters displayed in the group.

Future molecular work on the mesembs should focus on the Drosanthemeae as molecular resolution appears to be much greater than in the more advanced taxa in Ruschieae. This tribe currently consists of a single variable genus that should be subdivided. This fragmentation of *Drosanthemum* should start with the distinct *D. zygophylloides* that clearly belongs in its own genus. To understand the role of refugia in the evolution of the group, studies using micro-satellite techniques, such as were used for the Cichlid fishes from Lake Victoria (Verheyen *et al.* 2003), on widespread but disjunct genera such as *Hereroa* are recommended.

In conclusion, the diversification of mesembs in Succulent Karoo can be explained through niche-specific factors, the role of habitat fragmentation, isolation, an adjacent and available pool of diverse taxa in the Fynbos Biome, a lack of competition, the role of (water and nutrient) stress, and inherent features of the mesembs including their comparatively short life spans (Desmet & Cowling 1999; Jürgens *et al.* 1999).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

The Ruschioideae are extremely species-rich compared to other subfamilies in Aizoaceae *sensu stricto*. In terms of the sheer size of this group it would be tempting to pay tribute to this incomparable diversity by according it family status. However, due to the question of paraphyly, Mesembryanthemoideae must be included to ensure that we are dealing with a monophyletic group. The morphological innovations that have enabled such extreme diversification can only be attributable to the activities of major genes responsible for the leap or saltation *sensu* Gould & Eldredge (1993) witnessed in the mesembs inhabiting the Succulent Karoo today.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

CHAPTER 8
CONCLUSIONS

- An overview of morphological characters above the species level is provided for the mesembs and those useful for identification are distinguished from those of phylogenetic significance. Mesembs have numerous variable characters useful for identification and few of phylogenetic significance.
- A Dahlgrenogram showing genera was constructed and proved to be useful in the assessment of characters for their systematic significance.
- As a family, Mesembryanthemaceae displays high levels of 'evolutionary flexibility' that may have contributed to their adaptive radiation and speciation in the Succulent Karoo.
- Nectary structure was found to be a conservative character yielding useful phylogenetic information.
- The mesembs comprise five major groups and are primarily subdivided on the basis of characters of the floral nectary.
- The koilomorphic meronectary is a synapomorphy for subfamily Mesembryanthemoideae.
- Four tribes are described for Ruschioideae: Apatesieae, Dorotheantheae, Drosanthemeae and Ruschieae.
- In Ruschioideae, tribe Apatesieae is characterized by a broad, flat holonectary, tribe Dorotheantheae has broad, flat meronectaries, tribe Drosanthemeae has lophomorphic meronectaries and tribe Ruschieae has lophomorphic meronectaries (pleisiomorphic state) and lophomorphic holonectaries.
- The genus *Stomatium* has a specialized meronectary with visible nectar.
- Tribe Ruschieae is defined by the morphological synapomorphy: leaves basally fused.
- The new genus *Brianhuntleya* is described containing the single species *B.intrusa.*
- Two species were transferred from *Ruschia* to *Antimima*: *A. insidens* and *A. aristulata.*

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

- Haworth's species, *Ruschia acutangula* was rediscovered at the bottom of Jonaskop, near Worcester, Western Cape Province, South Africa.
- *Glottiphyllum*, which is tentatively placed in the Mitrophyllum Group, should be excluded from this group on the basis of its epidermal characters. Preliminary unpublished cladistic analyses of morphological data suggest that the genus may be closely allied to *Erepsia* and *Carpobrotus*.
- *Erepsia* may be polyphyletic, and species with the meronectary should be separated from it.
- The inflorescence morphology of *Ottosonderia monticola* is described.
- The Mitrophyllum Group, previously assumed to be primitive, is correctly placed in Ruschieae.
- A new fruit type is defined: the '*Cleretum*-type' fruit for members of tribe Dorotheantheae.
- The *Mitrophyllum*-type fruit is not regarded as most primitive in the Ruschioideae, and species belonging in Dorotheantheae have been assigned a new fruit type.
- Fruit characters are of limited value in defining groups above the genus level and are thought to be strongly influenced by climatic factors, rainfall in particular.
- 'Interactive Mesembs' is available on the Internet at http://www.mesembs.org.
- 'Interactive Mesembs' is a comprehensive, up-to-date nomenclatural database for the entire family Mesembryanthemaceae with added biogeographic data.
- 'Interactive Mesembs' comprises 5 957 names of which 1 666 are currently widely accepted species, 4 are hybrids, and 112 are subspecies in 126 current genera.
- 'Interactive Mesembs' enables identification of mesemb genera through an interactive key, and mesemb species through iterative searches (i.e. searching on search results).
- Illustrations of type specimens accompany names on the 'Interactive Mesembs' site, both current and synonyms, to facilitate species identification.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

- Data extracted from 'Interactive Mesembs' enabled the formulation of new hypotheses on mesemb distribution.
- Mesembs show extremely high levels of endemism at species level in Fynbos (93%), Albany Thicket (91%), Succulent Karoo (89%), and Grassland (84%).
- Of the 382 mesemb species that occur in Fynbos, 357 are endemic to it.
- A total of 871 mesemb species occur in Succulent Karoo, representing the highest diversity of Mesembryanthemaceae. Of these 778 are endemic to Succulent Karoo.
- Albany Thicket has high levels of endemism at species level (91%), but genus endemism is low (13%).
- At genus level, endemism is highest in Succulent Karoo (45%) and then Fynbos (24%).
- Succulent Karoo and Fynbos share the most genera (12 genera), suggesting closer links between these two biomes than any others in terms of their mesemb flora.
- Nama-Karoo & Succulent Karoo share the most species (34). This may be attributable to the extensive interface between these two biomes and the widespread distribution of non-specialist taxa shared between them.
- The Albany Centre shares species with Succulent Karoo, Nama-Karoo, Grassland, Coastal Belt and Fynbos. This biome is especially complex as it is located in a region that is the meeting point of a number of biomes, phytochoria and veld types (*sensu* Acocks 1953).
- The floristic link between Nama-Karoo and Albany Thicket supports the hypothesis that warmer lowland pockets of the Eastern Cape could have served as refugia where the tropical arid taxa of the Nama-Karoo survived during the last glacial maximum.
- It is mainly larger genera that show outliers in different biomes; smaller genera are generally confined to a single biome.
- The mostly weedy subfamily Mesembryanthemoideae is surprisingly widespread despite the small size of the genera.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

- In subfamily Ruschioideae only the presumed more primitive Apatesieae, Dorotheantheae and the *Mitrophyllum* Group (excluding *Glottiphyllum* and *Disphyma*) do not contain large, widespread genera.
- All other groups contain at least one relatively large, widespread genus and a range of smaller ones, suggesting that these groups may still be undergoing active speciation.
- The most primitive extant tribe in subfamily Ruschioideae, the Apatesieae, is clearly geographically clustered and almost entirely confined to the wetter southwestern Cape.
- The core of the *Mitrophyllum* Group is entirely confined to the Succulent Karoo. Features of the epidermis and fruit suggest a primitive position in tribe Ruschieae.
- Mesembs are not restricted to the winter-rainfall region of southern Africa, although winter rainfall is an important zonal factor for the predominance of leaf succulents.
- Mesembs in summer-rainfall biomes often have thick storage roots, leaf rosettes or tufted leaves. Few are shrubby.
- Biogeographic data shows that basal groups in Ruschioideae occur in the Fynbos Biome.
- The Fynbos Biome represents a mesic refugium for Mesembryanthemaceae.
- Biogeographic mesemb data supports the hypothesis that the Fynbos Biome is older than the Succulent Karoo Biome.
- The number of genera shared between Fynbos and Succulent Karoo supports the recognition of the Greater Cape Mediterranean Region.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

REFERENCES

ACOCKS, J. P. H. 1953. Veld types of South Africa. *Memoirs of the Botanical Survey of South Africa* 28: 1–128.

APG (Angiosperm Phylogeny Group). 1998. An ordinal classification for the families of flowering plants. *Annals of the Missouri Botanical Garden* 85: 531–553.

APG (Angiosperm Phylogeny Group). 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Botanical Journal of the Linnaean Society* 141: 399–436.

BARTHLOTT, W. & HUNT, D.R. 1993. Cactaceae. Pp. 161–197 in: Kubitzki, K., Rohwer, J.G. & Bittrich, V. (eds), *The families and genera of vascular plants*, 2. Springer-Verlag, Berlin.

BAYER, M.B. 1984. The Cape Flora and the Karoo – A winter rainfall biome versus a fynbos biome! *Veld & Flora* 70: 17–19.

BEHNKE, H.-D. & MABRY, T.J. (eds). 1994. *Caryophyllales. Evolution and systematics*. Springer-Verlag, Berlin. pp. 334.

BITTRICH, V. 1986. Untersuchungen zu Merkmalsbestand, Gliederung und Abgrenzung der Unterfamilie Mesembryanthemoideae (Mesembryanthemaceae Fenzl). *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 21: 5–116.

BITTRICH, V. 1993. Introduction to Centrospermae. In K. KUBITZKI, J.G. ROHWER & V. BITTRICH (eds), *The families and genera of vascular plants, vol. 2, Magnoliid, hamamelid, and caryophyllid families*, 13–19. Springer-Verlag, Berlin.

BITTRICH, V. & HARTMANN, H.E.K. 1988. The Aizoaceae—a new approach. *Botanical Journal of the Linnaean Society* 97: 239–254.

BITTRICH, V. & STRUCK, M. 1989. What is primitive in the Mesembryanthemaceae? An analysis of evolutionary polarity of character states. *South African Journal of Botany* 55: 321–331.

BOLUS, H.M.L. 1928. *Notes on* Mesembrianthemum *and some allied genera* 1. University of Cape Town, Cape Town.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

BOLUS, H.M.L. 1928–1935. *Notes on* Mesembryanthemum *and allied genera*. 2. University of Cape Town, Cape Town.

BOLUS, H.M.L. 1936–1958. *Notes on* Mesembryanthemum *and allied genera*. 3. University of Cape Town, Cape Town.

BRODIE, H.J. 1951. The splash-cup dispersal mechanism in plants. *Canadian Journal of Botany* 29: 224–234.

BRODIE, H.J. 1955. Springboard plant dispersal mechanisms operated by rain. *Canadian Journal of Botany* 33: 156–167.

BROWER, A.V.Z. 2000. Homology and the inference of systematic relationships: some historical and philosophical perspectives. in R. Scotland & R.T. Pennington (eds), *Homology and systematics. Coding characters for phylogenetic analysis*. pp. 10–21.

BROWN, N.E. 1921. *Mesembryanthemum* and some new genera separated from it. *Gardeners' Chronicle* 70: 151–152.

BROWN, N.E. 1925. *Mesembryanthemum* and some new genera separated from it. *Gardeners' Chronicle* 78: 212, 272, 273, 412, 413, 433.

BROWN, W.H. 1938. The bearing of nectaries on the phylogeny of flowering plants. *Proceedings of the american philosophical society* 79: 549–594.

BRUMMITT, R.K. 1996. In defence of paraphyletic taxa. Pp. 371–384 in: VAN DER MAESEN, L.J.G., VAN DER BURGT, X.M. & VAN MEDENBACH VAN ROOY, J.M. (eds), *The biodiversity of African plants. Proceedings of the XIVth AETFAT Congress, 22–27 August 1994. Wageningen*. Kluwer Academic Publishers, Dordrecht.

BRUMMITT, R.K. 2002. How to chop up a tree. *Taxon* 51: 31–41.

BURGOYNE, P.M. & SMITH, G.F. 1998. Preparing useful herbarium specimens of succulents and other plants with fleshy parts. *Aloe* 35: 102–103.

BURGOYNE, P.M., SMITH, G.F. & DU PLESSIS, F. 2000. Notes on the genus *Frithia* (Mesembryanthemaceae) and the description of a new species, *F. humilis*, in South Africa. *Bothalia* 30: 1–7.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

CHESSELET, P., BURGOYNE, P.M., KLAK, C., KURZWEIL, H., GRIFFIN, N.J. & SMITH, G.F. 2003a. Mesembryanthemaceae. In Germishuizen, G. & Meyer, N. (eds), *Plants of southern Africa: names and distribution. Strelitzia*: 633–738.

CHESSELET, P., MÖSSMER, M. & SMITH, G.F. 1995. Research priorities in the succulent plant family Mesembryanthemaceae Fenzl. *South African Journal of Science* 91: 197–209.

CHESSELET, P., SMITH, G.F., BURGOYNE, P.M., KLAK, C., HAMMER, S.A., HARTMANN, H.E.K., KURZWEIL, H., VAN JAARSVELD, E.J., VAN WYK, B-E., & LEISTNER, O.A. 2000a. Mesembryanthemaceae. In: Leistner, O.A. (ed), *Seed plants of southern Africa: families and genera. Strelitzia* 10: 360–410.

CHESSELET, P. & SMITH, G.F. 2001. *Antimima aristulata* comb. nov. (Mesembryanthemaceae Fenzl); a heterophyllous succulent from Cape Town, South Africa. *Bradleya* 19: 121–123.

CHESSELET, P., SMITH, G.F. & VAN WYK, A.E. 2000b. Systematic and evolutionary significance of morphology in the Mesembryanthemaceae: interactive database and illustrated atlas for identification. *Aloe* 37: 46–51.

CHESSELET, P., SMITH, G.F. & VAN WYK, A.E. 2000c. The habit and peculiar inflorescence of *Ottosonderia monticola* (Sond.) L.Bolus, Mesembryanthemaceae. *Aloe* 37: 88–90.

CHESSELET, P., SMITH, G.F. & VAN WYK, A.E. 2001. A new tribal classification for the Mesembryanthemaceae Fenzl based on characters of the floral nectary. *Aloe* 38: 25–28.

CHESSELET, P., SMITH, G. F. & VAN WYK, A.E. 2002. A new tribal classification of the Mesembryanthemaceae: evidence from floral nectaries. *Taxon*: 295–308.

CHESSELET, P. & VAN WYK, A.E. 2002. Mesembs with nut-like schizocarpic fruit and *Ruschianthemum* Friedrich sunk under *Stoeberia* Dinter & Schwantes Mesembryanthemaceae. *Bothalia* 187–189.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

CHESSELET, P., VAN WYK, A.E., GRIFFIN, N. & SMITH, G. F. 2003b. Patterns of floristic diversity in Mesembryanthemaceae. *Aloe* 40: 80–85.

CHESSELET, P., VAN WYK, A.E. & SMITH, G. F. 2004. Notes on African plants. Mesembryanthemaceae. A new tribe and adjustments to infrafamilial classification. *Bothalia* 34: 47–51.

CHESSELET, P. WOLFSON, M.M. & ELLIS, R.P. 1992. A comparative histochemical study of plant polyphenols in southern African grasses. *Journal of the Grassland Society of South Africa* 9: 119–125.

COLE, D. 1988. Lithops. *Flowering stones*. Acorn Books in association with Russel Friedman Books, South Africa.

COWLING R.M., ESLER, K.J. & RUNDEL, P.W. 1999. Namaqualand, South Africa—an overview of a unique winter-rainfall desert ecosystem. *Plant Ecology* 142: 3–21.

COWLING R.M. & PIERCE COWLING S.M. 1999. *Namaqualand. A succulent desert*. Fernwood Press, Cape Town.

COWLING, R.M., RUNDEL, P.W., DESMET, P.G. & ESLER, K.J. 1998. Extraordinary high regional-scale plant diversity in southern African arid lands: subcontinental and global comparisons. *Diversity and Distributions* 4: 27–36.

CROIZAT, L. 1993. On the structural and developmental history of the capsule of *Mesembryanthemum* s.l. *Kirkia* 14: 145–169.

CRONQUIST, A. 1981. *An integrated system of classification of flowering plants*. Columbia University Press, New York.

CUÉNOUD, P., SAVOLAINEN, V., CHATROU, L.W., POWELL, M., GRAYER, R.J. & CHASE, M.W. 2002. Molecular phylogenetics of Caryophyllales based on nuclear 18S rDNA and plastid *rbcL*, *atpB*, and *matK* DNA sequences. *American Journal of Botany* 89: 132–144.

DAHLGREN, R. & CLIFFORD, H.T. 1982. *The Monocotyledons. A comparative study*. Academic Press, London.

DAHLGREN, R., CLIFFORD, H.T. & YEO, P.F. 1985. *The families of the Monocotyledons. Structure, evolution and taxonomy*. Springer-Verlag, Berlin.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

DALLWITZ, M.J. 1980. *User's Guide to the DELTA System: a general system for encoding taxonomic descriptions.* CSIRO Division of Entomology, Canberra, Australia.

DEHN, M. 1988. Untersuchungen zum Merkmalsbestand und zur Stellung der Gattung *Antimima* N.E.Br. emend. Dehn (Mesembryanthemaceae Fenzl). *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 22: 189–215.

DEHN, M. 1992. Untersuchungen zum Verwandtschaftskeis der Ruschiinae (Mesembryanthemaceae Fenzl). *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 24: 91–198.

DE PINNA, M.C.C. 1991. Concepts and tests of homology in the cladistic paradigm. *Cladistics* 7: 367–394.

DESMET, P.G. & COWLING, R.M. 1999. Biodiversity, habitat and range-size aspects of a flora from a winter-rainfall desert in northwestern Namaqualand, South Africa. *Plant Ecology* 142: 23–33.

DIAL, K.P. & MARZLUFF, J.M. 1989. Nonrandom diversification within taxonomic assemblages. *Systematic Zoology* 38: 26–37.

DODD, M.E., SILVERTOWN, J. & CHASE, M.W. 1999. Phylogenetic analysis of trait evolution and species diversity variation among angiosperm families. *Evolution* 53: 732–744.

DUPONT, S. 1968. Épidermes et plantules des Mésembryanthemacées. Systématique. Évolution. *Bulletin de la Société d'Histoire Naturelle de Toulouse* 104: 7–64.

ECKARDT, T. 1976. Classical morphological features of centrospermous families. *Plant Systematics and Evolution* 126: 5–25.

EGBERT, K.J. & MARTIN, C.E. 2000. Light penetration via leaf windows does not increase photosynthesis in three species of desert succulents. *Journal of Plant Physiology* 157: 521–525.

EICHLER, A.W. 1878. *Blüthendiagramme. 2.* Tiel. Wilhelm Engelmann Verlag, Liepzig.

ELLNER, S. & SHMIDA, A. 1981. Why are adaptations for long-range seed dispersal rare in desert plants? *Oecologia* 51: 133–144.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

ENDRESS, P.K. 2003. What should a "complete" morphological phylogenetic analysis entail? Pp. 131–164. In Stuessy, T.F., Mayer, V. & Hörandl, E. (eds), *Deep Morphology: Toward a Renaissance of morphology in plant systematics.* A.R.G. Gantner Verlag, Ruggell, Liechtenstein.

FARRIS, J.S. 1988. Hennig 86 Version 1.5.

FENZL, E. 1836. Monographie der Mollugineen und Steudelieen, zweier Unterabtheilungen der Familie der Portulacaceen. *Annalen des Wiener Museums der Naturgeschichte* 1: 349.

FREUDENSTEIN, 1998. Paraphyly, ancestors, and classification—a response to Sosef and Brummitt. *Taxon* 47: 95–104.

FRIEDRICH, H.C. 1955. Beiträge zur Kenntnis einiger Familien der Centrospermae. *Mitteilungen aus der Botanischen Staatssammlung. München* 2: 56–66.

GARSIDE, S. & LOCKYER, 1930. Seed dispersal from the hygroscopic fruits of *Carpanthea* (Mesembryanthemum) *pomeridiana* N.E.Br. *Annals of Botany* 44: 639–655.

GERBAULET, M. 1995. *Phyllobolus* N.E.Br. emend. Bittrich (Aizoaceae): A reassessment of generic boundaries. *Botanische Jahrbücher* 117: 385–399.

GERBAULET, M. 1996a. Revision of the genus *Aridaria* N.E.Br. (Aizoaceae) *Botanische Jahrbücher* 118: 41–58.

GERBAULET, M. 1996b. Revision of the genus *Prenia* N.E.Br. (Aizoaceae). Botanische Jahrbücher 118: 25–40.

GERBAULET, M. 1996c. Revision of the genus *Sceletium* N.E.Br. (Aizoaceae) *Botanische Jahrbücher* 118: 9–24.

GERBAULET, M. 1997. Revision of the genus *Phyllobolus* N.E.Br. (Aizoaceae). *Botanische Jahrbücher* 119: 145–211.

GERBAULET, M. 2001. *Phyllobolus*. In: HARTMANN, H.E.K. (ed), *Illustrated handbook of succuent plants. Aizoaceae F–Z.* Springer-Verlag, Berlin.

GESS, S.K. & GESS, F.W. 1989. Flower-visiting masarid wasps in Southern Africa (Hymenoptera: Vespoidea: Masaridae). *Annals of the Cape provincial museums. Natural history.* 18: 95–134.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

GLEN, H.F. 1986. Numerical taxonomic studies in the subtribe Ruschiinae (Mesembryanthemaceae)—*Astridia*, *Acrodon* and *Ebracteola*. *Bothalia* 16: 203–226.

GOLDBLATT, P. 1978. An analysis of the flora of Southern Africa: its characteristics, relationships and origins. *Annals of the Missouri Botanical Garden* 65: 369–346.

GOULD, S.J. & ELDREDGE, N. 1993. Punctuated equilibrium comes of age. *Nature* 366: 223–227.

GOULD, S.J. & VRBA, E.S. 1982. Exaptation—a missing term in the science of form. *Paleobiology* 8: 4–15.

HAMMER, S.A. 1993. *The genus* Conophytum*: a conograph.* Succulent Plant Publications, Pretoria.

HAMMER, S. & HARTMANN, H.E.K. 1990. Shedding light on windows—in *Conophytum*. *Cactus & Succulent Journal (US)* 62: 35–42.

HARTMANN, H.E.K. 1982. Monographien der Subtribus Leipoldtiinae. III. Monographie der Gattung *Fenestraria* (Mesembryanthemaceae). *Botanische Jahrbücher* 103: 145–183.

HARTMANN, H.E.K. 1983a. Monographien der Subtribus Leipoldtiinae. V. Monographie der Gattung *Hallianthus* (Mesembryanthemaceae). *Botanische Jahrbücher* 104: 143–169.

HARTMANN, H.E.K. 1983b. Monographien der Subtribus Leipoldtiinae. IV. Monographie der Gattung *Vanzijlia* (Mesembryanthemaceae). *Botanische Jahrbücher* 103: 499–538.

HARTMANN, H.E.K. 1983c. Untersuchungen zum Merkmalsbestand und zur Taxonomie der Subtribus Leipoldtiinae (Mesembryanthemaceae). *Bibliotheca Botanica* 136: 1–67.

HARTMANN, H.E.K. 1988. Fruit types in Mesembryanthema. *Beiträge zur Biologie der Pflanzen* 63: 313–349.

HARTMANN, H.E.K. 1991. Mesembryanthema. *Contributions from the Bolus Herbarium* 13: 75–157.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

HARTMANN, H.E.K. 1992. *Ihlenfeldtia*, a new genus in Mesembryanthema (Aizoaceae). *Botanische Jahrbücher* 114: 29–50.

HARTMANN, H.E.K. 1993. Aizoaceae. Pp. 37–69 in: Kubitzki, K., Rohwer, J.G. & Bittrich, V. (eds), *The families and genera of vascular plants*, 2. Springer-Verlag, Berlin.

HARTMANN, H.E.K. 1998a. A letter to the MSG. *Mesemb Study Group Bulletin* 2: 32–34.

HARTMANN, H.E.K. 1998b. New combinations in Ruschioideae, based on studies in *Ruschia* (Aizoaceae). *Bradleya* 16: 44–91.

HARTMANN, H.E.K. 2001a. *Illustrated handbook of succulent plants. Aizoaceae A–E*. Springer-Verlag, Berlin.

HARTMANN, H.E.K. 2001b. *Illustrated handbook of succulent plants. Aizoaceae F–Z*. Springer-Verlag, Berlin.

HARTMANN, H.E.K. & BRUCKMANN, C. 2000. The capsules of *Drosanthemum* Schwantes (Ruschioideae, Aizoaceae). *Bradleya* 18: 75–112.

HARTMANN, H.E.K. & DEHN, M. 1987. Monographien der Subtribus Leipoldtiinae. VII. Monographie der Gattung *Cheiridopsis* (Mesembryanthemaceae). *Botanische Jahrbücher* 108: 567–663.

HARTMANN, H.E.K. & NIESLER, I.M. 2003. Notes on *Trichodiadema* Schwantes (Mesembryanthema, Aizoaceae): *T.intonsum* (Haw.) Schwantes. *Bradleya* 21: 93–106.

HARTMANN, H.E.K. & STÜBER, D. 1993. On spiny Mesembryanthema and the genus *Eberlanzia* (Aizoaceae). *Contributions from the Bolus Herbarium* 15: 1–75.

HENNIG, W. 1966. *Phylogenetic systematics*. University of Illinois Press, Urbana.

HERR, J.M. 1984. Embryology and taxonomy. In Johri, B.M. (ed), *Embryology of Angiosperms*. Springer-Verlag, Berlin. pp. 647–696.

HERRE, H. 1971. *The genera of the Mesembryanthemaceae*. Tafelberg, Cape Town.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

HERRE, H. & VOLK, O.H. 1948. Mesembryanthemaceae Herre et Volk, *familia nova. Sukkulentenkunde* 2: 38.

HICKEY, B. & VAN JAARSVELD, E. 1995. Propagation of three rare and endangered vygies. *British Cactus and Succulent Journal* 13: 141–146.

HOFMANN, U. 1994. Flower morphology and ontogeny. Pp. 123–166. In: Behnke, H.-D. & Mabry, T.J. (eds), *Caryophyllales. Evolution and Systematics*. Springer-Verlag, Berlin.

HOOKER, J.D. 1867. Aizoaceae. In: Bentham, G. & Hooker, J.D. (eds), *Genera Plantarum*, vol. 1, part 3. Lovell Reeve, London. pp. 854–856.

HUTCHINSON, J. 1959. *The families of flowering plants. Vol 1, Dicotyledons*. Clarendon, Oxford.

HUXLEY, J.S. (ed). 1940. *The new systematics*. Oxford, Oxford University Press.

IHLENFELDT, H.-D. 1960. Entwicklungsgeschichtliche, morphologische und systematische Untersuchungen an Mesembryanthemen. *Feddes Repertorium specierum novarum regni vegetabilis* 63: 1–104.

IHLENFELDT H.-D. 1983. Epidermis structure in Mesembryanthemaceae. *Bothalia* 14: 931–937.

IHLENFELDT, H.-D. 1978. Morphologie und Taxonomie der Gattung *Oophytum* N.E.Br. (Mesembryanthemaceae). Monographie der Mitrophyllinae Schwantes III. *Botanische Jahrbücher* 99: 303–328.

IHLENFELDT, H.-D. 1989. Life strategies of succulent desert plants. *Excelsa* 14: 75–83.

IHLENFELDT, H.-D. 1994. Diversification in an arid world: The Mesembryanthemaceae. *Annual Review and Ecology and Systematics* 25: 521–546.

IHLENFELDT, H.-D. & GERBAULET, M. 1990. Untersuchungen zum Merkmalsbestand und zur Taxonomie der Gattungen *Apatesia* N.E.Br., *Carpanthea* N.E.Br., *Conicosia* N.E.Br., *Herrea* Schwantes und *Hymenogyne* Haw. (Mesembryanthemaceae Fenzl). *Botanische Jahrbücher* 111: 457–498.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

IHLENFELDT, H.-D. & HARTMANN, H.E.K. 1982. Leaf surfaces in Mesembryanthemaceae. Pp. 397–424. In Cutler, D.F., Alvin, K.L. & Price, C.E. (eds), *The plant cuticle*. Academic Press, London.

IHLENFELDT, H.-D. & JÖRGENSEN, S. 1973. Morphologie und Taxonomie der Gattung *Monilaria* (Schwantes) Schwantes s. str. (Mesembryanthemaceae) (Monographie der Mitrophyllinae Schwantes I). *Mitteilungen aus dem Staatsinstitut für Allgemeine Botanik. Hamburg* 14: 49–94.

IHLENFELDT, H.-D., SCHWANTES, G. & STRAKA, H. 1962. Die höheren Taxa der Mesembryanthemaceae. *Taxon* 11: 52–56.

IHLENFELDT, H.-D. & STRUCK, M. 1987. Morphologie und Taxonomie der Dorotheanthinae Schwantes (Mesembryanthemaceae). *Beiträge zur Biologie der Pflanzen* 61, 1986: 411–453.

JACOBSEN, H. 1960. *A handbook of succulent plants*. Vol. 3. Blandford, London.

JÜRGENS, N. 1986. Untersuchungen zur Ökologie sukkulenter Pflanzen des südlichen Afrika. *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 21: 139–365.

JÜRGENS, N. 1990a. A life form concept including anatomical characters, adapted for the description of succulent plants. *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 23: 321–341.

JÜRGENS, N. 1990b. Remarks on the biogeography of Mesembryanthemaceae and their possible use in other arid regions. *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 23: 1047–1060.

JÜRGENS, N. 1996. Psammophorous plants and other adaptations to desert ecosystems with high incidence of sandstorms. *Feddes Repertorium* 107: 345–359.

JÜRGENS, N. 1997. Floristic biodiversity and history of African arid regions. *Biodiversity and Conservation* 6: 495–514.

JÜRGENS, N., GOTZMANN, I.H. & COWLING, R.H. 1999. Remarkable medium-term dynamics of leaf succulent Mesembryanthemaceae shrubs in the winter-rainfall desert of northwestern Namaqualand, South Africa. *Plant Ecology* 142: 87–96.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

KADEREIT, J.W. 1994. Molecules and morphology, phylogenetics and genetics. *Botanica acta* 107: 369–373.

KLAK, C. 1999. *Psilocaulon* N.E.Br.: a common but little known genus from southern Africa. *Aloe* 36: 75–79.

KLAK, C., HEDDERSON, T.A. & LINDER, H.P. 2003a. A molecular systematic study of the *Lampranthus* group (Aizoaceae) based on chloroplast *trnL-trnF* and nuclear ITS and *5S* NTS sequence data. *Systematic Botany* 28: 70–85.

KLAK, C., KHUNOU, A., REEVES, G., & HEDDERSON, T. 2003b. A phylogenetic hypothesis for the Aizoaceae (Caryophyllales) based on four plastid DNA regions. *American Journal of Botany* 90: 1433–1445.

KLAK, C & LINDER H.P. 1998. Systematics of *Psilocaulon* N.E.Br. and *Caulipsolon* Klak gen. nov. (Mesembryanthemoideae, Aizoaceae). *Botanische Jahrbücher* 120: 301–375.

KLAK, C., REEVES, G. & HEDDERSON, T. 2004. Unmatched tempo of evolution in southern African semi-desert ice plants. *Nature* 427: 63–65.

KURZWEIL, H. & CHESSELET, P. 2003. Studies in the genus *Machairophyllum* (Mesembryanthemaceae), with notes on some related genera. *Bothalia* 33: 19–39.

LANDRUM, J.V. 2001. Wide-band tracheids in leaves of genera in Aizoaceae: the systematic occurrence of a novel cell type and its implications for the monophyly of the subfamily Ruschioideae. *Plant Systematics and Evolution* 227: 49–61.

LEISTNER, O.A. 1958. A new monotypic genus of the Mesembryanthemaceae. *Notes on Mesembryanthemum and allied genera.* 3: 289–291.

LEISTNER, O.A. (ed). 2000. *Seed plants of southern Africa: families and genera. Strelitzia* 10: 1–775.

LIEDE, S. 1989. Untersuchungen zum Merkmalsbestand und zur Taxonomie der 'Erepsiinae' (Mesembryanthemaceae). *Beiträge zur Biologie der Pflanzen* 64: 391–479.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

LIEDE, S. & HAMMER, S. 1990. Aspects of floral structure and phenology in the genus *Conophytum* (Mesembryanthemaceae). *Plant Systematics and Evolution*. 172: 229–240.

LINDER, H.P. 2003. The radiation of the Cape flora, southern Africa. *Biological Review* 78: 597–638.

LINNAEUS, C. 1753. *Species plantarum*. Ed. 1. Laurentius Salvius, Stockholm.

LUCID 1999. *LucID Professional. Contemporary Identification Tools*. Centre for Pest Information and Technology Transfer. The University of Queensland, Brisbane, Australia. CSIRO Publishing.

MICKEVICH, M.F. 1978. Taxonomic congruence. *Systematic Zoology* 27: 143–158.

MIDGLEY, G.F., HANNAH, L., ROBERTS, R., MACDONALD, D.J. & ALLSOPP, J. 2001. Have Pleistocene climatic cycles influenced species richness patterns in the greater Cape Mediterranean Region? *Journal of Mediterranean Ecology* 2: 137–144.

MIDGLEY, G.F. & VAN DER HEYDEN, F. 1999. Form and function in perennial plants. Pp. 91–106. In: Dean, R.J. & Milton, S.J. (eds), *The Karoo. Ecological patterns and processes*. Cambridge University Press, Cambridge.

MILTON, S.J. 1991. Plant spinescence in arid southern Africa: does moisture mediate selection by mammals? *Oecologia* 87: 279–287.

MILTON, S.J. 1992. Plants eaten and dispersed by adult leopard totoises *Geochelone pardalis* (Reptilia: Chelonii) in the southern Karoo. *South African Journal of Zoology* 27: 45–49.

MILTON, S.J. & DEAN, W.R.J. 2001. Seeds dispersed in dung of insectivores and herbivores in semi-arid southern Africa. *Journal of Arid Environments* 47: 465–483.

MUSIL, C.F. & WAND, S.J.E. 1999. 15. Impact of UV-B radiation on South African Mediterranean ecosystems. Pp. 265–291. In: Rozema, J. (ed), *Stratospheric ozone depletion: the effect of enhanced UV-B radiation on terrestrial ecosystems*, Backhuys Publishers, Leiden.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

MYERS, N., MITTERMEIER, R.A., MITTERMEIER, C.G., DA FONSECA, G.A.B. & KENT, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853–858.

NIESLER, I.M. 1997a. Untersuchungen zur Ontogenie und zum Bau der Blätter bei Mesembryanthemaceae Fenzl unter besonderer Berücksichtigung der Epidermis. Doctoral thesis, University of Hamburg.

NIESLER, I.M. 1997b. Is *Trichodiadema* Schwantes one genus only?—Problems in delimitation or "What is a diadem?". *Bradleya* 15: 13–27.

ÖZTIG, Ö.F. Beiträge zur Kenntnis des Baues der Blattepidermis bei Mesembryanthemen, insbesondere bei den extreme xeromorphen Arten. *Flora* (Neue Folge) 34: 105–144.

PAROLIN, P. 2001. Seed expulsion in fruits of Mesembryanthema (Aizoaceae): a mechanistic approach to study the effect of fruit morphological structures on seed dispersal. *Flora* 196: 313–322.

PATTERSON, G. 1982. Morphological characters and homology. In: Joysey, K.A. & Friday, A.E. (eds), *Problems of phylogenetic reconstruction.* Academic Press, London. pp. 21–74.

PAX, F. 1889. Aizoaceae. In: ENGLER, A. & PRANTL, K. (eds), Die Natürlichen Pflanzenfamilien vol 3, part 1b, Engelmann, Leipzig, S. pp. 33–51.

PAYER, J.-B. 1857. Traite d'organogenie comparée de la fleur, Texte. Pp. 330–335, 349–360. Victor Masson, Paris.

POGUE, M.G. & MICKEVICH, M.F. 1990. Character definitions and character state delineation: the bête noire of phylogenetic inference. *Cladistics* 6: 319–361.

POPPENDIECK, H.-H. 1976. Untersuchungen zur Morphologie und Taxonomie der Gattung *Mitrophyllum* Schwantes s.lat. *Botanische Jahrbücher*: 97: 339–413.

POPPENDIECK, H.-H. 1995. Hygrochastic capsules in *Oenothera* (Onagraceae). *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 25: 99–115.

RAPPA, F. 1912. Per una classificazione naturale dei Mesembriantemi. *Bollettino delle reale orto botanico e giardino coloniale de Palermo* 11: 21–36.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

RAPPA, F. & CAMARRONE, V. 1962. La classificazione naturale delle Mesembriantemacee. *Lavori dell' Istituto Botanico e Giardino Coloniale Palermo* 18: 11–32.

RAUH, W. 1974. Window-leaved succulents. *Cactus & Succulent Journal (US)* 46: 12–25.

REZNIK, H., ENGEL, U. & WAMBACH, C. 1988. Untersuchungen über die Betalainfarbstoffe der Aizoaceae. 1. Die Betaxanthine der Ruschieae. *Beiträge zur Biologie der Pflanzen* 63: 209–219.

RICKLEFS, R.E. & RENNER, S.S. 1994. Species richness within families of flowering plants. *Evolution* 48: 1619–1636.

RICKLEFS, R.E. & RENNER, S.S. 2000. Evolutionary flexibility and flowering plant familial diversity: a comment on Dodd, Silvertown, and Chase. *Evolution* 54: 1061–1065.

RUST, S., BRUCKMANN, C. & HARTMANN, H.E.K. 2002. The flowers of *Drosanthemum* Schwantes (Ruschioideae, Aizoaceae). *Bradleya* 20: 121–147.

RUTHERFORD, M.C. & WESTFALL, R.H. 1986. Biomes of southern Africa: an objective categorization. *Memoirs of the Botanical Survey of South Africa* 54: 1–98.

SATTLER, R. 1996. Classical morphology and continuum morphology: opposition and continuum. *Annals of Botany* 78: 577–581.

SCHANDERL, H. 1935. Unteruchungen über die Lichtverhältnisse im Innern von Hartlaub- und Sukkulentenblättern. *Planta* 24: 454–469.

SCHEMSKE, D.W. & BIERZYCHUDEK, P. 2001. Perspective: Evolution of flower color in the desert annual *Linanthus parryae*: Wright revisited. *Evolution* 55: 1269–1282.

SCHMID, R. 1982. Descriptors used to indicate abundance and frequency in ecology and systematics. *Taxon* 31: 89–94.

SCHWANTES, G. 1927. Zur Systematik der Mesembryanthemen. *Sukkulentenkunde* 3: 14–30.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

SCHWANTES, G. 1947. System der Mesembryanthemaceen. *Sukkulentenkunde* 1: 34–40.

SCHWANTES, G. 1949. Biology and systematics of Mesembryanthemum. *The National Cactus & Succulent Journal*. December 1949: 73–74.

SCHWANTES, G. 1952. Die Früchte der Mesembryanthemaceen. *Mitteilungen aus dem Botanischen Museum der Universität Zürich* 39: 1–38.

SCHWANTES, G. 1957. *Flowering stones and mid-day flowers*. Ernest Benn Limited, London.

SMITH, G.F. & WALKER, C.C. 2001. The botanical paintings of Mary Maud Page. *Bradleya* 19: 124.

SMITH, G.F., CHESSELET, P., VAN JAARSVELD, E.J., HARTMANN, H., HAMMER, S., VAN WYK, B-E., BURGOYNE, P., KLAK, C. & KURZWEIL, H. 1998. *Mesembs of the world*. Briza, Pretoria.

SMITH, G.F., HOBSON, S.R., MEYER, N.L., CHESSELET, P., ARCHER, R.H., BURGOYNE, P.M., GLEN, H.F., HERMAN, P.P.J., RETIEF, E., SMITHIES, S.J., VAN JAARSVELD, E.J. & WELMAN, W.G. 1993. Southern African succulent plants—an updated synopsis. *Aloe* 30: 31–74.

SMITH, G.F., VAN JAARSVELD, E.J., ARNOLD, T.H., STEFFENS, F.E., DIXON, R.D. & RETIEF, J.A. 1997. *List of southern African succulent plants*. Umdaus Press, Pretoria.

SMITH, M.T., CROUCH, N.R., GERICKE, N. & HIRST, M. 1996. Psychoactive constituents of the genus *Sceletium* N.E.Br. and other Mesembryanthemaceae: a review. *Journal of Ethnopharmacology* 50: 119–130.

SOSEF, M.S.M. 1997: Hierarchical models, reticulate evolution and the inevitability of paraphyletic supraspecific taxa. *Taxon* 46: 75–85.

STEARN, W.T. 1939. An annotated index to Salm-Dyck's "Monographia Generum Aloes et Mesembryanthemi". *Cactus Journal* 7: 66–85.

STEVENS, P.S. 1974. *Patterns in Nature*. Little, Brown & company (Canada) Limited.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

STRACK, D., MARXEN, N, REZNIK, H. & IHLENFELDT, H.-D. 1990. Distribution of betacyanins and hydroxycinnamic acid –glucose esters in flowers of the Ruschieae. *Phytochemistry* 29: 2175–2178.

STRAKA, H. 1955. Anatomische und entwicklungsgeschichtliche Untersuchungen an Früchten paraspermer Mesembryanthemen. *Nova Acta Leopoldina*, Neue Folge 17: 118: 127–190.

STRUCK, M. 1989. The biology of the fruit capsules in *Dorotheanthus* Schwantes (Mesemb.). *Veld & Flora* 75: 41–43.

STRUCK, M. 1994. Flowering phenology in the arid winter rainfall region of southern Africa. *Bothalia* 24: 77–90.

STUESSY, T.F. 2003. Morphological data in plant systematics. Pp. 299–315. In Stuessy, T.F., Mayer, V. & Hörandl, E. (eds), *Deep Morphology: Toward a Renaissance of morphology in plant systematics*. A.R.G. Gantner Verlag, Ruggell, Liechtenstein.

SWOFFORD, D.L. 1998. PAUP*. Phylogenetic Analysis Using Parsimony (*and Other Methods). Version 4. Sinauer Associates, Sunderland, Massachusetts.

TAKHTAJAN, A.L. 1980. Outline of the classification of flowering plants (Magnoliophyta). *Botanical Review* 46: 225–359.

TANNER, V. & ELLER, B.M. 1986. Epidermis structure and its significance for the optical properties of leaves of the Mesembryanthemaceae. *Journal of Plant Physiology*. 125: 285–294.

TROLL, W. & WEBERLING, F. 1981. Infloreszenzstudien an Aizoaceen, Mesembryanthemaceen und Tetragoniaceen. *Tropische und Subtropische Pflanzenwelt* 35: 195–289.

VAN WELZEN, P.C. 1997. Paraphyletic groups or what should a classification entail. *Taxon* 46: 99–103.

VAN WYK, A.E. & SMITH, G.F. 2001. *Regions of floristic endemism in southern Africa. A review with emphasis on succulents.* Umdaus Press, Hatfield.

VAN WYK, B-E. & GERICKE, N. 2000. *People's plants. A guide to useful plants of southern Africa*. Briza, Pretoria.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

VERHEYEN, E., SALZBURGER, W., SNOEKS, J. & MEYER, A. 2003. Origin of the superflock of cichlid fishes from Lake Victoria, East Africa. *Science* 300: 325–329.

VOGEL, S. 1954. Blütenbiologische Typen als Elemente der Sippengliederung. In: TROLL, W. & VON GUTTENBERG, H. (eds), *Botanische Studien* 1. Fischer, Jena.

VON WILLERT, D.J., ELLER, B.M, WERGER, M.J.A., BRINKMANN, E. & IHLENFELDT, H.-D. 1992. *Life strategies of succulent plants in deserts with special reference to the Namib desert*. Cambridge University Press, Cambridge.

WALLACE, R.S. 1998. Systematic implications of evolutionary relationships within the Aizoaceae *s.l. Proceedings: Programme & Abstracts of the 25th Congress of the International Organization for Succulent Plant Study*. 31 August to 4 September 1998.

WILKINSON, M. 1995. A comparison of two methods of character construction. *Cladistics* 11: 297–308.

WILLIAMS, C.B. 1964. *Patterns in the balance of nature and related problems in quantitative ecology*. Academic Press, London.

WISURA, W. & GLEN, H.F. 1993. The South African species of *Carpobrotus* (Mesembryanthema—Aizoaceae). *Contributions from the Bolus Herbarium* 15: 76–107.

ZANDONELLA, P. 1977. Apports de l'étude comparée des nectaires floraux à la conception phylogénétique de l'ordre des Centrospermales. *Berichte der deutschen botanischen Gesellschaft* 90: 105–125.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

ACKNOWLEDGEMENTS

I wish to express my sincere thanks to those persons and institutions who have offered encouragement, assistance and co-operation in the preparation of this thesis:

Prof. Braam van Wyk, my promoter, for his encouragement, understanding and insights, as well as his constructive contributions to a number of co-authored papers. Hon. Prof. Gideon Smith, my co-promoter, for his support, drive and collaboration on a number of mesemb projects over the years.

To a number of staff members of the National Herbarium including Priscilla Burgoyne who shared her photographs of mesemb fruit; Dr Hugh Glen who provided the 'seed' for the 'Interactive Mesembs' database and translated some Latin text, and most of all to Dr Otto Leistner for his advice, discussions, knowledge of Latin and of the mesembs.

My parents, friends and family, particularly my brother Claude Chesselet for conceptualizing and developing the software that runs the 'Interactive Mesembs' website, my friend and collaborator Neil Griffin for his help with extracting data from the Interactive Mesembs database, and my brother Patrick for critically editing the text.

Prof. Norbert Jürgens for his encouragement and providing seed funding through the GTZ. The French Embassy in South Africa for providing generous funding for the Internet site.

Terry Trinder-Smith, curator of the Bolus Herbarium, University of Cape Town for his friendliness and co-operation in the mammoth task of photographing the collection of illustrations of mesemb types and other specimens.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

SUMMARY

Significance of morphology in the systematics of Mesembryanthemaceae: interactive database and illustrated atlas for identification

By

PASCALE C.M.H. CHESSELET

Promoter: Prof. Dr. A.E. van Wyk
Co-promoter: Hon. Prof. Dr. G.F. Smith
In the faculty of Biological and Agricultural Sciences
Department of Botany, University of Pretoria

PHILOSOPHIAE DOCTOR
2004

An overview and analysis of morphological characters that distinguish mesembs at genus level are provided. Data was sourced primarily from published literature, botanical illustrations, as well observations based on field and herbarium material. Chracters useful for identification were distinguished from those of phylogenetic significance.

A Dahlgrenogram was constructed for the genera of Mesembryanthemaceae and used to test the systematic significance of selected characters. From the vegetative set, characters of the epidermis, stomata, wide band tracheids and fusion of leaf pairs were found to be significant at higher taxonomic levels. From the reproductive character set, floral nectaries were found to be important in distinguishing taxa at the tribal level. Fruit characters are important at genus level, but may to a large extent reflect rainfall patterns. The *Cleretum*-type fruit is newly described for Dorotheantheae.

The mesembs comprise five major groups and are primarily subdivided on the basis of characters of the floral nectary. The koilomorphic meronectary is a synapomorphy for subfamily Mesembryanthemoideae. Four tribes are described for Ruschioideae: Apatesieae is characterized by a broad, flat holonectary, Dorotheantheae has a broad, flat meronectary, Drosanthemeae has a lophomorphic

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

meronectary and members of tribe Ruschieae have the lophomorphic meronectary (pleisiomorphic state) or lophomorphic holonectary. The genus *Stomatium* has a specialized meronectary with visible nectar. Tribe Ruschieae is defined by the morphological synapomorphy: leaves basally fused.

The Internet site, 'Interactive Mesembs' was established and is available at http://www.mesembs.org. It is a comprehensive, up-to-date nomenclatural database for the entire family Mesembryanthemaceae with added biogeographic data. It comprises 5 957 names of which 1 666 are currently widely accepted species, 4 are hybrids, and 152 are subspecies in 126 current genera. The site enables identification of mesemb genera through an interactive key, and mesemb species through iterative searches. Illustrations of type specimens are linked to names to facilitate species identification.

Data extracted from 'Interactive Mesembs' enabled the formulation of new hypotheses on mesemb distribution. Mesembs show extremely high levels of endemism at species level in Fynbos (93%), Albany Centre (91%), Succulent Karoo (89%), and Grassland (84%). Of the 382 mesemb species that occur in Fynbos, 357 are endemic to it. A total of 871 mesemb species occur in Succulent Karoo, representing the highest diversity of Mesembryanthemaceae. Of these 778 are endemic to this biome. Albany Thicket has high levels of endemism at species level (91%), but genus endemism is low (13%). At genus level, endemism is highest in Succulent Karoo (45%) and then Fynbos (24%).

Most genera are shared between Succulent Karoo and Fynbos (12 genera), suggesting closer links between these two biomes than any others in terms of their mesemb flora. Most species are shared between Nama-Karoo & Succulent Karoo (34). This may be attributable to the extensive interface between these two biomes and the widespread distribution of non-specialist taxa shared between them.

In subfamily Ruschioideae only the presumed more primitive Apatesieae, Dorotheantheae and the *Mitrophyllum* Group do not contain large, widespread genera.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

All other groups contain at least one relatively large, widespread genus and a range of smaller ones, suggesting that these groups may still be undergoing active speciation.

Biogeographic data shows that basal groups in Ruschioideae occur in the Fynbos Biome that represents a mesic refugium for Mesembryanthemaceae. Biogeographic mesemb data supports the hypothesis that the Fynbos Biome is older than the Succulent Karoo Biome. The number of shared genera between Fynbos and Succulent Karoo supports the recognition of the Greater Cape Mediterranean Region.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

CURRICULUM VITAE

Pascale Chesselet was born in Brussels, Belgium in 1959. After spending time in both Belgium and South Africa, she attended Cape Town High School where she matriculated in 1976. She studied at the University of Cape Town, returned to Belgium and came back to Cape Town to obtain her BSc with distinction in Botany in 1985. She obtained her BSc (Hon.) *cum laude* in 1986. In 1989, she obtained her MSc on the systematic implications of leaf anatomy and palynology in the Disinae and Coryciinae (Orchidaceae) at the University of Cape Town. Throughout her studies she worked as a free-lance scientific illustrator, mostly in the fields of entomology, zoology and mycology, and has always illustrated her own research work. She then took a post in Palaeontology at Geological Survey, Pretoria, in 1990. From 1991 to early 1993 she worked at the Grassland Research Institute, at Roodeplaat, Pretoria, on the histochemistry of polyphenolics in southern African grasses. She was then appointed to the staff of the National Botanical Institute in April 1993, and is still working for this organization focusing primarily on systematics of Mesembryanthemaceae and on the generation of computerized interactive keys.

List of publications

1985

Lamarck, J.B. 1985. On the cause of metamorphosis of the insects. English translation by P. Chesselet, R. Toms, and C. Peeters from Lamarck, J.B. 1840. Histoire naturelle des Animaux sans Vertèbres. Ballière, Paris. *Rostrum* 11: 3-4.

1991

Kurzweil, H., Linder, H.P. & Chesselet, P. 1991. The phylogeny and evolution of the Pterygodium-Corycium complex (Coryciinae, Orchidaceae). *Plant Systematics and Evolution* 175: 161–223.

1992

Chesselet, P. 1992. Disarticulated remains of an Ordovician metazoan from the Cedarberg Formation, South Africa: A re-interpretation of *Eohostimella parva* Kovács 1986. *Palaeontologia Africana* 29: 11–20.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Chesselet, P. Wolfson, M.M. & Ellis, R.P. 1992. A comparative histochemical study of plant polyphenols in southern African grasses. *Journal of the Grassland Society of South Africa* 9: 119–125.

1993

Chesselet, P. & Linder H.P. 1993. Pollen morphology of the Diseae (Orchidoideae; Orchidaceae). *Grana* 32: 101–110.

Smith, G.F., Hobson, S.R., Meyer, N.L., Chesselet, P., Archer, R.H., Burgoyne, P.M., Glen, H.F., Herman, P.P.J., Retief, E., Smithies, S.J., Van Jaarsveld, E.J. & Welman, W.G. 1993. Southern African succulent plants—an updated synopsis. *Aloe* 30: 31–74.

1995

Chesselet, P., Mössmer, M. & Smith, G.F. 1995. Research priorities in the succulent plant family Mesembryanthemaceae Fenzl. *South African Journal of Science.* 91: 197–209.

Chesselet, P. & Hartmann, H.E.K. 1995. *Khadia alticola* Chess. & H.E.K.Hartm. spec. nov. (Mesembryanthema, Aizoaceae). *Aloe* 32: 46–49.

1997

Chesselet, P., & De Wet, B.C. 1997. Mesembryanthemaceae. In Smith, G.F., Van Jaarsveld, E.J., Arnold, T.H., Steffens, F.E., Dixon, R.D. & Retief, J.A. *List of southern African succulent plants*. Umdaus Press, Hatfield.

Smith, G.F. & Hartzer, P. 1997. (1293–1294) Proposals to conserve the names *Mossia* and *M. intervallaris* (Aizoaceae) against their earlier homonyms. *Taxon* 46: 349–350.

Smith, G.F., Hartzer, P. & Van Wyk, A.E. 1997. Plate 310. *Mossia intervallaris. Curtis's Botanical Magazine* 14: 16–22.

Hartzer, P. 1997. Mesembryanthemaceae. In Meyer, N.L., Mössmer, M & Smith, G.F (eds.), *Taxonomic literature of southern African Plants. Strelitzia* 5: 89–95. National Botanical Institute, Pretoria.

1998

Chesselet, P., Hartmann, H.E.K., Hahn, N., Burgoyne, P. and Smith, G.F. 1998. Studies in *Khadia* (Mesembryanthemaceae/Aizoaceae). *Bothalia* 28: 25–33.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Burgoyne, P.M., Smith, G.F. & Chesselet, P. 1998. *Hammeria*, a new genus of Aizoaceae from South Africa. *Cactus and Succulent Journal* (U.S) 70: 203–208.

Smith, G.F., Chesselet, P., Van Jaarsveld, E.J., Hartmann, H., Hammer, S., Van Wyk, B-E., Burgoyne, P., Klak, C. & Kurzweil, H. 1998. *Mesembs of the world.* Briza Publications, Pretoria. pp. 405.

1999

Smith, G.F., Burgoyne, P.M., Chesselet, P. 1999. *Delosperma cooperi* fa. *cooperi. Flowering plants of Africa* 56: 46–52.

2000

Chesselet, P., Smith, G.F. & Van Wyk, A.E. 2000. Systematic and evolutionary significance of morphology in the Mesembryanthemaceae: interactive database and illustrated atlas for identification. *Aloe* 37: 46–51.

Chesselet, P., Smith, G.F., Burgoyne, P.M., Klak, C., Hammer, S.A., Hartmann, H.E.K., Kurzweil, H., Van Jaarsveld, E.J., Van Wyk, B-E., & Leistner, O.A. 2000. Mesembryanthemaceae. In: Leistner, O.A. (ed), *Seed plants of southern Africa: families and genera. Strelitzia* 10: 360–410.

Chesselet, P., Smith, G. F. & Van Wyk, A.E. 2000. The habit and peculiar inflorescence of *Ottosonderia monticola* (Sond.) L.Bolus, Mesembryanthemaceae. *Aloe* 37: 88–90.

2001

Hartmann, H.E.K. & Chesselet, P. 2001. *Khadia.* Ruschioideae. In Hartmann, H.E.K (ed), *Illustrated Handbook of Succulent Plants: Aizoaceae F–Z.* Springer-Verlag, Berlin. pp. 72–74.

Chesselet, P. & Smith, G.F. 2001. *Antimima aristulata* comb. nov. (Mesembryanthemaceae Fenzl); a heterophyllous succulent from Cape Town, South Africa. *Bradleya* 19: 121–123.

Chesselet, P., Smith, G. F. & Van Wyk, A.E. 2001. A new tribal classification for the Mesembryanthemaceae Fenzl based on characters of the floral nectary. *Aloe* 38: 25–28.

Chesselet, P. 2001. A new combination in *Antimima* N.E.Br. (Mesembryanthemaceae). *Aloe* 38: 17.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

2002

Chesselet, P. & Smith, G.F. 2002. The rediscovery of *Ruschia acutangula* (Haw.) Schwantes (Mesembryanthemaceae Fenzl). *Bradleya* 20: 17–22.

Chesselet, P. & Van Wyk, A.E. 2002. Mesembs with nut-like schizocarpic fruit and *Ruschianthemum* Friedrich sunk under *Stoeberia* Dinter & Schwantes Mesembryanthemaceae. *Bothalia* 187–189.

Chesselet, P., Smith, G. F. & Van Wyk, A.E. 2002. A new tribal classification of the Mesembryanthemaceae: evidence from floral nectaries. *Taxon*: 295–308.

2003

Chesselet, P., Van Wyk, A.E., Griffin, N. & Smith, G. F. 2003. Patterns of floristic diversity in Mesembryanthemaceae. *Aloe* 40: 80–85.

Chesselet, P., Hammer, S.A. & Oliver, I. 2003. *Brianhuntleya*, a new genus endemic to the Worcester-Robertson Karoo, South Africa. Notes on African plants. Mesembryanthemaceae. *Bothalia* 33:160–164.

Chesselet, P., Burgoyne, P.M., Klak, C., Kurzweil, H., Griffin, N.J. & Smith G.F. 2003a. Mesembryanthemaceae. In Germishuizen, G. & Meyer, N. (eds), Plants of southern Africa: names and distribution. *Strelitzia*: 633–738.

Chesselet, P. & Anderson, F. 2003. *Dorotheanthus rourkei.* Mesembryanthemaceae. South Africa. *Flowering plants of Africa* 58: 70–73.

Kurzweil, H. & Chesselet, P. 2003. Studies in the genus *Machairophyllum* (Mesembryanthemaceae), with notes on some related genera. *Bothalia* 33: 19–39.

2004

Chesselet, P., Van Wyk, A.E. & Smith, G. F. 2004. Notes on African plants. Mesembryanthemaceae. A new tribe and adjustments to infrafamilial classification. *Bothalia* 34: 47–51

Chesselet, P. Interactive Mesembs: an illustrated comprehensive nomenclatural database for family Mesembryanthemaceae. http//www. mesembs.org

Chesselet, P. Mesembryanthemaceae. PlantZAfrica.com, NBI website. http://www.plantzafrica.com/plantklm/mesembs.htm

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

APPENDICES

Appendix 1 299

Chesselet, P., Mössmer, M. & Smith, G.F. 1995. Research priorities in the succulent plant family Mesembryanthemaceae Fenzl. *South African Journal of Science*. 91: 197–209.

Appendix 2 313

Chesselet, P., Smith, G.F., Burgoyne, P.M., Klak, C., Hammer, S.A., Hartmann, H.E.K., Kurzweil, H., Van Jaarsveld, E.J., Van Wyk, B-E., & Leistner, O.A. 2000a. Mesembryanthemaceae. In: Leistner, O.A. (ed), *Seed plants of southern Africa: families and genera. Strelitzia* 10: 360–410.

Appendix 3 358

Chesselet, P., Smith, G.F. & Van Wyk, A.E. 2000. Systematic and evolutionary significance of morphology in the Mesembryanthemaceae: interactive database and illustrated atlas for identification. *Aloe* 37: 46–51.

Appendix 4 365

Chesselet, P., Smith, G. F. & Van Wyk, A.E. 2002. A new tribal classification of the Mesembryanthemaceae: evidence from floral nectaries. *Taxon*: 295–308.

Appendix 5 380

Chesselet, P., Van Wyk, A.E. & Smith, G. F. 2004. Notes on African plants. Mesembryanthemaceae. A new tribe and adjustments to infrafamilial classification. *Bothalia* 34: 47–51.

Appendix 6 386

Chesselet, P., Burgoyne, P.M., Klak, C., Kurzweil, H., Griffin, N.J. & Smith G.F. 2003a. Mesembryanthemaceae. In: Germishuizen, G. & Meyer, N. (eds), *Plants of southern Africa: names and distribution. Strelitzia*: 633–738.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 7 551

Chesselet, P. & Smith, G.F. 2002. The rediscovery of *Ruschia acutangula* (Haw.) Schwantes (Mesembryanthemaceae Fenzl). *Bradleya* 20: 17–22.

Appendix 8 558

Chesselet, P., Smith, G.F. & Van Wyk, A.E. 2001. A new tribal classification for the Mesembryanthemaceae Fenzl based on characters of the floral nectary. *Aloe* 38: 25–28.

Appendix 9 563

Chesselet, P., Smith, G.F. & Van Wyk, A.E. 2000c. The habit and peculiar inflorescence of *Ottosonderia monticola* (Sond.) L.Bolus, Mesembryanthemaceae. *Aloe* 37: 88–90.

Appendix 10 567

Chesselet, P. & Smith, G.F. 2001. *Antimima aristulata* comb. nov. (Mesembryanthemaceae Fenzl); a heterophyllous succulent from Cape Town, South Africa. *Bradleya* 19: 121–123.

Appendix 11 571

Chesselet, P. & Van Wyk, A.E. 2002. Mesembs with nut-like schizocarpic fruit and *Ruschianthemum* Friedrich sunk under *Stoeberia* Dinter & Schwantes Mesembryanthemaceae. *Bothalia* 187–189.

Appendix 12 576

Chesselet, P. & Anderson, F. 2003. *Dorotheanthus rourkei*. Mesembryanthemaceae. South Africa. *Flowering plants of Africa* 58: 70–73.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 13 581

Chesselet, P., Hammer, S.A. & Oliver, I. 2003. *Brianhuntleya*, a new genus endemic to the Worcester-Robertson Karoo, South Africa. Notes on African plants. Mesembryanthemaceae. *Bothalia* 33:160–164.

Appendix 14 587

Chesselet, P. 2001. A new combination in *Antimima* N.E.Br. (Mesembryanthemaceae). *Aloe* 38: 17.

Appendix 15 589

Taxon x character state matrix for identification of mesembs genera.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 1

Chesselet, P., Mössmer, M. & Smith, G.F. 1995. Research priorities in the succulent plant family Mesembryanthemaceae Fenzl. *South African Journal of Science*. 91: 197–209.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Research priorities in the succulent plant family Mesembryanthemaceae Fenzl

Pascale Chesselet, Marthina Mössmer and Gideon F. Smith

National Botanical Institute, Private Bag X101, Pretoria, 0001 South Africa.

The Mesembryanthemaceae, South Africa's largest succulent plant family, constitutes a major part of the southern African succulent flora. With approximately 1 800 species in 117 genera, it is also South Africa's second largest plant family. It is almost entirely endemic to southern Africa, although a few species occur naturally outside this region. We view the group as a distinct family and recommend using the legitimate family name Mesembryanthemaceae Fenzl. The re-inclusion of this group in the Aizoaceae is not advocated here.

More than three-quarters of Mesembryanthemaceae species have never been revised. This neglect by systematists is rooted primarily in the magnitude of the group and the morphological problems associated with succulence. This article aims to summarize the current taxonomic status of mesemb genera, highlight the problematic areas in mesemb classification, and prioritize taxonomic research in the Mesembryanthemaceae. We detail the hierarchic level at which taxonomic treatments are available, indicate the hierarchic level which is seen as most problematic, and provide subjective priority ratings for each genus as a guideline for future research.

The Mesembryanthemaceae is South Africa's largest succulent plant family, comprising *c.* 63% of the southern African succulent flora.[1] With an estimated 1 800 species in 117 genera, it is also South Africa's second largest plant family. The group is almost entirely endemic to southern Africa.

To most South Africans, plants of the Mesembryanthemaceae are known as *vygies*. This Afrikaans vernacular name is often qualified by a descriptive prefix, as in *skaapvygie* or *tierbekvygie*.[2] The name 'midday flower' reflects the original name, *Mesembrianthemum*, which refers to the opening of flowers around noon, proposed in 1689 by Breyne. Other common names include fig-marigold, ice plant and mesemb. For convenience, we use *mesemb* to refer to any member of the Mesembryanthemaceae throughout this article.

Despite its significance in terms of numbers of genera and species, endemism, arid land agriculture and horticultural appeal, the Mesembryanthemaceae remains one of the problem groups of South African botany. Only 21% of species have been revised since 1940 – a significant date in mesemb taxonomy, as most genera were described in the 1920s and 1930s. This unsatisfactory state of affairs has important implications – from a lack of understanding of phylogenetic relationships, to the uncertain and often confusing use of names in horticulture, conservation biology and ecology.

The purpose of this article is primarily to stimulate intensified taxonomic research in the Mesembryanthemaceae. We have summarized the current taxonomic status of mesemb genera, provided references to species level revisions for currently accepted genera, highlighted problematic areas in mesemb classification, and prioritized taxonomic research by indicating the urgency of species level treatments for this extraordinary family. Author citations for genera and species, following Brummitt and Powell,[3] are given in Tables 3 and 4, or in the text. References for the genera and higher taxa, and the most recent taxonomic revisions for all currently accepted genera are listed in the Appendix.

Historical overview

The taxonomy of the Mesembryanthemaceae started in 1753 when Linnaeus listed 35 species under the genus *Mesembryanthemum* in his *Species Plantarum*. The subsequent introduction of large numbers of novel southern African mesembs to European botany during the late 18th century made this single genus increasingly heterogeneous and unwieldy, with most species assigned to it on the basis of the superficial resemblance of their flowers.[4] Haworth,[5] in his *Revisiones Plantarum Succulentarum*, described 310 species of *Mesembryanthemum*, which he grouped under 69 different sections. He considered some of these sections to be distinct genera, but – with the exception of the genus *Hymenogyne* – did not publish generic names. In his *Monographiae Generum Aloes et Mesembryanthemi* (1836–1863) – a collection of lithographed and partly hand-coloured plates accompanied by Latin descriptions – Salm-Dyck divided both *Aloe* and *Mesembryanthemum* into numerous sections distinguished by numbers.[6] Subsequent monographers of *Mesembryanthemum*, such as Berger,[7] based their compilations mainly on Salm-Dyck's illustrations and descriptions. These, although beautifully figured, are notorious for their lack of structural detail of reproductive organs, and misapplied names.

It was not until 172 years after Linnaeus's original description that N.E. Brown of Kew, following intensive investigation of floral, fruit and seed characters of original plant material, began dismantling *Mesembryanthemum*. He wrote: 'All of us have followed one another blindly by accepting the generic characters as given in books without investigating their applicability as a whole to the various species.'[8] Brown, who had never travelled to the countries of origin of the succulents that he studied for more than 60 years, had remarkable powers of minute observation, and recognizable drawings could be made from his plant descriptions.[9] He made the fundamental distinction between species with axile placentation and those with 'parietal' placentation,[4] which now forms the basis for the separation of the Mesembryanthemaceae into two subfamilies, the Mesembryanthemoideae and Ruschioideae (Fig. 1). The mesembs subsequently underwent extensive generic fragmentation, and more than 120 genera[6] are widely recognized.

Brown's discovery[4] initiated intense interest in the supra-specific taxonomy of the Mesembryanthemaceae. The main players in the ensuing race to establish genera and describe new species were based in England, Germany and South Africa.

Professor G. Schwantes, a German prehistorian and amateur botanist, provided a basic typification of mesemb seed capsules.[10-12] Loculicidal hygrochastic capsules, which repeatedly open when wet and close when dry, are characteristic of the Mesembryanthemaceae.[13] Schwantes' classification was refined by Hartmann,[13] who described nine unique morphological functional syndromes for capsules of the entire group. Schwantes also described a number of genera and provided the first supra-generic classification of the group,[14] which was later amended by Schwantes,[12,15] Ihlenfeldt, Schwantes and Straka,[16] and Straka

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

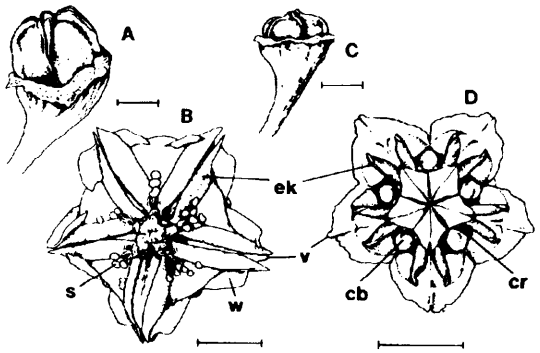


Fig. 1. Fruit capsules of the Mesembryanthemaceae. *A, B* Mesembryanthemoideae: *Mesembryanthemum crystallinum* L. (H.F. Glen *1180*); *C, D* – Ruschioideae: *Ruschia rigidicaulis* (Haw.) Schwantes (E.J. van Jaarsveld *13110*). In both subfamilies, the hygrochastic loculicidal capsules are closed when dry (*A, C*) and open when wet (*B, D*). The repetitious dehiscence mechanism, whereby the valves (V) that form the lid of the capsule are opened, relies on the response of expanding keels (EK) to moisture, limiting the dispersal of seeds to wet weather conditions. This unique dispersal mechanism is particularly suited to dissemination and germination in habitats where rainfall is episodic. Seeds are liberated from the open capsules. Dispersal mechanisms are usually more complex in the Ruschioideae than in the Mesembryanthemoideae: various contrivances such as closing bodies (CB), closing rodlets (CR), and covering membranes (CM) over the seeds, control and direct dispersal. In all mesembryanthemoid genera, the placenta is axile. Seeds (S) are visible and may become lodged under wings (W). Placentation is parietal or basal in the Ruschioideae. Scale bar = 5 mm.

and Ihlenfeldt following Schwantes in Herre.[5]

In South Africa, Mrs H.M.L. Bolus described a number of genera but specialized in the description of new species – a total of 1 445 between 1928 and 1958! She often named new species after people, encouraging collectors from all over South Africa to send her all the mesembs they could find. Although she is sometimes described as the ultimate splitter, her descriptions of geographic variants are valuable to modern taxonomists.[17] Beautiful paintings by Mary Page and Beatrice Carter accompanied her descriptions. The well-curated collection at the Bolus Herbarium (BOL), containing many type specimens, provides a sound base for mesemb research in South Africa.

Few South African botanists, however, have included the Mesembryanthemaceae in their research programmes; notable exceptions being Bolus,[18-20] Nel,[21] Leistner,[22,23] Lavis,[24,25] Glen,[26,27] and Van Jaarsveld.[28-30] During the past few decades, scientists from outside South Africa have produced most of the research on the Mesembryanthemaceae. The Hamburg Working Group on Mesembryanthema has provided numerous revisions, as well as lists of genera for the Royal Botanic Gardens, Kew,[31] and the US Department of Agriculture.[32]

Familial relationships and classification

The mesembs are widely classified under the family Aizoaceae, in the order Centrospermae or Caryophyllales. Despite intensified interest in the familial relationships of the order,[33-37] the phylogenetic position of the Aizoaceae among the betalain-producing centrosperms remains problematic.[34,35,38] In addition, the taxonomic status of the mesembs – either as a separate family (Mesembryanthemaceae) or as two of the five subfamilies of the Aizoaceae – is controversial (Table 1).

The relationship of the mesembs with the Aizoaceae was recently re-examined,[38-41] and the familial rank they had aquired in the late 1940s[42] was lost through their re-integration in the Aizoaceae.[43] The informal name 'Mesembryanthema'[44] is widely used to distinguish mesembs from aizoaceous taxa. At the National Herbarium (PRE) the family name Mesembryanthemaceae is preferred.

There are a number of reasons for upholding the familial status of the mesembs: primarily their distinctness from the remaining subfamilies of Aizoaceae *sensu stricto* and their common ancestry.[39,43] The monophyly of the Aizooideae, Sesuvioideae and Tetragonioideae as a group is, however, uncertain.[38,43] Synapomorphic characters of groups within the Aizoaceae *sensu stricto* are shown in Table 2.

Distribution: centres of diversity and collecting intensity

Distribution patterns of genera of the Mesembryanthemaceae in southern Africa were recently analysed by Jürgens[45] and updated by Hartmann[44] (Fig. 2). Results show that the highest frequency of genera occurs in the western part of southern Africa – the arid and semi-arid winter rainfall area. The dominance of Ruschioideae and Mesembryanthemoideae forms the base of the description of the 'leaf succulent zone.'[45,46] It is generally accepted that these high genus frequencies reflect the original distribution area of Mesembryanthemaceae.[13,44-48]

Five centres of diversity are currently recognized for the Mesembryanthemaceae (Fig. 2: *A–E*). Endemism at the generic level is high (*c.* 60%) in the Gariep and Little Karoo centres. It is

Table 1. Names applicable to the mesembs with the appropriate author citations. When interpreted as part of the Aizoaceae *sensu stricto*, the mesembs comprise two of five subfamilies. Together, the two subfamilies are often referred to as 'Mesembryanthema.' If the mesembs are regarded as a separate family, as is advocated here, the name Mesembryanthemaceae is correct.

Aizoaceae Rudolphi *sensu stricto* (following Bittrich and H.E.K.Hartmann excluding Molluginaceae)				
Mesembryanthemoideae Ihlenf., Schwantes and Straka	Ruschioideae Schwantes in Ihlenf., Schwantes and Straka emend. Bittrich and H.E.K.Hartmann	Aizooideae	Sesuvioideae Lindley	Tetragonioideae Lindley
'Mesembryanthema'				
Mesembryanthemaceae Fenzl emend. A.G.J.Herre and Volk		**Aizoaceae** Rudolphi *sensu stricto* (excluding Mesembryanthemaceae)		
Mesembryanthemoideae	Ruschioideae Schwantes in Ihlenf., Schwantes and Straka emend. Bittrich and H.E.K.Hartmann			

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Table 2. Synapomorphic (shared advanced) characters defining the mesembs and related taxa.

Taxa	Synapomorphies
Aizoaceae *sensu stricto*	epidermal bladder-cell idioblasts
Aizoaceae *sensu stricto* (excluding Mesembryanthemaceae)	perianth petaloid on inside, sepaloid on outside druse crystals of calcium oxalate $n = 8$
Mesembryanthemaceae	semi-epigynous or epigynous flowers petals of staminodal origin raphide crystals of calcium oxalate $n = 9$
Mesembryanthemoideae	stamens and petals (mostly) forming a tube nectaries koilomorphic (shell-shaped) cortical bundles present expanding tissue present as expanding keels
Ruschioideae	stamens hairy at base nectaries lophomorphic (crest-shaped) placentation basal or parietal expanding keels more or less restricted to valves covering membranes present

Note: The Aizoaceae *sensu stricto* relies on a single controversial synapomorphy – epidermal idioblast cells. The development of a simple hygrochastic or hygroscopic capsule with septal expanding tissue has been suggested as another possible synapomorphy for the Aizoaceae *sensu stricto*. Refer to Table 1 for a circumscription of these groups. Data from Bittrich and Hartmann[38] and Bittrich and Struck.[39]

less significant in the Vanrhynsdorp centre (*c.* 30%), where the highest frequency of different genera is found. Hartmann[44] interprets high levels of endemic genera as indicative of a long history in which evolution at generic level could take place. Data relating to endemism at species level are not available.

The number of mesemb genera drops quite severely in the summer rainfall area, and the central southern African plateau is generally regarded as impoverished in its mesemb flora.[44] Hartmann[44] points out that in the summer rainfall areas, present patterns reflect only the state of field work, precluding phytogeographical interpretations.

As is the case for most succulent plants, the mesembs are largely undercollected by South African botanists. A lack of expertise in identification has compounded this neglect. Until recently, there has not been a taxonomist dedicated to mesemb curation, identification and research in the National Herbarium, and the treatment of this family in the recently published *Plants of southern Africa: names and distribution*[49] is, at best, an unsatisfactory approximation.

Succulence: implications for taxonomy

Although difficult to circumscribe,[1] succulents are generally regarded as adapted to seasonal drought in arid environments. In contrast to other xerophytic plants, succulents tolerate drought by storing water in the tissues of various organs, most commonly in the leaves. Accordingly, water relations are optimized and prioritized against other factors such as carbon gain.[50] A variety of succulent strategies can be observed in the Mesembryanthemaceae.[29] Specialized photosynthetic carbon fixation mechanisms are associated with succulence and have been investigated in a number of representatives of the Mesembryanthemaceae.[30,31] In addition to the usual C_3 pathway of carbon fixation, most succulents use CAM (Crassulacean Acid Metabolism) whereby CO_2 is taken up through the stomatal apertures at night. Some plants shift from C_3 to CAM in response to changing environmental conditions.[50] Insufficient data on the taxonomic distribution of photosynthetic pathways, which have been shown to relate to growth form,[51] have limited the use of these characters in taxonomy.

A striking aspect of succulent plant morphology is the phenomenon of convergence in phylogenetically remote groups. Morphological convergence is more apparent in succulents than in any other plant type; this suggests limitations to the number of solutions under similar selective forces.[50] Life-form systems, such as that proposed by Jürgens[52] for succulent plants, reflect convergent evolution. The identification of homologous characters in systematics is obscured by the superficial similarities of convergent features. The sharing of characters between taxa which have evolved along different lines can be observed not only in different succulent families, but also across genera within a family. The windowed, truncate leaves and similar sunken growth forms of *Fenestraria rhopalophylla* (Schltr. and Diels) N.E.Br. (Leipoldtiinae; Ruschioideae), *Frithia pulchra* N.E.Br. (uncertain affinities; Ruschioideae) and *Haworthia maughanii* Poelln. (Aloaceae) exemplify convergence in growth form within a family, as well as across the widely divergent Dicotyledonae and Monocotyledonae.

Ontogenetic studies have provided some clues regarding evolutionary processes in the Mesembryanthemaceae. Dupont,[53] in a detailed study of the ontogeny of seedlings, found that the least succulent species presented the most variation in the course of their ontogeny. Conversely, the most succulent species have a very much reduced phase of ontogenetic development in seedling stages. Her results are corroborated by Ihlenfeldt,[54] who notes that in species with maximum adaptation, the young is identical

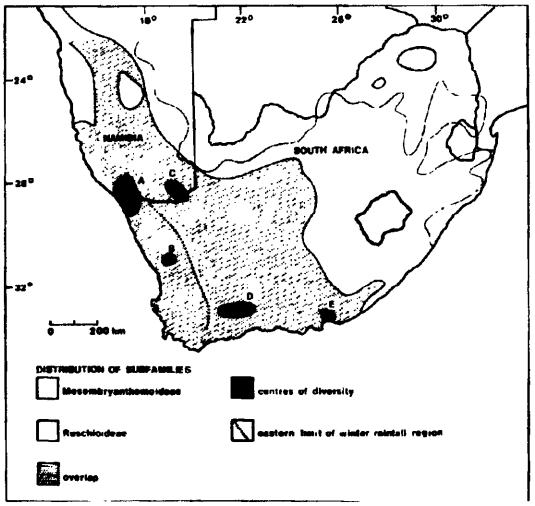


Fig. 2. Centres of high genus frequency for the Mesembryanthemaceae in southern Africa. *A* = Gariep Centre (30 genera, 15 endemic genera); *B* = Vanrhynsdorp Centre (31 genera, eight endemic genera); *C* = Pofadder Centre (14 genera, two endemic genera); *D* = Little Karoo Centre (27 genera, 12 endemic genera) and *E* = Albany Centre (18 genera, number of endemic genera uncertain) (modified from Hartmann[44]). The highest genus frequency for the family is found in the dry winter rainfall region of South Africa. Two major centres, the Gariep and Vanrhynsdorp, occur in this area. The arid Pofadder Centre, which extends across the border from south-eastern Namibia into the adjacent Northern Cape Province, receives rain mostly in March. Two isolated centres, the Little Karoo and the Albany, are situated outside the winter rainfall area. Both subfamilies have their highest frequency of genera in the arid west. The distribution of Ruschioideae genera extends throughout southern Africa, whereas genera of the Mesembryanthemoideae are concentrated in the western part of southern Africa.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Table 3. Current taxonomic status of the subfamily Mesembryanthemoideae. The level at which taxonomic resolution is available is indicated in column 4 as follows: S-TRIB = position in subtribe established, GEN = generic delimitations satisfactory, S GEN = treatment available to subgenus level, SPE = species level revision available with or without a key to species. Research priorities are detailed in column 5 for each genus: GEN-REL = generic relations problematic, GEN-DEL = generic delimitations problematic, SPE-LEV = species level revision required. Our own priority ratings are provided in column 6. Those groups that require urgent taxonomic revision are indicated with three asterisks. A single asterisk indicates low priority either because the groups are under revision, or recent treatments are available. Genera not regarded as urgently requiring revision are given two asterisks.

Genus author citation = Important synonyms	Number of species PRE	Number of species Hartmann (1993)	Level of taxonomic resolution	Research priorities	Urgency of treatment	Date established	Date of latest revision
Aptenia N.E.Br. = *Platythyra* N.E.Br.	3	*c.* 4	GEN	SPE-LEV	*	1925	-
Aspazoma N.E.Br.	1	1	GEN	SPE-LEV	*	1925	-
Brownanthus Schwantes	8	*c.* 8	GEN, SPE	GEN-DEL	*	1927	1985
Dactylopsis N.E.Br.	2	1–2	GEN	SPE-LEV	*	1925	-
Mesembryanthemum L., emend. L.Bolus = *Callistigma* Dinter and Schwantes = *Cryophytum* N.E.Br. = *Derenbergiella* Schwantes = *Eurystigma* L.Bolus = *Halenbergia* Dinter = *Hydrodea* N.E.Br. = *Opophytum* N.E.Br.	*c.* 50	*c.* 25	GEN, S-GEN	SPE-LEV	*	1753	-
Phyllobolus N.E.Br. = *Amoebophyllum* N.E.Br. = *Aridaria* N.E.Br. = *Prenia* N.E.Br. = *Sceletium* N.E.Br. = *Sphalmanthus* N.E.Br.	150	25	GEN, S-GEN	GEN-DEL, SPE-LEV	*	1925	-
Pseudobrownanthus Ihlenf. and Bittrich	1	1	GEN, SPE	GEN-DEL	*	1985	-
Psilocaulon N.E.Br.	66	*c.* 12	GEN	SPE-LEV	*	1925	-
Synaptophyllum N.E.Br.	1	1	GEN	SPE-LEV	*	1925	-

Note: The same coding is used for genera of the Ruschioideae (Table 4).

to the adult through a process of ontogenetic abbreviation.

A confounding problem to mesemb taxonomy is morphological change that occurs in response to environmental factors such as watering regime and light intensity. In his treatment of *Glottiphyllum*, section *Linguæformia*, Haworth[55] observed that 'every individual of this section varies in size and gloss, and even in length of peduncle, from being well or poorly fed: and it is only when out of doors, and in unshaded situations, that the true direction of the leaves can be depended on....' The term 'phenotypic plasticity' is often used to describe these responses, but in the mesembs phenotypic changes do not appear to be fixed during development. The phenotype may change as fast as the environment. Such traits have been termed labile[56] and are physiologically based.

For the taxonomist the implications of environmentally induced changes in certain characters are important. The poor quality of succulent plant herbarium material necessitates the study of live specimens. In addition to field studies of plant populations, which are often costly and time-consuming, greenhouse-kept plants are usually used for further study. However, in many genera, leaf characteristics such as size, pigmentation and orientation of cultivated plants differ from those of plants growing in their natural habitat. Dupont[53] notes that *Eberlanzia spinosa* (L.) Schwantes no longer produces spines under greenhouse conditions, and that humidity may prevent the formation of the diadem crowning the leaves of *Trichodiadema*. Such drastic changes in cultivation considerably complicate the use of morphological characters in taxonomic studies and emphasize the importance of field observations.

The genera of the Mesembryanthemaceae

In this article, the 117 genera of the Mesembryanthemaceae are arranged according to subfamily, with the genera of the Mesembryanthemoideae (Table 3) and those of the Ruschioideae (Table 4) presented separately. Our primary objective was to detail research priorities in a simple and easily accessible way.

The first column of each table contains accepted generic names with their correct author citations. The dates of initial publication of genera and of taxonomic treatments at species level are given in columns seven and eight. In columns two and three, the number of species recognized by the National Herbarium (PRE) (i.e. an approximation of validly published names) is contrasted with the number of species recognized or estimated by Hartmann[43] for each genus. The latter number, in many cases, may be a more reliable assessment of the real situation. Discrepancies in these numbers reflect the extent to which species level taxonomy is problematic.

The hierarchic level (i.e. subtribe, genus, subgenus and species) at which revisions are available is shown in the fourth column. Similarly, in column five, priority areas of research for each genus indicate the hierarchic level we see as most problematic. For example, in an unrevised genus, the main problem area might be in the delimitation of that genus and its overlap with other genera (GEN-DEL), or the genus might be well defined, but its relation to other genera might be problematic (GEN REL). Sub-

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Table 4. Current taxonomic status of the subfamily Ruschioideae. Refer to explanation of codes in caption of Table 3.

Genus author citation	Number of species PRE	Number of species Hartmann (1993)	Level of taxonomic resolution	Research priorities	Urgency of treatment	Date established	Date of latest revision
Acrodon N.E.Br.	4	4	S-TRIB, SPE	GEN-DEL	*	1927	1986
Aethephyllum N.E.Br.	1	1	S-TRIB, GEN, SPE	-	*	1928	1986
Aloinopsis Schwantes	15	*c.* 12	GEN, SPE	GEN-REL, GEN-DEL	***	1926	1958
Amphibolia L.Bolus ex A.G.H.Herre	1 + 4 incertae sedis	-	GEN, SPE	GEN-DEL	*	1971	1989
Antegibbaeum Schwantes ex C.Weber	1	1	SPE	GEN-REL	**	1968	-
Antimima N.E.Br. emend Dehn	6 valid	*c.* 60	S-TRIB, GEN, S-GEN	SPE-LEV	***	1930,1988	
Apatesia N.E.Br.	3	*c.* 2	GEN, SPE	-	*	1927	1990
Arenifera A.G.H.Herre	1	1	S-TRIB	GEN-DEL	**	1948	-
Argyroderma N.E.Br.	10	10	S-TRIB, GEN, SPE	-	*	1922	1977
Astridia Dinter	7	*c.* 7	S-TRIB, SPE	GEN-DEL, SPE-LEV	**	1926	1986
Bergeranthus Schwantes	11	12	-	GEN-DEL	***	1926	-
Bijlia N.E.Br.	1	1	SPE	-	*	1928	1992
Braunsia Schwantes	5	4–6	-	GEN-DEL, SPE-LEV	***	1928	-
Calamophyllum Schwantes	3	-	-	GEN-DEL	***	1927	-
Carpanthea N.E.Br.	1	1	GEN, SPE	-	*	1925	1990
Carpobrotus N.E.Br.	7	*c.* 25	SPE	GEN-DEL	**	1925	1993
Carruanthus (Schwantes) Schwantes	2	1–2	-	GEN-DEL	***	1927	-
Caryotophora Leistner	1	1	GEN, SPE	-	*	1958	1990
Cephalophyllum N.E.Br.	30	30	S-TRIB, GEN, S-GEN, SPE	-	*	1925	1988
Cerochlamys N.E.Br.	1	1	-	GEN-DEL	***	1928	-
Chasmatophyllum Dinter and Schwantes	6	*c.* 6	-	GEN-DEL, SPE-LEV	***	1927	-
Cheiridopsis N.E.Br.	25	23	S-TRIB, GEN, S-GEN, SPE	-	*	1925	1987
Circandra N.E.Br.	1	1	GEN, SPE	-	*	1930	1989
Cleretum N.E.Br.	3	3	S-TRIB, GEN, SPE	-	*	1925	1986
Conicosia N.E.Br.	2	*c.* 2	GEN, S-GEN, SPE	-	*	1925	1990
Conophytum N.E.Br.	87	*c.* 290	GEN, SPE	-	*	1922	1993
Cylindrophyllum Schwantes	6	*c.* 5	-	GEN-DEL, SPE-LEV	***	1927	-
Delospema N.E.Br. emend Lavis	163	155	-	GEN-DEL, SPE-LEV	***	1925	-
Dicrocaulon N.E.Br.	7	*c.* 12	S-TRIB	SPE-LEV	**	1928	-
Didymaotus N.E.Br.	1	1	SPE	-	**	1925	-
Dinteranthus Schwantes	4	5	SPE	-	*	1926	1978
Diplosoma Schwantes	2	2	S-TRIB, GEN, SPE	-	*	1926	1988
Disphyma N.E.Br.	2	*c.* 3	-	GEN-REL, SPE-LEV	*** (*Austr.)	1925	-
Dorotheanthus Schwantes	6	5	S-TRIB, GEN, SPE	-	*	1927	1986
Dracophilus (Schwantes) Dinter and Schwantes	4	3–4	SPE	GEN-DEL	**	1927	1939
Drosanthemopsis Rauschert	2	2	GEN	-	*	1982	-
Drosanthemum Schwantes	112	*c.* 100	-	SPE-LEV	***	1927	-

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Table 4. Continued.

Genus author citation	Number of species PRE	Number of species Hartmann (1993)	Level of taxonomic resolution	Research priorities	Urgency of treatment	Date established	Date of latest revision
Eberlanzia Schwantes	1+ 1 incertae sedis	*c.* 12	S-TRIB, GEN, SPE	GEN-DEL, SPE-LEV	*	1926	1993
Ebracteola Dinter and Schwantes	5	5	SPE	GEN-REL	*	1927	1986
Ectotropis N.E.Br.	1	(1 pers. commun.)	-	GEN-DEL, SPE-LEV	*	1927	-
Enargantha N.E.Br.	1	1	GEN	SPE-LEV	**	1930	-
Erepsia N.E.Br.	27	27	GEN, SPE	-	*	1925	1989
Esterhuysenia L.Bolus	1	1	GEN	SPE-LEV	**	1967	-
Faucaria Schwantes	33	33		GEN-REL, GEN-DEL, SPE-LEV	*	1926	-
Fenestraria N.E.Br.	1	1	S-TRIB, GEN, SPE	-	*	1925	1982
Frithia N.E.Br.	1	1	-	GEN-REL, SPE-LEV	***	1925	-
Gibbaeum (Haw.) N.E.Br.	15	*c.* 15	SPE	GEN-REL	**	1921	-
Glottiphyllum N.E.Br.	16	16	SPE	GEN-REL	*	1921	1993
Hallianthus H.E.K.Hartmann	1	1	S-TRIB, GEN, SPE	-	*	1983	-
Hereroa (Schwantes) Dinter and Schwantes	31	*c.* 30	-	GEN-REL, GEN-DEL, SPE-LEV	***	1927	-
Hymenogyne Haw.	2	2	GEN, SPE	-	*	1821	1990
Ihlenfeldtia H.E.K.Hartmann	2	2	GEN, SPE	-	*	1992	-
Imitaria N.E.Br. Sum	1	1	SPE	-	*	1927	-
Jacobsenia L.Bolus and Schwantes	2	2	S-TRIB	GEN-REL	**	1954	-
Jensenobotrya A.G.H. Herre	1	1	-	GEN-REL	**	1951	-
Jordaaniella H.E.K.Hartmann	4	4	S-TRIB, GEN, SPE	-	*	1983	-
Juttadinteria Schwantes	12	*c.* 5	SPE	GEN-DEL, SPE-LEV	**	1926	1939
Khadia N.E.Br.	6	*c.* 5	-	GEN-REL, SPE-LEV	*	1930	
Lampranthus N.E.Br.	219	*c.* 180	-	GEN-DEL, SPE-LEV	***	1930	-
Lapidaria (Dinter and Schwantes) N.E.Br.	1	1	-	GEN-DEL	***	1928	
Leipoldtia L.Bolus	21	10	S-TRIB, GEN, S-GEN	SPE-LEV	**	1927	-
Lithops N.E.Br.	35	35	SPE	GEN REL	*	1922	1988
Machairophyllum Schwantes	10	10	-	GEN-REL, SPE-LEV	***	1927	-
Malephora N.E.Br.	14	8–9	-	GEN-REL, SPE-LEV	***	1927	-
Mestoklema N.E.Br. ex Glen	6	6	-	SPE-LEV	***	1936, 1981	-
Meyerophytum Schwantes	1	1	-	SPE-LEV	***	1927	-
Mitrophyllum Schwantes	6	6	S-TRIB, GEN, S-GEN, SPE	-	*	1926	1976
Montlaria (Schwantes) Schwantes	5	5	S-TRIB, SPE	-	*	1929	1973
Mossia N.E.Br.	1	1	-	GEN-REL	**	1930	-
Mutria N.E.Br.	1	1	-	GEN-REL	*	1927	-
Namaquanthus L.Bolus	1	1	-	GEN-REL	***	1954	-
Namibia (Schwantes) Schwantes	2	1	SPE	GEN-DEL	**	1927	1939
Nananthus N.E.Br.	10	*c.* 7	SPE	GEN-DEL, SPE-LEV	***	1925	1958

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Table 4. Continued.

Genus author citation	Number of species PRE	Number of species Hartmann (1993)	Level of taxonomic resolution	Research priorities	Urgency of treatment	Date established	Date of latest revision
Nelia Schwantes	4	1	-	GEN-REL, SPE-LEV	***	1928	-
Neohenricia L.Bolus	2	1	-	-	*	1938	-
Octopoma N.E.Br.	8	8	GEN	GEN-DEL, SPE-LEV	***	1930	-
Odontophorus N.E.Br.	3	3	S-TRIB, GEN, SPE	-	*	1927	1976
Oophytum N.E.Br.	2	2	S-TRIB, SPE	-	*	1925	1978
Ophthalmophyllum Dinter and Schwantes	10	*c.* 15	SPE	SPE-LEV	*	1927	1993
Orthopterum L.Bolus	2	2	-	GEN-DEL	***	1927	
Oscularia Schwantes	3	1–3	-	GEN-DEL	***	1927	-
Ottosonderia L.Bolus	2	1	-	GEN-REL	**	1958	-
Pleiospilos N.E.Br.	4	4	GEN, S-GEN, SPE	-	*	1925	1986
Polymita N.E.Br.	2	2	S-TRIB	GEN-REL	**	1930	-
Psammophora Dinter and Schwantes	4	2–3	-	GEN-DEL, SPE-LEV	**	1926	-
Rabiea N.E.Br.	7	*c.* 4	-	GEN-REL, SPE-LEV	***	1930	1958
Rhinephyllum N.E.Br.	14	*c.* 14	-	GEN-DEL, SPE-LEV	***	1927	-
Rhombophyllum (Schwantes) Schwantes	3	3	-	GEN-DEL	***	1927	-
Ruschia Schwantes	289	*c.*350	S-TRIB, GEN, S-GEN	GEN-DEL, SPE-LEV	***	1926	-
Ruschianthemum Friedrich	1	2	S-TRIB	GEN-REL	**	1960	-
Ruschianthus L.Bolus	1	1	-	GEN-REL	**	1961	-
Saphesia N.E.Br.	1	1	GEN, SPE	-	*	1932	1990, 1994
Sarcozona J.M. Black (Australia)	(2)		GEN, SPE	GEN-DEL	**	1934	1969
Schlechteranthus Schwantes	2	2	-	GEN-DEL, GEN-REL	**	1929	-
Schwantesia Dinter	10	3–5	-	GEN-REL, SPE-LEV	***	1927	-
Scopelogena L.Bolus	2	2	-	GEN-REL	**	1962	-
Skiatophytum L.Bolus	1	1	GEN, SPE	-	*	1927	1990
Smicrostigma N.E.Br.	1	1	-	GEN-REL	***	1930	
Stayneria L.Bolus	1	1	S-TRIB	GEN-REL	**	1961	
Stoeberia Dinter and Schwantes emend. Friedrich	3	3	S-TRIB, SPE	-	*	1927, 1960	1994
Stomatium Schwantes	40	40	-	GEN-REL, SPE-LEV	***	1926	-
Tanquana H.E.K. Hartmann and Liede	3	3	GEN, S-GEN, SPE	-	*	1986	
Titanopsis Schwantes	6	*c.* 6	-	GEN-REL, GEN-DEL, SPE-LEV	***	1926	-
Trichodiadema Schwantes	36	*c.* 30	-	SPE-LEV	***	1926	-
Vanheerdea L.Bolus ex H.E.K.Hartmann	2	2	GEN, SPE	-	*	1938, 1992	-
Vanzylia L.Bolus	1	1	S-TRIB, GEN	-	*	1927	
Wooleya L.Bolus	1	1	-	GEN-REL	***	1961	-
Zeuktophyllum N.E.Br.	1	1	-	GEN-REL	**	1927	-

jective priority ratings are indicated as asterisks in the sixth column. A single asterisk indicates low priority either because the genus is under revision or an adequate treatment is available. Two asterisks were assigned to genera in need of revision, but not pressingly. Three asterisks signify genera urgently in need of treatment. A number of criteria were used to assign high-priority ratings. These include: the publication date of the latest revision and its value in the context of current knowledge; an overall lack of knowledge of the genus, including taxonomy, ecology and distribution, e.g. *Delosperma*; the existence of several undescribed

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

species in a genus, e.g. *Hereroa*; nomenclatural problems arising through an obvious need for synonymization, e.g. *Ruschia*; genera for which only unpublished revisions are available, e.g. *Lampranthus*; and the frequency with which material of problematic groups (e.g. *Delosperma*, *Ruschia*, *Lampranthus*) is submitted to PRE for identification. Providing species names for such genera is difficult, and often impossible. It is not unusual that a combination of these criteria applies to a single genus, e.g. *Delosperma*.

One of the main reasons for differences in the number of species (columns two and three) is the lack of formal species level treatments in a large number of genera. Some genera have been revised to the generic and subgeneric level, omitting revision of species (e.g. *Antimima*, *Mesembryanthemum*, *Phyllobolus*). Without follow-up treatments of species, these efforts to sort out generic limits have created more confusion at species level. With the exception of nomenclatural types for subgenera, new combinations and new names have not been published as required by the International Code of Botanical Nomenclature (ICBN)[57] and valid species names are not available for the revised genera.

Problems at the generic level are discussed by Hartmann,[43,44] who has provided keys to and descriptions of genera of the Mesembryanthemaceae.[43,58]

The Mesembryanthemoideae

Plants assigned to the Mesembryanthemoideae are primarily distinguished from ruschioid genera by the axile placentation of the ovary. The majority of Mesembryanthemoideae species have subcylindrical leaves and most are suffruticose. Some species are herbaceous with large flat leaves covered with glistening papillae, e.g. *Mesembryanthemum crystallinum* L. The group also includes 'articulated' stem succulents with reduced leaves, such as *Psilocaulon* and *Brownanthus*.

Since the recent morphological and phylogenetic work of Bittrich,[48] the taxonomy of the subfamily Mesembryanthemoideae has been in a state of flux. Presently, nine genera with a number of subgenera are recognized (Table 3). In Bittrich's study, a number of genera were placed in synonymy; these genera are denoted by = in Table 3. New combinations have not been published under the new genera and consequently valid species names are not available. Only 3% (*Pseudobrownanthus* and *Brownanthus*)[59] have been treated at the species level. The entire subfamily is presently under revision at the Bolus Herbarium (BOL). At PRE, a total of 282 species names is listed for the Mesembryanthemoideae. This high figure – compared to Hartmann's[43] total of 95 – is undoubtedly an overestimation of the true number of species.

The Ruschioideae

The majority of mesembs, including the well-known collector's genera such as *Lithops*, *Conophytum* and *Faucaria*, are classified in the Ruschioideae. This subfamily is distinguished by the basal or parietal position of the placenta in the ovary. Capsule types are diverse and often highly complex. Generally, leaves are opposite and connate. A variety of growth forms occur in this group. Genera such as *Lithops* and *Frithia* grow almost entirely underground with only the windowed[60] upper surfaces of the leaves protruding above ground. Genera with almost spherical plant bodies, e.g. *Conophytum* and *Argyroderma*, have achieved the ultimate reduction in surface to volume ratio. In contrast, genera such as *Ruschia*, *Erepsia* and *Lampranthus* are shrubby, with succulent leaves. Creeping growth forms are characteristic of a number of genera, including *Cephalophyllum*, *Mossia* and *Carpobrotus*. Although most ruschioids are perennial, moderately succulent genera such as *Dorotheanthus* have annual life cycles. Ruschioid genera inhabiting the summer rainfall region of southern Africa often have enlarged roots, with mat-forming or shrubby above-ground parts, e.g. *Khadia*, *Delosperma* and *Hereroa*. These roots may provide a sink for reserves during the dormant winter season. A single taxon, *Stoeberia beetzii* (Dinter) Dinter and Schwantes var. *arborescens* Friedrich, has been accorded tree status.[61] More recently, a new species of *Stoeberia*, reaching heights of up to 3.5 m, was discovered by van Jaarsveld.[30]

Of the 1 518 species (PRE) in the Ruschioideae, only 25% have been revised at species level. In Table 4, 108 genera are listed, including the Australian genus *Sarcozona*, which is often understood as a synonym of *Carpobrotus*, and *Amphibolia*, which Hartmann[43] has sunk under *Eberlanzia*. Species level treatments are not available for either of these transfers. *Imitaria* is included although it should be sunk in *Gibbaeum*.[62,63] *Corpuscularia* Schwantes is listed by Hartmann,[43,44] but is not listed in Table 4 as its segregation from *Delosperma* has not yet been concluded at species level. The controversial genus *Marlothistella* Schwantes[64] is not included, as it was sunk under *Ruschia*[65] and has not been formally re-instated. The Australian species of *Disphyma* are currently under investigation. Extinction appears to have been the fate of the monotypic genus *Circandra*.[66]

Analysis

The overall classification of the Mesembryanthemaceae is by no means adequate or uniformly critical, particularly if one considers the large percentage of unrevised taxa. The wide variation encountered in the vegetative morphology of this group further complicates taxonomic interpretation, creating difficulties in applying uniform species and genus concepts. Yet a consistent classification with comparability between taxa at a given taxonomic rank is preferable,[67] whether it be produced by a lumper or a splitter.

Williams[67] analysed a number of classifications and found that in almost every modern classification the number of monotypic genera is greater than the number of genera with two species; and the number of genera with two species exceeds that of the number of genera with three, and so forth. The principle that emerged from his analyses is that at all levels of classification, the frequency distribution of groups (e.g. genera) and units (e.g. species) is closely represented by the log series. To test this model for the Mesembryanthemaceae, we analysed data in Tables 3 and 4 (column 2) and plotted the frequency distribution of genera of different sizes. The fitted logarithmic curve was calculated according to the number of genera and the size of the family as outlined by Williams.[67] Although it may be argued that such an analysis is premature considering the heterogeneous nature of the data set, it does provide a clear and useful picture of the situation at present (Fig. 3). It highlights the high number of monotypic genera (34) which is larger than the predicted value (27), and the sheer size of the relatively few larger, unrevised genera.

Although many taxonomists have misgivings about very large genera and genera with only one species, both are integral to classification schemes.[67] Monotypic genera may be truly monotypic, but some are founded on peculiarities, and others represent genera of convenience – proposing a new genus is preferable to misplacing a species in an existing genus. Exploration sometimes turns up new species: a second species of *Neohenricia* was discovered after more than 50 years.[68] Further research and field work could clarify the status of some monotypic genera – *Maughaniella* and *Diplosoma* were recently combined under the single genus *Diplosoma* after their separation was found to be unjustified.[69]

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

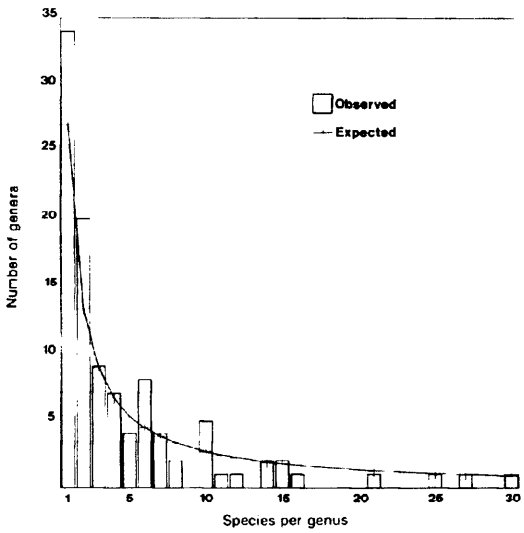


Fig. 3. Frequency distribution of genera of the Mesembryanthemaceae showing the observed and calculated number of genera of different sizes. As in most modern classifications, the number of monotypic genera (34) is in excess of the predicted value (27). Not shown in the graph are single genera containing 31, 33, 35, 36, 40, 50, 66, 87, 112, 150, 163, 219, and 289 species. Data were extracted from Tables 3 and 4.

Despite emendations and discovery, it has been stressed by Stace[70] that monotypic genera are clearly natural entities and should be recognized as such by taxonomists. Clayton[71] considers high numbers of monotypic genera as inherent in our concept of genera. Earlier classifications, such as that of Linnaeus for the birds of the world, followed a different pattern, with monotypic genera not so dominant.[67] In modern classifications, the departure of monotypic genera from the calculated curve is remarkably similar in different families, and interpreted as indicative of a consistently applied genus concept.[71] Clayton,[71] however, expresses his concern over the desirability of a gradual convergence between genus and species concepts.

The relative distribution of large and small genera depends on the generic diversity of a classification scheme, which is determined by a constant conception in the mind of the classifier. The splitter produces a classification with high generic diversity, whereas one with low generic diversity is created by a lumper.[67] The index of diversity (α), was calculated at 27.4 for the Mesembryanthemaceae, a relatively low value. This is indicative of broadly conceived genera,[71] but may partly reflect the number of large unrevised genera such as *Delosperma* – a genus that should be segregated[53] – and *Ruschia*, which is in the process of segregation with approximately 60 species requiring valid transfer to *Antimima*. In addition, the aggregation of genera into *Phyllobolus* and *Mesembryanthemum*[48] may also considerably lower the diversity index of the family.

Although 19% of Mesembryanthemaceae species have not been revised, 35% of the genera have been treated at the species level. This discrepancy shows that research in the family has concentrated on comparatively small genera, whereas the larger problematic genera, such as *Delosperma* and *Drosanthemum*, have mostly been avoided *Conophytum*[72] and *Argyroderma*[73] being notable exceptions.

Discussion

Although problems in the Mesembryanthemaceae are found at all levels of classification, resolution at higher hierarchic levels relies on sound species taxonomy. With the aim of prioritizing research in the family, we have concentrated on the immediate problems at generic and species levels.

Generic concepts

Recently, criteria for the delimitation and ranking of genera in the Mesembryanthemaceae were discussed by Bittrich,[48] who recognizes three major concepts of genera: (1) genera defined by apomorphies, (2) genera with character states equally distant from two other existing genera, and (3) genera characterized by character combinations. Neither Bittrich[48] nor Hartmann[74] found that these criteria can be applied in isolation in the delimitation of genera of the Mesembryanthemoideae and Ruschioideae, respectively. Ideally, genera should be inferred *a posteriori* as a result of a robust phylogenetic analysis at species level.

The re-appraisal of genera and the characters upon which they were founded has shown that a number of old genera in the Mesembryanthemaceae are not natural entities. Some have been re-cast in recent years, with the associated nomenclatural consequences. In such cases nomenclatural stability should be evaluated against the evidence for change.

In the Mesembryanthemoideae the shifting of generic limits[48] has resulted primarily in changes of rank. A constant concept of the genus category has not been achieved in this subfamily. Formerly well-known genera have been reduced to subgenera in the more inclusive, but less definable *Phyllobolus* and *Mesembryanthemum* (Table 3). In contrast, the aberrant capsule of *Pseudobrownanthus* is the sole justification for the separation of this monotypic genus from *Brownanthus*.[59]

Careful consideration of the relative importance assigned to character sets is necessary in the evaluation of generic limits. Data sets from different sources have been shown to be incongruent in the Mesembryanthemaceae. Groups established on the basis of capsule types[13] do not coincide with groups postulated on the basis of combinations of vegetative and reproductive organs.[43,44] Dupont[53] found that delimitation of groups based on seedling ontogeny does not correspond with groups delineated by leaf epidermal characteristics. The character set on which emphasis is placed may affect the diagnosis of a genus. This is well illustrated in the recent revision of the characteristically spiny genus *Eberlanzia*. Fruit capsule types were found to be more important in the delimitation of genera than the possession of spines, which were shown to differ in their ontogeny. *Eberlanzia* was subsequently fragmented into 10 species belonging to five different genera.[75]

Since Brown's[4] initial segregation of *Mesembryanthemum sensu lato* on the basis of a combination of vegetative and reproductive morphology, emphasis is increasingly being placed on the morphology of the fruit capsule in the Mesembryanthemaceae.[75-77] Yet characters that are products of specialization often have limited value in taxonomy. The highly co-evolved flowers of orchids are examples of extreme specialization, and a classification of orchids based on floral morphology might to a large extent reflect pollination syndromes.[78] Similarly, the loculicidal hygrochastic capsules of the Mesembryanthemaceae have been classified into functional syndromes which optimize the dispersal of seeds.[13] Although it is tempting to concentrate on these complex and unique reproductive structures in the taxonomy of mesembs, particularly in view of the variation encountered in leaf morphology, it is imperative to test as many sources of data as possible and evaluate the hierarchic level at which they differentiate taxa *a posteriori*.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Species concepts

Species play a critically important role in evolutionary biology as the primary units of study.[79] A sound species-level taxonomy is essential before limits and relationships at generic and higher hierarchic levels can be resolved in the Mesembryanthemaceae. In contrast to Mrs H.M.L. Bolus's species concept, the fundamental principle of the Phylogenetic Species Concept[79-82] is species diagnosability, i.e. species are delimited on the basis of unique and constant character combinations.[83] Davis and Manos[83] use the biological population as their focal point to test species boundaries. The problem of species complexes requires that variable traits, which are not universally distributed among comparable individuals within a terminal lineage, be separated from taxonomically useful characters. Nixon and Wheeler[79] stress that this distinction is vital to the understanding of the phylogenetic species concept.

It is widely thought that the polarization of characters into primitive and advanced states is problematic in the Mesembryanthemaceae. Primitive and derived character states have been discussed by Dupont,[53] Bittrich and Struck[39] and Ihlenfeldt and Gerbaulet.[84] The identification and assessment of homologous morphological characters is a prerequisite for meaningful research in the Mesembryanthemaceae.

One of the major problems facing mesemb taxonomists is species that have been delimited too narrowly. Mrs Bolus's species concept, with locality as a central tenet, resulted in a proliferation of specific names. Brown[85] commented: '... species are being described and referred to this or that group or supposed affinity in the most haphazard manner, or are described without any indication of affinity, rendering it almost impossible to identify the species without seeing the type specimen.' The types themselves are problematic: they are often fragmentary, without a clear locality or an assessment of population variation.

The obvious advantage of describing geographic forms is that of documenting biodiversity, which was Mrs Bolus's intention. However, emphasis has been placed on the polymorphic traits of populations rather than on phylogenetically informative characters. This narrow species concept is one of the main causes of the notoriously difficult task of identifying mesembs to species level. Different names do not necessarily refer to distinct species. Often, geographically based species cannot be distinguished morphologically and relationships between species are murky. The descriptions provided are not always useful for identification of, or discrimination between, similar species, particularly when new localities are found.

In addition to creating identification problems, the Bolusian species concept has led to new names being coined for conspecific plants from different localities, obscuring their true distribution. In large unrevised genera such as *Delosperma*, *Drosanthemum* and *Ruschia*, many species may have to be synonymized to rectify unrepresentative geographic patterns. Although loss of information is an undesirable consequence of excessive lumping together of geographic variants, it is occasionally necessary to synonymize on a large scale. Hammer,[72] in a recent treatment of *Conophytum*, treated *C. bilobum* (Marloth) N.E.Br. subsp. *bilobum* as a single polymorphic taxon with 105 synonyms.

Conclusions

The taxonomy of the Mesembryanthemaceae has been a challenge to the few, past and present, who have attempted to unravel the complexity of this group. Commenting on *Mesembryanthemum sensu lato*, Haworth[86] wrote: '... their actual limits and essential characteristics ... lie veiled in difficulties, which escape development and defy research. They will not be fettered.' Haworth's comments certainly forecast the appalling state of Mesembryanthemaceae taxonomy – a legacy of unsound taxonomic practice compounded by difficulties associated with succulence.

This article is an attempt towards resolution in the taxonomy of the Mesembryanthemaceae. Problems at species level arising from a lack of monographic work are usually masked in generic level treatments of the family and render the circumscription of many genera arbitrary. Consequently, hypotheses of phylogeny remain highly speculative. A sound classification of the group depends on sound species. We have attempted to redirect attention to these fundamental problems, which have important implications not only from a systematic point of view but also for the basic taxonomic practice of plant identification.

By highlighting the hierarchic levels at which information is available, we have emphasized the immature state of taxonomy in the Mesembryanthemaceae. The results are startling: 44 of the 117 genera have not been reassessed since publication, only 35% of genera have been treated at species level, and a formal revised subtribal classification is long overdue.

For too long, South African taxonomists have approached the Mesembryanthemaceae with trepidation and reluctance – or avoided it completely. We have provided an assessment of the hierarchic level at which problems are most pressing, as well as an indication of the urgency of such work for each genus. Research priorities identified here should provide clear guidance for future researchers. We hope that this paper will serve as a catalyst for co-operative work on one of southern Africa's most impressive succulent plant families.

The informative and constructive criticism of three anonymous referees is greatly appreciated. We thank Shirley Pierce Cowling for information on genera under revision. Frik Hartzer and Jeremy Hollmann made many valuable comments on earlier drafts; any mistakes that remain are our own.

Postscript

Since the completion of this article, an additional monotypic genus, *Vlokia* S.A. Hammer, [87] has been described. This brings the total number of mesemb genera to *c.* 118.

Received 4 November 1994; accepted 24 February 1995.

1. Smith G.F., Hobson, S.R., Meyer N.L., Chesselet P., Archer R.H., Burgoyne P.M., Glen H.F., Herman P.P.J., Retief E., Smithies S.J., van Jaarsveld E.J. and Welman W.G. (1993). Southern African succulent plants – an updated synopsis. *Aloe* **30**, 31–74.
2. Smith C.A. (1966). Common names of South African plants. *Mem. bot. Surv. S. Afr.* **35**, 1–642.
3. Brummitt R.K. and Powell C.E. (1992). *Authors of Plant Names*. Royal Botanic Gardens, Kew.
4. Brown N.E. (1925). *Mesembryanthemum* and some new genera separated from it. *Gdnrs' Chron. Ser. 3.* **78**, 211–212.
5. Haworth A.H. (1821). *Revisiones Plantarum Succulentarum*. R. and A. Taylor, London.
6. Herre H. (1971). *The Genera of the Mesembryanthemaceae*. Tafelberg, Cape Town.
7. Berger A. (1908). *Mesembrianthemen und Portulacaceen*. Verlagsbuchhandlung Eugen Ulmer, Stuttgart.
8. Brown N.E. (1925). *Mesembryanthemum* and some new genera separated from it. *Gdnrs' Chron. Ser. 3.* **78**, 211.
9. Rowley G.D. (1989). *N.E. Brown Stapeliae, extracted from 'The Gardeners' Chronicle 1875–1935.'* International Asclepiad Society, Aspley Guise.
10. Schwantes G. (1929). Biologisches und Systematisches über die Mesembrianthemeen. *Mitt. Inst. allg. Bot., Hamb.* **8**, 161–167.
11. Schwantes G. (1952). Die Früchte der Mesembryanthemaceen. *Mitt. bot. Mus. Univ. Zürich* **39**, 1–38.
12. Schwantes G. (1957). *Flowering Stones and Mid-day Flowers*. Ernest Benn, London.
13. Hartmann H.E.K. (1988). Fruit types in Mesembryanthema. *Beitr. Biol. Pfl.* **63**, 313–349.
14. Schwantes G. (1947). System der Mesembryanthemaceen. *Sukkulentenkunde* **1**, 34–40.
15. Schwantes G. (1960). The Classification of the Mesembryanthemums. In *A Handbook of Succulent Plants*, ed. H. Jacobsen, pp. 951–955. Blanford, London.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

16. Ihlenfeldt H.-D., Schwantes G. and Straka H. (1962). Die höheren Taxa der Mesembryanthemaceae. *Taxon* **11**, 52–56.
17. Hammer S.A. (1993). Mrs Bolus and the automatic sausage machine. *Aloe* **30**, 88–91.
18. Bolus H.M.L. (1928). *Notes on* Mesembrianthemum *and Allied Genera I.* University of Cape Town, Cape Town.
19. Bolus H.M.L. (1928–1935). *Notes on* Mesembrianthemum *and Some Allied Genera II.* University of Cape Town, Cape Town.
20. Bolus H.M.L. (1936–1958) *Notes on* Mesembryanthemum *and Allied Genera III.* University of Cape Town, Cape Town.
21. Nel G.C. (1951). *The* Gibbaeum *Handbook.* Blandford, London.
22. Leistner O.A. (1958). A new monotypic genus of the Mesembryanthemaceae. In *Notes on* Mesembryanthemum *and Allied Genera III*, H.M.L. Bolus, pp. 289–291. University of Cape Town, Cape Town.
23. Leistner O.A. (1958). *Skiatophytum* L. Bol.: 'n morfologies-taksonomiese studie. *Jl S. Afr. Bot.* **24**, 89–102.
24. Lavis M. (1966). Notes on the genus *Delosperma* (Mesembrieae). *Jl S. Afr. Bot.* **32**, 209–210.
25. Koutnik D. and O'Connor-Fenton M. (1984). Notes on the genus *Mesembryanthemum* L. *Jl S. Afr. Bot.* **50**, 365–371.
26. Glen H.F. (1986). Numerical taxonomic studies in the subtribe Ruschiinae (Mesembryanthemaceae) – *Astridia, Acrodon* and *Ebracteola. Bothalia* **16**, 203–226.
27. Wisura W. and Glen H.F. (1993). The South African species of *Carpobrotus* (Mesembryanthema, Aizoaceae). *Contr. Bol. Herb.* **15**, 76–107.
28. Van Jaarsveld E.J. (1982). The discovery and history of *Sineopeculum rourkei. Veld Flora* **68**, 17–19.
29. Van Jaarsveld E.J. (1987). The succulent riches of South Africa and Namibia and their adaptive significance. *Aloe* **24**, 47–92.
30. Van Jaarsveld E.J. (1995). A synopsis of the genus *Stoeberia. Aloe* **31**, 68–76.
31. Brummitt P.K. (1992). *Vascular Plant Families and Genera.* Royal Botanic Gardens, Kew.
32. Gunn C.R., Wiersema J.H., Ritchie C.A. and Kirkbride J.H. (jun.) (1992). *Families and genera of spermatophytes recognized by the Agricultural Research Service.* Technical Bulletin no. 1796. U.S. Department of Agriculture, Beltsville, MD.
33. Mabry T.J. (1977). The order Centrospermae. *Ann. Mo. bot. Gdn* **64**, 210–220.
34. Rodman J.E., Oliver M.K., Nakamura R.R., McClammer J.U. (jun.) and Bledsoe A.H. (1984). A taxonomic analysis and revised classification of Centrospermae. *Syst. Bot.* **9**, 297–323.
35. Rodman J.E. (1990). Centrospermae revisited, Part 1. *Taxon* **39**, 383–393.
36. Reutig J.H., Wilson H.D. and Manhart J.R. (1992). Phylogeny of the Caryophyllales – gene sequence data. *Taxon* **41**, 201–209.
37. Downie S.R. and Palmer J.D. (1994). A chloroplast DNA phylogeny of the Caryophyllales based on structural and inverted repeat restriction site variation. *Syst. Bot.* **19**, 236–252.
38. Bittrich V. and Hartmann H.E.K. (1988). The Aizoaceae – a new approach. *Bot. J. Linn. Soc.* **97**, 239–254.
39. Bittrich V. and Struck M. (1989). What is primitive in Mesembryanthemaceae? An analysis of evolutionary polarity of character states. *S. Afr J. Bot.* **55**, 321–331.
40. Bittrich V. (1990). Systematic studies in Aizoaceae. *Mitt. Inst. allg. Bot. Hamb.* **23**, 491–507.
41. Hartmann H.E.K. and Bittrich V. (1991) Typification of suprageneric names – some nomenclatural changes in Aizoaceae. *S. Afr. J. Bot.* **57**, 73–75.
42. Herre H. and Volk O.H. (1948). Mesembryanthemaceae Herre et Volk, familia nova. *Sukkulentenkunde* **2**, 38.
43. Hartmann H.E.K. (1993). Aizoaceae. In *The Families and Genera of Vascular Plants*, eds. K. Kubitzki, J.G. Rohwer and V. Bittrich, vol. 2, pp. 37–69. Springer Verlag, Berlin.
44. Hartmann H.E.K. (1991). Mesembryanthema. *Contr. Bol. Herb.* **13**, 75–157.
45. Jürgens N. (1986). Untersuchungen zur Ökologie sukkulenter Pflanzen des südlichen Afrika. *Mitt. Inst. allg. Bot. Hamb.* **21**, 139–365.
46. Jürgens N. (1990). Remarks on the biogeography of *Mesembryanthemaceae* and their possible use in other arid regions. *Mitt. Inst. allg. Bot. Hamb.* **23**, 1047–1060.
47. Hartmann H.E.K. (1987) Phytogeography of the subtribe Leipoldtiinae (Mesembryanthemaceae). *Bothalia* **17**, 205–212.
48. Bittrich V. (1986). Untersuchungen zu Merkmalsbestand, Gliederung und Abgrenzung der Unterfamilie Mesembryanthemoideae (Mesembryanthemaceae Fenzl). *Mitt. Inst. allg. Bot. Hamb.* **21**, 5–116.
49. Arnold T.H. and de Wet B.C. (eds.) (1993). *Plants of Southern Africa: Names and Distribution.* National Botanical Institute, Pretoria.
50. Von Willert D.J., Eller B.M., Werger M.J.A., Brinckmann E. and Ihlenfeldt H.-D. (1992). *Life Strategies of Succulents in Deserts. With Special Reference to the Namib Desert.* Cambridge University Press, Cambridge.
51. Mooney H.A., Troughton J.H. and Berry J.A. (1977). Carbon isotope ratio measurements of succulent plants in southern Africa. *Oecologia (Berl.)* **30**, 295–305.
52. Jürgens N. (1990). A life form concept including anatomical characters, adapted for the description of succulent plants. *Mitt. Inst. allg. Bot. Hamb.* **23**, 321–341.
53. Dupont S. (1968). Épidermes et plantules des Mesembryanthemacées. Systématique. Évolution. *Bull. Soc. Hist. nat. Toulouse* **104**, 7–64.
54. Ihlenfeldt H.-D. (1975). Some trends in the evolution of the Mesembryanthemaceae. *Boissiera* **24**, 249–254.
55. Haworth A.H. (1821). *Revisiones Plantarum Succulentarum.* R. and A. Taylor, London. p. 94.
56. Scheiner S.M. (1993). Genetics and evolution of phenotypic plasticity. *A. Rev. Ecol. Syst.* **24**, 35–68.
57. Greuter W., Barrie F.R., Burdet H.M., Chaloner W.G., Demoulin V.R., Hawksworth D.L., Jorgenson P.M., Nicolson D.H., Silva P.C., Trehane P. and McNeill J. (1994). *International Code of Botanical Nomenclature.* Regnum Vegetabile No. 131. Koeltz Scientific Books, Königstein.
58. Hartmann H.E.K. (1991). Keys to the genera of Mesembryanthema. *S. Afr. J. Bot.* **57**, 95–106.
59. Ihlenfeldt H.-D. and Bittrich V. (1985). Morphologie, Gliederung und Abgrenzung der Gattung *Psilocaulon* N.E. Br. *s.l.* (Mesembryanthemaceae). *Bot. Jb.* **105**, 289–322.
60. Hammer S.A. and Hartmann H.E.K. (1990). Shedding light on windows in *Conophytum. Cactus Succ. J., U.S.* **62**, 35–42.
61. Von Breitenbach F. (1990). *National List of Indigenous Trees*, 2nd edn. Dendrological Foundation, Pretoria.
62. Glen H.F. (1974). *A revision of the Gibbaeinae (Mesembryanthemaceae).* M.Sc. thesis, Univ. of Cape Town.
63. Rowley G.D. (1978). Reunion of some genera of Mesembryanthemaceae. *Natn. Cactus Succul. J.* **33**, 6–9.
64. Schwantes G. (1928). Mesembriaceen Studien. *Gartenwelt* **32**, 599.
65. Dyer R.A. (1975). *The Genera of Southern African Flowering Plants. 1. Dicotyledons.* Department of Agricultural Technical Services, Pretoria.
66. Liede S. (1989). Untersuchungen zum Merkmalsbestand und zur Taxonomie der 'Erepsiinae' (Mesembryanthemaceae). *Beitr. Biol. Pfl.* **64**, 391–479.
67. Williams C.B. (1964). *Patterns in the Balance of Nature and Related Problems in Quantitative Ecology.* Academic Press, London.
68. Hammer S.A. (1994). A novel *Neohenricia. Cactus Succ. J., U.S.* **66**, 84–86.
69. Ihlenfeldt H.-D. (1988). Morphologie und Taxonomie der Gattungen *Diplosoma* Schwantes und *Maughaniella* L. Bolus (Mesembryanthemaceae. Monographie der Mitrophyllinae Schwantes IV). *Beitr. Biol. Pfl.* **63**, 375–401.
70. Stace C. A. (1989). *Plant Taxonomy and Biosystematics.* Edward Arnold, London.
71. Clayton W.D. (1972). Some aspects of the genus concept. *Kew. Bull.* **27**, 281–287.
72. Hammer S.A. (1993). *The Genus* Conophytum: *A Conograph.* Succulent Plant Publications, Pretoria.
73. Hartmann H. (1977). Monographie der Gattung *Argyroderma* N.E.Br. (Mesembryanthemaceae Fenzl). *Mitt. Inst. allg. Bot. Hamb.* **15**, 121–235.
74. Hartmann H.E.K. (1992). *Ihlenfeldtia*, a new genus in Mesembryanthema (Aizoaceae). *Bot. Jb.* **114**, 29–50.
75. Hartmann H.E.K. and Stüber D. (1993). On the spiny Mesembryanthema and the genus *Eberlanzia* (Aizoaceae). *Contr. Bol. Herb.* **15**, 1–75.
76. Dehn M. (1988). Untersuchungen zum Merkmalsbestand und zur Stellung der Gattung *Antimima* N.E.Br. emend. Dehn (Mesembryanthemaceae Fenzl). *Mitt. Inst. allg. Bot. Hamb.* **22**, 189–215.
77. Dehn M. (1992). Untersuchungen zum Verwandtschaftskreis der Ruschiinae (Mesembryanthemaceae Fenzl) *Mitt. Inst. allg. Bot. Hamb.* **24**, 91–198.
78. Linder H.P. (1986) Notes on the phylogeny of the Orchidoideae, with particular reference to the Diseae. *Lindleyana* **1**, 51–64.
79. Nixon K.C. and Wheeler Q.D. (1990). An amplification of the phylogenetic species concept. *Cladistics* **6**, 211–223.
80. Cracraft J. (1983). Species concepts and speciation analysis. In *Current Ornithology 1*, ed. R. F. Johnston, pp. 159–187. Plenum, New York.
81. Cracraft J. (1989). Speciation and its ontology: the empirical consequences of alternative species concepts for understanding patterns and processes of differentiation. In *Speciation and its Consequences*, eds. D. Otte and J.A. Endler, pp. 28–59. Sinauer, Sunderland, Mass.
82. Eldredge N. and Cracraft J. (1980). *Phylogenetic Patterns and the Evolutionary Process.* Columbia University Press, New York.
83. Davis J.I. and Manos P.S. (1991). Isozyme variation and species delimitation in the *Pucinellia nuttalliana* complex (Poaceae): an application of the phylogenetic species concept. *Syst. Bot.* **16**, 431–445.
84. Ihlenfeldt H.-D. and Gerbaulet M. (1990). Untersuchungen zum Merkmalsbestand und zur Taxonomie der Gattungen *Aptenia* N.E.Br., *Carpanthea* N.E.Br., *Conicosia* N.E.Br., *Herrea* Schwantes und *Hymenogyne* Haw. (Mesembryanthemaceae Fenzl). *Bot. Jb.* **111**, 457–498.
85. Brown N.E. (1925). *Mesembryanthemum* and some new genera separated from it. *Gdnrs' Chron. Ser. 3.* **78**, 212.
86. Haworth A.H. (1821). *Revisiones Plantarum Succulentarum.* R. and A. Taylor, London. pp. 79–80.
87. Hammer S.A. (1994). *Vlokia*, a new genus in Aizoaceae. *Cactus Succ. J., U.S.* **66**, 255–258.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix

Mesembryanthemaceae Fenzl, *Ann. Wiener Mus. Naturgesch.* **1**: 349 (1836), emend. Herre and Volk, *Sukkulentenkekunde* **2**, 38 (1948).

Mesembryanthemoideae
Aptenia N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 412 (1925).
Bittrich (1986). *Mitt. Inst. allg. Bot. Hamb.* **21**, 5–116.
Aspazoma N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 413 (1925).
Bittrich (1986). *Mitt. Inst. allg. Bot. Hamb.* **21**, 5–116.
Brownanthus Schwantes, *Z. SukkulKde* **3**, 14 (1927).
Ihlenfeldt and Bittrich (1985). *Bot. Jb.* **105**, 289–322.
Bittrich (1986). *Mitt. Inst. allg. Bot. Hamb.* **21**, 5–116.
Dactylopsis N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 413 (1925).
Bittrich (1986). *Mitt. Inst. allg. Bot. Hamb.* **21**, 5–116.
Mesembryanthemum L., *Sp. Pl.*, 480 (1753), *nom. cons.*, emend. Bolus, *Notes on Mesembryanthemum and Allied Genera* **3**, 166 (1939).
Koutnik and O'Connor-Fenton (1984). *Jl S. Afr. Bot.* **50**, 365–371.
Bittrich (1986). *Mitt. Inst. allg. Bot. Hamb.* **21**, 5–116.
Phyllobolus N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 413 (1925).
Bittrich (1986). *Mitt. Inst. allg. Bot. Hamb.* **21**, 5–116.
Pseudobrownanthus Ihlenf. and Bittrich, *Bot. Jb.* **105**, 319 (1985).
Ihlenfeldt and Bittrich (1985). *Bot. Jb.* **105**, 289–322.
Bittrich (1986). *Mitt. Inst. allg. Bot. Hamb.* **21**, 5–116.
Psilocaulon N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 433 (1925).
Bittrich (1986). *Mitt. Inst. allg. Bot. Hamb.* **21**, 5–116.
Synaptophyllum N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 412 (1925).
Bittrich (1986). *Mitt. Inst. allg. Bot. Hamb.* **21**, 5–116.

Ruschioideae Schwantes in Ihlenf., Schwantes and Straka, *Taxon* **11**, 54 (1962) emend. H.E.K.Hartmann and Bittrich *S. Afr. J. Bot.* **57**, 74 (1991).
Acrodon N.E.Br., *Gdnrs' Chron. Ser. 3*, **81**, 12 (1927).
Glen (1986). *Bothalia* **16**, 203–226.
Aethephyllum N.E.Br., *Möller's Deutsche Gärtn.-Zeitung* **43**, 400 (1928).
Ihlenfeldt and Struck (1986). *Beitr. Biol. Pfl.* **61**, 411–453.
Aloinopsis Schwantes, *Z. SukkulKde* **2**, 177 (1926).
Bolus (1958). *Notes on Mesembryanthemum and Allied Genera* **3**, 372–381.
Amphibolia L.Bolus, *Jl S. Afr. Bot.* **31**, 169 (1965) ex A.G.J.Herre, *Genera of the Mesembryanthemaceae*, 70 (1971).
Hartmann and Dehn (1989). *Bothalia* **19**, 179–182.
Antegibbaeum Schwantes ex C.Weber, *Baileya* **16**, 10–11 (1968).
Antimima N.E.Br., *Gdnrs' Chron. Ser. 3*, **87**, 211 (1930) emend. Dehn, *Mitt. Inst. allg. Bot. Hamb.* **22**, 210 (1988).
Dehn (1988). *Mitt. Inst. allg. Bot. Hamb.* **22**, 189–215.
Apatesia N.E.Br., *Gdnrs' Chron. Ser. 3*, **81**, 12 (1927).
Ihlenfeldt and Gerbaulet (1990). *Bot. Jb.* **111**, 457–498.
Arenifera A.G.J.Herre, *Sukkulentenkunde* **2**, 35 (1948).
Argyroderma N.E.Br., *Gdnrs' Chron. Ser. 3*, **71**, 92 (1922).
Hartmann (1977). *Mitt. Inst. allg. Bot. Hamb.* **15**, 121–235.
Astridia Dinter, *Gdnrs' Chron. Ser. 3*, **80**, 430 (1926).
Glen (1986). *Bothalia* **16**, 203–226.
Bergeranthus Schwantes, *Z. SukkuleKde* **2**, 179 (1926).
Bijlia N.E.Br., *J. Bot.* **66**, 267 (1928).
Hartmann (1992). *Cactus Succ. J., U.S.* **64**, 173–180.
Braunsia Schwantes, *Gartenwelt* **32**, 644 (1928).
Calamophyllum Schwantes, *Z. SukkulKde* **3**, 15, 28 (1927).
Carpanthea N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 412 (1925).
Ihlenfeldt and Gerbaulet (1990). *Bot. Jb.* **111**, 457-498.
Carpobrotus N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 433 (1925).
Wisura and Glen (1993). *Contr. Bol. Herb.* **15**, 76–107.
Carruanthus (Schwantes) Schwantes, *Z. SukkulKde* **3**, 106 (1927).
Caryotophora Leistner, Bolus, *Notes on Mesembryanthemum and Allied Genera* **3**, 289 (1958).
Ihlenfeldt and Gerbaulet (1990). *Bot. Jb.* **111**, 457–498.
Cephalophyllum N.E.Br., *Gdnrs'. Chron. Ser. 3*, **78**, 433 (1925).
Hartmann (1988). *Mitt. Inst. allg. Bot. Humb.* **22**, 93–187.
Cerochlamys N.E.Br., *J. Bot.* **66**, 171 (1928).
Chasmatophyllum Dinter and Schwantes, *Z. SukkulKde.* **3**, 14, 17 (1927).
Cheiridopsis N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 433 (1925).
Hartmann and Dehn (1987). *Bot. Jb.* **108**, 567–663.
Hammer (1993). *Bradleya* **11**, 75–85.
Circandra N.E.Br., *Gdnrs' Chron. Ser. 3*, **87**, 126 (1930).
Liede (1989). *Beitr. Biol. Pfl.* **64**, 391–479.
Cleretum N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 412 (1925).
Ihlenfeldt and Struck (1986). *Beitr. Biol. Pfl.* **61**, 411–453.
Conicosia N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 433 (1925).
Ihlenfeldt and Gerbaulet (1990). *Bot. Jb.* **111**, 457–498.
Conophytum N.E.Br., *Gdnrs' Chron. Ser. 3*, **71**, 19 (1922).
Hammer (1993). *The genus Conophytum: A Conograph.* 283 pp.
Cylindrophyllum Schwantes, *Z. SukkulKde* **3**, 15, 28 (1927).
Delosperma N.E.Br., *Gdnrs' Chron. Ser 3*, **78**, 412 (1925) emend. Lavis, *Jl S. Afr. Bot.* **32**: 209 (1966).
Dicrocaulon N.E.Br., *J. Bot.* **66**, 141. (1928).
Didymaotus N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 433 (1925).
Dinteranthus Schwantes, *Z. SukkulKde* **2**, 184 (1926).
Sauer (1978). *Fl. Pl. Africa* **45**, t1778–1780.
Diplosoma Schwantes, *Z. SukkulKde* **2**, 179 (1926).
Ihlenfeldt (1988). *Beitr. Biol. Pfl.* **63**, 375–401.
Disphyma N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 433 (1925).
Chinnock (1971). *N.Z. Jl Bot.* **9**, 331–374.
Dorotheanthus Schwantes, *Möller's Deutsche Gärtn.-Zeitung* **42**, 283 (1927).
Ihlenfeldt and Struck (1986). *Beitr. Biol. Pfl.* **61**, 411–453.
Dracophilus (Schwantes) Dinter and Schwantes, *Möller's Deutsche Gärtn.-Zeitung* **42**, 187 (1927).
Walgate (1939). In Bolus, *Notes on Mesembryanthemum and Allied Genera* **3**, 171–188.
Drosanthemopsis Rauschert, *Taxon* **31**, 555 (1982).
Drosanthemum Schwantes, *Z. SukkulKde* **3**, 14, 29 (1927).
Eberlanzia Schwantes, *Z. SukkulKde* **2**, 189 (1926).
Hartmann and Stüber (1993). *Contr. Bot. Herb.* **15**, 1–75.
Ebracteola Dinter and Schwantes, *Z. SukkulKde* **3**, 15, 24 (1927).
Glen (1986). *Bothalia* **16**, 203–226.
Ectotropis N.E.Br., *Gdnrs' Chron. Ser. 3*, **81**, 12 (1927).
Enarganthe N.E.Br., *Gdnrs' Chron. Ser. 3*, **87**, 71 (1930).
Erepsia N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 433 (1925).
Liede (1989). *Beitr. Biol. Pfl.* **64**, 391–479.
Esterhuysenia L.Bolus, *S. Afr. J. Bot.* **33**, 308 (1967).
Faucaria Schwantes, *Z. SukkulKde* **2**, 176 (1926).
Fenestraria N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 433 (1925).
Hartmann (1982). *Bot. Jb.* **103**, 145–183.
Frithia N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 433 (1925).
Gibbaeum (Haw.) N.E.Br., *Gdnrs' Chron. Ser. 3*, **70**, 273 (1921).
Glottiphyllum N.E.Br., *Gdnrs' Chron. Ser. 3*, **70**, 311 (1921).
Hartmann and Gölling (1993). *Bradleya* **11**, 1–49.
Hallianthus H.E.K.Hartmann, *Bot. Jb.* **104**, 167 (1983).
Hartmann (1983). *Biblithca bot.* **136**, 1–67.
Hartmann (1983). *Bot. Jb.* **104**, 143–169.
Hereroa (Schwantes) Dinter and Schwantes, *Z. SukkulKde* **3**, 23 (1927).
Hymenogyne Haw., *Saxifrag. Enum.*, 192 (1821). *Revisiones Plantarum Succulentarum*. pp. 192–193.
Ihlenfeldt and Gerbaulet (1990). *Bot. Jb.* **111**, 457–498.
Ihlenfeldtia H.E.K.Hartmann, *Bot. Jb.* **114**, 47 (1992)
Hartmann (1992). *Bot. Jb.* **114**, 29–50.
Imitaria N.E.Br., *J. Bot.* **65**, 348 (1927).
Jacobsenia L.Bolus and Schwantes, in Bolus, *Notes on Mesembryanthemum and Allied Genera* **3**, 255 (1954).
Jensenobotrya A.G.J.Herre, *Sukkulentenkunde* **4**, 79 (1951).
Jordaaniella H.E.K.Hartmann, *Biblithca bot.* **136**, 57 (1983).
Hartmann (1983). *Biblithca bot.* **136**, 1–67.
Hartmann (1984). *Bot. Jb.* **104**, 321–360.
Juttadinteria Schwantes, *Z. SukkulKde* **2**, 182 (1926).
Walgate (1939). In Bolus, *Notes on Mesembryanthemum and Allied Genera* **3**, 171–188.
Khadia N.E.Br., *Gdnrs' Chron. Ser. 3*, **88**, 279 (1930).
Lampranthus N.E.Br., *Gdnrs' Chron. Ser. 3*, **87**, 71 (1930).
Lapidaria (Dinter and Schwantes) N.E.Br., *Gdnrs' Chron. Ser. 3*, **84**, 472 (1928).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Acrodon N.E.Br. 2405001

(Ruschioideae: 10. Ruschia Group)
Brown: 12 (1927a); Herre: 62 (1971); Glen: 212 (1986); Hartmann: 29 (1996b); Burgoyne (1998); Smith *et al.*: 178 (1998).

Compact, tufted perennials up to ± 100 mm high, rarely creeping, internodes usually ± hidden by sheathing leaf bases. **Leaves** opposite, crowded in basal rosette, sharply triquetrous, 30–50 mm long, keel and margins often with small teeth, spreading, reflexed, smooth, grey-green to dark green. **Flowers** solitary, bracteate, ± 40 mm in diameter; opening midday, closing by evening. **Sepals** 5 or 6, nearly equal, ovate, sometimes with membranous margins. **Petals** 1–3-seriate, narrowly linear-lanceolate, often emarginate, white to pink, usually with a conspicuous pink to magenta centre line and sometimes also with darker-coloured margins and tip. **Stamens**: filaments connivent to erect, papillate at least at base, white to reddish above; anthers white; staminodes 0 to few. **Nectary** a crested, dark green ring. **Ovary** top conical; stigmas 5, ± broadly subulate, short, plumose; placentation parietal. **Fruit** a 5-locular capsule, nearest Ruschia type, woody, valves opening incompletely; valve wings awn-like or rarely absent; expanding keels slightly diverging; covering membranes stiff, complete; closing bodies large, lens-shaped. **Seeds** pear-shaped, rough with microscopic ± spherical knobs, dark brown to almost black. $x = 9$ (1 report).

Flowering in early spring.
Distinguishing characters: tufted or creeping perennials with sharply triquetrous leaves which are toothed on keel and at apex; solitary flowers usually with striped petals and white pollen; fruit with lens-shaped closing bodies.

Species 4, found in a broad band in the coastal region of SW and S Western Cape, including wetter parts of the Little Karoo and SW Eastern Cape.

Aethephyllum N.E.Br. 2405002

(Ruschioideae: 2. Cleretum Group).
Brown: 400 (1928b); Herre: 64 (1971); Ihlenfeldt & Struck: 411 (1986); Smith *et al.*: 58 (1998).
Micropterum Schwantes: 17 (1928a) in part; Winkler: 19 (1957).

Annual procumbent herbs; stems and leaves papillate, glistening. **Leaves** ± flat, oblong to ovate in outline, irregularly lyrate-pinnatifid. **Flowers** solitary, up to 10 mm in diameter, pedicellate, ebracteate; opening in afternoon, around 16:00. **Sepals** 5, unequal, largest lanceolate. **Petals** ± 20, 2- or 3-seriate, linear-oblong, pointed, light yellow. **Stamens** usually ± 5(14), 1-seriate with filamentous papillae near base; staminodes 0. **Nectary** of 5 inconspicuous light green glands. **Ovary** vaulted above; placentas parietal; stigmas (4)5(6), filiform, ± 3 mm long, spreading. **Fruit** a (4)5(6)-locular capsule, of Mitrophyllum type; expanding sheets large, tapering into loose apical membranes; covering membranes reduced to a limb; closing bodies 0. **Seeds** with very small tubercles.
Flowering mid-winter to early spring.

Distinguishing characters: annual herbs with flat-growing habit and pinnatifid leaves; fruit on relatively long pedicels and flat on top; flowers yellow.

Species 1: *Aethephyllum pinnatifidum* L.f., restricted to a narrow north-south band in the SW part of the Western Cape; so far recorded from Gifberg near Vanrhynsdorp, the Cederberg, as well as the areas around Tulbagh, Paarl and Stellenbosch; the species forms part of the early post-fire vegetation in fynbos.

Aloinopsis Schwantes 2405003

(Ruschioideae: 6. Titanopsis Group).
Schwantes: 177 (1926c); Bolus: 372 (1958a); Herre: 66 (1971); Smith *et al.*: 156 (1998).

Acaulon N.E.Br.: 76 (1928d). *Aistocaulon* Poelln. ex H.Jacobsen: 123 (1935).

Compact, tufted, dwarf perennials with tuberous rootstock. **Leaves** in a dense rosette, ovate to spatulate in outline, in section fairly flat to 3-angled to almost semiterete, often conspicuously tuberculate or punctate. **Flowers** solitary or occasionally in twos or threes, pedicellate, 18–40 mm in diameter, usually bracteate, opening in afternoon, closing sunset or opening towards evening and closing before dawn. **Sepals** 5 or 6, nearly equal, erect or recurved, obtuse, acute or acuminate, with narrow membranous margins. **Petals** 2- or 3-seriate, yellow, salmon, flesh-pink or rose, the yellow ones sometimes with a red, central stripe. **Stamens** with filaments papillate towards base; staminodes 0. **Nectary glands** angular, in a ring. **Ovary** flat, convex or subglobosely or conically elevated above; placentas parietal; stigmas 6–14, slender, ± as long as stamens. **Fruit** a 6–14-locular capsule of Titanopsis type, nearly flat to conical above, semiglobose, convex, obconic or nearly flat below; expanding keels parallel, diverging at tips; covering membranes complete or relictual; valve wings well developed; closing bodies 0, rudimentary or well developed. **Seeds** broadly obovate, minutely tuberculate to nearly smooth, brown.

Flowering from late winter to early spring.

Distinguishing characters: rosette-forming perennials with rough, spoon-shaped leaves; roots tuberous; flowers with striped petals; seeds ovoid.

Species 14, predominantly in the Great and Little Karoo, in the Western and Eastern Cape, extending slightly into the S Northern Cape; a single outlier: *Aloinopsis orpenii* (N.E.Br.) L.Bolus, northeastern corner of the Northern Cape.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Amphibolia L.Bolus 2405005

(Ruschioideae: 12. Eberlanzia Group).

Bolus: 169 (1965); Herre: 70 (1971); Toelken & Jessop: 64 (1976); Hartmann & Dehn: 179 (1989); Hartmann: 34 (1996b); Hartmann: 44 (1998c); Smith *et al.*: 316 (1998).

Eberlanzia Schwantes: 189 (1926b), in part. Hartmann & Stüber: 63 (1993).

Sprawling shrubs, up to 400 mm high, 700 mm in diameter; stems light-coloured. **Leaves** opposite, connate at bases, ascending-spreading, club-shaped with rounded tips, light green to greyish, surfaces smooth, waxy. **Flowers** solitary or in threes, shortly pedicelled with pink bracts. **Sepals** 5, nearly equal, sometimes with narrow, membranous margins. **Petals** 2-seriate, obtuse or subacute, light violet and creamy white, with distinct colour pattern: a dark area at the tip with a thin dark line running down to base, where it broadens and darkens, dark bases of all petals forming a clearly demarcated ring surrounded by a creamy whitish region, resulting in a characteristic star-like pattern. **Stamens** conically arranged; filaments often papillate; staminodes papillate. **Nectary** a crenulate ring. **Ovary** slightly conical above; placentas parietal; stigmas 5, subulate, purple. **Fruit** a capsule, whitish, often filled with spongy tissue, 5-locular with locules deep and narrow, obconical, once open does not close again; valves with rectangular wings (as in Lampranthus type); expanding keels diverging, touching at their bases; covering membranes with closing rodlets or thick closing ledges on distal undersurfaces; closing bodies small, white, endocarpal, sometimes deep in the locule. **Seeds** subglobose or slightly narrowed to one end, brown, glossy.

Flowering in summer.

Distinguishing characters: white-stemmed shrubs; fruit with valve wings, without covering membranes; flowers with star-like colour pattern.

Species 5, coastal plains of Namibia between Lüderitz and Oranjemund and southwards to Namaqualand in the Northern Cape, to the Cape Peninsula in the Western Cape.

Antegibbaeum Schwantes ex C.Weber 2405007

(Ruschioideae: 9. Lampranthus Group).

Weber: 9 (1968); Herre: 74 (1971); Smith *et al.*: 134 (1998).

Dense, tufted, dwarf perennials; branches erect to prostrate, up to 100 mm long, radiating from a small woody stem. **Leaves** ± digitiform, one slightly anisomorphic leaf pair per branch; upper surface flat or slightly convex; lower surface rounded and compressed towards obtuse apex; grey-green or somewhat reddish, smooth or slightly rugose. **Flowers** on short pedicels, 60 mm in diameter; with 2 pairs of bracts below flowers and fruit (unlike *Gibbaeum*); opening from midday until evening. **Sepals** 6, unequal, 2 lateral the longest, often keeled and with membranous margins. **Petals** 1–3-seriate, free, linear, often flaccid, violet-red. **Stamens** bearded at base; staminodes present or 0. **Nectary** a crenulate ring (unlike *Gibbaeum*). **Ovary** often raised above body of receptacle; placentas parietal; stigmas 6, stout, subulate, plumose. **Fruit** a 6-locular capsule, of Lampranthus type, shortly conical to convex, with prominent sutures; valve wings broad; covering membranes present; closing bodies 0. **Seeds** echinate, brown. $x = 9$ (1 report).

Flowering late winter to early spring.

Distinguishing characters: large magenta flowers (60 mm diameter), pedicel with 2 pairs of bracts; nectary annular; seeds echinate.

Species 1: *Antegibbaeum fissoides* (Haw.) Schwantes ex C.Weber., restricted to the semi-arid Little Karoo in the Western Cape.

Antimima N.E.Br. emend. Dehn 2405129

(Ruschioideae: 11. Leipoldtia Group).

Brown: 211 (1930a); Dehn: 189 (1988); Hartmann: 229 (1996a); Hartmann & Stüber: 1 (1993); Hartmann: 67 (1998b); Smith *et al.*: 246 (1998).

Ruschia Schwantes: 186 (1926b) in part.

Compact, tufted, mat-forming or shrubby perennials, often with a compact centre forming long shoots; isophyllous or heterophyllous. **Leaves** of isophyllous species boat-shaped with convex sides, to nearly finger-shaped, often keeled in upper part, of heterophyllous species mostly oval and very often connate for at least part of their length, enveloping subsequent leaf pair during resting season, mucronate, epidermis cells flat to papillate, with wax cover smooth or, in papillate forms, with a smooth lateral channel and wax flakes or platelets on remaining surface. **Flowers** 1(–3), rarely in well-developed cymes; bracts and bracteoles present; opening in the morning and closing in evening; sometimes strongly scented. **Petals** often arranged in 5, rarely 6 groups, pink to purple, rarely white; staminodes mostly in a central cone surrounding stamens closely. **Nectary** a crenulate ring. **Ovary** with basal-parietal placentas; stigmas 5(6), subulate. **Fruit** a 5(6)-locular capsule, close to Leipoldtia type, stalked, always with persisting bracteoles, top with high or low valve rims, base mostly bowl-shaped, sometimes funnel-shaped; covering membranes undulate, more rarely straight, mostly elevated in centre, in several species with radial or tangential wings or other protrusions on them; closing bodies

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

large, rarely small and 0 in one species; expanding keels broad, diverging and radial in distal part, reaching tip of valve; valves with or without mostly narrow valve wings.

Flowering throughout the year with a peak in winter.

Distinguishing characters: variable perennials, sometimes heterophyllous; leaves often rough-textured; 5-locular capsules with large, stalked, white closing bodies.

Species 99, most species occur in the winter-rainfall area along the southwestern coast, from near Aus in Namibia to the south, extending into South Africa as far as the Eastern Cape. Only a few species are found in the Great Karoo of the Northern Cape and Free State.

Apatesia N.E.Br. 2405008

(Ruschioideae: 1. Apaptesia Group).
Brown: 12 (1927); Brown: 80 (1928); Brown: 262 (1932); Herre: 76 (1971); Ihlenfeldt & Gerbaulet: 457 (1990); Smith *et al.*: 60 (1998).

Annual herbs with decumbent branches, the initial rosette developing into a rich, dichasial inflorescence. **Leaves** flat to slightly channelled, strictly decussate with petiole dilated below and sheathing; epidermis covered with wax flakes. **Flowers** solitary on long pedicels; open in daylight hours. **Sepals** 5, united slightly beyond union with ovary into a saucer-shaped limb, unequal, narrowly spatulate from a broad base, inner ones with broad, membranous margins, longest one often longer than petals. **Petals** 4- or 5-seriate, free, widely spreading, arising from saucer-shaped limb of calyx, their margins ciliate; yellow. **Stamens** and **staminodes** many, from saucer-shaped limb of calyx, inner filaments bearded at base. **Nectary** a flat ring with emarginate rim. **Ovary** flat on top and sunk below rim of calyx; placentas parietal; stigmas 8–12, stout, 2 mm long. **Fruit** a 8–12-locular capsule, shallow, slightly convex beneath; valves horizontally spreading when expanded, narrowly deltoid; expanding keels ± half as long as valve and subcontiguous into a central keel, very small covering membranes present; *A. sabulosa* has valves with a narrow membranous rim (valve wings 0 in the other 2 species); complete seed-pockets present at base. **Seeds** globose, smooth. $x = 9$.

Flowering in early summer.

Distinguishing characters: annual herbs with flat, stalked leaves; pedicels long; seeds many, a few developing in seed-pockets (paraspermy); flowers yellow.

Species 3, Western Cape, in a broad band parallel to the west coast from Vanrhynsdorp to Cape Town.

Aptenia N.E.Br. 2405009

(Mesembryanthemoideae)
Brown: 412 (1925); Herre: 78 (1971); Bittrich: 5 (1986); Smith *et al.*: 28 (1998); Gerbaulet (in press).

Platythyra N.E.Br.: 412 (1925); Herre: 250 (1971). *Litocarpus* L.Bolus: t. 261 (1927b) name illegitimate.

Small perennial shrubs or climbers, prostrate or decumbent, with fibrous roots, rarely with fleshy rootstock; stems 4-angled or terete, weakly lignified, green and succulent with additional vascular bundles, epidermal bladder cells tall and closely packed. **Leaves** decussate or occasionally becoming alternate in inflorescences, with or without petiole, flat or semicylindrical, heart-shaped, ovate or linear, papillose with loosely arranged bladder cells, rarely deciduous. **Flowers** solitary or in few-flowered dichasia, pedicellate, 15–35 mm in diameter; open in daylight. **Sepals** 4, 2 often larger, basally fused or free towards base. **Petals** united at base into a short tube; white, pale pink, cream to yellowish, staminodes 0 or present. **Nectary** consisting of 4 separate grooves. **Ovary** conical above; placentas axile; stigmas 4, subulate, minute. **Fruit** a 4-locular capsule, of Mesembryanthemum type, with or without valve wings; expanding keels extending to centre of fruit. **Seeds** D-shaped, 1.3–1.5 mm long, rough, blackish brown. $x = 9$.

Flowering spring, summer and autumn.

Distinguishing characters: green succulent stems with closely arranged bladder cell idioblasts; seeds large and blackish brown.

Species 4, naturally in the summer-rainfall areas of sthn Afr., *Aptenia cordifolia* (L.f.) Schwantes and *A. lancifolia* L.Bolus are frequently found in shady places on rocky outcrops in regions of higher rainfall. The natural distribution of *A. cordifolia* is unclear as it becomes easily established in areas beyond its natural distribution. *Aptenia* is used world-wide as an ornamental in suitable climates.

Arenifera A.G.J.Herre 2405010

(Ruschioideae: 10. Ruschia Group).
Herre: 35 (1948); Hartmann: 29 (1996b); Smith *et al.*: 346 (1998).

Shrublets, ± 150 mm high, densely branched. **Leaves** slightly connate at base, members of a leaf pair somewhat unequal in size and shape; younger ones green and viscid, increasingly covered by adhering dust and sand with age, surface glaucous and rough, with warty elevations above the subhypodermal tannin idioblasts, obtuse, somewhat convex; up to 25 mm long and 5 mm broad and thick, somewhat curved and blunt above and along sides; shorter leaves 6–15 mm long, ± 7 mm diameter. **Flowers** in ternate inflorescence, with lateral ones sometimes developing rather slowly; peduncle terete, central

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

pedicel without bracts; flowers open at midday. **Petals** 2-seriate, recurved, linear, obtuse or subacute, ± 22 mm in diameter, pale rose to light violet, with an inconspicuous, central band. **Sepals** 4, almost equal, interior ones with a broad, membranous margin. **Stamens** with surrounding staminodes; filaments sparingly bearded at base; anthers and pollen whitish. **Nectary** a dark green crenulate ring. **Ovary** slightly convex above; placentas parietal; stigmas 8, long, subulate, conspicuously fringed at base. **Fruit** a 8-locular capsule, of Ruschia type but with valve wings, turbinate, ± 8 mm in diameter, woody, cupular, margins of valves prominent, forming a small column in centre; valves transversely ribbed, with 2 conspicuous, recurved teeth at tip; valve wings large; expanding keels parallel, diverging widely at tips; covering membranes half covering locules, additional closing devices (projections) at opening; closing bodies conspicuous. **Seeds** long, quadrangular, somewhat convex, finely ribbed longitudinally, light yellowish brown.

Flowering autumn and winter.

Distinguishing characters: many-branched perennials with reddish brown stems; leaves often with adhering sand; fruit 6–8-locular.

Species 4, Northern and Western Cape, from the Richtersveld to Calvinia in the Northern Cape, and the Knersvlakte to Matjiesfontein in the Western Cape.

Argyroderma N.E.Br. 2405011

(Ruschioideae: 11. Leipoldtia Group).
Brown: 92, 105 (1922a); Herre: 82 (1971); Hartmann: 121 (1977); Smith *et al.*: 82 (1998).
Roodia N.E.Br.: t. 78 (1922b).

Compact, dwarf perennials, rarely tufted, sometimes single-bodied, rarely subterranean, branching from base, each stem or branch with 2 or, when new leaf pairs are forming, 4–6 leaves. **Leaves** opposite, finger-shaped, hood-shaped, semi-ovoid or semiglobose, united at base, erect or spreading, with upper surface flat or slightly convex, lower surface convex, silvery to grey-green. **Flowers** solitary, terminal, with a distinct hypanthium into which stamens bend; opening at midday and closing in afternoon. **Sepals** 6–8, produced above ovary into a short tube. **Petals** many, arising from top of calyx tube, free, in shades of yellow, purple, or red, rarely white. **Stamens** many; staminodes 0 or few. **Ovary**: placentas parietal or basal; stigmas united into a small, entire or slightly crenate and disc-like cushion. **Nectary** annular. **Fruit** a 12–25-locular capsule, of Leipoldtia type, broad and shallow; covering membranes rather rigid; closing bodies large, nearly closing outer opening of locules; valve wings rather narrow; expanding keels stout, awned. **Seeds** subglobose, small, smooth, brown. $x = 9$.

Flowering autumn and early winter.

Distinguishing characters: rounded, highly succulent perennials, single-bodied or tufted; leaves smooth, silver to grey-green; flowers solitary, with distinct hypanthium and stigmas fused into a disc.

Species 11, northwestern part of the Western Cape. It has a restricted distribution in southern Namaqualand in an area known as the Knersvlakte.

Aridaria N.E.Br. 2405012

(Mesembryanthemoideae).
Brown: 433 (1925); Friedrich: 16 (1970); Herre: 84 (1971); Gerbaulet: 41 (1996a); Smith *et al.*: 30 (1998).

Manettia Adans.: 242 (1763) name illegitimate. *Nycteranthus* Necker ex Rothmaler: 413 (1941) name illegitimate. *Phyllobolus* subgen. *Aridaria* (N.E.Br.) Bittrich: 74 (1986); Hartmann: 47 (1993).

Shrubs, low growing or up to 1 m high and erect; branches much lignified; cortical bundles 0; epidermal bladder cell idioblasts small and much flattened; roots thickened. **Leaves** decussate throughout and shortly connate at base, subcylindrical, deciduous; with distinct central water storing tissue. **Flowers** in dichasia, up to 40 mm in diameter, white or bright pink on inside, suffused in different shades on outside; open during day, evening, or night. **Sepals** 4; sepals, petals and stamens basally connate into a short tube. **Petals** in several series, narrowly linear, white or pink, suffused in different shades of yellow, copper, pink or red on outside. **Stamens** erect; pollen tricolpate, tectum punctate or punctate-foveolate, microspinulose or spinulose. **Nectary** composed of 4 shell-shaped depressions. **Ovary** semi-inferior, placentation axile; stigmas 4 or 5, subulate, 3–5 mm long. **Fruit** a Mesembryanthemum type capsule, 4- or 5-locular, hygrochastic, usually opening and closing repeatedly, rarely opening only once and not closing again; expanding keels parallel; valve wings present; fruit breaking off easily and stalks becoming spiny. **Seeds** D- or horseshoe-shaped, ± 1.5 mm long, brown or dark brown, with or without a crest; testa cells with central papillae, in distinct or indistinct concentric rows. $x = 9$ (polyploidy).

Flowering spring to early summer.

Distinguishing characters: stems woody; leaves with flattened bladder cell idioblasts; upper and lower parts of fruits of equal proportions.

Species 4, southern and central Namibia and in karroid areas of the Western, Eastern and Northern Cape.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Aspazoma N.E.Br. 22405013

(Mesembryanthemoideae).

Brown: 413 (1925); Herre: 86 (1971); Bittrich: 5 (1986); Smith *et al.*: 32 (1998).

Shrublets up to ± 150 mm high. **Leaves** more than 2 to a branch, some alternate, others opposite, semiterete or subtrigonous to ± terete, basally free but enveloping each other, forming a prominent sheath, with slightly xeromorphic bladder-cells. **Flowers** terminal, solitary, ± 40 mm diameter, white to pale yellow. **Sepals** 4 or 5, with 2 lobes foliaceous, others shorter and more membranous, united into a short tube above ovary. **Petals** 2- or 3-seriate, linear, united into a short tube at base, white to pale yellow. **Stamens** and **staminodes** many, erect; pollen punctate-foveolate, microspinulose. **Nectary** a ring with ± entire rim. **Ovary** conical with axile placentas. **Fruit** a 4- or 5-locular capsule, of Mesembryanthemum type; expanding keels with a broad, inflexed or erect submembranous flap or wing on each side, locules mostly with 2 seeds only. **Seeds** 2.2 mm long, light brown, almost smooth, epicuticular sculpture very finely verrucose.

Flowering in spring.

Distinguishing characters: leaves stem-clasping; seeds large.

Species 1: *Aspazoma amplectens* (L.Bolus) N.E.Br., confined to Namaqualand, including the Richtersveld in the Northern and Western Cape.

Astridia Dinter 2405014

(Ruschioideae: 10. Ruschia Group).

Dinter: 430, 447 (1926); Friedrich: 17 (1970); Herre: 88 (1971); Glen: 203 (1986); Smith *et al.*: 348 (1998).

Robust, erect shrublets; internodes shorter than leaves; young parts variably minutely pubescent, or glabrous. **Leaves** ascending or spreading, usually decurrent, bluntly triquetrous, often subfalcate to falcate, usually 30–60 mm long, 10–30 mm in diameter, with sheath 2–6 mm long, greyish green, persistent; epidermis with convex cells or ± distinctly papillate. **Flowers** solitary or 3 together, lateral ones developing after marked interval, large, shortly pedunculate, opening in daytime; bracts embracing receptacle. **Sepals** 6, unequal, inner ones subulate, with membranous margins. **Petals** with outer ones longer, 1- or 2-seriate, inner ones narrower, 2- or 3-seriate, white, lemon, orange, pink or various shades of purple and red, centre often differently coloured. **Stamens** and **staminodes** in 6–8 series, conically collected, coloured, outer ciliately papillate in lower part, inner ones more densely papillate near middle. **Nectary** a crenulate ring. **Ovary**: apical lobes distant, acutely or obtusely compressed, rarely reaching nectary; placentas parietal; stigmas 6, subulate-caudate, rarely exceeding height of stamens. **Fruit** a 6-locular capsule of Ruschia type, obconic below; sutures strongly compressed; expanded valves widely spreading, wingless; expanding keels parallel below, diverging upwards, aristate; closing bodies and covering membranes well developed, with 2 processes or additional closing devices on underside near exit, obconical. **Seeds** covered with long, brown, papillate hairs, shortly echinate, tuberculate or muricate. $x = 9$.

Flowering mainly in late summer.

Distinguishing characters: robust perennials, erect, woody with large grey-green, smooth or textured leaves; sheathing stems at their partially fused bases; flowers large, solitary with bracts just below them; seeds echinate, tuberculate or hairy.

Species 7, across the border between South Africa and Namibia, along the lower reaches of the Orange River. This is an extremely arid area of the Northern Cape.

Bergeranthus Schwantes 2405015

(Ruschioideae: 8. Bergeranthus Group).

Schwantes: 179 (1926c); Herre: 90 (1971); Smith *et al.*: 202 (1998).

Compact tufted perennials, branching from base into clumps, with tuberous rootstock. **Leaves** opposite, shortly connate at base, crowded, triquetrous to awl-shaped, mucronate, up to ± 130 mm long, 20 mm broad, surface dark green; epidermis ± smooth, stomata hardly sunken, surface even or somewhat elevated above subhypodermal tannin idioblasts. **Flowers** on pedicels with sheathing bracts in dichotomous cymes, but axillary flowers sometimes suppressed, ± 50 mm diameter, bracteate; opening from late afternoon to early evening, closing before midnight. **Sepals** 5, lanceolate, 3-angled, keeled with membranous margins. **Petals** in several series, linear-lanceolate, yellow, reddish on outer surface. **Stamens** erect, epapillate. **Nectary** a crenate ring. **Ovary** conical above; placentas parietal; stigmas 5, filiform or subulate, longer than stamens. **Fruit** a 5-locular capsule, close to Mitrophyllum type; with a well-developed broad spongy closing ledge; expanding keels in a more tangential position; broad, dark brown, with membranous points; covering membranes rigid; closing bodies large, somewhat trigonous. **Seeds** globose, pear-shaped or triangular-ovoid. $x = 9$ (aneuploids, polyploidy).

Flowering almost any time of the year.

Distinguishing characters: tufted perennials; leaves triquetrous, smooth; inflorescences cymose; pedicels bracteate; fruit with large, white closing bodies.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Species 10, Eastern Cape, between Graaff-Reinet and Port Elizabeth in the west and East London and Queenstown in the east.

Bijlia N.E.Br. 2405017

(Ruschioideae: 8. Bergeranthus Group).
Brown: 267 (1928); Herre: 94 (1971); Hartmann: 173 (1992a); Hammer 195 (1995); Smith *et al.*: 136 (1998).

Bolusanthemum Schwantes: 514 (1928c).

Dwarf perennials branched from base into clumps, mostly with 2 or 3 branches only. **Leaves** opposite, somewhat unequal, gibbous-trigonous with a ± rounded oblique keel, one side ± flat, the other inflated, but both sides often indented; spreading and often pushed aside by old fruit capsules situated at centre of plant; surface smooth, glaucous, whitish, stomata ± superficial, outer epidermis wall very thick. **Flowers** 1–3, shortly pedicellate, bracteate; opening at noon, closing at night. **Sepals** 5, subequal. **Petals** 2-seriate, free, cuneately linear, yellow. **Stamens** collected in a column, epapillate. **Nectary** of 5 separate glands. **Ovary** slightly conical above; placentas parietal; stigmas 5, filiform. **Fruit** a 5-locular capsule; valves erect in expanded capsule; valve rims broad; close to Mitrophyllum type with well-developed hood-shaped closing bodies and short ± tangential expanding keels gradually merging into expanding sheets; covering membranes present, slightly stiff, with acute depressions between ridges. **Seeds** acutely ovoid, several per locule. $x = 9$ (1 report).

Flowering in autumn.

Distinguishing characters: perennials with boat-shaped, unequal, light green to yellowish white leaves; flowers large, yellow; fruit persistent.

Species 2, rather restricted distribution in the Western Cape where it occurs near the small town of Prince Albert.

Braunsia Schwantes 2405018

(Ruschioideae: 9. Lampranthus Group).
Schwantes: 644 (1928c); Bolus: 306 (1967); Herre: 96 (1971); Smith *et al.*: 276 (1998).

Echinus L.Bolus: t. 266 (1927).

Compact, erect to prostrate shrublets. **Leaves** opposite, nearly equal, connate up to half their length, triquetrous, sometimes apiculate, with serrate and cartilaginous keels and margins, ± 25 mm long, 15 mm broad; velvety from long papillae, stomata overarched by papillae, outer epidermal wall thick. **Flowers** 1(–3), solitary or in cymes, pedicellate or occasionally sessile, ± 40 mm in diameter; opening midday to late afternoon. **Sepals** 5, exterior 2 flattened, inner ones with conspicuous, membranous margins. **Petals** 1–5-seriate, purple to pink, rarely white. **Stamens**: filaments slightly ciliate-papillate; staminodes present. **Nectary** an inconspicuous, minutely crenulate ring. **Ovary** slightly elevated to slightly concave; placentas parietal; stigmas (4)5(–7), subulate. **Fruit** a (4)5(–7)-locular capsule, of Lampranthus type but covering membranes not as broad and long as in typical form; lacking closing ledges; expanding keels parallel, lacerate, aristate; covering membranes well developed or reduced to a limb; closing bodies 0; valve wings present. **Seeds** somewhat globose, echinate. $x = 9$ (1 report).

Flowering from mid-summer to early winter.

Distinguishing characters: shrublets with leaves fused for half their length, often with cartilaginous or serrated edges, sometimes velvety with a sharp tip; seeds echinate.

Species 5, southwestern part of South Africa, mostly in arid areas of the Western and S Northern Cape including the Little Karoo, and at Matjiesfontein and Laingsburg in the Great Karoo.

Brownanthus Schwantes 2405135

(Mesembryanthemoideae).
Schwantes: 14 (1927d); Ihlenfeldt & Bittrich: 289 (1985); Bittrich: 5 (1986); Pierce & Gerbaulet: 42 (1997); Smith *et al.*: 34 (1998).

Pseudobrownanthus Ihlenf. & Bittrich: 319 (1985).

Decumbent to erect shrubs, 150–1000 mm high, with fibrous roots; stems (young) weakly lignified, articulate, green and succulent; epidermal bladder cells tall, closely packed; old stems woody. **Leaves** decussate, ± terete, free or shortly fused towards bases, ephemeral, sometimes spinescent; bladder cells at base and edges often becoming hair-like. **Flowers** solitary or in dichasia, 5–25 mm diameter; open during daylight hours. **Sepals** 4 or 5, ± equal, consistently erect during anthesis. **Petals** free towards bases, cream; staminodes 0. **Nectary** consisting of 4 or 5 separate grooves. **Ovary** with axile placentas; stigmas 4 or 5. **Fruit** a 4- or 5-locular capsule, of Mesembryanthemum type, rarely nut-like; expanding keels extending to centre of fruit; valve wings present; sometimes with a basal seed pocket, then expanding keels not separated by placenta. **Seeds** D- or pear-shaped, 1–1.3 mm long, surface mostly smooth, rarely rough, ochre or brown. $x = 9$ (polyploidy).

Flowering spring to early summer.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Distinguishing characters: stems succulent, later becoming woody; different arrangements of bladder cell idioblasts on stems (closely packed) and leaves (loosely arranged); leaves free or shortly fused at the bases.

Species 10, both summer- and winter-rainfall regions of the Western and Northern Cape, also in Namibia and extending into Angola.

Calamophyllum Schwantes 2405019

(Ruschioideae: uncertain).
Schwantes: 15, 28 (1927d); Herre: 98 (1971); Smith *et al.*: 204 (1998).

Tufted perennials, often with visible internodes, up to 200 mm high. **Leaves** opposite, crowded, ± club-shaped, nearly terete at base, upper surface ± flat towards apex, bluish green. **Flowers** solitary, terminal, 30–50 mm in diameter; peduncle ± as long as leaves; opening in afternoon. **Sepals** 4, unequal. **Petals** in several series, sometimes obtuse or emarginate, uniformly red to red with a white centre. **Stamens** white or red, with red anthers. **Ovary** 10–12-locular, with parietal placentas; stigmas as many as locules, diverging. **Fruit** and **seeds** unknown.

Distinguishing characters: plants may be distinguished by their bluish green, ± club-shaped, angled leaves with blunt tips; capsules 10–12-locular.

Species 3, natural distribution is unknown. The genus is based on cultivated specimens described originally by Haworth in 1794 under *Mesembryanthemum* and has not since been definitely identified.

Carpanthea N.E.Br. 2405020

(Ruschioideae: 1. Apatesia Group).
Brown: 412 (1925); Herre: 100 (1971); Ihlenfeldt & Gerbaulet: 457 (1990); Smith *et al.*: 62 (1998).

Macrocaulon N.E.Br.: 12 (1927a).

Annual herbs; stems papillate, glistening, woolly. **Leaves** opposite, decussate, radical or on lower part of flowering branches, blade shorter than petiole, somewhat connate at base, spatulate or lanceolate, obtuse, 3-nerved, with scattered white hairs, margins ciliate with elongated bladder cells. **Flowers** 1–3, terminal, principally in dichasia, pedicellate, bracteate, 40–70 mm diameter; open during afternoon, closing up tightly into a twisted tip at night. **Sepals** 5, unequal, 2 outer foliaceous, inner ovate with membranous margin. **Petals** linear, acute, with ciliate margins, free or nearly so, golden yellow with reddish tinge towards tips, slender. **Stamens** and **staminodes** many. **Nectary** a ring with entire rim. **Ovary** broader than deep; placentas basal; stigmas 12–18, filiform, acute. **Fruit** a 12–18-locular capsule, firm, persistent septa overarching locules from sides; placenta raised by a false basal septum, broader than deep; valves narrow, with a pair of closely contiguous expanding keels ending in awns; locules without covering membranes and with narrow exit for seeds. **Seeds** roundish. $x = 9$.

Flowering late spring to early summer.

Distinguishing characters: annual herbs with flat, green leaves; stems hairy; flowers yellow; fruit 12–18-locular with contiguous expanding keels ending in awns.

Species 1: *Carpanthea pomeridiana* (L.) N.E.Br., in the extreme SW parts of Western Cape.

Carpobrotus N.E.Br. 2405021

(Ruschioideae: ? 9. Lampranthus Group).
Brown: 433 (1925); Herre: 102 (1971); Wisura & Glen: 76 (1993); Smith *et al.*: 252 (1998).

Robust trailing perennials, forming large mats; stems maroon to yellow, sometimes narrowly winged, with ± upright flowering branches. **Leaves** opposite, slightly united at base, sharply 3-angled, up to 150 mm long, green or grey-green, often tinged with a reddish hue, margins and keel cartilaginous and often serrate. **Flowers** large, up to 150 mm diameter, terminal, pedicellate, borne on bracteate stalks; base of flower two-ridged tapering into flower stalk; opening in morning and closing at night. **Sepals** 5, equal or unequal. **Petals** free, white, yellow or various shades of purple or pink. **Stamens** many. **Nectary** a crenulate ring. **Ovary**: placentas parietal; stigmas 4–20, radiating, plumose. **Fruit** fleshy-succulent, indehiscent, 4–20-locular, often edible. **Seeds** large, obovoid, slightly compressed, on long funicles, embedded in a sticky mucilage. $x = 9$.

Flowering from early spring to summer.

Distinguishing characters: robust perennials, trailing; leaves triquetrous, smooth, long; flowers large, up to 150 mm in diameter; fruit fleshy, seeds embedded in mucilage.

Species 13; 7 in sthn Afr., along the coast at low altitudes, with few species found inland. Species of *Carpobrotus* are cultivated and have been introduced worldwide into areas with suitable climates; in some parts of the United States of America they have escaped cultivation and are invading natural vegetation types.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Carruanthus (Schwantes) Schwantes 2405022

(Ruschioideae: 8. Bergeranthus Group).
Schwantes: 106 (1927d); Herre: 104 (1971); Smith *et al.*: 180 (1998).

Tischleria Schwantes: 78 (1951).

Compact, tufted perennials branching from base into clumps, with tuberous rootstock. **Leaves** opposite, crowded, slightly connate at base, trigonous, upper surface flat or somewhat concave, lower surface deep and obtusely keeled, toothed along margins towards apex, keel not toothed, grey to glossy-green, unmarked, up to ± 60 mm long, 18 mm broad. **Flowers** 1–3, solitary or in dichotomous cymes, 40–50 mm in diameter; peduncle 2-angled, shorter than leaves, with 1 or 2 pairs of bracts; pedicels ± erect, ± 100 mm long, slender, twice as long as leaves; opening in late afternoon and staying open a little after dark. **Sepals** 5, subequal, somewhat keeled. **Petals** linear-lanceolate, yellow with orange to reddish tips. **Stamens** yellow, epapillate. **Nectary** of 5 separate, crenulate glands. **Ovary** conical above; placentas parietal; stigmas 5, filiform or subulate, recurved. **Fruit** a 5-locular capsule; close to Mitrophyllum type, but with narrow valve wings; resembling capsules of *Hereroa* or *Bergeranthus*; rims of valves very high and expanding keels diverging on valves, not reaching deep into locule, both features resulting in an incomplete opening of valves; covering membranes reduced to a limb; closing bodies reduced or 0. **Seeds** ± pear-shaped or orbicular, ± 1 mm long. $x = 9$ (1 report).

Flowering late winter to early summer (*Carruanthus ringens* (L.) Boom) or spring to early summer (*Carruanthus peersii* L.Bolus).

Distinguishing characters: perennials with tuberous roots and toothed, smooth, yellowish green leaves; flowers yellow, pedicel long (up to 100 mm).

Species 2, restricted to areas around Willowmore, straddling the border between the Western and Eastern Cape.

Caryotophora Leistner 2405023

(Ruschioideae: 1. Apatesia Group).
Leistner: 289 (1958a); Herre: 106 (1971); Ihlenfeldt & Gerbaulet: 457 (1990); Smith *et al.*: 64 (1998).

Low, slightly succulent glabrous perennials, with suckers arising from a thick laterally spreading root, each giving rise to a very short stem bearing a tuft of leaves and decumbent annual flowering branches. **Leaves** alternate or subopposite, lanceolate-spatulate, obtuse or subacute, flat, decurrent and stem-clasping at base, entire, ascending, dark green, mesomorphic. **Flowers** solitary, terminal, 40–60 mm in diameter, peduncle 30–100 mm long; opening by day. **Sepals** 5. **Petals** linear-attenuate, white. **Stamens** and **staminodes** incurved; filaments papillose near base. **Nectary** a crenulate ring. **Ovary** 3- or 4-locular, receptacle subturbinate, slightly convex on upper surface; placentas axile; stigmas 3 or 4, subulate. **Fruit** a schizocarp, with 3 or 4 bilocular, nut-like, woody mericarps, with a single ovule in each locule. **Seeds** reniform, up to 2 mm long, verrucose, reddish brown.

Flowering from spring to early summer.

Distinguishing characters: flat, smooth, slightly succulent, lance- to spoon-shaped leaves; fruit comprising 3 to 4 nut-like parts; flowers white.

Species 1: *Caryotophora skiatophytoides* Leistner, with a very restricted distribution to the west of Cape Agulhas, the southernmost point of Africa, in the Western Cape. It is known only from sandy flats with coastal fynbos vegetation in the Brandfontein area, near Bredasdorp.

Caulipsolon Klak 2405200

(Mesembryanthemoideae).
Klak & Linder: 301 (1998); Smith *et al.*: 36 (1998).

Perennials with prostrate annual stems and tuberous rootstock; stems weakly lignified, articulate, green and succulent, smooth. **Leaves** decussate, free towards bases, semicylindrical, ephemeral, smooth. **Flowers** solitary or in few-flowered dichasia, several per axis, single on shorter side branches, 20–30 mm diameter. **Sepals** 5. **Petals** white, decreasing in length towards center of flower. **Staminodes** 0. **Nectary** consisting of 5 separate grooves. **Ovary**: placentas axile. **Fruit** a 5-locular capsule of Mesembryanthemum type, base funnel-shaped, to 10 mm deep; expanding keels extending to centre of fruit; valve wings reflexed and fused in pairs. **Seeds** D-shaped, 1–1.3 mm long, surface rough, ochre.

Flowering late winter to early spring.

Distinguishing characters: tuberous rootstock; creeping annual stems; stems and leaves smooth; fruit funnel-shaped in lower part.

Species 1: *Caulipsolon rapaceum* (Jacq.) Klak is found in Namaqualand (Northern Cape).

Cephalophyllum N.E.Br. 2405024

(Ruschioideae: 11. Leipoldtia Group).
Brown: 433 (1925); Friedrich: 20 (1970); Herre: 108 (1971); Hartmann: 264 (1978); Hartmann: 653 (1983d); Hartmann: 141 (1984b); Hartmann: 263 (1986); Hartmann: 93 (1988b); Smith *et al.*: 256 (1998).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Prostrate perennials, sometimes compact, rarely erect and shrubby, with a prominent, vegetative, monopodial head in several species; main stem short, producing decumbent or prostrate branches, with distinct internodes between some leaf pairs. **Leaves** opposite, not connate, crowded at end of stem and branches, apically triangular in cross section, basally rounded, rarely quilt-shaped, club-shaped or triquetrous, often mucronate; stomata not sunken. **Flowers** 1–3, rarely solitary, terminal, up to 50 mm in diameter, on elongate, bibracteate or ebracteate pedicels; opening midday or afternoon. **Sepals** 5. **Petals** free, linear, yellow, purple or white in various combinations. **Stamens** erect, often differing in colour from petals. **Nectary** a crenulate ring. **Ovary** with top raised into a crater-like rim surrounding stigmas or sometimes simply depressed in centre; placentas basal; stigmas 10–21, plumose. **Fruit** a 10–21-locular capsule, of Leipoldtia type; with a prominent closing bulge formed by roof of locule; valve wings well developed; expanding keels parallel; covering membranes present; closing bodies large; sometimes as tumble fruit. **Seeds** ovoid or pear-shaped, small, brown. $x = 9$ (polyploidy).

Flowering in winter.

Distinguishing characters: cushion-forming perennials, creeping or erect; flowers often brilliantly multicoloured; fruit 10–20-locular with large closing bodies, broad valve wings and covering membranes with large closing bulges distally.

Species 33, in a broad band from Lüderitz to Aus in Namibia, stretching southwards through the Northern Cape and into the Western Cape, occasionally reaching the sea, and extending as far east as Oudtshoorn.

Cerochlamys N.E.Br. 2405025

(Ruschioideae: 8. Bergeranthus Group).
Brown: 171 (1928a); Herre: 110 (1971); Hartmann: 44 (1998); Smith *et al.*: 138 (1998).

Compact tufted perennials. **Leaves** opposite, shortly united at base, 1–3 pairs on a branch, trigonously clavate with rounded keels, often twisted almost at right angles from base, firm in texture with waxy covering, ± 40 mm long, purplish green to yellowish. **Flowers** terminal, 1–3; pedicel bracteolate; opening in late morning, open all day, long-lasting. **Sepals** 5 or 6, nearly equal. **Petals** 2- or 3-seriate, free, linear, pink with white bases, or white. **Stamens**: filaments epapillate; anthers yellow or orange. **Staminodes** present. **Nectary** appearing annular, of 5 separate crenulate glands, touching each other. **Ovary** obconic, flattish on top; placentas parietal; stigmas 5 or 6, short, acute. **Fruit** a 5- or 6-locular capsule; persisting on the plant; shortly obconic to nearly flat, with raised sutures on top; possibly close to Mitrophyllum type because of its widely diverging, broad expanding keels ending in awns, but valve wings absent; valves with high rims, only opening into a vertical position; spongy tissue separating locules; covering membranes stiff, acute, with dense mass of funicles at openings of locules. **Seeds** acutely ovoid, microscopically tuberculate. $x = 9$.

Flowering in autumn and winter.

Distinguishing characters: small tufted perennials flowering in mid-winter; leaves purplish green with a partially peeling waxy covering; capsule valves open to vertical position only.

Species 3. In crevices of rocks or in shaly places in the Little and Great Karoo, Western Cape.

Chasmatophyllum Dinter & Schwantes 2405026

(Ruschioideae: 5. Stomatium Group).
Schwantes: 14, 17 (1927d); Friedrich: 23 (1970); Herre: 112 (1971); Smith *et al.*: 182 (1998).

Dwarf shrublets, tufted or producing prostrate branches, often forming small mats. **Leaves** opposite, sheathing at base, 6–8 on branchlets, often oblong or spatulate, obtusely keeled, often obtusely toothed on margins and keel, surface somewhat warty and rough. **Flowers** solitary, terminal, pedicellate, ebracteate, 20–50 mm in diameter; open from late afternoon to early evening. **Sepals** 5, unequal, 3-angled. **Petals** 2- or 3-seriate, lanceolate, golden yellow, with reddish tips. **Stamens** many, converging. **Nectary** of 5 separate, somewhat crenulate glands, distinct. **Ovary**: top flat or nearly so; placentas parietal; stigmas 5, filiform. **Fruit** a 5-locular capsule, of Drosanthemum type; with broad valve wings; covering membranes present. **Seeds** obtusely hooked, somewhat rough, small, light yellow.

Flowering in summer.

Distinguishing characters: small, compact, creeping perennials; leaves with soft whitish teeth; flowers yellow.

Species 6, a wide, but sparse distribution in the sthn Afr. interior, stretching from the Karas Mountains in Namibia in the west, scattered in the Great and Little Karoos, Eastern Cape, North-West and Gauteng to Mpumalanga.

Cheiridopsis N.E.Br. 2405027

(Ruschioideae: 11. Leipoldtia Group).
Brown: 433 (1925); Brown: 406 (1926b); Friedrich: 24 (1970); Herre: 114 (1971); Hartmann & Dehn: 567 (1987); Hammer: 75 (1993a); Hammer: 59 (1995g); Smith *et al.*: 206 (1998).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Compact, tufted, dwarf to somewhat shrubby perennials; isophyllous or heterophyllous, rarely with a compact storage root. **Leaves** opposite, 1 or 2 pairs to a branch, up to 3 pairs in cultivation variably united, withering, leaf sheath of one pair developing into a prominent, papery, dry sleeve, short or long, triangular, rarely flattened or hood-shaped, green to glaucous-green, often with 1 or 2 small teeth along keel or near apex; epidermis papillate, covered with waxy compound, surface ± velvety, sometimes with prominent elevations above subhypodermal tannin idioblast layer. **Flowers** solitary, terminal, mostly pedicellate, with bracts, 10–100 mm in diameter; opening around midday and closing by sunset; scented. **Sepals** 4 or 5. **Petals** in several series, free, various shades of yellow, rarely purple or red. **Stamens** many; staminodes 0. **Nectary** a crenulate ring. **Ovary**: top raised at first, becoming depressed in fruit; placentas parietal to basal; stigmas 10–20, ± plumose. **Fruit** a 10–20-locular capsule, of Leipoldtia type with rather straight covering membranes and reduced additional closing devices; often with dorsal appendages (wings, tubes, flanges) on the covering membranes; with narrow, widely spreading or reflexed valves; diverging expanding keels with membranous, awn-like points; valve wings usually 0; closing bodies large. **Seeds** pear-shaped, obtusely 3-angled, smooth or rough, whitish to brownish. $x = 9$ (polyploidy).

Flowering from autumn to early spring.

Distinguishing characters: mostly tufted, variable perennials; leaf pairs closely pressed together, old leaves sometimes forming papery sheaths; flower stalk may be curved; fruit 10–20-locular, with awn-like points at ends of valves.

Species 33, in a broad band stretching from Lüderitz, in Namibia, southwards through the Richtersveld and Namaqualand in the Northern Cape, to the northern parts of the Western Cape. The largest concentration of species is in the vicinity of Steinkopf and Platbakkies.

Circandra N.E.Br. 2405138

(Ruschioideae: 9. Lampranthus Group).
Brown: 126 (1930a); Liede: 391 (1989); Smith *et al.*: 318 (1998).

Sparsely branched shrubs, up to 600 mm high, branching at base; stems smooth, up to 5 mm in diameter. **Leaves** slender, up to 35 mm long, free towards bases, acute, sharply 3-angled, smooth with serrated margins. **Flowers** terminal, solitary, pedicellate, bracteate, up to 50 mm in diameter. **Sepals** 5, unequal. **Petals** bright yellow. **Stamens** very short, broadening and connate at base; staminodes 0. **Nectary** unknown. **Ovary** 5-locular; placentas parietal. **Fruit** a 5-locular capsule, of Lampranthus type, to 12 mm in diameter; expanding keels diverging and extending into an awn with broad wings; covering membranes covering locules; closing bodies 0. **Seeds** large, up to 1.6 mm long, surface rough.

Flowering in early summer.

Distinguishing characters: shrub with distinctly curved branches; leaves serrated; flowers solitary, large and yellow.

Species 1: *Circandra serrata* (L.) N.E.Br., in a small area in the Western Cape and has been collected from the surroundings of Ceres, Tulbagh and Villiersdorp, at low altitudes of up to 500 m.

Cleretum N.E.Br. 2405140

(Ruschioideae: 2. Cleretum Group).
Brown: 412 (1925); Friedrich: 26 (1970); Ihlenfeldt & Struck: 411 (1986); Smith *et al.*: 66 (1998).
Micropterum Schwantes: 17 (1928a); Winkler: 20 (1957); Herre: 210 (1971).

Annual prostrate to erect herbs, with prominent, soft papillae. **Leaves** opposite, ± spatulate, entire or occasionally pinnatifid. **Flowers** solitary, terminal, pedicellate, ebracteate, small or large; opening during day, or cleistogamous. **Sepals** 5, papillate. **Petals** 1- to 3-seriate, few (± 20) and short (2–4 mm long) or many and long, yellow or white. **Stamens** relatively few; staminodes 6 to many. **Nectary** of 5 separate dark green glands. **Ovary** convex above with 5 prominent ridges; placentas parietal; stigmas 5(6), filiform to narrowly subulate. **Fruit** a 5(6)-locular capsule, close to Mitrophyllum type; upper part of capsule distinctly ridged; with large expanding sheets; expanding keels parallel, large; valve wings broad; covering membranes small or 0; closing bodies 0. **Seeds** obtusely triangular, compressed, minutely tuberculate or smooth.

Flowering from late winter to spring.

Distinguishing characters: annual herbs with flat leaves; flowers white or yellow, sometimes cleistogamous; upper surface of fruit ridged.

Species 3, western parts of South Africa, from the Cape Peninsula in the Western Cape, northwards through Namaqualand to the Richtersveld in the Northern Cape.

Conicosia N.E.Br. 2405028

(Ruschioideae: 1. Apatesia Group).
Brown: 433 (1925); Herre: 116 (1971); Hartmann: 52 (1993); Smith *et al.*: 68 (1998).
Herrea Schwantes: 436 (1927a); Herre: 170 (1971); Ihlenfeldt & Gerbaulet: 457 (1990).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial or occasionally biennial herbs, usually with a short main stem ending in a tuft of leaves with mostly
prostrate flowering branches; often with a tuberous rootstock. **Leaves** opposite, sometimes alternate, slightly stem-clasping, triquetrous or ± terete, sometimes slightly concave on upper surface, up to 400 mm long, entirely without bladder cells; deciduous after fruiting. **Flowers** solitary, terminal, on long, ebracteate pedicels, variable in size, up to 130 mm in diameter, often with unpleasant smell; opening in afternoon and closing at sunset. **Sepals** 5, terete or subulate, from broad base. **Petals** free, in several series, linear, margins papillate, in various shades of yellow, rarely white above and salmon on lower surface. **Stamens**: many, filaments bearded at base; staminodes many. **Nectary** a low, weakly crenulate ring. **Ovary** concave or somewhat conical in centre above; placentas parietal or basal; ovules several per locule; stigmas 10–25, filiform. **Fruit** a 10–25-locular capsule, large, ± xerochastic—seed dispersal dependent on separation of valves by desiccation; with two parietal seed pockets per locule; without expanding keels; each valve with a pair of thin, submembranous, wing-like, locular partitions on inner face. **Seeds** subglobose, often slightly keeled, smooth. $x = 9$.

Flowering spring to early summer.

Distinguishing characters: perennial or biennial; leaves elongated; flowers yellow or whitish yellow; fruit distinctive, cone-shaped, 10–25-locular, without expanding keels, with seed pockets.

Species 2, western parts of South Africa (Western and Northern Cape) as well as S Namibia. *Conicosia pugioniformis* (L.) N.E.Br. subsp. *muirii* (N.E.Br.) Ihlenf. & Gerbaulet occurs in a distinct belt along the coastal regions as far east as Knysna. *C. pugioniformis* has been introduced to SE Australia and Victoria.

Conophytum N.E.Br. 2405030

(Ruschioideae: 7. Dracophilus Group)
Brown: 198 (1922a); Friedrich: 27 (1970); Herre: 120 (1971); Hammer: (1993b); Hammer: 23 (1995e); Hammer 34 (1995f); Smith *et al.*: 86 (1998).

Berrisfordia L.Bolus: 313 (1932); Herre: 92 (1971); Hartmann: 60 (1993). *Herreanthus* Schwantes: 514 (1928c); Herre: 172 (1971); Hartmann: 60 (1993). *Derenbergia* Schwantes: 137 (1925). *Ophthalmophyllum* (Dinter & Schwantes) Schwantes: 64 (1927b); Friedrich: 89 (1970); Herre: 238 (1971).

Dwarf, cushion-forming or single-bodied perennials, virtually stemless in early stages and with only fractional annual increments, internodes enclosed in young plants, moderately to profusely branched, rarely solitary bodies. **Leaves** of each pair usually united into obconic, cylindric or oblong bodies, with a small, mouth-like opening in centre or between lobes; turning into dry sheaths protecting subsequent year's growth during dry season; green to brown, reddish or whitish blue, spotted or lined, often velvety, warted or windowed. **Flowers** solitary, or in rare cases in delayed groups of two or three; with a prominent long perianth-stamen tube; emerging through opening in leaves sometimes appearing out of dry leaf sheath; bracts always present but concealed within leaves; usually scented; anthesis diurnal or nocturnal. **Petals** few to many in 1–several series, spreading or recurved; partially united and sometimes connected to sepal tube; magenta to blackish or coppery-red, yellow, orange, pink, white and often bicoloured, rarely scarlet. **Sepals** 4–6, united into a short, membranous tube above ovary, partly included or exserted from leaves. **Stamens** few to many, erect, included or partly exserted from corolla tube. **Nectary** a crenulate ring. **Ovary** flat or convex on top; usually hidden inside body; stigmas 3–8, plumose, basal parts usually fused into a style of varying length; placenta parietal to basal, very rarely axile. **Fruit** a 3–8-locular capsule, of Delosperma type; without covering membranes or closing bodies; very fragile, but often held together by leaves. **Seeds** ovoid, smooth or rough, minute. $x = 9$ (polyploidy).

Flowering mostly in autumn, few species flowering in other seasons.

Distinguishing characters: cushion-forming or single-bodied perennials; flowers with petals fused into a tube, pedicels with bracts.

Species 88, widely distributed over the winter-rainfall, semi-arid and arid regions, including the western parts of the Northern Cape notably Namaqualand, the Richtersveld and Bushmanland, the Western Cape including the Little Karoo and the southern margin of the Great Karoo. The genus just enters the western part of the Eastern Cape. More specifically the genus occurs northwards from Paarl to Alexander Bay and east to Pofadder, and in the south it ranges from Avondrust to Steytlerville. However, it is not found in parts of the Great Karoo which receive summer rain. The highest concentration of species is found in the Namaqualand region.

Corpuscularia Schwantes 2405130

(Ruschioideae: 4. Delosperma Group).
Schwantes: 186 (1926a); Dupont: 7 (1968); Smith *et al.*: 278 (1998).

Schonlandia L.Bolus: t. 259 (1927g).

Low shrublets, sometimes with trailing branches with internodes usually hidden by leaves. **Leaves** sharply triangular in cross section, sides ± parallel, with tiny pointed tips, smooth and firm in texture, very pale green to bluish green, unspotted. **Flowers** solitary, short-stalked, rather large and white to pale pinkish or cream; bracts leaf-like. **Sepals** 6, firm. **Petals** long and narrow, rather stiff, white. **Stamens** erect, sparsely hairy; staminodes few. **Nectary** of 6 separate, but nearly touching glands. **Ovary**: placentas parietal; stigmas 6. **Fruit** a 6-locular capsule, of Delosperma type; robust, whitish, with dark persistent petal remains, not closing completely after first opening; expanding keels parallel;

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

valve wings broad; covering membranes 0; closing bodies 0. **Seeds** pear-shaped and nearly smooth. x = 9.

Flowering in spring and summer.

Distinguishing characters: shrublets with pale grey-green, triquetrous, dotless leaves; flowers white with stiff petals and 6 sepals; old petals persist on the developing fruit.

Species 2, restricted to the Eastern Cape, where it occurs from around Port Elizabeth up to Grahamstown.

Cylindrophyllum Schwantes 2405031

(Ruschioideae: 11. Leipoldtia Group)
Schwantes: 15, 28 (1927d); Herre: 122 (1971); Smith *et al.*: 210 (1998).

Tufted perennials up to 180 mm high, with short branches, often forming large cushions; stems woody with age, but internodes hidden, procumbent to ascending. **Leaves** opposite, connate at base, cylindric or terete, up to ± 100 mm long, 8 mm in diameter, grey-green, often reddish, finely dotted, fairly crowded, old leaves persistent; epidermis with elongate elevations of several cell rows, stomata in valleys, outer epidermal walls very thick and layered, thick waxy layer on epidermis. **Flowers** solitary, terminal, shortly pedicellate, ebracteate, ± 70 mm in diameter; opening at noon, closing by evening. **Sepals** 5, 3 larger than others and keeled. **Petals** short, in several series, whitish to yellow or pinkish, often with darker colours in centre. **Stamens** in several series, epapillate. **Staminodes** conically collected, orange or reddish. **Nectary** a crenulate ring. **Ovary** fairly sharply conical on top; placentas parietal; stigmas 5–11, subulate, much shorter than stamens. **Fruit** a 5–11 locular capsule; of firm consistency, locules deep, and placenta parietal as in Ruschia type; with long, narrow, awn-like valve wings (not awn-like in *C. tugwelliae* L.Bolus); expanding keels toothed, parallel; covering membranes present; closing bodies small. **Seeds** orbicular, tessellate, dark brown. x = 9.

Flowering from spring to early summer.

Distinguishing characters: tufted perennials, with cylindrical leaves; flowers large, yellowish with many stamens; fruit with toothed parallel expanding keels and long, awn-like valve wings; placentation partially axile.

Species 6, mainly in the Little Karoo in the Western Cape. *Cylindrophyllum dyeri* L.Bolus has been recorded from Jansenville in the Eastern Cape and *C. hallii* L.Bolus on Brakfontein, near Loeriesfontein in the Northern Cape.

Dactylopsis N.E.Br. 2405032

(Mesembryanthemoideae)
Brown: 413 (1925); Herre: 124 (1971); Hartmann: 47 (1993); Gerbaulet: 145 (1997).

Phyllobolus N.E.Br. in part; Smith *et al.*: 42 (1998).

Compact, dwarf, highly succulent perennials forming clumps with age; roots thickened. **Leaves** alternate, 2 or 3 per branch, finger-like, cylindrical with long sheaths completely enveloping internodes, withering completely into a membranous covering protecting young buds. **Flowers** terminal, solitary, sessile, 10–20 mm in diameter, remaining continuously open for ± 3 weeks. **Sepals** 5, equal, forming a short tube above ovary. **Petals** white, stiff, numerous, in several series, merging into staminodes. **Stamens** numerous, linear, arising from rim of ovary and united into short tube; pollen punctate-foveolate, microspinulose. **Ovary** half-superior; placentas axile. **Nectary** of 5 separate grooves. **Fruit** a capsule, 5-locular, of Mesembryanthemum type; expanding keels parallel, diverging slightly distally; valves with membranous marginal wings or flaps. **Seeds** smooth, brown. x = 9.

Flowering from spring to early summer.

Distinguishing characters: compact, highly succulent perennials; leaves finger-like, cylindrical; flowers solitary, terminal, remaining open for ± 3 weeks.

Species 2, Vanrhynsdorp and Vredendal districts, Western Cape.

Deilanthe N.E.Br. 2405018

(Ruschioideae: 6. Titanopsis Group)
Brown: 137 (1931b); Hammer: 172 (1995d); Smith *et al.*: 160 (1998).

Aloinopsis Schwantes, in part.

Almost stemless tufted perennials with a thick and firmly fleshy rootstock, deeply rooting. **Leaves** opposite, united at base in sparse rosettes, spatulate-ovate or spatulate-lanceolate, flat on ground to erect, dark green to reddish brown and inconspicuously dotted, velvety. **Flowers** solitary or in delayed sets of three, pedicellate, bracteate at base of thick pedicel; opening in late afternoon or evening. **Sepals** 5, subequal. **Petals** in 3 or 4 series, free, linear to narrowly spatulate, pale to deep yellow or a greyish salmon colour sometimes obscurely striped with white. **Stamens** erect, in a loose cylindrical mass, papillate. **Nectary** glands large, in a crenulate ring. **Ovary** flattish or slightly convex on top, glassy; placentas basal to parietal; stigmas 8–12, erect, subulate. **Fruit** a 8–12-locular capsule, shortly obconic,

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

flattish at top, with raised sutures; valves narrowly deltoid, with a very prominent, acute keel on inner face; expanding keels diverging from base, ± half as long as valve, each tipped with a pallid awn reaching nearly to tips of valves, and with short, broad, membranous marginal wings at base united in pairs between valves; covering membranes rather stiff, closing bodies small. **Seeds** pear-shaped, smooth.

Flowering from winter to early spring.

Distinguishing characters: rosette-forming perennials with tuberous roots; leaves spatulate-ovate or spatulate-lanceolate, velvety and often dust-covered; flowers deep yellow to salmon-coloured, opening in the afternoon.

Species 2, widespread in the Little and Great Karoos in the central Western Cape, extending slightly into the Northern and Eastern Cape. Species of *Deilanthe* grow from Anysberg in the southwest to Luckhoff in the northeast. A single species, *D. peersii* (L.Bolus) N.E.Br., occurs in the Free State.

Delosperma N.E.Br. emend. Lavis 2405033

(Ruschioideae: 4. Delosperma Group)
Brown: 412 (1925); Brown: 433 (1925); Lavis: 209 (1966); Friedrich: 34 (1970); Herre: 126 (1971); Smith *et al.*: 292 (1998).

Shrubs, shrublets or perennial herbs, often with annual branches, decumbent or prostrate, rarely scrambling; stems sometimes reddish, with peeling bark when older; rootstock sometimes tuberous and lower roots sometimes with multiple small tubers. **Leaves** opposite, sessile, slightly connate or free, sometimes hairy or prickly, usually with visible bladder cell idioblasts, variable in shape from broadly triangular to cylindrical, mostly semiterete with a concave upper side, rarely flat; from bluish green to yellowish green or reddish, usually soft. **Flowers** solitary or in 3-flowered dichasial inflorescences; pedicels variable in length; bracts small or foliaceous. **Sepals** 5, unequal, sometimes horn- or tail-like. **Petals** in 1–4 whorls, linear, obtuse or emarginate, rarely hairy, white to pink or purple, rarely yellow, salmon, orange, rust-red, scarlet, carmine or wine-coloured. **Stamens** erect; staminodes usually arranged in a cone, whitish, sometimes hairy. **Nectary** of 5 separate glands, rarely united into a ring. **Ovary** slightly convex or concave on top; placentas parietal; stigmas (4)5(6), subulate or caudate, papillate. **Fruit** a (4)5(6)-locular capsule of Delosperma type; expanding keels parallel; valve wings ± rectangular; covering membranes mostly 0; closing bodies 0. **Seeds** globose, pale brown, smooth to slightly textured. $x = 9$ (aneuploids, polyploidy).

Flowering spring to summer, or sporadically.

Distinguishing characters: creeping or shrubby perennials; leaves soft, glistening or hairy; fruit without covering membranes.

Species ± 163, mostly in South Africa where the genus is widespread in all the provinces except the climatically severe central Northern Cape. It also occurs in Lesotho, Swaziland, Botswana and further north to E Africa through Zimbabwe, Kenya and Tanzania to Ethiopia as well as Arabia and the Yemen. The Indian Ocean islands of Madagascar and Reunion also have a few indigenous species. A very heterogeneous genus in need of revision.

Dicrocaulon N.E.Br. 2405034

(Ruschioideae: 3. Mitrophyllum Group)
Brown: 141 (1928c); Herre: 128 (1971); Ihlenfeldt, Hartmann & Poppendieck: 171 (1978); Smith *et al.*: 234 (1998).

Woody shrublets, cushion-forming or up to 500 mm high, often with markedly different long shoots and dense shorter shoots with narrow rings left by scars of past leaf pairs. **Leaves** papillate, of two types: first type of leaf pair united except for central aperture, small, forming a globose or elliptic body; second type arising from within aperture, oblong-terete, connate for half its length, base changing into a dry sheath. **Flowers** solitary, terminal, in position of a long leaf pair, i.e. base often enclosed by short leaf pair forming a cup; opening either in morning or at midday, remaining permanently open after a few days. **Sepals** 4 or 5, unequal. **Petals** free, filiform, vivid magenta or white, turning rosy pink. **Stamens** erect; staminodes present. **Nectary** a crested ring. **Ovary**: placentas parietal; stigmas (4)5(6–9), minute, subulate. **Fruit** a (4)5(6–9)-locular capsule, of Mitrophyllum type; flat with high rims on the valves; closing bodies 0; expanding sheets merging into prominent, contiguous expanding keels, with broad, membranous margins; covering membranes membranous. **Seeds** globose, light brown, shiny. $x = 9$ (polyploidy).

Flowering late winter to spring.

Distinguishing characters: shrublets with two different kinds of leaf pairs and woody, hard, thin stems; resting leaf bodies inconspicuous.

Species 7, Namaqualand, straddling the border between the Northern and Western Cape.

Didymaotus N.E.Br. 2405035

(Ruschioideae: Titanopsis Group)
Brown: 433 (1925); Herre: 130 (1971); Smith *et al.*: 94 (1998).

Compact, dwarf, highly succulent perennials, occurring as single leaf pairs and forming small clumps with age. **Leaves** opposite, young leaf pairs almost completely connate, forming obtusely rhomboid-

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

ovoid, broadly keeled bodies, later splitting partly open to expose flattish upper leaf surfaces, one of the two leaves of a pair usually slightly larger than the other, usually as long as broad, roughly dotted, greyish green to reddish. **Flowers** 1 or 2 (in extreme cases up to 9), arising in axils of lower leaves (side shoots) which gradually shrink as 2 foliaceous bracts and upper leaves enlarge, ± 40 mm in diameter; opening around noon and closing by evening. **Sepals** 6, keeled, 2 larger than others. **Petals** in several series, free, whitish to purple, darkest in centre or occasionally at tips. **Stamens** papillate at base, with violet filaments; staminodes 0. **Nectary** a crenate, dark brownish green ring. **Ovary** convex above; placentas parietal; stigmas 6, subulate and somewhat plumose, shorter than stamens. **Fruit** a 6-locular capsule, of Drosanthemum type; covering membranes present; closing bodies 0. **Seeds** globose, yellowish brown. $x = 9$ (1 report).

Flowering in early summer.

Distinguishing characters: single-bodied or developing into small clumps; producing 2 flowers simultaneously, one on each side of the leaf pair; leaves keeled, waxy.

Species 1: *Didymaotus lapidiformis* (Marloth) N.E.Br., Tanqua Karoo in the Western Cape with predominantly winter-rainfall.

Dinteranthus Schwantes 2405036

(Ruschioideae: 6. Titanopsis Group)

Schwantes: 184 (1926b); Friedrich: 35 (1970); Herre: 132 (1971); Sauer: 9 (1975); Sauer: t. 1778 (1978); Smith *et al.*: 96 (1998).

Compact, dwarf perennials with leaf pairs forming ± spheroid bodies, stemless but with one to several branches, sometimes forming clumps with age. **Leaves** approximately 30 mm long, 20 mm wide, connate for a third to two-thirds of their length, separated by a shallow or deep fissure from which flowers arise; epidermis with variously sized indentations and horny ridges, or leaves smooth with scattered dark green or purple dots, greyish green. **Flowers** solitary, terminal, on short, stout, winged pedicel, appearing sessile, 30–50 mm in diameter, ebracteate; opening late in afternoon, closing by evening. **Sepals** (6)7(8), unequal, pubescent, some with membranous margins. **Petals** many, free or somewhat connate at base, spreading, light to dark yellow. **Stamens** papillate or glabrous near base, collected in a cone. **Nectary** a crenulate ring. **Ovary** convex or somewhat conical above; placentas parietal; stigmas 6–15, subulate, diverging, papillate or plumose. **Fruit** a 6–15-locular capsule, of Delosperma type; shortly and broadly obconic, flattish, with slightly raised sutures on top; valve wings well developed; expanding keels closely contiguous into a central keel; covering membranes reduced to a limb, narrow or 0; closing bodies 0. **Seeds** many in each locule, very small and finely rough, white or brownish. $x = 9$ (1 report).

Flowering from late summer to mid-winter.

Distinguishing characters: single-bodied or as small clumps; leaves often with distinct keel; pedicels short and stout; sepals 6–8.

Species 4, NW parts of the Northern Cape, and the southeastern parts of Namibia. Its distribution area is bounded by Prieska in the southeast, Sperlingspütz in the west and Karasberg in the north.

Diplosoma Schwantes 2405037

(Ruschioideae: 3. Mitrophyllum Group)

Schwantes: 179 (1926b); Herre: 134 (1971); Ihlenfeldt: 375 (1988); Smith *et al.*: 98 (1998).

Maughaniella L.Bolus: 264 (1961); Herre: 202 (1971). *Maughania* N.E.Br.: 389 (1931) not of J.St.Hil.

Compact, dwarf, highly succulent perennials forming clumps with age; with dry, dormant stage; each stem annually producing 2 opposite leaves, enclosed by brown to black sclerotic sheaths derived from leaf bases of previous year; root system short, fibrous. **Leaves** spreading horizontally to ± upright, shortly and obliquely united at base, soft and tender with hyaline dots, reddish in colour, ± 25 mm long, 5 mm broad, first leaf pair persistent, hidden inside previous year's sheaths, second pair only basally connate and short-lived; flowers breaking through connate base of last leaf pair. **Flowers** solitary or in 2s or 3s, terminal, sessile between leaf bases, ebracteate, ± 25 mm diameter; opening at noon, closing in evening. **Sepals** 5–7, unequal, roundish. **Petals** 2- or 3-seriate, linear, purple, basally white. **Stamens** with papillate bases, surrounded by staminodes (purplish black in *D. luckhoffii* (L.Bolus) Schwantes ex Ihlenf.). **Nectary** a dark green, slightly crenulate ring. **Ovary** flat or pear-shaped at top; placentas parietal; stigmas 5–7, filiform. **Fruit** a 5–7-locular capsule, of Mitrophyllum type; flat; without any closing devices; expanding keels broad, dark brown, ending either in an awn or a wing; covering membranes present; closing bodies 0. **Seeds** pear-shaped, small. $x = 9$ (1 report).

Flowering from winter to spring.

Distinguishing characters: compact dwarf plants forming clumps with age; leaves soft, often reddish, with large micro-windows; flowers sessile.

Species 2, confined to a few localities in the northwestern parts of the Western Cape.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Disphyma N.E.Br.

2405038

(Ruschioideae: ? 3. Mitrophyllum Group)

Brown: 433 (1925); Herre: 136 (1971); Chinnock: 331 (1971); Chinnock: 77 (1986); Chinnock: 59 (1996); Smith *et al.*: 260 (1998).

Prostrate perennials forming dense mats, rooting at nodes, with internodes 20–30 mm long. **Leaves** opposite, triquetrous, semiterete and sometimes minutely fringed at base, in small rosettes at nodes, hyaline-dotted seen against light, up to ± 30 mm long, bright green, later becoming reddish or yellowish. **Flowers** 1–3, terminal, rarely 2 or 3 in dichasia on tufted, short side branches; ± 40 mm in diameter; pedicels up to ± 30 mm long, ebracteate; opening at noon, closing by evening. **Sepals** 5, unequal, inner ones with membranous margins. **Petals** ± 2-seriate, linear, obtuse, free; white, pink to purple. **Stamens** with inner ones papillate at base; staminodes 0. **Nectary** a deeply crenulate ring. **Ovary** convex at top; placentas parietal; stigmas 5, subulate, plumose, up to ± 4 mm long. **Fruit** a 5-locular capsule, near Mitrophyllum type; pale yellow, spongy; valves becoming reflexed; closing bodies large, bifid, spongy, rarely 0; expanding keels diverging, with lacerate margins; valve wings ± oblong, as long as valves; covering membranes present. **Seeds** ± ovoid. $x = 9$ (polyploidy).

Flowering winter to early spring.

Distinguishing characters: mat-forming perennials; fruit spongy, closing bodies bilobed.

Species 4, South Africa, Australia, Tasmania and New Zealand; 2 in sthn Afr., coastal belt in the Western and Eastern Cape.

Dorotheanthus Schwantes

2405039

(Ruschioideae: 2. Cleretum Group)

Schwantes: 283 (1927c); Herre: 138 (1971); Ihlenfeldt & Struck: 411 (1986); Brusse: 89 (1996); Smith *et al.*: 70 (1998).

Pherelobus N.E.Br.: 400 (1928); Herre: 248 (1971). *Stigmatocarpum* L.Bolus: 326 (1927h). *Sineoperculum* Van Jaarsv.: 5 (1982).

Annual, papillate herbs, procumbent to ascending, rarely compact; up to ± 100 mm high in flower. **Leaves** mostly alternate, first two whorls decussate, spatulate to oblong-ovoid to linear, flattish, in rosettes below and somewhat spaced above, not or only slightly connate at base, soft, narrowed into petiole-like base. **Flowers** solitary, terminal or axillary, up to 40 mm in diameter, on ebracteate pedicels up to 60 mm long; opening in morning and closing at night. **Sepals** 5, variable, sometimes foliaceous, softly papillate. **Petals** 2-seriate, free, linear-lanceolate or inconspicuous in *D. apetalus*; in many different colours ranging from white, yellow and orange to various shades of red, pink and purple; usually lighter towards base, resulting in a halo effect, centre mostly darker. **Stamens** brown or reddish, sometimes hairy at base; staminodes 0. **Nectary** a crenulate ring. **Ovary** flattish, without ribs or tubercles; placentas parietal; stigmas 5, subulate, papillate on inside. **Fruit** a 5-locular capsule, of Mitrophyllum type; with persistent stigmas; expanding sheets large; expanding keels diverging; valve wings narrow, acute; covering membranes present or 0. **Seeds** pear-shaped to globose, smooth and whitish or verrucose and dark brown. $x = 9$.

Flowering late winter to spring in habitat.

Distinguishing characters: annuals, with glistening bladder cell idioblasts; flowers multicoloured; fruit often with persistent stigmas.

Species 7, restricted to winter-rainfall region of South Africa. They are common along the coast and interior of Namaqualand in the Western and Northern Cape.

Dracophilus (Schwantes) Dinter & Schwantes

2405040

(Ruschioideae: 7. Dracophilus Group)

Schwantes: 187 (1927c); Walgate: 171 (1939); Herre: 140 (1971); Smith *et al.*: 140 (1998).

Juttadinteria subgen. *Dracophilus* Schwantes: 183 (1926).

Compact, dwarf perennials forming dense, low clumps, up to ± 300 mm high. **Leaves** opposite, trigonous, united at bases, ± 50 mm long and 15 mm broad, flattish above, grey to blue-green, rarely dentate on keel and margins; epidermis with rounded papillae of different sizes, largest ones over subhypodermal tannin idioblasts. **Flowers** terminal, solitary, ± 30 mm in diameter, on bibracteate pedicels ± 25 mm long; opening late in afternoon well into night, honey-scented. **Sepals** 5, nearly equal, obtuse. **Petals** 2- or 3-seriate, free, nearly as long as sepals, with reflexed tips, white to pink. **Stamens** collected in a central cone; filaments hairy at base. **Nectary** a crenulate ring. **Ovary** depressed, with raised centre; nectar glands annular, crenulate; placentas parietal; stigmas 8–11(14), subulate, semipersistent, recurved. **Fruit** a 8–11(14)-locular capsule, of Titanopsis type; closing bodies absent; valve wings present, large; expanding keels parallel, lacerate, ending in an awn; covering membranes present, covering two-thirds of locule, flattish, translucent. **Seeds** pear-shaped, greyish brown.

Flowering all year round.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Distinguishing characters: perennials with smooth or slightly toothed, finely textured, grey-green leaves; sepals 5 (*Juttadinteria* has 4); pedicels bracteate; flowers opening in the evening; fruit with covering membranes.

Species 4, arid areas from Lüderitz in SW Namibia, southwards to the northern part of the Richtersveld in the Northern Cape. Closely related with *Juttadinteria* and sometimes united with it (e.g. Friedrich: 58 (1970)).

Drosanthemum Schwantes 2405041

(Ruschioideae: 4. Delosperma Group)
Schwantes: 14, 29 (1927d); Friedrich: 37 (1970); Herre: 142 (1971); Smith *et al.*: 300 (1998).

Shrublets or loosely branched woody shrubs up to 800 mm high, erect, decumbent, or prostrate, with distinct internodes; stems maroon to ochre, with or without short to long hairs (bladder cells). **Leaves** decussate, sometimes trigonous or triquetrous, up to ± 50 mm long, 4 mm in diameter, free, bases rarely fused, with a rounded tip; mostly short-lived, easily dropped but rarely all leaves shed during dry season; with glistening papillae or bladder cells which are sometimes xeromorphic. **Flowers** solitary or in dichasia branched to various degrees, mostly pedicellate, on short, lateral branchlets, up to ± 30 mm in diameter; opening around midday, closing by evening. **Sepals** 5 or 6. **Petals** 1- or 2-seriate white, yellow, orange, scarlet or purple. **Stamens** standing in a central cone; staminodes, if present, white, pink or deep black, black staminodes associated with yellow or red flowers; when staminodes absent, stamens widely spreading. **Nectary** in several crenulate parts. **Ovary** flat or somewhat convex on top; placentas parietal; stigmas 4–6, filiform to lanceolate, or plumose, rarely 3-angled. **Fruit** a 5(6)-locular capsule, of Drosanthemum type; sometimes with seed-pockets; valve wings present; expanding keels contiguous, parallel or divergent; covering membranes present; closing bodies very small or 0; capsule often turning from light grey to blackish when wet. **Seeds** small, rough, with ribs and tubercles. $x = 9$.

Flowering mostly in spring and summer.

Distinguishing characters: creeping or shrubby perennials with visible bladder cell idioblasts on the leaves; fruit with valve wings and covering membranes.

Species ± 120, mainly southwestern parts of sthn Afr., including S Namibia and western, southern and central South Africa.

Eberlanzia Schwantes 2405042

(Ruschioideae: 12. Eberlanzia Group)
Schwantes: 189 (1926b); Friedrich: 42 (1970); Herre: 144 (1971); Hartmann & Stüber: 1 (1993); Hartmann: 29 (1996b); Smith *et al.*: 350 (1998); Hartmann: 44 (1998c).

Shrubs up to 500 mm high, sometimes thorny, erect to procumbent; internodes whitish. **Leaves** of a pair slightly connate, short and fat with convex sides, mucronate, greyish green to dark green; epidermis with elevations above subhypodermal tannin idioblasts, papillate. **Flowers** relatively small, ± 10–20 mm in diameter, in richly to poorly branched dichasia, with additional lateral inflorescences, sometimes umbellate and crowded, rarely solitary; spines in inflorescences irregularly distributed, derived from pedicels having lost the fruit; with 2 leafy bracts, with or without bracteoles. **Sepals** 5, nearly equal. **Petals** in 1 series or 0, white to violet. **Stamens** and **staminodes** present, collected in a cone, often papillate. **Nectary** a crenulate ring. **Ovary** raised on top; placentas parietal; stigmas 5, subulate, erect. **Fruit** capsule close to the Ruschia type; 5-locular; bottom bell-shaped, top convex, valve rims high; valves opening completely, valve wings broad and rectangular; closing bodies white; covering membranes complete with distal closing rodlets and low rims. **Seeds** smooth, almost round, amber-coloured. $x = 9$ (1 report).

Flowering throughout the year, peaking in winter.

Distinguishing characters: flat-growing to erect shrubs; leaves greyish green or reddish or bluish, textured; fruit with valves folding back entirely when expanded.

Species 8, mainly on sandy flats with limestone pebbles characteristic of the southern Namib Desert, Namibia, also in western Namaqualand, Northern Cape.

Ebracteola Dinter & Schwantes 2405043

(Ruschioideae: 10. Ruschia Group)
Schwantes: 15, 24 (1927d); Friedrich: 44 (1970); Herre: 146 (1971); Glen: 203 (1986); Hartmann: 29 (1996b); Smith *et al.*: 212 (1998).

Compact, tufted, dwarf, much-branched perennials with thickened roots. **Leaves** opposite, connate at base, trigonous to triquetrous, narrowing towards the apiculate apex, 30–40 mm long, 10 mm wide, light greyish green to blue-green becoming tinged with red in sunlight, often with dense, black or green dots, surface ± smooth; stomata only slightly sunken. **Flowers** 1(–3), terminal, shortly pedicellate, pedicels seemingly without bracts but bracts borne low down and difficult to see when whithered; up to ± 25 mm in diameter; opening late morning, closing evening. **Sepals** 5, free. **Petals** ± 1-seriate, purple to light purple with colour more intense at tips, or pure white. **Stamens** with linear filaments; staminodes surrounding stamens in a central cone. **Nectary** a crenulate ring. **Ovary** with placentas parietal; stigmas 5, subulate, ± plumose. **Fruit** a 5-locular capsule, persisting for many years on plants;

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

broad expanding keels and broad valve wings indicate a relation to Titanopsis type of fruit, but deep locules and hook-shaped closing bodies agree with Ruschia type; valve wings narrow; expanding keels broad, sheet-like, toothed; covering membranes stiff; closing bodies small, often crenulate as in *Hereroa*. **Seeds** subglobose, smooth, whitish.

Flowering spring and summer (*E. wilmaniae* (L.Bolus) Glen) or throughout the year.

Distinguishing characters: tufted perennials with thickened rootstock; leaves bluish green; flowers purple fading to pink or white towards centre, or white.

Species 4, horseshoe-shaped distribution in sthn Afr., extending from central Namibia through the Northern Cape to central South Africa. Recent fieldwork has extended the distribution into the North-West, Free State and Gauteng.

Ectotropis N.E.Br. 2405044

(Ruschioideae: 4. Delosperma Group)
Brown: 12 (1927a); Bolus: 99 (1927e); Hammer 96 (1997); Smith *et al.*: 306 (1998).

Small tufted perennials, scarcely more than 15 mm high, 30 mm wide; with slender, prostrate, rooting branches; upper parts herbaceous, papillate, possibly annual; roots tuberous. **Leaves** semiterete or subtrigonous, upper surface flat, dorsally convex, ± 4 mm long, 1.5 mm in diameter; minutely textured and reddish in colour. **Flowers** solitary, ± 9 mm in diameter; pedicels ± 13 mm long. **Petals** few, white. **Stamens** ± 25, in one series erect; staminodes 0. **Ovary** partly superior, 5-celled; placentas parietal; stigmas 5, subulate. **Fruit** a 5-locular capsule, small and thin, extremely fragile; valve wings reduced; covering membranes and closing bodies 0. **Seeds** ellipsoid, smooth.

Flowering in summer.

Distinguishing characters: minute tufted perennials; leaves with visible bladder cell idioblasts; flowers solitary, white, without staminodes and with few petals.

Species 1: *Ectotropis alpina* N.E.Br., restricted distribution at Hogsback in the Amatola Mountains and the Katberg, Eastern Cape. A poorly known plant better placed in *Delosperma*.

Enarganthe N.E.Br. 2405045

(Ruschioideae: 9. Lampranthus Group)
Brown: 71, 151 (1930a); Herre: 148 (1971); Smith *et al.*: 320 (1998).

Shrubs up to 400 mm high, with smooth, woody branches and fibrous roots. **Leaves** opposite, not united, ± terete with a widened rounded apex, up to ± 35 mm long, 15 mm in diameter; epidermal cells with crystals in outer walls, stomata not sunken, wax cover ± smooth or with fine threads. **Flowers** solitary or occasionally with 2 lateral ones in addition, shortly pedicellate or subsessile, 60–70 mm in diameter; opening at noon. **Sepals** 4, unequal, 2 foliaceous, 2 with broad membranous margins. **Petals** many in ± 2 series, free, obtuse, bright magenta, sometimes with obscure stripe. **Stamens** 1-seriate; filaments papillate, magenta; staminodes 0. **Nectary** a crenulate ring. **Ovary** convex on top; placentas parietal; stigmas 8, short, subulate. **Fruit** a 8-locular capsule, of Lampranthus type but with narrow valve wings; fairly large and woody; expanding keels diverging; covering membranes present, small, not covering entire locule; closing bodies small (unusual in a Lampranthus type capsule). **Seeds** pear-shaped, brown to blackish brown.

Flowering in mid-winter.

Distinguishing characters: erect perennials with woody branches; flowers magenta; fruit 8-locular, with small closing bodies.

Species 1: *Enarganthe octonaria* (L.Bolus) N.E.Br., Richtersveld, between the Augrabies Mountain and Brakfontein in the Northern Cape.

Erepsia N.E.Br. 2405046

(Ruschioideae: 9. Lampranthus Group)
Brown: 433 (1925); Herre: 150 (1971); Liede: 391 (1989); Liede: 1 (1990), Hartmann: 44 (1998c); Smith *et al.*: 322 (1998).

Kensitia Fedde: 11 (1940); Herre: 186 (1971). *Piquetia* N.E.Br.: 433 (1925) not of H.Hallier (1921). *Semnanthe* N.E.Br.: 12 (1927a); Herre: 284 (1971).

Shrubs or shrublets, erect or decumbent, often branching from the base; stems smooth. **Leaves** acutely 3-angled, always with mucro, ± smooth, with a thin wax layer, often with hyaline dots. **Flowers** in many-flowered inflorescences, sometimes reduced to single flowers, sometimes almost sessile; often staying open day and night. **Sepals** 5. **Petals** free, ± linear but spoon-shaped in *E. pillansii* (Kensit) Liede, white, pink or puce. **Stamens** arising from inner surface or top of calyx tube, either partly or completely covered by staminodes. **Nectary** a series of small teeth in a continuous ring or rarely in groups of five. **Ovary** concave on top, forming an hypanthium with stamens bending down into it; placentas parietal; stigmas 5(9–13), very small, ± narrowly conical to almost globular. **Fruit** a capsule of ± Lampranthus type, usually 5-locular, rarely 9–13-locular, woody, base funnel-shaped; expanding keels ending in awns; valve wings variable; covering membranes with lateral-marginal closing ledges; closing bodies 0. **Seeds** large (0.9–1.6 mm long), dark brown, surface rough. $x = 9$ (1 report).

Flowering in summer.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Distinguishing characters: shrubs with sharp-tipped leaves; flowers with distinct hypanthium into which stamens bend.

Species 28, mainly found in the winter-rainfall area of the Western Cape, with an outlier around Port Elizabeth in the Eastern Cape.

Esterhuysenia L.Bolus 2405047

(Ruschioideae: 9. Lampranthus Group)
Bolus: 308 (1967); Herre: 152 (1971); Hartmann: 44 (1998c); Smith *et al.*: 280 (1998).

Low shrublets, 200–300 mm high, with smooth, reddish stems from which a reddish powder may flake off; roots fibrous. **Leaves** decussate, always equal and similar, ascending or spreading, lower side rounded, upper side flattened, apiculate, up to 12 mm long, minutely tuberculate, often tinged with red. **Flowers** terminal, solitary, up to 20 mm in diameter, pedicellate. **Sepals** 5. **Petals** magenta. **Stamens** papillate at base; staminodes 0. **Nectary** a crenulate ring. **Ovary** slightly convex on top; placentas parietal; stigmas 5. **Fruit** a 5-locular capsule, of ± Lampranthus type, obconical, woody; expanding keels parallel at base, divergent at points; valve wings very narrow, often absent in old capsules; covering membranes flexible, ± covering the locules; closing bodies 0. **Seeds** D-shaped, ± 1.2 mm long, brown, testa rough.

Flowering spring and summer.

Distinguishing characters: dwarf shrublets with reddish stems; leaves often red-tipped, fruit flat on top, valve wings very narrow, often absent in old capsules.

Species 4, in rocky places often on high mountain peaks near Caledon, Ceres, Robertson and Worcester in the winter-rainfall region of the Western Cape.

Faucaria Schwantes 2405049

(Ruschioideae: 5. Stomatium Group).
Schwantes: 176 (1926b); Bolus: 109 (1937/1938); Herre: 156 (1971); Smith *et al.*: 184 (1998); Groen & Van der Maesen: 35 (1999).

Dwarf, branched, rosette-forming perennials; short stems are often found with age but are generally obscured by clump-forming habit; roots slightly fleshy. **Leaves** opposite, 2–4 pairs per abbreviated branch, slightly connate at base, broadly triangular, varying from triangular in cross section to almost terete, up to 45 mm long, 20 mm broad, with distinct margins which are either smooth, white and cartilaginous or distinctly toothed, in some species teeth elongated and ending in a thin thread, surfaces smooth to variously tubercled or marbled and ribbed; dark green, reddish purple or rarely bluish. **Flowers** solitary, terminal, shortly pedicelled, sessile or subsessile, ebracteate, 30–50 mm in diameter; opening in afternoon, closing in evening. **Sepals** 5, unequal, often keeled and with membranous margins. **Petals** 2- or 3-seriate, free, linear, acuminate, obtuse or emarginate, often recurved, yellow to orange within, reddish copper outside and when withering, or rarely white. **Stamens** epapillate; staminodes 0. **Nectary** of 5 separate, crenate, yellow or greenish to dark brown glands. **Ovary** raised into a cone or subglobose on top; placentas axile to parietal; stigmas 5 or 6, filiform, erect. **Fruit** a 5- or 6-locular capsule, similar to Leipoldtia type but without closing bodies; appearing 10-locular and seedless: 5 empty hollows alternate with locules and seeds obscured by bent lamellae; valve wings firm, stout, connate with valves in their basal part only and standing rigidly above locules after opening of capsule; expanding keels ending in an awn, eventually capsules squeezed out by growth of new leaves. **Seeds** ± 1.5 mm long, reddish brown with minute, stalked protuberances. $x = 9$ (polyploidy).

Flowering late summer to autumn.

Distinguishing characters: compact perennial rosettes; leaves with distinct margins and rows of short to long teeth; flowers yellow, rarely white.

Species 6, components of the subtropical thickets of the Eastern Cape, in the western parts of the distribution range the genus extends into the Little and Great Karoo of the Western Cape.

Fenestraria N.E.Br. 2405050

(Ruschioideae: 11. Leipoldtia Group).
Brown: 433 (1925); Friedrich: 46 (1970); Herre: 158 (1971); Hartmann: 145 (1982a); Smith *et al.*: 100 (1998).

Dwarf, succulent perennials, forming clumps or mats, mostly subterranean, with leaf tips protruding above ground; stems and roots fleshy. **Leaves** few on each stem or branch, clavate, apically windowed; epidermis smooth, crystal sand present in guard cells of stomatal apparatus. **Flowers** 1(–3), pedicel long; ± 80 mm in diameter; opening at midday, closing late afternoon. **Sepals** 5, with membranous margins. **Petals** in 1 to several whorls, free, linear, yellow or white. **Stamens** many, with or without basal papillae; staminodes 0. **Nectary** a crenulate ring. **Ovary** half-inferior; placentas parietal; stigmas 8–16, spreading, plumose. **Fruit** a 8–16-locular capsule of Leipoldtia type, but with small closing bodies; becoming detached from plant and acting as tumble fruit; expanding keels parallel, diverging at

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

tips, with teeth; valve wings small, with diverging tips; axile column firm; covering membranes well developed. **Seeds** somewhat conical, whitish, with brown tip. $x = 9$ (1 report).

Flowering from mid-winter to spring.

Distinguishing characters: plants mostly underground with windowed tips visible; leaf surface smooth; capsule multilocular; flowers yellow or white, without filamentous staminodes.

Species 1: *Fenestraria rhopalophylla* (Schltr. & Diels) N.E.Br., with 2 subspecies, surroundings of Lüderitz, southwards along the coast of Namibia into the Richtersveld (Northern Cape).

Frithia N.E.Br. 2405051

(Ruschioideae: ? 5. Stomatium Group).
Brown: 433 (1925); Herre: 160 (1971); Hammer: 199 (1989); Zimmermann: 7 (1996b); Smith *et al.*: 102 (1998); Burgoyne *et al.*: 1 (2000).

Dwarf, stemless perennials, forming mats, often sunken in the soil; rhizome and adventitious roots slightly thickened and fleshy. **Leaves** alternate, 5–7 on each stem or branch, growing up to ground level, tiny (length < 10 mm), terete, with a distinct, flat, windowed top; sides of leaves papillate. **Flowers** solitary, sessile or subsessile from among leaves, ± 25 mm in diameter, with a hypanthium. **Sepals** 5, resembling leaves, united into a short tube above ovary. **Petals** in several series, shortly connate at base, purple to white; opening mid-morning, open until mid-afternoon. **Stamens** ± 3-seriate, papillate; with an outer series of epapillate staminodes. **Nectary** of 5 separate crenulate glands. **Ovary** slightly conical above; placentas parietal; stigmas 5 or 6, short, stout, acute. **Fruit** a 5- or 6-locular capsule, of Delosperma type but without valve wings; valves only rising to a ± erect position, margins of valves recurved when open; expanding keels parallel, with small wings and diverging tips; very fragile, breaking up when wet, ripe or moistened or rolling as tumble fruit to disperse seeds. **Seeds** small, minutely tuberculate.

Flowering spring to summer.

Distinguishing characters: plants mostly underground with windowed tips visible; leaf surfaces with visible bladder cell idioblasts in rows; flowers with a series of filamentous staminodes; capsule 5- or 6-locular.

Species 2, summer-rainfall areas in the northeastern part of South Africa. It has been collected on the Magaliesberg range to the west of Gauteng in the North-West and is also known from the vicinity of Bronkhorstspruit and Witbank, straddling the boundary between Gauteng and Mpumalanga.

Gibbaeum Haw. 2405052

(Ruschioideae: 4. Delosperma Group).
Haworth: 104 (1821); Brown: 273 (1921); Brown: 129, 151 (1922a); Nel: (1953); Herre: 162 (1971); Frandsen: 14 (1998); Smith *et al.*: 104 (1998); Van Jaarsveld & Hammer: 14 (1998).

Imitaria N.E.Br.: 348 (1927c); Herre: 178 (1971); Hartmann: 56 (1993). *Rimaria* N.E.Br.: 413 (1925). *Mentocalyx* N.E.Br.: 251 (1927a). *Argeta* N.E.Br.: 113 (1927b).

Dwarf, succulent perennials forming small, dense clumps or mats, up to 200 mm high; usually with a short woody rootstock, occasionally with fleshy roots. **Leaves** often very unequal and variable in shape, connate to different degrees, forming ± spherical bodies or trigonous with an apical chin to digitiform; light to dark green, bluish green, reddish, metallic grey, whitish green or grey-white; epidermis minutely hairy or with long dense hairs, more rarely smooth; stomata, and in most cases, subsidiary cells, sunken. **Flowers** solitary, terminal, pedicellate, ebracteate, 20–80 mm in diameter; opening in afternoon and closing in evening. **Sepals** 6–9, unequal. **Petals** 1–3-seriate, linear, free, white, pink, or different shades of purple. **Stamens**: staminodes present or 0, often bearded at base. **Nectary** of 6(?–9) large, separate, crenulate glands. **Ovary** often somewhat conical; placentas parietal; stigmas 6–9, usually stout and subulate, plumose. **Fruit** a 6–9-locular capsule, of Drosanthemum type; convex or conical with prominent sutures; valves deltoid, spreading, reflexed when expanded; expanding keels parallel or diverging, rarely toothed, terminating in broad wings; covering membranes present; closing bodies 0. **Seeds** many in each locule, acutely ovoid, smooth. $x = 9$ (polyploidy).

Flowering from late winter to early summer.

Distinguishing characters: Dwarf perennials with subequal to unequal leaves united into bodies with an oblique fissure separating the leaves of a pair, often velvety; flowers purple or white.

Species 16, mostly found growing in the Little Karoo, Western Cape and adjacent areas, it only extends peripherally into the Northern Cape.

Glottiphyllum (Haw.) N.E.Br. 2405053

(Ruschioideae: ? 3. Mitrophyllum Group).
Brown: 311 (1921); Herre: 164 (1971); Hartmann & Gölling: 1 (1993); Smith *et al.*: 144 (1998).

Compact, dwarf perennials, sparsely branched, with short branches often adpressed to ground, rarely tufted, with mostly hidden internodes; anisophyllous. **Leaves** 4 or more to a stem, very fleshy, mostly distichously arranged, tongue-shaped or linear-lanceolate, often twisted; bladder cells often only along

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Leipoldtia L.Bolus, in Pole Evans, *Fl. Pl. South Africa* **7**, 256 (1927).
Hartmann (1983). *Biblithca bot.* **136**, 1–67.
Hartmann and Stüber (1993). *Contr. Bol. Herb.* **15**, 1–75.
Lithops N.E.Br., *Gdnrs' Chron. Ser. 3*, **71**, 44 (1922).
Cole (1988). *Lithops. Flowering Stones.* 254 pp.
Machairophyllum Schwantes, *Möller's Deutsche Gärtn. Zeitung* **42**, 187 (1927).
Malephora N.E.Br., *Gdnrs' Chron. Ser. 3*, **81**, 12 (1927).
Mestoklema N.E.Br. *Gdnrs' Chron. Ser. 3*, **100**, 164 (1936) ex Glen, *Bothalia* **13**, 454 (1981).
Meyerophytum Schwantes, *Möller's Deutsche Gärtn.-Zeitung* **42**, 436 (1927).
Mitrophyllum Schwantes, *Z. SukkulKde* **2**, 181 (1926).
Poppendieck (1976). *Bot. Jb.* **97**, 339–413.
Monilaria (Schwantes) Schwantes, *Gartenwelt* **33**, 69 (1929).
Ihlenfeldt and Jörgensen (1973). *Mitt. Staatsinst. allg. Bot. Hamb.* **14**, 49–94.
Mossia N.E.Br., *Gdnrs' Chron. Ser. 3*, **87**, 71 (1930).
Muiria N.E.Br., *Gdnrs' Chron. Ser. 3*, **81**, 116 (1927).
Namaquanthus L.Bolus, *Notes on Mesembryanthemum and Allied Genera* **3**, 257 (1954).
Namibia (Schwantes) Schwantes, *Z. SukkulKde* **3**, 106 (1927).
Walgate (1939). In Bolus, *Notes on Mesembryanthemum and Allied Genera* **3**, 171–188.
Nananthus N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 433 (1925).
Bolus (1958). *Notes on Mesembryanthemum and Allied Genera* **3**, 382–385.
Nelia Schwantes, *Möller's Deutsche Gärtn.-Zeitung* **43**, 92 (1928).
Neohenricia L.Bolus, *Jl S. Afr. Bot.* **4**, 51 (1938).
Hammer (1994). *Cactus Succ. J., U.S.* **66**, 84–86.
Octopoma N.E.Br., *Gdnrs' Chron. Ser. 3*, **87**, 72 (1930).
Odontophorus N.E.Br., *Gdnrs' Chron. Ser. 3*, **81**, 12 (1927).
Hartmann (1976). *Bot. Jb.* **97**, 161–225.
Oophytum N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 413 (1925).
Ihlenfeldt (1978). *Bot. Jb.* **99**, 303–328.
Ophthalmophyllum Dinter and Schwantes, *Möller's Deutsche Gärtn.-Zeitung* **42**, 64 (1927).
Hammer (1993). *The Genus Conophytum: A Conograph.* 283 pp.
Orthopterum L.Bolus, *S. Afr. Gdnr* **17**, 281 (1927).
Oscularia Schwantes, *Möller's Deutsche Gärtn.-Zeitung* **42**, 187 (1927).
Glen (1980). *Taxon* **29**, 693–694.
Ottosonderia L.Bolus, *Notes on* Mesembryanthemum *and Allied Genera* **3**, 292 (1958).
Pleiospilos N.E.Br., *Gdnrs' Chron. Ser. 3*, **78**, 433 (1925).
Hartmann and Liede (1986). *Bot. Jb.* **106**, 433–485.
Polymita N.E.Br., *Gdnrs' Chron. Ser. 3*, **87**, 72 (1930).
Psammophora Dinter and Schwantes, *Z. SukkulKde* **2**, 188 (1926).
Rabiea N.E.Br., *Gdnrs' Chron. Ser. 3*, **88**, 279 (1930).
Bolus (1958). *Notes on Mesembryanthemum and Allied Genera* **3**, 369–372.
Rhinephyllum N.E.Br., *Gdnrs' Chron. Ser. 3*, **82**, 92 (1927).
Rhombophyllum (Schwantes) Schwantes, *Z. SukkulKde* **3**, 16, 23 (1927).
Ruschia Schwantes, *Z. SukkulKde* **2**, 186 (1926).
Dehn (1992). *Mitt. Inst. allg. Bot. Hamb.* **24**, 91–198.
Hartmann and Stüber (1993). *Contrib. Bol. Herb.* **15**, 1-75.
Ruschianthemum Friedrich, *Mitt. Bot. Staatssamml. München* **3**, 563 (1960).
Ruschianthus L.Bolus, *Jl S. Afr. Bot.* **27**, 62 (1961).
Saphesia N.E.Br., *Gdnrs' Chron. Ser. 3*, **91**, 205 (1932).
Ihlenfeldt and Gerbaulet (1990). *Bot. Jb.* **111**, 457–498.
Van Jaarsveld (1994). *Cactus Succ. J., Gr. Br.* **12**, 98–103.
Sarcozona J.M.Black. *Trans. R. Soc. S. Aust.* **58**, 176 (1934).
Blake (1969). *Contr. Queensland Herb.* **7**, 1–65.
Schlechteranthus Schwantes, *Mschr. dt. KaktGes.* **1**, 16 (1929).
Schwantesia Dinter, *Möller's Deutsche Gärtn.-Zeitung* **42**, 234 (1927).
Scopelogena L.Bolus, *Jl S. Afr. Bot.* **28**, 9 (1962).
Skiatophytum L.Bolus, *S. Afr. Gdnr* **17**, 435 (1927).
Ihlenfeldt and Gerbaulet (1990). *Bot. Jb.* **111**, 457–498.
Smicrostigma N.E.Br., *Gdnrs' Chron. Ser. 3*, **87**, 72 (1930).
Stayneria L.Bolus, *Jl S. Afr. Bot.* **27**, 47 (1961).
Stoeberia Dinter and Schwantes, *Z. SukkulKde* **3**, 14, 17 (1927) emend. Friedrich, *Mitt. Bot. Staatssamml. München* **3**, 560 (1960).
Friedrich (1960). *Mitt. Bot. Staatssamml. München* **3**, 554–567.
Van Jaarsveld (1994). *Aloe* **31**, 68–76.
Stomatium Schwantes, *Z. SukkulKde* **2**, 175 (1926).
Tanquana H.E.K.Hartmann and Liede, *Bot. Jb.* **106**, 479 (1986).
Hartmann and Liede (1986). *Bot. Jb.* **106**, 433–485.
Hartmann and Liede (1986). *Mitt. Inst. allg. Bot. Hamb.* **21**, 117–125.
Titanopsis Schwantes, *Z. SukkulKde* **2**, 178 (1926).
Trichodiadema Schwantes, *Z. SukkulKde* **2**, 187 (1926).
Ihlenfeldt (1980). *Mitt. Inst. allg. Bot. Hamb.* **17**, 145–163.
Vanheerdea L.Bolus, *Notes on Mesembryanthemum and Allied Genera* **3**, 136 (1938) ex H.E.K.Hartmann. *Bradleya* **10**, 15 (1992).
Hartmann (1992). *Bradleya* **10**, 5–16.
Vanzijlia L.Bolus, Pole Evans, *Fl. Pl. S. Afr.* **7**, 262 (1927).
Hartmann (1982). *Mitt. Inst. allg. Bot. Hamb.* **18**, 85–101.
Hartmann (1983). *Bot. Jb.* **103**, 499–538.
Wooleya L.Bolus, *Jl S. Afr. Bot.* **27**, 48 (1961).
Zeuktophyllum N.E.Br., *Gdnrs' Chron. Ser. 3*, **81**, 12 (1927).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 2

Chesselet, P., Smith, G.F., Burgoyne, P.M., Klak, C., Hammer, S.A., Hartmann, H.E.K., Kurzweil, H., Van Jaarsveld, E.J., Van Wyk, B-E., & Leistner, O.A. 2000a. Mesembryanthemaceae. In: Leistner, O.A. (ed), *Seed plants of southern Africa: families and genera. Strelitzia* 10: 360–410.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021



Mesembryanthemaceae



(Caryophyllidae—Caryophyllales)

Compiled by P. Chesselet, G.F. Smith, P.M. Burgoyne, C. Klak, S.A. Hammer, H.E.K. Hartmann, H. Kurzweil, E.J. van Jaarsveld, B-E. van Wyk & O.A. Leistner

Annual to perennial succulents, ranging from minute to compact and tufted to prostrate to decumbent; herbs, dwarfshrubs, subshrubs or shrubs, rarely spiny. **Leaves** opposite, rarely alternate, simple, free at base to almost completely united into single, conical to ± spherical bodies, often sheathing stem, flat to 3-angled to cylindric, all similar (plant homophyllous) or different types of leaf pairs present (plant heterophyllous, e.g. Mitrophyllum Group), members of a leaf pair similar (plant isophyllous) or dissimilar (plant anisophyllous), surface heterocellular (with cells of different sizes) or homocellular (cells of similar size), ephemeral to persistent, with or without bladder cells, sometimes tuberculate or punctate; stipules 0. **Flowers** bisexual, regular, in cymose inflorescences, sometimes representing ± entire plant, to solitary. **Calyx** 4–6-lobed, sometimes forming a short tube above ovary. **Corolla** of many ± linear petals of staminodial origin, either free or shortly connate at base. **Stamens** many, often surrounded by few to many filamentous staminodes. **Nectary** either koilomorphic: represented by usually 4 or 5 shell-shaped depressions (in Mesembryanthemoideae), or lophomorphic: raised into a crested ring, continuous or broken into ± 5 crested glands (in Ruschioideae). **Ovary** inferior to half-inferior (in Mesembryanthemoideae), (3, 4)5(–25)-locular; placentas ranging from axile through basal to parietal; ovules usually many; style 0; stigmas usually as many as locules, subulate to filiform, sometimes fused at base, sometimes plumose. **Fruit** a loculicidal capsule, splitting open when dry or mostly when wetted by means of hygroscopic expanding keels, rarely schizocarpic with winged or nut-like mericarps, or fleshy and indehiscent; valves with or without wings, expanding keels parallel to divergent, locules open or with covering membranes, closing bodies blocking distal exits of locules present or 0. **Seeds** ± reniform, glossy to rugose or papillate and rough, black to brown to pale cream; embryo curved around perisperm.

Genera ± 123, species ± 1 680, mostly in the southwestern parts of the African continent, from ± 16° N in Angola down to the Western Cape Province, extending well into the east over the central plateau of South Africa and reaching into Zimbabwe and Botswana; sthn Afr.: genera ± 122, species ± 1 662. Outside this core area, several species of *Delosperma* are found from N Tanzania up to the Yemen and also in the Arabian Peninsula and Madagascar. A few species of *Mesembryanthemum* occur around the Mediterranean Sea, and most species of the genus *Disphyma* are found in Australia, New Zealand and the adjacent islands. The genus *Sarcozona* and some species of *Carpobrotus* are restricted to Australia, but species of *Ruschia* and *Lampranthus* may not be indigenous to Australasia. It is also not clear whether species of *Malephora* and *Carpobrotus* are recent introductions to South America, but the populations of *Carpobrotus* found along the west coast of North America were certainly introduced by man.

Subfamily MESEMBRYANTHEMOIDEAE

Genera classified in the subfamily Mesembryanthemoideae share the following characters: stamens and petals (mostly) forming a tube; nectaries koilomorphic (shell-shaped); cortical bundles present; expanding tissue present as expanding keels extending from centre of capsule to tips of valves.

Aptenia, Aridaria, Aspazoma, Brownanthus, Caulipsolon, Dactylopsis, Mesembryanthemum, Phyllobolus, Prenia, Psilocaulon, Sceletium, Synaptophyllum.

Subfamily RUSCHIOIDEAE

In the Ruschioideae synapomorphies include: stamens hairy at base; nectaries lophomorphic (crest-shaped); placentation basal or parietal; expanding keels ± restricted to valves; covering membranes often present.

The Ruschioideae may be subdivided into the following groups (a question mark indicates uncertain classification):

1. Apatesia Group

Plants annual to perennial. Leaves mostly flat, only some bladder cells along the leaf margins. Flowers with a flat, broad nectariferous ring. Capsules with expanding tissue reduced or absent, sometimes breaking into mericarps, often with seed pockets derived from false septa, rarely nuts.

Apatesia, Carpanthea, Caryotophora, Conicosia, Hymenogyne, Saphesia, Skiatophytum.

2. Cleretum Group

Plants annual. Leaves flat, with prominent bladder cells. Flowers with a flat, broad nectariferous ring. Capsules with or without covering membranes, with or without spongy sills (as closing bodies) at the outer rim of the distal opening, expanding sheets predominant, their extension related directly to the size of the covering membranes.

Aethephyllum, Cleretum, Dorotheanthus.

3. Mitrophyllum Group

Plants perennial, heterophyllous, rarely homophyllous, with two leaf pairs per season, sometimes anisophyllous, with prominent bladder cells. Flowers with a lophomorphic nectary ring, rarely reduced. Capsules with complete or reduced covering membranes of constant shape, expanding sheets merging into expanding keels, rarely separate, with or without spongy closing sills or bodies, with broad rectangular valve wings.

Dicrocaulon, Diplosoma, ?Disphyma, ?Glottiphyllum, ?Hammeria, Jacobsenia, Meyerophytum, Mitrophyllum, Monilaria, Oophytum.

4. Delosperma Group

Plants perennial. Leaves terete to trigonous, rarely flat, with ± prominent bladder cells and/or hairs. Flowers with 5 separate lophomorphic nectaries, with filamentous staminodes, rarely without. Capsules with or without covering membranes, expanding keels and sheets separated, rarely merging, closing bodies absent, valve wings present, broad, rectangular, often with basal seed pockets.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Corpuscularia, *Delosperma*, *Drosanthemum*, *Ectotropis*, *Gibbaeum*, *Lampranthus p.p.*, *?Malephora*, *Mestoklema*, *Muiria*, *Oscularia*, *Trichodiadema*.

5. Stomatium Group

Plants perennial, rhizomatous with enlarged rootstocks. Leaf pairs 2 or 3 to a branch, leaves homocellular, xeromorphic, crystals in irregular zones, surface rough or warty from elevations above subhypodermal tannin idioblasts, often denticulate. Flowers with five separate nectaries. Capsules with or without covering membranes, without closing bodies, valve wings broad to reduced.

Chasmatophyllum, *Faucaria*, *?Frithia*, *?Mossia*, *Neohenricia*, *Orthopterum*, *Rabiea*, *Rhinephyllum*, *Stomatium*.

6. Titanopsis Group

Plants perennial, with fleshy tap roots, rarely with fibrous roots, but often with fleshy rhizomes. Leaves in rosettes or only one pair per branch, surface homocellular, xeromorphic, crystal layer in certain areas often predominant, smooth or warty. Flowers solitary, with a lophomorphic nectary ring. Capsules without or with covering membranes, these bending later into the empty locules along a preformed line, with broad valve wings tapering towards the tip of the valve, without or with very small closing bodies.

Aloinopsis, *Deilanthe*, *Didymaotus*, *Dinteranthus*, *Ihlenfeldtia*, *Lapidaria*, *Lithops*, *Nananthus*, *Schwantesia*, *Tanquana*, *Titanopsis*, *Vanheerdea*, *Zeuktophyllum*.

7. Dracophilus Group

Plants perennial. Leaves heterocellular, xeromorphic, surface rarely sticky. Flowers mostly solitary, with a lophomorphic nectary ring, rarely five separate glands; without, rarely with filamentous staminodes. Capsules mostly 5-locular, with or without covering membranes, without closing bodies, with broad valve wings.

Conophytum, *Dracophilus*, *Hartmanthus*, *Jensenobotrya*, *Juttadinteria*, *Namibia*, *Nelia*, *Psammophora*, *Ruschianthus*.

8. Bergeranthus Group

Plants perennial. Leaves homocellular, xeromorphic, mostly free to the base. Flowers mostly in exserted inflorescences, with five separate nectaries. Capsules with firm, straight, complete covering membranes, closing bodies present or absent, valve wings reduced.

Bergeranthus, *Bijlia*, *Carruanthus*, *Cerochlamys*, *Hereroa*, *Machairophyllum*, *Rhombophyllum*.

9. Lampranthus Group

Plants perennial. Leaves free, homocellular, mesomorphic to xeromorphic, crystal layer thin to absent. Flowers with five separate nectaries, sometimes united into a ring. Capsules deep, with firm, complete covering membranes with additional closing devices at their distal recurved ends, opening blocked by sterile funicles, fruit rarely a berry.

Antegibbaeum, *Braunsia*, *?Carpobrotus*, *Circandra*, *Enarganthe*, *Erepsia*, *Esterhuysenia*, *Lampranthus s.s.*, *Namaquanthus*, *Scopelogena*, *Smicrostigma*, *Vlokia*, *Wooleya*.

10. Ruschia Group

Plants perennial. Leaves free to connate, surfaces homocellular, xeromorphic, crystal layer thick. Flowers with filamentous staminodes and a lophomorphic nectary ring. Capsules with firm, complete, ± convex covering membranes with closing rodlets at their distal recurved ends, with closing bodies up to medium size, valve wings usually absent; fruit rarely nutlets.

Acrodon, *Arenifera*, *Astridia*, *Ebracteola*, *Khadia*, *Marlothistella*, *Polymita*, *Ruschia s.s.*, *Stayneria*.

11. Leipoldtia Group

Plants perennial. Leaves free to connate, homocellular, xeromorphic, crystal layer of fine granules, often like sand. Flowers with or without filamentous staminodes, with a lophomorphic nectary ring. Capsules with firm, resilient, ± concave covering membranes with closing ledges, bulges or rodlets at the ± prominent distal recurved ends, closing bodies large, rarely small, rarely absent.

Antimima, *Argyroderma*, *Cephalophyllum*, *Cheiridopsis*, *Cylindrophyllum*, *Fenestraria*, *Hallianthus*, *Jordaaniella*, *Leipoldtia*, *Octopoma*, *Odontophorus*, *Ottosonderia*, *Pleiospilos*, *Schlechteranthus*, *Vanzijlia*.

12. Eberlanzia Group

Stems whitish. Capsules with valve wings and closing bodies which are mostly small and often deep inside the locules so that they appear absent.

Amphibolia, *Eberlanzia*, *Ruschianthemum*, *Stoeberia*.

Genera of uncertain classification

Although the following genera have been assigned to groups, these placings are to some extent tentative.

Carpobrotus, *Disphyma*, *Frithia*, *Glottiphyllum*, *Hammeria*, *Malephora*, *Mossia*. *Calamophyllum* was left out of the classification and the keys because it is insufficiently known.

CLASSIFICATION OF FRUIT

With few exceptions, loculicidal, hygrochastic capsules, which repeatedly open when wet, and close when dry, are characteristic of the Mesembryanthemaceae. Schwantes' (1952) early work on mesemb fruits was refined by Hartmann (1988a) who described nine unique functional syndromes for fruit capsules of the entire group. This system is followed in the generic treatment below.

Guide to fruit types

1a Seeds/funicles axile; expanding keels extending from central axis of capsule to tips of valves..... **Mesembryanthemum type**

1b Seeds/funicles ± parietal, rarely axile (*Caryotophora*, *Hymenogyne*) but then fruits schizocarpic; expanding keels not extending to central axis or absent:

2a Valve wings narrow or absent, or fruits schizocarpic or fleshy and indehiscent; closing bodies present or represented by bunches of sterile funicular hairs:

3a Covering membranes absent or fruit schizocarpic..... **Apatesia type**

3b Covering membranes well developed or fruit fleshy and indehiscent:

4a Closing bodies small, rod-shaped..... **Ruschia type**

4b Closing bodies absent but represented by bunches of sterile funicular hairs..... **Lampranthus type**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

2b Valve wings broad; closing bodies absent or large, or sometimes developed from a broad base in the shape of a ledge, boss or bracket; or represented by bunches of funicular hairs:
5a Expanding keels ± in the form of broad, ± flat sheets and appressed to valves ..... **Mitrophyllum type**
5b Expanding keels markedly raised, not merging into expanding sheets:
6a Closing bodies large, distinctly stalked, often whitish; capsule often with 10 or more locules ..... **Leipoldtia type**
6b Closing bodies absent, or small, or represented by bunches of sterile funicular hairs; capsules seldom with up to 10 locules:
7a Expanding keels parallel, radial ..... **Delosperma type**
7b Expanding keels divergent:
8a Exits of locules blocked by bunches of funicular hairs ..... **Lampranthus type**
8b Exits of locules without closing devices:
9a Covering membranes flat ..... **Drosanthemum type**
9b Covering membranes with boundaries of central parts slightly raised into ridges; margins of distal parts bent into locules ..... **Titanopsis type**

Mesembryanthemum type

Expanding keels strictly septal, radial on valves and reaching the central axis (in closed fruit). Expanding sheets absent. Covering membranes absent. Closing bodies absent. Valve wings broad, entirely connate to valves.

Mitrophyllum type

Expanding sheets dominant, transgrading into an expanding keel in central valvar position; consequently expanding keels ± flat and appressed to valves. Covering membranes derived from parts of valvar endocarp that do not develop into expanding tissue, simple, translucent, persistent in shape, ± flat with an inconspicuous marginal edge from inner endocarpal tissue. Closing bodies infrequently developed from a broad base in the shape of a ledge, boss or bracket consisting of spongy cutinised tissue situated above the placenta and below the expanding sheet which diminishes on the closing bodies or bosses. Valve wings broad.

Apatesia type

Expanding sheet predominant but expanding properties reduced. Covering membranes absent. Valve wings absent.

Drosanthemum type

Expanding keel distinct from expanding sheet, divergent over the valves with a ± free, radial elongation, the keel-awn broadened towards the centre of the valve. Covering membranes compound: proximal part derived from valvar endocarp including the epidermis, marginal parts derived from inner endocarpal tissue (the complementary epidermis forms the extension of the expanding keel); persistent in shape, translucent, ± flat, and of ± equal diameter throughout. Closing bodies absent. Valve wings broad.

Titanopsis type

Expanding keels distinct from expanding sheets, divergent and broadened towards the centre of the valve. Covering membranes compound (as in the Drosanthemum type), but central parts thicker than marginal parts, and boundaries slightly raised into low ridges, and marginal parts bent into the empty locules, translucent and descending centrifugally; extension of very floppy, thin covering membranes reduced. Closing bodies absent or small. Valve wings broad.

Delosperma type

Expanding keels ± radial, distinct from expanding sheets. Covering membranes absent or vestigial, derived entirely from inner endocarpal valvar tissue declining into the empty locules. Closing bodies absent. Valve wings broad.

Lampranthus type

Expanding keels divergent, sometimes broadened. Covering membranes rigid, stout, of persistent convex shape, with a distinct recurved rim above and a closing ledge below their distal ends. Closing bodies absent but with bunches of sterile funicular hairs at exits of locules. Valve wings present or absent.

Ruschia type

Expanding keels widely divergent, short, without a radial extension, not higher than broad. Covering membranes stout, of persistent convex shape with distal upright rims and prominent closing rodlets below. Closing bodies small, rodlet-shaped, each with a small central corky part. Valve wings narrow or absent.

Leipoldtia type

Expanding keels divergent, with distinct radial awns, not broadened; expanding sheets present. Covering membranes persistent, resilient, of permanent concave shape with curved radial upper edges, distally and distinctly recurved; endocarp forming a ± pronounced boss or ledge below the expanding keel. Closing bodies large, distinctly stalked, outer layers sclerenchymatous, inner corky tissue well developed. Valve wings broad.

Keys to genera

Many genera of this family are difficult to key out. This is due partly to insufficient knowledge of the group and partly to the great variability of its members. Two keys to genera are presented here: Key 1, based on Bolus in Herre (1971), using mainly fruit and flower characters; and Key 2 (see p. 322) based on Hartmann (1991b), using mainly vegetative features. In Key 2 several genera will key out in more than one group.

Key 1 (based mainly on fruit and flower characters)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

1a Placentation axile:
2a Leaves flat:
3a Fruit a schizocarp:
4a Perennials; petals white; fruit consisting of 3 or 4 nut-like, bilocular mericarps which contain a single seed in each locule ..... **Caryotophora**
4b Annuals; petals yellow; fruit consisting of 18–21 membranous, 1-seeded sections ..... **Hymenogyne**
3b Fruit a capsule:
5a Leaves persisting as membranous skeletons with margins and veins intact, sometimes until the next season's growth ..... **Sceletium**
5b Leaves not as above:
6a Stigmas red ..... **Mesembryanthemum**
6b Stigmas green or pallid:
7a Leaves opposite:
8a Annuals; leaves conspicuously united ..... **Synaptophyllum**
8b Perennials; leaves not conspicuously united ..... **Aptenia**
7b Leaves alternate on flowering branches:
9a Bladder cells conspicuous; leaves of the central tuft, if present, usually forming a rosette, margins undulate ..... **Mesembryanthemum**
9b Bladder cells not, or scarcely, visible; leaves of the central tuft erect, margins flat ..... **Prenia**
2b Leaves terete, subterete, or semiterete:
10a Perennials:
11a Internodes entirely enclosed in embracing leaf tissue, or with age becoming evident:
12a Leaves semiterete, up to 35 mm long and 8 mm in diameter; sepals very unequal; corolla fugitive, up to 25 mm long; shrubby ..... **Aspazoma**
12b Leaves terete and finger-like, up to 70 mm long and 20 mm in diameter; sepals nearly equal; corolla long-lived, up to 15 mm long, petals stiff; forming clumps ..... **Dactylopsis**
11b Internodes not thus enclosed:
13a Branches usually constricted at the nodes; leaf bases sheathing, persistent; staminodes usually petaloid:
14a Leaf sheaths fringed with conspicuous, deflexed hairs at base (or in *B. marlothii* at the tip of the leaf sheaths) ..... **Brownanthus**
14b Leaf sheaths nude at the base, inconspicuous:
15a Plants with creeping annual stems and tuberous rootstocks ..... **Caulipsolon**
15b Plants with upright stems; roots not tuberous ..... **Psilocaulon**
13b Branches very rarely constricted at the nodes; leaf bases not conspicuously persistent; staminodes filamentous, usually absent in *Aridaria* and *Phyllobolus*:
16a Bladder cells scarcely visible; branches and peduncles woody or wiry; cymes distinctive, dichasial; flowers usually nocturnal ..... **Aridaria**
16b Bladder cells usually evident; young branches and peduncles externally herbaceous; flowers 1–3-nate; flowers usually diurnal ..... **Phyllobolus**
10b Annuals or biennials ..... **Mesembryanthemum**
1b Placentation parietal:
17a Fruit indehiscent, juicy and edible ..... **Carpobrotus**
17b Fruit capsular:
18a Locules of the capsule without covering membranes:
19a Nectary composed of 5 or 6 (in *Corpuscularia*) pits or hollows, sometimes surmounted by rudimentary glands:
20a Annuals; herbaceous parts papillose; leaves flat, entire or pinnatifid ..... **Cleretum**
20b Perennials, herbaceous parts not papillose; leaves thick, usually acutely keeled and dentate ..... **Stomatium**
19b Nectary not composed of pits or hollows:
21a Capsule dehiscing in dry conditions; valves without expanding keels, remaining ± erect (except in *Conicosia* species, previously in *Herrea*, where the capsule breaks up into separate segments):
22a Leaves flat; stigmas 5; capsule closing again if placed in water ..... **Saphesia**
22b Leaves triquetrous or terete or subterete; stigmas more than 10 ..... **Conicosia**
21b Capsule dehiscing in wet conditions; valves with expanding keels, widely spreading or recurved when fully expanded:
23a Nectary composed of separate glands, which in *Mossia* are so close as to form an almost annular nectary:
24a Petals united at the base; staminodes and stamens joined at the corolla tube ..... **Ruschianthus**
24b Petals not united at the base:
25a Leaves entirely united to form an ovoid or subglobose body, pubescent with deflexed hairs ..... **Muiria**
25b Leaves not as above:
26a Leaves fenestrate at the apex ..... **Frithia**
26b Leaves not fenestrate:
27a Capsule very small, with thin walls, sometimes breaking up into 5 parts, or whitish with 6 locules:
28a Leaves glistening, finely papillose, to hairy:
29a Plants minute, lower than 15 mm ..... **Ectotropis**
29b Plants small to medium-sized shrubs or herbs ..... **Delosperma**
28b Leaves rough or smooth in texture, greyish to silvery green:

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

30a Capsules with dark persistent petals on top, valves not closing again completely..... **Corpuscularia**
30b Capsules without persistent petals, closing again after opening..... **Hartmanthus**
27b Capsule not as above:
31a Compact plants with internodes enclosed:
32a Leaves usually rough (in *R. macradenium* smooth), not papillose..... **Rhinephyllum**
32b Leaves very smooth; bracts present..... **Carruanthus**
31b Plants ± loosely branched with internodes visible:
33a Plants creeping; leaves with feint dark spots..... **Mossia**
33b Plants occasionally creeping; leaves often with visible water storage cells..... **Delosperma**
23b Nectary annular:
34a Petals stiff and rather thick, staying fresh longer than is known in any other genus except *Dactylopsis*..... **Nelia**
34b Petals not as above, ± fugitive:
35a Sepals and petals united to form a calyx tube and corolla tube..... **Conophytum**
35b Sepals and petals free at base:
36a Leaves expanded and flat:
37a Flowers opening in the afternoon; petals yellow; plants annual, sun-loving..... **Apatesia**
37b Flowers opening in the morning; petals white; plants not annual, shade-loving..... **Skiatophytum**
36b Leaves not expanded and flat:
38a Plants resembling clusters of grapes on account of the rounded, grape-like or club-shaped leaves... **Jensenobotrya**
38b Plants not as above:
39a Peduncle with bracts:
40a Herbaceous parts with sand adhering to the viscid epidermis..... **Psammophora**
40b Herbaceous parts not as above:
41a Leaves acutely keeled upwards; sepals 6..... **Conophytum**
41b Leaves not acutely keeled; sepals 5:
42a Shrubby; petals whitish; staminodes present..... **Zeuktophyllum**
42b Dwarf, compact plants; petals yellow, with or without a central, red stripe; staminodes absent..... **Nananthus**
39b Peduncle bractless:
43a Compact plants with internodes enclosed in the leaf sheaths:
44a Sepals 4..... **Juttadinteria**
44b Sepals 5–10:
45a Stigmas 9–25..... **Namibia**
45b Stigmas 4–10:
46a Leaf pairs forming bodies:
47a Petals in the lower half white, in the upper half purplish..... **Oophytum**
47b Petals yellow or white:
48a Apex of leaves ± flattened; sepals 4–7..... **Lithops**
48b Apex of leaves not flattened, if flattened (as in *D. pole-evansii* and *D. vanzijlii*) sepals 8–10..... **Dinteranthus**
46b Leaf pairs not forming bodies..... **Schwantesia**
43b Plants with elongated branches; some of the internodes visible:
49a Creeping; leaf pairs of one form; flowers nocturnal..... **Neohenricia**
49b Erect; leaf pairs of two, or at flowering time of three different forms; flowers diurnal..... **Mitrophyllum**
18b Locules of the capsule with covering membranes, which are sometimes incomplete:
50a Locules without closing bodies (closing bodies occasionally present in *Drosanthemum* and *Trichodiadema*):
51a Annuals:
52a Leaves pinnatifid..... **Aethephyllum**
52b Leaves entire:
53a Stigmas 5, hardening and accrescent with age and persisting throughout the fruiting stage..... **Dorotheanthus**
53b Stigmas 12–20, withering with the rest of the flower before the fruit matures..... **Carpanthea**
51b Perennials:
54a Leaf pairs of two or of three different forms, or as persistent membranous sheaths protecting the subsequent developing leaf pair:
55a Internodes invisible; lower pair of leaves not always evident:
56a Upper leaf pair spreading or prostrate on the ground, much more united on one side than on the other; flowers sessile..... **Diplosoma**
56b Upper leaf pair erect or suberect or ascending, symmetrically united below; flowers usually moniliform; staminodes absent..... **Monilaria**
55b Some internodes visible; lower pair of leaves always evident:
57a Plants creeping, rooting at nodes; leaves toothed..... **Hammeria**
57b Plants not rooting at nodes; leaves not toothed:
58a Leaf pairs trimorphic at flowering time..... **Mitrophyllum**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

58b Leaf pairs dimorphic throughout:
59a Sepals 4; staminodes present ..... **Dicrocaulon**
59b Sepals 5 or 6; staminodes absent:
60a Lower leaf pairs oviform in earlier stages; petals rather lax, rose or rose-purple ..... **Meyerophytum**
60b Lower leaf pairs bead-like; petals dense, white, or white and rose in the same species ..... **Monilaria**
54b Leaf pairs of one form (or in *Drosanthemum diversifolium* dimorphic):
61a Nectary composed of separate glands, which rarely may be contiguous and form an almost annular nectary:
62a Sepals and petals connate below; style present ..... **Gibbaeum**
62b Sepals and petals not connate; style absent:
63a Herbaceous parts papillose:
64a Leaves usually crowned with spreading or erect bristles, or their vestiges ..... **Trichodiadema**
64b Leaves without terminal bristles (tubercle in locules of capsule very rarely present) ..... **Drosanthemum**
63b Herbaceous parts not papillose:
65a Plants creeping:
66a Petals yellow ..... **Chasmatophyllum**
66b Petals white ..... **Mossia**
65b Plants not creeping:
67a Flowers cymose ..... **Oscularia**
67b Flowers solitary:
68a Leaves dentate, teeth ending in a bristle ..... **Faucaria**
68b Leaves entire:
69a Peduncle bracteate:
70a Petals yellow ..... **Rabiea**
70b Petals purple-rose ..... **Cerochlamys**
69b Peduncle bractless ..... **Gibbaeum**
61b Nectary annular or indistinct:
71a Petals yellow (red-orange in *Titanopsis hugo-schlechteri*):
72a Stigmas 10 ..... **Vanheerdea**
72b Stigmas 5–7:
73a Compact plants with internodes enclosed in the leaf sheaths:
74a Glabrous; leaves warted or pustulate in the upper part; sepals and stigmas 6 ..... **Titanopsis**
74b Receptacle and sepals pubescent; leaves without warts or pustules (microscopically granulated); sepals 7; stigmas 6 or 7 ..... **Lapidaria**
73b Erect, decumbent or creeping plants with internodes visible:
75a Leaf keel serrate ..... **Circandra**
75b Leaf keel entire:
76a Valves of the expanded capsule winged ..... **Lampranthus**
76b Valves of the expanded capsule not winged ..... **Scopelogena**
71b Petals rose-purple, pink, red, pallid or white:
77a Stigmas 8–14:
78a Stigmas minute, completely hidden by staminodes and stamens:
79a Leaf keels entire ..... **Smicrostigma**
79b Leaf keels lacerate ..... **Erepsia**
78b Stigmas not as above:
80a Peduncle bracteate:
81a Low, compact plants; sepals 5 ..... **Dracophilus**
81b Shrubby plants, 150–300 mm high; sepals 4:
82a Herbaceous parts smooth; stamens not papillose; seeds echinate ..... **Namaquanthus**
82b Herbaceous parts appearing as if dusted with grey powder; stamens papillose; seeds smooth. ..... **Wooleya**
80b Peduncle bractless:
83a Staminodes present; valves of the expanded capsule not winged ..... **Khadia**
83b Staminodes absent, valves of the expanded capsule winged ..... **Jacobsenia** (=*Drosanthemopsis*)
77b Stigmas 5 or 6:
84a Herbaceous parts ± papillose:
85a Sepals and stigmas 5 ..... **Jacobsenia**
85b Sepals and stigmas 6 ..... **Drosanthemum**
84b Herbaceous parts not papillose:
86a Flowers terminating the previous year's growth, otherwise developing axillary shoots ..... **Didymaotus**
86b Flowers not as above:
87a Flowers in conspicuously branched, pedunculate cymes; rootstock remarkably large and sometimes tuberous ..... **Mestoklema**
87b Flowers and rootstock not as above:

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

88a Herbaceous parts smooth:
89a Seeds echinate ... **Braunsia**
89b Seeds not as above:
90a Valves of the expanded capsule winged ... **Lampranthus**
90b Valves of the expanded capsule not winged:
91a Fruit 5–7-locular; flowers with 6 sepals; petals sparse, pink ... **Vlokia**
91b Fruit (4)5–11-locular; flowers with 5 or 6 sepals; petals more abundant, white, pink or magenta ... **Khadia**
88b Herbaceous parts hairy ... **Braunsia**
50b Locules of the capsule with closing bodies (sometimes obscure or absent in *Aloinopsis* and *Antimima*, very small in *Antegibbaeum* and uncertain in *Calamophyllum*):
92a Stigmas 5 or 6:
93a Petals purple-red, pink or white:
94a Nectary composed of separate glands ... **Cerochlamys**
94b Nectary annular:
95a Placental tubercle 2-lobed ... **Disphyma**
95b Placental tubercle not 2-lobed:
96a Peduncle not spinescent:
97a Herbaceous parts with sand adhering to the viscid epidermis ... **Arenifera**
97b Herbaceous parts not as above:
98a Capsule in the lower part isolated into mericarps ... **Ruschianthemum**
98b Capsule not as above:
99a Valves of the expanded capsule winged:
100a Shrubby; internodes visible; cymes often conspicuously branched:
101a Capsule not closing again after first opening ... **Stoeberia**
101b Capsule not as above ... **Amphibolia**
100b Dwarf, compact plants; internodes enclosed; flowers solitary or 1–3-nate:
102a Leaves cylindrical or subcylindrical; flowers solitary:
103a Bracts large, sometimes exceeding the flowers; sepals 5 ... **Cylindrophyllum**
103b Bracts very small; sepals 6 ... **Antegibbaeum**
102b Leaves laterally compressed in the upper part; flowers finally 2- or 3-nate ... **Ebracteola**
99b Valves of the expanded capsule wingless:
104a Seeds echinate or rough ... **Astridia**
104b Seeds not as above:
105a Leaves toothed to a greater or lesser extent, or with one or two mucros at the apex:
106a Closing bodies white; pollen white ... **Acrodon**
106b Closing bodies brownish or colourless; pollen yellow ... **Ruschia**
105b Leaves not toothed, with or without mucros at apex:
107a Roots tuberous ... **Marlothistella**
107b Roots not as above ... **Antimima**
96b Some or all of the peduncles spinescent:
108a Valves bend backwards more than 180 degrees when capsule is wet; valve wings broad and rectangular ... **Eberlanzia**
108b Valves do not reach horizontal position when fruit is wet; valve wings rudimentary ... **Ruschia** subgenus **Spinosa**
93b Petals yellow, golden or orange-red:
109a Leaf pairs of two different forms at flowering time; nectary annular ... **Mitrophyllum**
109b Leaf pairs of one form; nectary composed of separate glands:
110a Wings of the locules of the expanded capsules erect ... **Orthopterum**
110b Wings not erect:
111a Leaves short and thick, polymorphic; valves erect in expanded capsule ... **Bijlia**
111b Leaves not as above; valves widely spreading or recurved:
112a Leaves usually triquetrous:
113a Filaments papillate; stigmas 5; keels of valves in expanded capsule diverging from the base; closing bodies large ... **Bergeranthus**
113b Filaments epapillate; stigmas 5 or 6; keels parallel below; closing bodies small ... **Machairophyllum**
112b Leaves not triquetrous, one of a pair often slightly differing in form from the other:
114a Closing bodies with a dividing line in the middle ... **Rhombophyllum**
114b Closing bodies not as above ... **Hereroa**
92b Stigmas more than 6 (or 6 in some species of *Khadia*):
115a Leaves fenestrate at the apex ... **Fenestraria**
115b Leaves not as above:
116a Petals filiform-linear, white, often in 5 groups ... **Polymita**
116b Petals not as above:
117a Plants dwarf, compact:

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

118a Peduncle bractless:
119a Petals pink or rose-purple; staminodes present ... **Khadia**
119b Petals yellow or rarely white; staminodes absent ... **Glottiphyllum**
118b Peduncle with bracts:
120a Leaf pairs of two different forms ... **Cheiridopsis**
120b Leaf pairs of one form:
121a Receptacle produced above the ovary into a tube; stamens deflexed; stigmas obscurely defined, forming a viscid, circular pulvinus ... **Argyroderma**
121b Receptacle, stamens and stigmas not as above:
122a Herbaceous parts glabrous:
123a Rootstock (where known) tuberous:
124a Leaves velvety, appearing dust-covered, long-triangular ... **Deilanthe**
124b Leaves rough-textured, spoon-shaped ... **Aloinopsis**
123b Rootstock not tuberous:
125a Nectary usually composed of separate glands ... **Machairophyllum**
125b Nectary annular (unknown in *Calamophyllum*):
126a Petals pallid, rose, rose-purple or deep red:
127a Flowers solitary:
128a Sepals 5 ... **Cylindrophyllum**
128b Sepals 4 ... **Calamophyllum**
127b Flowers not solitary ... **Cephalophyllum**
126b Petals yellow, golden or orange-red:
129a Fruit 10-locular, convex on top, with tiny closing bodies ... **Tanquana**
129b Fruit 9–15-locular, with large white to brown closing bodies ... **Pleiospilos**
122b Herbaceous parts pilose or pubescent:
130a Leaves obtusely keeled, dentate or denticulate ... **Odontophorus**
130b Leaves entire or rarely with the keels only dentate, in which case they are acutely keeled upwards ... **Cheiridopsis**
117b Plants with ± elongated branches with at least some of the internodes visible, except in young plants of the shrubby *Ottosonderia*:
131a Inflorescence persisting for several years and eventually becoming an obconic cyme, the axils of the previous year's highly succulent hypsophylls (bract-like leaves within the inflorescence) normally producing one to several flowers which represent the annual growth ... **Ottosonderia**
131b Inflorescence not as above:
132a Leaf pairs of two different forms ... **Vanzijlia**
132b Leaf pairs of one form:
133a Peduncle with bracts:
134a Sepals 4:
135a Leaves entire, 40–60 mm long:
136a Filaments papillose; stigmas 8; seeds smooth ... **Enarganthe**
136b Filaments not papillose; stigmas 8–12; seeds echinate ... **Namaquanthus**
135b Leaves denticulate, shorter than 20 mm ... **Octopoma**
134b Sepals 5 or 6:
137a Sepals 5:
138a Leaves shorter than 20 mm: flowers sessile or subsessile ... **Octopoma**
138b Leaves longer than 20 mm; flowers pedunculate:
139a Herbaceous parts pubescent:
140a Leaves dentate ... **Odontophorus**
140b Leaves entire ... **Cheiridopsis**
139b Herbaceous parts glabrous:
141a Leaves rough, sometimes dentate ... **Cheiridopsis**
141b Leaves not as above:
142a Usually decumbent and often creeping; stigmas 10 or more:
143a Leaves tapering at both ends; fruit squarish-looking on top with valves bent at a ± 90 degree angle ... **Jordaaniella**
143b Leaves spindle-, quill- or club-shaped; capsules not as above ... **Cephalophyllum**
142b Usually erect or, if decumbent, not creeping; stigmas 10 or fewer:
144a Leaves obtusely keeled; valve wings present:
145a Plants upright ... **Leipoldtia**
145b Plants creeping ... **Hallianthus**
144b Leaves acutely keeled; valve wings absent ... **Stayneria**
137b Sepals 6 ... **Schlechteranthus**
133b Peduncle bractless:
146a Leaves of a pair dissimilar and unequal in length, the large more than 50 mm long, sometimes with a marginal tooth or hump, or with a conspicuous white margin ... **Glottiphyllum**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

146b Leaves of a pair similar and about equal in length, shorter than 50 mm, entire and without a white margin ..... **Malephora**

Key 2 (based mainly on vegetative characters)

1a Ovary always with an axile placenta; nectary koilomorphic: represented usually by 4 or 5 shell-shaped depressions; fruits with expanding keels, if present, reaching from central axis to tips of valves; fruit rarely a woody nut: MESEMBRYANTHEMOIDEAE:
2a Leaves flat:
3a Leaves becoming skeleton-like with lignified veins and margins, persistent and enclosing young buds ..... **Sceletium**
3b Leaves not drying skeleton-like:
4a Leaves stem-clasping, opposite, shape and particularly size of basal and upper leaves markedly different..... **Synaptophyllum**
4b Leaves not stem-clasping, opposite, occasionally becoming alternate in the inflorescence, or throughout the plant, occasionally appearing petiolate, with no marked difference in size between basal and upper leaves:
5a Leaves with conspicuous bladder cells, leaf margins often undulate..... **Mesembryanthemum**
5b Leaves with inconspicuous bladder cells, leaf margins flat:
6a Leaves shortly fused at the base, glaucous, covered with a thick wax layer that rubs off easily; the green parts of the stem become dry and remain on the slightly woody stem as a thick whitish layer..... **Prenia**
6b Leaves not fused at the base, shiny green, without visible wax layer; stems green and succulent, 4-angled or cylindrical..... **Aptenia**
2b Leaves ± cylindrical:
7a Internodes entirely enclosed in embracing leaf tissue:
8a Leaves alternate, finger-like, up to 100 mm long and up to 20 mm in diameter; plants compact, dwarf ..... **Dactylopsis**
8b Leaves opposite, subterete, basally free, up to 35 mm long and up to 8 mm in diameter; shrublets up to 150 mm high..... **Aspazoma**
7b Internodes not entirely enclosed by leaf tissue but often with green, succulent cortex:
9a Stems constricted at nodes, green, with persistent, succulent primary cortex:
10a Bladder cells at base and edges of leaves often becoming hair-like, bladder cells on stems densely arranged and firm to the touch, those on the leaves more sparse and soft to the touch ..... **Brownanthus**
10b Bladder cells on leaves and stems similar to ± absent, rarely becoming hair-like:
11a Perennials with creeping annual stems and tuberous rootstock ..... **Caulipsolon**
11b Perennials or annuals with erect to decumbent stems; roots not tuberous ..... **Psilocaulon**
9b Plants with a continuous stem, only the young stages green, primary cortex not persistent:
12a Bladder cells scarcely visible; branches and peduncles woody or wiry..... **Aridaria**
12b Bladder cells usually conspicuous; young branches and peduncles externally herbaceous:
13a Shrublets or subshrubs, often with thickened roots; stems corky or lignified, at least towards the base . **Phyllobolus**
13b Annual to perennial fleshy herbs with fibrous roots; stems herbaceous..... **Mesembryanthemum**
1b Ovary with placenta parietal to basal, very rarely axile (*Caryotophora*, *Hymenogyne*, both with schizocarpic fruit); nectaries lophomorphic: crest-shaped, either as separate glands or united into a ring, rarely ± absent; fruit with expanding keels never reaching the centre of the fruit; fruit, if not opening when wetted, then rarely opening when drying out, fleshy or breaking up into mericarps: RUSCHIOIDEAE:

Key to groups of Ruschioideae

1a Leaves with a sticky surface, sand and soil adhering to it..... **Group A**
1b Leaves with a smooth or papillate surface, often glistening, but not sticky:
2a Plants heterophyllous: different types of leaf pairs present:..... **Group B**
2b Plants homophyllous: all leaves ± similar:
3a Leaves flat, wider than thick, petiolate..... **Group C** (p. 323)
3b Leaves three-dimensional, triquetrous, trigonous, terete, not wider than thick:
4a Plants creeping, with procumbent stems ..... **Group D** (p. 324)
4b Plants compact, caespitose or shrubby:
5a Plants compact and tufted, all internodes completely concealed by the leaves ..... **Group E** (p. 324)
5b Plants caespitose, shrubby, or if basally compact then with additional long shoots:
6a Plants caespitose, internodes short but visible, procumbent, stems not rooting..... **Group F** (p. 327)
6b Plants shrubby, long shoots ascending, erect, or climbing, sometimes with a compact centre:
7a Shrubs or shrublets without spines ..... **Group G** (p. 328)
7b Shrubs or shrublets with spines ..... **Group H** (p. 329)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Group A. Plants with sticky surfaces

Capsules with covering membranes, locules 8; epidermis cells of leaves undivided ..... **Arenifera**
Capsules without covering membranes or with narrow rims, locules 5; epidermis cells of leaves divided by secondary walls...
..... **Psammophora**

Group B. Heterophyllous plants (different types of leaf pairs are present)

1a Leaf surface with bladder cells:
2a Plants compact, tufted:
3a Capsules with parallel expanding keels ..... **Oophytum**
3b Capsules with divergent expanding keels:
4a Plants small, lower than 40 mm ..... **Diplosoma**
4b Plants larger, 40–150 mm high ..... **Monilaria**
2b Plants shrubby:
5a Old leaf sheaths with sclerotic bases, enclosing the internodes completely ..... **Monilaria**
5b Old leaf sheaths papery or parchment-like, entire:
6a Leaves dentate ..... **Hammeria**
6b Leaves not dentate:
7a More than 2 leaf pairs produced per season ..... **Dicrocaulon**
7b Two leaf pairs produced per season:
8a Flowers basally enclosed by a cup ..... **Dicrocaulon**
8b Flowers exserted above the leaves, without a basal cup:
9a Both leaf pairs connate for more than 50% of their length ..... **Meyerophytum**
9b One leaf pair connate for less than 25% of its length, spreading; the other connate for more than 50% of its length, erect ..... **Mitrophyllum**
1b Leaf surface without bladder cells, homocellular:
10a Capsules 5-locular ..... **Antimima**
10b Capsules multilocular:
11a Plants with long, erect or straggling branches from a compact (tufted) base ..... **Vanzijlia**
11b Plants compact to caespitose ..... **Cheiridopsis** subgenus **Cheiridopsis**

Group C. Plants with ± flat leaves (leaves wider than thick)

1a Plants perennial:
2a Leaves soft and smooth, surface mesomorphic:
3a Fruit woody, finally disintegrating into nutlets ..... **Caryotophora**
3b Fruit a capsule:
4a Capsule xerochastic:
5a Leaves homocellular, without bladder cells; capsules with separate marginal seed-pockets at half their height.....
..... **Skiatophytum**
5b Leaves with bladder cells; capsule without pockets ..... **Saphesia**
4b Capsule hygrochastic with well-developed expanding keels and sheets:
6a Plants anisophyllous, i.e. the leaves of a pair are unequal in size; capsules multilocular, with firm, undulating covering membranes, with or without reduced valve wings ..... **Glottiphyllum**
6b Plants isophyllous, i.e. the leaves of a pair are equal in size; capsules 5-locular, without covering membranes, but with broad, triangular valve wings ..... **Delosperma**
2b Leaves hard, with warts or white dots, or velvety and dust-covered, leaf surface xeromorphic:
7a Leaves with fine white, often raised dots, leaf tips tapering ..... **Nananthus**
7b Leaves with warts, particularly along the distal broadened margin, leaf tips broadly rounded:
8a Fruit 5-locular ..... **Titanopsis**
8b Fruit multilocular:
9a Leaves velvety, dust-covered ..... **Deilanthe**
9b Leaves tuberculate or punctate ..... **Aloinopsis**
1b Plants annual:
10a Leaf surface ± smooth:
11a Leaf margin ciliate; capsules with locules covered by the overarching covering membranes ..... **Carpanthea**
11b Leaf margin with bladder cells, never ciliate; capsules with seed pockets:
12a Leaf epidermis with tanniniferous idioblasts; fruit breaking into mericarps enclosing one seed each ..... **Hymenogyne**
12b Leaf epidermis without tanniniferous idioblasts; fruit opening hygroscopically by expanding keels ..... **Apatesia**
10b Leaf surface with prominent bladder cells:
13a Leaves lyrate:
14a Top of capsule flat; valves with expanding sheets only ..... **Aethephyllum**
14b Top of capsule with ribs; valves with expanding keels merging into expanding sheets ..... **Cleretum**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

13b Leaves entire:
15a Valve wings broad, rectangular ..... **Cleretum**
15b Valve wings tapering into awns ..... **Dorotheanthus**

Group D. Plants with creeping growth form

(Plants procumbent, rooting at the nodes, only short branches, usually with tufted leaves, growing erect.)
Note: Not included are genera such as *Rhinephyllum* and *Cylindrophyllum* which may comprise creeping forms.

1a Internodes on the main stems long, woody or spongy; adventitious roots fibrous:
2a Internodes with prominent hairs (elongated bladder cells) ..... **Drosanthemum**
2b Internodes with papillate or smooth surface:
3a Fruit a berry ..... **Carpobrotus**
3b Fruit a hygrochastic capsule:
4a Leaf surface mesomorphic; leaves soft:
5a Capsule multilocular ..... **Malephora**
5b Capsule 5- or 6-locular:
6a Capsule with parallel expanding keels:
7a Plants minute, 15 mm high, 30 mm wide ..... **Ectotropis**
7b Plants not minute, taller than 15 mm ..... **Delosperma**
6b Capsule with diverging expanding keels:
8a Closing bodies large, bipartite ..... **Disphyma**
8b Closing bodies absent; locule closed by funicles ..... **Lampranthus**
4b Leaf surface xeromorphic; leaves firm:
9a Leaves with teeth along margins and keel ..... **Chasmatophyllum**
9b Leaves without teeth at margins or keel (but mucronate):
10a Capsules multilocular:
11a Capsules with small closing bodies ..... **Jordaaniella**
11b Capsules with large closing bodies:
12a Stems strictly procumbent, each node with adventitious roots ..... **Cephalophyllum**
12b Some stems spreading, later curving down and rooting near their tips (saltatory) ..... **Leipoldtia**
10b Capsules usually 5- or 6-locular:
13a Leaves small, <15 mm long ..... **Mossia**
13b Leaves larger, >20 mm long:
14a Fruit without closing bodies ..... **Vlokia**
14b Fruit with closing bodies ..... **Ruschia**
1b Internodes on the main stem short; adventitious roots thickened and fleshy:
15a Leaves ± sharply triquetrous:
16a Capsules with >10 locules ..... **Cephalophyllum**
16b Capsules with <10 locules:
17a Leaf margins serrate ..... **Acrodon**
17b Leaf margins entire:
18a Flowers yellow ..... **Bergeranthus**
18b Flowers purple or white ..... **Khadia**
15b Leaves ± club-shaped, terete but widening distally:
19a Widened tip of leaf warty, rough ..... **Neohenricia**
19b Widened tip of leaf with a window:
20a Capsules multilocular ..... **Fenestraria**
20b Capsules 5- or 6-locular ..... **Frithia**

Group E. Plants with a compact growth form ('Flowering stones')

(Internodes of these plants are very short and not visible because they are enclosed by the sheathing leaf bases.)

1a Plants heterophyllous, i.e. with two different leaf pairs per season:
2a Leaves xeromorphic ..... **Cheiridopsis**
2b Leaves mesomorphic:
3a Fruit with parallel expanding sheets ..... **Oophytum**
3b Fruit with expanding keels widely diverging and merging gradually into expanding sheets:
4a Plants lower than 40 mm ..... **Diplosoma**
4b Plants higher than 50 mm ..... **Monilaria**
1b Plants isophyllous or anisophyllous, but not heterophyllous:
5a Leaves of a pair highly connate (>50%):
6a Plants sunken into the ground or in crevices:

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

7a Capsules >10-locular:
8a Leaf surface smooth, almost white, hard ... **Argyroderma**
8b Leaf surface with distant papillae, bright green ... **Vanheerdea**
7b Capsules 5–8-locular:
9a Fruit with basal bracteoles ... **Conophytum**
9b Fruit without basal bracteoles:
10a Predominant number of locules per fruit in a population 5 or 6 ... **Lithops**
10b Predominant number of locules per fruit 7 or more:
11a Seeds tuberculate, tubercles distant ... **Dinteranthus**
11b Seeds smooth to rugose ... **Lithops**
6b Plants above ground, clumpy:
12a Capsules without covering membranes:
13a Leaves firm, xeromorphic ... **Conophytum**
13b Leaves soft, mesomorphic:
14a Leaves with fine, velvety hairs ... **Muiria**
14b Leaf surface smooth, sometimes papillate ... **Conophytum**
12b Capsules with covering membranes:
15a Leaf surface smooth, glaucous-grey ... **Argyroderma**
15b Leaf surface with papillae:
16a Capsules 5–8-locular ... **Gibbaeum**
16b Capsules >10-locular:
17a Capsules with large closing bodies; leaves with prominent teeth along edges ... **Odontophorus**
17b Capsules without closing bodies ... **Vanheerdea**
5b Leaves of a pair less connate (<30%):
18a Plants with a persistent primary stem forming a head with closely arranged foliage leaves (similar to a rosette, but not flat); inflorescences developed laterally and mainly basally:
19a Leaves xeromorphic; capsules with broad, rectangular valve wings ... **Cephalophyllum**
19b Leaves mesomorphic; capsules without valve wings or with narrow ones ... **Conicosia**
18b Plants without a distinct persistent primary stem and without a head as described above:
20a Leaf surface mesomorphic; with bladder cells or smooth:
21a Leaves anisophyllous, tongue-shaped ... **Glottiphyllum**
21b Leaves isophyllous, ± terete or flattish:
22a Leaf tips with a diadem (a group of spreading bristles with a corky base) ... **Trichodiadema**
22b Leaf tips without a diadem ... **Delosperma**
20b Leaves xeromorphic, without bladder cells, firm, smooth to papillate:
23a Leaves with a sticky surface, sand adhering to it ... **Psammophora**
23b Leaves not sticky:
24a Leaves triquetrous-acuminate, i.e. tapering from the base into a pointed tip, leaves slender; developing a fleshy stem with age (corm):
25a Plants growing sunken into the ground on loamy or silty flats; leaf tips emerging ... **Nananthus**
25b Plants with the leaves completely above ground, in rocky, stony or shaly ground:
26a At least some leaves with teeth or a serrate keel; flowers with central red stripes along petals; fruit with a rounded base ... **Acrodon**
26b Leaves without teeth, not serrate:
27a Flowers and fruit on stalked dichasia projecting beyond the leaves ... **Bergeranthus**
27b Flowers ± solitary, not carried above the leaves:
28a Capsule with tiny closing bodies; plants with a thickened rootstock:
29a Capsule with a flat or centrally raised top and a funnel-shaped base ... **Ebracteola**
29b Capsule with a rounded top and base ... **Rabiea**
28b Capsule with large closing bodies; plants developing corms with age:
30a Petals striped ... **Marlothistella**
30b Petals not striped ... **Khadia**
24b Leaves trigonous, hunched (± gibbose), semiglobose-terete, tongue-shaped, or club-shaped but never triquetrous-acuminate as above:
31a Leaves of a pair anisophyllous:
32a Leaves keeled, triangular in cross section:
33a Keel sharply pleated, serrate ... **Cephalophyllum**
33b Keel rounded:
34a Leaves ± symmetrical and as broad as thick; capsule without closing bodies ... **Cerochlamys**
34b Leaves asymmetrical or thicker than broad; capsule with closing bodies ... **Bijlia**
32b Leaves without a keel (oval to round in cross section):
35a Leaf surface velvety from papillae ... **Gibbaeum**
35b Leaf surface smooth:
36a Leaves slender, > 3× longer than wide; capsule dark brown with a rounded top ... **Antegibbaeum**
36b Leaves short, < 3× longer than wide; capsule greyish with a flat top ... **Tanquana**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

31b Leaves of a pair isophyllous:
37a Plants sunken into the ground:
38a Several subsequent pairs of foliage leaves on a shoot forming a rosette:
39a Leaves small, < 8 mm wide:
40a Leaves with an apical window ..... **Frithia**
40b Leaves with tiny warts, spirally arranged towards tip ..... **Neohenricia**
39b Leaves larger, > 10 mm wide:
41a Capsule > 10-locular ..... **Aloinopsis**
41b Capsule 5–7-locular ..... **Titanopsis**
38b One pair of foliage leaves per shoot (two only during active growth or in cultivation):
42a Capsule 5–8-locular ..... **Lithops**
42b Capsules >10-locular:
43a Leaves club-shaped with an apical window ..... **Fenestraria**
43b Leaves semiglobose to semi-oval, with a thick whitish surface ..... **Argyroderma**
37b Plants in clumps above the ground:
44a Leaves with well-developed papillae, i.e. velvety to the touch:
45a Leaves with teeth:
46a Capsules 5-locular ..... **Schwantesia**
46b Capsules multilocular:
47a Capsules with tiny closing bodies ..... **Ihlenfeldtia**
47b Capsules with large closing bodies:
48a Capsule with a flat top and funnel-shaped base ..... **Cheiridopsis**
48b Capsules with a rounded top and semiglobose base ..... **Odontophorus**
45b Leaves without teeth:
49a Capsules without covering membranes:
50a Leaves very thick, semi-ovate, as broad as thick; capsule multilocular ..... **Namibia**
50b Leaves triquetrous, keel prominent; capsule 5-locular ..... **Schwantesia**
49b Capsules with covering membranes:
51a Capsules <10-locular:
52a Covering membranes distally reflected, firm, resilient ..... **Antimima**
52b Covering membranes straight or distally inflexed, thin, flexible ..... **Gibbaeum**
51b Capsules >10-locular:
53a Capsules with narrow valve wings ..... **Cheiridopsis**
53b Capsules with broad valve wings, at least at their base:
54a Valve wings rectangular ..... **Cephalophyllum**
54b Valve wings tapering into awns, pointed ..... **Aloinopsis**
44b Leaves without papillae, epidermal cells sometimes elevated but never velvety to the touch:
55a Leaves without a distinct keel, although sometimes hunched (± gibbose), therefore oval to round in cross section:
56a Capsules 5–8-locular ..... **Cylindrophyllum**
56b Capsules with > 10 locules:
57a Leaves semiglobose, less than twice as long as broad ..... **Pleiospilos**
57b Leaves elongate, at least as long as broad ..... **Cephalophyllum**
55b Leaves keeled, therefore triangular in cross section:
58a Capsule multilocular (>10):
59a Capsules without closing bodies ..... **Dracophilus**
59b Capsules with closing bodies:
60a Closing bodies small ..... **Machairophyllum**
60b Closing bodies large:
61a Leaves whitish ..... **Argyroderma**
61b Leaves dark green:
62a Capsules dark brown, ± round ..... **Pleiospilos**
62b Capsules greyish brown, with an almost flat top ..... **Cheiridopsis**
58b Capsules 5–8-locular:
63a Capsules with covering membranes:
64a Leaves fat and short; flowers and fruits solitary:
65a Flowers developed seemingly laterally; one leaf pair per branch ..... **Didymaotus**
65b Flowers clearly terminal; 2 or 3 leaf pairs per branch ..... **Lapidaria**
64b Leaves more than three times longer than broad; flowers and fruits in dichasia:
66a Flowers white ..... **Nelia**
66b Flowers yellow:
67a Leaves with an extensive, often emarginate hunch superseding the tip of the upper side of the leaf ..... **Rhombophyllum**
67b Leaves only moderately hunched (gibbose) ..... **Hereroa**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

63b Capsules without covering membranes, sometimes with a rim:
68a Valve wings absent or narrow:
69a Valve wings absent; flowers white or pink ..... **Ruschianthus**
69b Valve wings narrow; flowers yellow ..... **Carruanthus**
68b Valve wings broader than expanding keels, rectangular:
70a Valve wings stiff and woody, stretching over the locules ..... **Faucaria**
70b Valve wings flexible:
71a Flowers (and fruits) with bracteoles:
72a Leaves rounded-trigonous, sides concave, rarely straight; flowers with hypanthium.. ..... **Stomatium**
72b Leaves sharply triangular, sides straight to concave; flowers without a hypanthium:
73a Margins of leaves with teeth (sometimes few); leaves bright green ..... **Orthopterum**
73b Margins of leaves entire; leaves whitish ..... **Conophytum**
71b Flowers and fruits without bracteoles:
74a Leaves with a prominent, hard, spiny tip ..... **Schwantesia**
74b Leaves with a rounded though mucronate tip ..... **Dinteranthus**

Group F. Plants with caespitose growth form

(Internodes are short, the main shoots prostrate; adventitious roots are absent or only rarely formed.)

1a Leaves mesomorphic, with or without bladder cells:
2a Leaves of a pair anisophyllous ..... **Glottiphyllum**
2b Leaves of a pair isophyllous:
3a Internodes smooth ..... **Delosperma**
3b Internodes with hairs derived from elongated bladder cells ..... **Drosanthemum**
1b Leaves xeromorphic, firm, smooth to papillate, velvety:
4a Leaves with apical windows:
5a Capsules 5-locular ..... **Frithia**
5b Capsules multilocular ..... **Fenestraria**
4b Leaves without apical windows:
6a Plants anisophyllous:
7a Leaf surface velvety or minutely papillate ..... **Gibbaeum**
7b Leaf surface smooth:
8a Capsules with >10 locules ..... **Cephalophyllum**
8b Capsules with <10 locules ..... **Antegibbaeum**
6b Plants isophyllous:
9a Leaves of a pair united into a fleshy body (corpuscule) ..... **Conophytum**
9b Leaves of a pair free for most of their length:
10a Leaves finger-shaped to terete, not keeled:
11a Leaves small, < 6 mm in diameter, with spirally arranged warts ..... **Neohenricia**
11b Leaves larger, > 8 mm in diameter, without warts:
12a Leaves greyish green; capsules with a flat top; flowers with a hypanthium, number of elements < 300..... ..... **Argyroderma**
12b Leaves dark green; capsules with high valve rims, top therefore elevated; flowers without a hypanthium, number of elements > 2 000 ..... **Cylindrophyllum**
10b Leaves trigonous to triquetrous, keeled:
13a Leaf surface velvety-papillate:
14a Closing bodies small ..... **Ihlenfeldtia**
14b Closing bodies large:
15a Valve wings rectangular, if pointed, plants heterophyllous ..... **Cheiridopsis**
15b Valve wings tapering into awns ..... **Odontophorus**
13b Leaf surface smooth or rough, but not papillate:
16a Leaves trigonous:
17a Covering membranes absent or narrow rims:
18a Leaves with teeth along margins, rarely only horny ..... **Stomatium**
18b Leaves without teeth, surface rough from hard white tubercles, or smooth ..... **Rhinephyllum**
17b Covering membranes complete:
19a Closing bodies small, hook-shaped ..... **Ruschia**
19b Closing bodies large or bipartite:
20a Covering membranes undulate with dorsal appendages ..... **Antimima**
20b Covering membranes straight, ± flat:
21a Leaves with an extensive, often emarginate hunch superseding the tip of the leaf..... **Rhombophyllum**
21b Leaves not or only moderately hunched ..... **Hereroa**
16b Leaves sharply triquetrous, ± awl-shaped:

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

22a Flowers and fruits solitary ..... **Khadia**
22b Flowers and fruit in exserted dichasia ..... **Bergeranthus**

Group G. Shrubs or shrublets without spines

(Plants with woody, rarely succulent, persistent stems.)

1a Leaves soft, with or without bladder cells:
2a Plants homophyllous, producing several similar leaf pairs per season:
3a Internodes with prominent hairs (elongated bladder cells) ..... **Drosanthemum**
3b Internodes without prominent distant hairs:
4a Leaf tips with apical diadems (groups of spreading bristles with a corky base) ..... **Trichodiadema**
4b Leaf tips without diadems, although sometimes with elongated bladder cells:
5a Covering membranes absent ..... **Delosperma**
5b Covering membranes present:
6a Capsules with > 10 locules ..... **Malephora**
6b Capsule with 5–8 locules:
7a Leaves as long and broad as a finger; flowers with a nectary ring ..... **Jacobsenia**
7b Leaves shorter, if as long as a finger then more slender; flowers with 5 separate nectaries:
8a Leaves broadly trigonous, glaucous-grey, often dentate ..... **Oscularia**
8b Leaves terete or semiterete, if trigonous, shorter than 20 mm:
9a Inflorescences mostly as solitary flowers ..... **Lampranthus**
9b Inflorescences distinctly differentiated from the vegetative part, very floriferous, bracteate and bracteolate:
10a Leaves terete, up to 60 mm long, apically rounded ..... **Scopelogena**
10b Leaves trigonous, up to 30 mm long, apiculate ..... **Mestoklema**
2b Plants heterophyllous, producing two leaf pairs per season:
11a Leaves toothed ..... **Hammeria**
11b Leaves not toothed:
12a Basal parts of old leaf sheaths sclerotic, completely enveloping the stem ..... **Monilaria**
12b Old leaf sheaths papery or parchment-like:
13a Bracteoles connate, forming a cup enclosing the base of the flower ..... **Dicrocaulon**
13b Bracteoles well below the flower:
14a Both leaf pairs of a season connate for > 30% of their length ..... **Meyerophytum**
14b First leaf pair of a season connate for > 25% of its length, spreading, the second connate for > 50%, erect..... **Mitrophyllum**
1b Leaves firm:
15a Leaves continuous with succulent, green internodes:
16a Fruit 5–7-locular:
17a Capsules without closing bodies, with valve wings; seeds echinate ..... **Braunsia**
17b Capsules with closing bodies, without valve wings; seeds smooth or papillate ..... **Ruschia**
16b Fruit >8-locular:
18a Capsules 10- or more-locular:
19a Leaves more than 50 mm long, semiterete, tip blunt ..... **Leipoldtia**
19b Leaves less than 20 mm long, triquetrous, tip spiny ..... **Polymita**
18b Capsules 8-locular:
20a Covering membranes reduced ..... **Zeuktophyllum**
20b Covering membranes well developed:
21a Valves basally connate, only tips expanding once, capsule then staying open ..... **Stayneria**
21b Valve free to base, capsule opening repeatedly ..... **Smicrostigma**
15b Leaves clearly distinct from the wooden internodes:
22a Leaves longer than internodes, dominating the aspect (succulent shrubs):
23a Leaves almost globular, shaped like a grape ..... **Jensenobotrya**
23b Leaves trigonous to terete:
24a Internodes shiny, spongy ..... **Jordaaniella**
24b Internodes rough from peeling bark:
25a Foliage leaves slender, digitiform, leaves in inflorescence trigonous, much shorter ..... **Ottosonderia**
25b Leaves similar:
26a Seeds echinate:
27a Capsules with closing bodies, without valve wings ..... **Astridia**
27b Capsules without closing bodies, with valve wings ..... **Braunsia**
26b Seeds glabrous or papillate:
28a Capsules without covering membranes:

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

29a Fruit not closing properly after opening ..... **Corpuscularia**
29b Fruit opening and closing repeatedly when wetted ..... **Hartmanthus**
28b Capsules with covering membranes:
30a Capsules with closing bodies:
31a Capsules 5-locular ..... **Astridia**
31b Capsules > 10-locular:
32a Fruit in persistent inflorescences to which partial inflorescences are added each season; valve wings rectangular ..... **Cephalophyllum**
32b Fruit solitary or in dichasia, sometimes persistent; valve wings tapering slightly ..... **Schlechteranthus**
30b Capsules without closing bodies:
33a Valve wings absent:
34a Flowers bright magenta ..... **Enarganthe**
34b Flowers white to pink ..... **Wooleya**
33b Valve wings present:
35a Capsules 5-locular ..... **Hereroa**
35b Capsules > 8-locular:
36a Flowers bright magenta ..... **Namaquanthus**
36b Flowers white:
37a Calyx 4-lobed ..... **Juttadinteria**
37b Calyx 6–8-lobed ..... **Jacobsenia**
22b Leaves shorter than internodes, aspect dominated by woody stems (woody shrubs):
38a Capsules 5-locular (rarely up to 10 locules):
39a Fruits woody, dispersal units nutlets ..... **Ruschianthemum**
39b Fruit loculicidal capsules:
40a Capsules opening only once completely:
41a Seeds flat, dispersal by wind ..... **Stoeberia**
41b Seeds roundish, dispersal by rain ..... **Erepsia**
40b Capsules opening repeatedly:
42a Capsules with closing bodies:
43a Valve wings absent ..... **Ruschia**
43b Valve wings present:
44a Closing bodies large, locules shallow ..... **Antimima**
44b Closing bodies small, locules deep:
45a Capsules breaking away from pedicels; plants therefore ± spiny ..... **Eberlanzia**
45b Capsules remaining on pedicels ..... **Amphibolia**
42b Capsules without closing bodies:
46a Valve wings broad:
47a Leaves rough from tiny elevations ..... **Rhinephyllum**
47b Leaves smooth, glabrous:
48a Valve wings rectangular ..... **Lampranthus**
48b Valve wings narrowed towards the tip ..... **Circandra**
46b Valve wings absent or narrow:
49a Valve wings absent, expanding keels short and radial ..... **Esterhuysenia**
49b Valve wings narrow (rarely broader), expanding keels longer, diverging ..... **Erepsia**
38b Capsules > 8-locular:
50a Plants with a compact centre and long shoots:
51a Long shoots procumbent but never rooting ..... **Hallianthus**
51b Long shoots erect, later leaning in other shrubs:
52a Plants homophyllous; leaves with dentate margins ..... **Odontophorus**
52b Plants heterophyllous (first leaf pair of a branch highly connate); leaves entire, mucronate ..... **Vanzijlia**
50b Plants without a compact renewal centre of assimilating short shoots:
53a Capsules without closing bodies ..... **Erepsia**
53b Capsules with closing bodies:
54a Covering membranes straight ..... **Octopoma**
54b Covering membranes distally recurved and undulate ..... **Leipoldtia**

Group H. Shrubs or shrublets with spines

1a Capsules 6–9-locular:
2a Valve wings rectangular, broader than expanding keels; more spines than fruits per inflorescence; closing bodies large; internodes often shorter than leaves ..... **Leipoldtia**
2b Valve wings reduced to awns or absent; few spines per inflorescence; closing bodies medium-sized, hook-shaped ..... **Ruschia**
1b Capsules 5-locular (very rarely 4- or 6-locular):
3a Closing bodies absent ..... **Mestoklema**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

3b Closing bodies present:
4a Closing bodies large, white; covering membranes without additional closing devices ..... **Arenifera**
4b Closing bodies small, translucent to glassy; covering membranes with closing rodlets:
5a Valve wings broad; blunt spines derived from pedicels after the ripe fruit has been shed ..... **Eberlanzia**
5b Valve wings absent or very narrow; sharp spines developed from pedicels after abortion mainly of buds or flowers ..... **Ruschia** subgenus **Spinosa**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

leaf edges, from several times as long as broad to only slightly longer than broad, those of each pair unequal and with apical portions often differing in shape, bright green or various shades of red or purple. **Flowers** apparently solitary, axillary, ebracteate, sessile or shortly pedicellate, up to ± 70 mm in diameter; opening in morning and staying open all day. **Sepals** 4. **Petals** free or slightly united at base, linear-cuneate, bright yellow, rarely white. **Stamens** with epapillate filaments. **Nectary** 0. **Ovary** half-inferior, convex or flattish on top; placentas parietal; stigmas 5–14, spreading to reflexed, plumose. **Fruit** a 5–14-locular capsule, superficially similar to Leipoldtia type; valve wings 0 or very narrow; differing in broad-based shape and spongy-corky consistency of large closing bodies and mostly incomplete differentiation between expanding keel and expanding sheet; therefore tentatively placed with Mitrophyllum type. **Seeds** relatively large and variable in texture. $x = 9$.

Flowering in spring or autumn.

Distinguishing characters: perennials with very succulent, mostly distichously arranged, tongue-shaped leaves; flowers large, sepals 4, petals yellow; fruit pale, multilocular with large closing bodies.

Species 17, southern parts of South Africa. They occur over much of the southern Cape interior, particularly the Little Karoo where it straddles the border between the Western and Eastern Cape. Outliers are found in the Tanqua Karoo and Great Karoo in the west and north, and further east in the Eastern Cape.

Hallianthus H.E.K.Hartmann 2405150

(Ruschioideae: 11. Leipoldtia Group).
Hartmann: 1 (1983c); Hartmann: 143, 167 (1983a); Smith *et al.*: 370 (1998).

Leipoldtia L.Bolus in part.

Procumbent shrubs with a compact centre of short shoots and 4–20 trailing floriferous shoots with long, thin internodes. **Leaves** opposite, scarcely fused at base, trigonous to falcate, dark green, often laterally compressed; stomata not sunken, crystal layer in outer epidermal wall reduced. **Flowers** 1–3, bracteate. **Sepals** 5. **Petals** white, pink or bicoloured. **Stamens** in a central cone encircled by many staminodes, brightly coloured apically. **Nectary** a crenulate ring. **Ovary** with parietal placentas. **Fruit** a 10-locular capsule, of Leipoldtia type; turret-shaped with prominent subproximal elevations on covering membranes; expanding keels parallel; expanding sheets extensive.

Flowering autumn and winter.

Distinguishing characters: flat-growing perennials with long internodes; leaf pairs laterally flattened; fruit 10-locular, turret-shaped on top.

Species 1: *Hallianthus planus* (L.Bolus) H.E.K.Hartmann, Namaqualand in the Northern Cape and further south in the Western Cape in the Tanqua Karoo.

Hammeria Burgoyne 2405190

(Ruschioideae: ? 3. Mitrophyllum Group).
Burgoyne *et al.*: 203 (1998); Smith *et al.*: 188 (1998).

Small, prostrate shrublets up to 500 mm high; long shoots may spread from central stem, rooting at widely-spaced nodes. **Leaves** opposite, borne upright, basal leaves joined for up to a third of their lengths becoming membranous and persistent, forming sheaths around young leaves which form the next leaf pair, green leaf pairs 10 to 20 mm long, D-shaped in cross section and borne close together, margins toothed at tips; surfaces with a layer of flaking wax and dark green translucent dots, colour varying from grey-green in rainy season to buff in dry season. **Flowers** 1 or 2, borne upright on stalks up to 30 mm long, ± 20 mm in diameter, subtended by bracts resembling leaves; open from midday to mid-afternoon. **Sepals** 5, equal, recurved, sometimes with toothed tips. **Petals** in 2 or 3 whorls, pale pink with white at the centre. **Stamens** forming a central cone; staminodes short. **Nectary** a crenulate, dark green ring. **Ovary**: placentas parietal; stigmas 5, longer than stamens. **Fruit** a 5-locular capsule, close to Mitrophyllum type; covering membranes ample; valves winged; expanding keels diverging and expanding sheets conspicuous; closing bodies absent or present as small bulges. **Seeds** smooth, honey-coloured with darker tips.

Flowering in spring.

Distinguishing characters: small shrublets, branches prostrate, rooting at the nodes; leaves toothed at tips; capsule 5-locular, ± of the Mitrophyllum type.

Species 2, restricted to the Tanqua Karoo and the Ceres Karoo in the Western and Northern Cape.

Hartmanthus S.A.Hammer 2405189

(Ruschioideae: 7. Dracophilus Group).
Hammer: 77 (1995a); Smith *et al.*: 282 (1998).

Delosperma N.E.Br. emend. Lavis in part.

Compact, small to medium-sized shrublets, with erect or somewhat spreading, woody branches. **Leaves** greenish grey to silvery, strongly compressed lengthwise and keeled on back; leaf margins not very

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

sharp, often with a reddish tinge in full sun; leaf surfaces rough to the touch. **Flowers** in long, flattened and long-lived inflorescences, faintly scented. **Sepals** 5, unequal. **Petals** almost white to light or distinctly pink. **Nectary** a crenulate ring, or of 5 separate, crenulate glands. **Ovary** with basal-parietal placentas. **Fruit** a 6-locular capsule, of Delosperma type; whitish; expanding keels parallel, yellowish; valve wings large; covering membranes 0; closing bodies 0. **Seeds** medium-sized, pear-shaped, rather glossy.

Flowering during late winter and early spring.

Distinguishing characters: compact shrublets; leaves greenish grey to silvery green, laterally flattened, sometimes rough, shrinking unevenly when dehydrated, leaf margins reddish purple; pedicel strongly flattened.

Species 2, in very arid regions in the northern Richtersveld, Northern Cape, and in the Sperrgebiet in S Namibia.

Hereroa (Schwantes) Dinter & Schwantes 2405055

(Ruschioideae: 8. Bergeranthus Group).
Schwantes: 23 (1927d); Friedrich: 55 (1970); Herre: 168 (1971); Smith *et al.*: 214 (1998).

Bolusanthemum Schwantes: 514 (1928c).

Dwarf, tufted perennials, or shrublets up to ± 200 mm high. **Leaves** opposite, connate at base, ± finger-like and narrowing to a blunt tip, sometimes compressed laterally in upper part, ± free, lower apical part forming a hood or chin or resembling a hatchet or narrowing to a blunt tip, bright to dark green, often greyish or purplish green; surface smooth, covered with dark dots which are raised when leaves are not fully swollen; stomata not or only a little sunken, central water tissue milky-white from many intercellular spaces. **Flowers** solitary to several in dichotomous cymes, pedicellate and bracteate, up to ± 40 mm in diameter; opening afternoon and evening; scented. **Sepals** 5, unequal, acuminate. **Petals** 2–4-seriate, yellow with reddish exterior, rarely white. **Stamens** often papillate at base. **Nectary** with glands separate or fused into a ring. **Ovary** often somewhat concave above; placentas parietal; stigmas 5, filiform, longer than stamens. **Fruit** a 5-locular capsule, close to Mitrophyllum type but closing bodies small, variable in shape; locules either deep or shallow and with a raised placenta; expanding keels diverging, without wings or membranous points, often narrow; covering membranes present, translucent. **Seeds** small, pear-shaped, with concave depression, light brown. $x = 9$.

Flowering mainly in summer.

Distinguishing characters: plants tufted, with tuberous roots; leaves dotted; flowers in cymes, on bracteate pedicels, petals yellow, flowers opening during the afternoon or evening.

Species 32, extensive yet discontinuous in sthn Afr., widespread in S Namibia and in South Africa where it is found in all the provinces except Mpumalanga and KwaZulu-Natal.

Hymenogyne Haw. 2405059

(Ruschioideae: 1. Apatesia Group).
Haworth: 192 (1821); Herre: 176 (1971); Ihlenfeldt & Gerbaulet: 457 (1990); Gerbaulet & Ihlenfeldt: 511 (1990); Smith *et al.*: 74 (1998).

Thyrasperma N.E.Br.: 412 (1925).

Annual herbs of tufted habit when young, later branching prostrately. **Leaves** opposite, radical or clustered at ends of prostrate or decumbent branches, flat, petiolate, sheathing at base, not connate; tannin idioblasts in epidermis (only case known in family), surface covered with wax flakes. **Flowers** mostly solitary, on elongate, erect pedicels becoming prostrate in fruit; opening in afternoon and closing at night. **Sepals** 5. **Petals** free or nearly so, ivory to yellow, fading to orange, epapillate. **Stamens** epapillate; staminodes 0. **Nectary** an inconspicuous, faintly crenulate ring. **Ovary** basin-shaped with a depressed top, with a mushroom-shaped structure in the centre, formed by connate stigmas, with 8–12 papilla-like stigmatic surfaces on top; placentas axile. **Fruit** a schizocarpic capsule, 8–12-locular; without opening devices but breaking up into flat, circular, broadly winged, 1-seeded units (clausae); dispersal anemochoric. $x = 9$.

Flowering from spring to early summer.

Distinguishing characters: annual herbs with flat leaves; flowers solitary, petals ivory to yellow, fading to reddish with age, stigmas forming a central column; fruit schizocarpic.

Species 2, Western Cape, from the Cape Peninsula to Clanwilliam.

Ihlenfeldtia H.E.K.Hartmann 2405161

(Ruschioideae: 6. Titanopsis Group).
Hartmann: 47 (1992b); Smith *et al.*: 108 (1998).

Cheiridopsis N.E.Br. in part.

Compact, dwarf, clump-forming perennials developing few to many short branches, each with only 1 leaf pair in the dry season. **Leaves** opposite, leaf pairs connate towards base, distinctly keeled, 3-sided,

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

upper surface ± triangular, sometimes with tiny, often reddish teeth along margins and keels, papillate. **Flowers** solitary, erect, bracteate, up to 70 mm in diameter; opening from midday until dusk. **Sepals** 5. **Petals** all shades of yellow to cream or pure white, often purplish suffused, particularly sides of petals, all colours may turn red with age. **Stamens** erect to connivent. **Nectary** a crenulate ring. **Ovary**: placentas parietal; stigmas 10–15, narrowly triangular. **Fruit** a 10–15-locular capsule, of Titanopsis type; with tiny endocarpal closing bodies; covering membranes thin, flexible, collapsing into empty seed chambers once seeds have been dispersed; valve wings taper from broad bases to tips. **Seeds** pear-shaped, smooth.

Flowering in winter.

Distinguishing characters: compact perennials with keeled leaves; flowers yellow, tinged with purple or red; fruit with robust stalks, closing bodies small or absent.

Species 2, Northern Cape, and prefer quartzitic soils in Bushmanland and the adjacent areas of Namaqualand.

Jacobsenia L.Bolus & Schwantes emend. Ihlenf.

2405061

(Ruschioideae: 3. Mitrophyllum Group).
Bolus & Schwantes, in Bolus: 255 (1954a); Bolus & Schwantes, in Schwantes: 69 (1954); Herre: 180 (1971); Ihlenfeldt: 109 (1997); Smith *et al.*: 142, 236 (1998).

Anisocalyx L.Bolus: 385 (1958b); Herre: 72 (1971); not of Hance ex Walp., 1852 (Scrophulariaceae). *Drosanthemopsis* Rauschert: 555 (1982).

Compact or densely tufted shrublets, 150 mm high; stems to 10 mm diameter; adult plants either with erect shoots with elongated internodes and distinct lateral short shoots with very short internodes, or with ± compact habit without clear distinction between long and short shoots. **Leaves** opposite, succulent, at least last leaf pair of season persisting on stem until next season; leaf pairs of a season isophyllous, leaves of a pair sometimes slightly anisophyllous, each stem usually developing 2 leaf pairs per season; leaf pairs basally connate for ± a fifth of their length, leaves erect or spreading, ± digitiform, often ± curved, upper surface sometimes flattened, lower surface sometimes somewhat keeled; the very base of the connate portion of a leaf pair developing into a narrow, ring-shaped, persisting, sclerotic sheath, usually brown-red; leaves to 70 mm long, 10 mm in diameter; epidermis with bladder cells. **Flowers** terminal, emerging towards end of season from connate portion of 2nd or sometimes 1st leaf pair, solitary, pedicellate; pedicels 10–70 mm long, up to ± 80 mm in diameter; opening in morning, closing in evening. **Sepals** (4)5 or 6(–8), 3 with membranous margins. **Petals** 4- or 5-seriate, acuminate, white to lemon yellow, or rarely purplish, inner petals shorter. **Stamens**: filaments white or yellow, papillate; pollen reticulate, spinulose; staminodes 0–very few. **Nectary** a finely crenulate, ± 5-angled ring. **Ovary**: placentas parietal; stigmas 5, subulate. **Fruit** a 5-locular capsule, of Mitrophyllum type; closing bodies 0; valve wings broad, recurved; expanding keels diverging, margins toothed, ending in awns; covering membranes covering a half to three-quarters of locule. **Seeds** globose, brown to light brown, testa minutely papillate. $x = 9$.

Flowering in spring to early summer.

Distinguishing characters: shrublets with long, erect branches bearing inflorescences; leaves of a pair forming plant bodies only in juvenile stage; flowers white, on long, red-brown, bare stems.

Species 3, southwestern Namaqualand in the vicinity of Vanrhynsdorp and Vredendal, Northern and Western Cape.

Jensenobotrya A.G.J.Herre

2405062

(Ruschioideae: 7. Dracophilus Group).
Herre: 79 (1951); Friedrich: 58 (1970); Herre: 17 (1970); Herre: 182 (1971); Giess: 3 (1974); Smith *et al.*: 264 (1998).

Shrubs, prostrate or often hanging, with thick woody stems forming large dense mats; branches covered with old, dry leaves; internodes 2 or 3 mm long. **Leaves** 4–6 on a branch, opposite, shaped like a grape, very fleshy, 12–15 mm in diameter, smooth, grey, often purplish suffused; epidermis cells flat, outer walls with a rather thick crystal layer. **Flowers** terminal, solitary, shortly pedunculate, up to ± 25 mm in diameter; all elements of androecium on a raised rim above nectary; opening at noon, closing by dusk. **Sepals** 5, unequal, 3 inner with membranous margins. **Petals** 2-seriate, free, acute, magenta with white at base. **Stamens** many, filaments pubescent at base; staminodes 0. **Nectary** a dark green, crenulate ring. **Ovary** flat or somewhat concave on top; placentas parietal; stigmas 5, subulate, with rudimentary stylodia. **Fruit** a 5(6)-locular capsule, of Delosperma type; flat, basin-shaped, up to 12 mm in diameter with septa prominent, erect, arched towards central column; expanding keel contiguous towards base, diverging and excurrent into very long, narrow, pennant-like white wings; covering membranes 0; closing bodies 0. **Seeds** oblong-ovate, ± 1 mm long, shiny, brown.

Flowering in autumn and winter.

Distinguishing characters: perennials with thick woody stems and leaves resembling grapes; highly localised in its distribution.

Species 1: *Jensenobotrya lossowiana* A.G.J.Herre, endemic to Namibia, and occurs at Dolphin Head in Spencer Bay, in the coastal desert between Lüderitz and Walvis Bay.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Jordaaniella H.E.K.Hartmann 2405145

(Ruschioideae: 11. Leipoldtia Group).
Hartmann: 57 (1983c); Hartmann: 1 (1983c); Hartmann: 321 (1984a); Smith *et al.*: 266 (1998).

Cephalophyllum N.E.Br. in part.

Prostrate perennials, with long orange-coloured or yellow internodes with a spongy persistent primary cortex; adventitious roots many, arising from nodes of trailing branches. **Leaves** fusiform, characteristically broadest towards middle and tapering towards both ends; stomata not sunken. **Flowers** solitary on short side branches, bracteate; opening midday, closing in afternoon. **Sepals** (4)5(6). **Petals** in different shades of yellow or purple, rarely white. **Stamens**: inner filaments papillate at base, yellow, white or salmon-pink; staminodes 0. **Nectary** a weakly crenulate ring. **Ovary**: placentas parietal. **Fruit** a 10–25-locular capsule, of Leipoldtia type but with small closing bodies. x = 9.

Flowering in winter and spring.

Distinguishing characters: perennials with trailing stems; leaves tapering towards both ends; fruit 10–25-locular, with angular valves, appearing squarish on top.

Species 4, mainly on coastal sands in Strandveld and in the succulent Karoo, restricted to S Namibia, Northern and Western Cape.

Juttadinteria Schwantes 2405063

(Ruschioideae: 7. Dracophilus Group).
Schwantes: 182 (1926b); Walgate: 171 (1939); Friedrich: 58 (1970); Herre: 184 (1971); Smith *et al.*: 148 (1998).

Dwarf, tufted perennials, with short internodes, or erect, ascending, rarely procumbent dwarf shrubs. **Leaves** mostly short and fleshy, decussate, connate at base, ovoid, subcylindric, broadly boat-shaped or triangular, sometimes with reddish or brownish teeth on margins and keel, pale grey-green or blue-green; epidermis with rounded papillae of unequal size, smaller ones surrounding stomata, larger epidermal cells with anticlinal secondary walls, grey from a flaky wax layer. **Flowers** solitary, terminal, shortly pedicellate, ebracteate, ± 50 mm in diameter; often scented; opening in early afternoon, closing at night. **Sepals** 4, 2 outer ones often toothed, lanceolate, 2 shorter ones with membranous margins. **Petals** 1–3-seriate, free or somewhat connate at base, linear, reflexed, mostly white, light to dark violet-red, glistening on both sides. **Stamens** hairy at base, collected in a cone; staminodes 0. **Nectary** a crenulate ring. **Ovary** ± flat or slightly conical; placentas parietal; stigmas 8(–11), subulate, sometimes on short style. **Fruit** a 8(–11)-locular capsule, near Delosperma type; with central column and thick septa between locules; valve wings long, narrow; expanding keels parallel, diverging slightly near tips; covering membranes rarely well developed, mostly reduced to a limb; closing bodies 0. **Seeds** ± spherical or pear-shaped, wrinkled or warty.

Flowering in winter.

Distinguishing characters: branches erect to spreading; leaves tuberculate; flowers with 4 sepals, petals white, stigmas 8, opening in the morning; pedicels ebracteate; fruit with rudimentary covering membranes.

Species 10, confined to the northern Richtersveld in the Northern Cape and in Namibia it ranges from Lüderitz in the northwest to Aus in the northeast; it is common in the Sperrgebiet.

Khadia N.E.Br. 2405065

(Ruschioideae: 10. Ruschia Group).
Brown: 279 (1930b); Herre: 188 (1971); Chesselet & Hartmann: 46 (1995); Chesselet, Hartmann, Hahn, Burgoyne & Smith: 25 (1998); Smith *et al.*: 218 (1998); Winter & Hahn: 16 (1999).

Compact to mat-forming dwarf perennials; rootstock thickened or not, bearing ± horizontal branches with internodes mostly reduced and hidden or elongated up to 40 mm, with adventitious roots at nodes; ± anisophyllous. **Leaves** opposite, with 2 (3, in cultivation up to 4) new leaf pairs per branch, per season; connate at base, triquetrous distally with acuminate tips, semiterete basally and broader than thick, dark green or glaucous; subepidermal enlarged tanniniferous cells (pellucid dots) concentrated along keel and margins. **Flowers** solitary, pedicellate; opening in sunlight or in afternoon (*C. carolinensis*). **Sepals** 5 or 6. **Petals** in 2–4 series, white to deep magenta, with shades of pink. **Stamens**: filaments variable in colour and length; staminodes white to purple, forming a distinct cone in newly opened flowers, spreading and bending backwards in time. **Nectary**: glands forming a dark green crenate ring. **Ovary** with upper surface convex or centrally depressed; placentas parietal; stigmas (4)5–11, sometimes longer than filaments. **Fruit** a (4)5–11-locular capsule, reddish when young, dark brown later; pedicel persistent or breaking off, resulting in a tumble fruit; valves without wings but with enlarged rims; bases of expanding keels widely separated; covering membranes complete, rather firm, filled ± with a whitish spongy tissue, with low rims at distal ends; closing device at distal rim of capsule reduced to a tiny bud or knob formed by placenta or by an outgrowth of expanding sheet over some protrusion from endocarp. **Seeds** ± 1 mm long; micropylar end curved and elongated or short and straight.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Flowering in summer.

Distinguishing characters: perennials tufted with tuberous roots, often trailing and rooting at the nodes; flowers solitary.

Species 6, North-West, Gauteng and Mpumalanga, extending into N KwaZulu-Natal.

Lampranthus N.E.Br. 2405066

(Ruschioideae: 9. Lampranthus Group).
Brown: 71 (1930a); Friedrich: 64 (1970); Herre: 190 (1971); Hartmann: 44 (1998c); Smith *et al.*: 326 (1998).

Prostrate, decumbent or erect shrublets or shrubs; stems smooth, occasionally rooting at nodes; roots fibrous, rarely thickened. **Leaves** decussate, shortly fused towards base or free, always equal and similar, terete, semiterete or 3-angled, blunt or tapering, occasionally dotted, up to 50 mm long; epidermis smooth or scabrid. **Flowers** terminal or axillary, in dichasia or solitary, mostly pedicellate, rarely sessile; 7–70 mm in diameter. **Sepals** 5. **Petals** white, yellow, orange, red or purple. **Staminodes** 0 or present, conically collected or spreading. **Nectary** a low, crested ring. **Ovary** with placentas parietal; stigmas 5(–7), ± triangular. **Fruit** a capsule of Lampranthus type, usually 5-locular, woody, base funnel-shaped, occasionally with seed pockets; valve wings large, or rarely absent; expanding keels diverging; covering membranes stout; closing bodies absent but sterile funicles blocking exits of locules. **Seeds** D- or pear-shaped, 0.8–2.0 mm long, brown to black, surface rough or smooth.

Flowering mostly in spring and early summer but throughout the year.

Distinguishing characters: creeping to erect shrubs or shrublets; leaves smooth, cylindrical; fruit with funicular hairs at distal exits of locules, covering membranes and valve wings present.

Species ± 220 described, the majority found in a broad band along the western and southern coasts of the Northern, Western and Eastern Cape. Further towards the east it grows near the Mthamvuna River mouth on the border between the Eastern Cape and KwaZulu-Natal, also extends as far north as S Namibia.

Lapidaria (Dinter & Schwantes) N.E.Br. 2405067

(Ruschioideae: 6. Titanopsis Group).
Brown: 472, 492 (1928e); Friedrich: 66 (1970); Herre: 192 (1971); Smith *et al.*: 110 (1998).

Compact, ± stemless, dwarf, succulent perennials with 1–4 leaf pairs per main branch. **Leaves** in a rosette, short, trigonous, lower part produced like a chin, keel and edges obvious but not sharp, pale pinkish brown or whitish in colour; surface with a minutely rough texture; epidermal cells somewhat elevated, stomata and subsidiary cells sunken, outer epidermal wall with a thick crystal layer. **Flowers** solitary or up to 3 in succession, terminal, ± 50 mm in diameter; borne on short, winged stalks; open during day. **Sepals** 6–8, ± equal. **Petals** 3-seriate, slightly connate at base, golden yellow. **Stamens** with filaments papillate at base; staminodes present. **Nectary** a low crenulate ring. **Ovary** flattish on top; placentas parietal; stigmas 6–8, subulate, recurving. **Fruit** a 6–8-locular capsule, of Titanopsis type, flat with raised sutures; valves widely spreading or recurved when expanded; expanding keels contiguous towards base, diverging towards apex with broad, membranous margins; covering membranes present; closing bodies 0. **Seeds** small, pear-shaped, light brown. $x = 9$.

Flowering in winter.

Distinguishing characters: compact, stemless perennials with keeled leaves, often appearing somewhat shrunken; flowers yellow; pedicels winged.

Species 1: *Lapidaria margaretae* (Schwantes) Dinter & Schwantes, Warmbad area of S Namibia and in adjacent parts of the Northern Cape.

Leipoldtia L.Bolus 2405068

(Ruschioideae: 11. Leipoldtia Group).
Bolus: 256 (1927d); Friedrich: 67 (1970); Herre: 194 (1971); Hartmann: 1 (1983c); Hartmann & Stüber: 1 (1993); Hartmann & Rust: 275 (1994); Hartmann & Stüber: 353 (1994); Smith *et al.*: 372 (1998).

Rhopalocyclus Schwantes: 599 (1928c).

Straggling or dense shrubs up to 1 m high, rarely procumbent or creeping, rarely with spines derived from pedicels, sometimes with branches rooting some distance from mother plant. **Leaves** opposite, trigonous, rarely crescent-shaped and compressed, borne upright, greyish, with smooth surfaces; epidermal cells flat to somewhat elevated, stomata a little sunken. **Flowers** mostly in many-flowered dichasia, rarely solitary, ± 25 mm in diameter; pedicel constricted under calyx, bracteate below middle, persisting and sometimes spinescent; open in day-time. **Sepals** 5(6), subequal, with membranous margins. **Petals** 1- or 2-seriate, linear-spatulate, obtuse, purple or pink, rarely white or yellow. **Stamens** with filaments of inner stamens papillate; staminodes spreading, conically collected or absent. **Nectary** a crenate ring. **Ovary** slightly convex on top; placentas parietal; stigmas 10(–16), subulate-acuminate. **Fruit** a 10(–16)-locular capsule, of Leipoldtia type; covering membranes wavy with closing rodlets at distal end; expanding keels radially spreading, contiguous towards base; valve wings broad; closing bodies large and white. **Seeds** ± smooth, pear-shaped, ochre to light brown. $x = 9$.

Flowering mainly in winter.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Distinguishing characters: sparse shrubs; fruit 10(–16)-locular; whitish grey when closed.

Species 11, extends from near Aus, Namibia, down into South Africa to the region of Worcester, into the Little Karoo in the Western Cape, and eastwards to the Eastern Cape. Most species occur in the vicinity of the Richtersveld (Northern Cape).

Lithops N.E.Br. 2405069

(Ruschioideae: 6. Titanopsis Group).
Brown: 44 (1922a); Friedrich: 68 (1970); Herre: 196 (1971); Cole (1988); Clark: 1 (1996); Smith *et al.*: 112 (1998).

Compact, ± stemless, dwarf, succulent perennials, ± sunken in the soil, of 1 or more ± connate leaf pairs (bodies); roots fibrous. **Leaves** opposite, connate to form an obconic body with a truncate apex, old leaves turning into ± hard sheaths enclosing new body, flat tops variously marked, sculptured or windowed; surface ± smooth, but epidermal cells often bluntly elevated, rarely papillate, with remarkable, thick outer epidermal walls encrusted with cutinised blocks and thick crystal layers, crystals increasing basipetally in size. **Flowers** solitary, rarely 2 or 3, from centre of fissure between leaves of a pair, shortly pedicellate, ebracteate, 15–40 mm in diameter; opening mid-afternoon, closing at sunset. **Sepals** 4–7. **Petals** 1–4-seriate, linear, white, yellow or orange. **Stamens** sometimes papillate towards base; staminodes 0. **Nectary** a crenulate ring. **Ovary** with parietal placentas; style short or 0; stigmas 4–7(9), filiform. **Fruit** a 4–7(9)-locular capsule, of Delosperma type; small; valves with broad valve wings; expanding keel single, stout, central on valve, divided at apex; covering membranes reduced to a limb or 0; closing bodies 0. **Seeds** highly variable in size, shape, colour and texture. $x = 9$.

Flowering autumn to early winter.

Distinguishing characters: compact dwarf perennials, mostly underground with paired leaves fused to form ± obconic bodies with flat or rounded, often windowed and ornamented tops; fruit 4–7(9)-locular; pedicels ebracteate.

Species 36, widespread in sthn Afr. (Namibia, Botswana and South Africa, but excluding Mpumalanga and KwaZulu-Natal) and occurs mainly in the Nama Karoo, succulent karoo and in rare cases in semi-arid savanna regions.

Machairophyllum Schwantes 2405070

(Ruschioideae: 8. Bergeranthus Group).
Schwantes: 187 (1927c); Herre: 198 (1971); Hammer: 77 (1991); Smith *et al.*: 220 (1998).
Perissolobus N.E.Br.: 278 (1930b).

Dwarf perennials, compact to caespitose, or with branching habit, up to 1.2 m in diameter; stems often rooting at nodes. **Leaves** opposite, crowded, up to ± 200 mm long, 20 mm broad, sharply triangular in cross section, mucronate, tapering to sharp points, canescent, surface dotless, very smooth, pale green, sometimes flushed with red, sometimes becoming whitish green; old leaves persistent; stomata superficial, outer epidermal wall densely filled with crystals. **Flowers** solitary or mostly in threes, on long pedicels with large bracts, up to 65 mm in diameter; usually nocturnal. **Sepals** 5–8, unequal, acuminate or occasionally obtuse. **Petals** densely 3–7-seriate, copper-red outside, yellow, golden or orange within. **Stamens** many, only inner stamens inconspicuously papillate, up to 1000 elements in androecium; staminodes 0. **Nectary** a crenulate ring, or of ± separate glands, sometimes with nectariferous depression at base. **Ovary** usually convex or conical above; placentas parietal; stigmas 5–15, slender. **Fruit** a 5–15-locular capsule; resembling capsule of *Cylindrophyllum* and therefore perhaps close to Leipoldtia type, but with a ± spongy tissue in covering membrane; small closing bodies and no additional closing devices at distal opening. **Seeds** ovoid, granulate. $x = 9$ (1 report).

Flowering late winter to early summer.

Distinguishing characters: tufted, robust perennials; leaves smooth, hard; flowers large to very large with many petals and staminodes, usually nocturnal; pedicels long, bracteate.

Species 10, predominantly Little Karoo, extending from Barrydale (Western Cape) in the west to Willowmore in the east, also recorded from Zuurberg in Eastern Cape.

Malephora N.E.Br. 2405071

(Ruschioideae: ? 4. Delosperma Group).
Brown: 12 (1927); Jacobsen & Rowley: 77 (1958); Herre: 200 (1971); Smith *et al.*: 268 (1998).
Crocanthus L.Bolus: t. 255 (1927a). *Hymenocyclus* Dinter & Schwantes: 27 (1927d); Friedrich: 56 (1970).

Shrubs or undershrubs, procumbent to prostrate with greyish to yellow stems and distinct internodes. **Leaves** opposite, slightly connate at base, up to 50 mm long, almost terete to trigonous, mucronate; epidermis ± flat, bladder cells rare, often flat, smooth, often with bluish, waxy coating. **Flowers** solitary or in rich dichasia, terminal or axillary, shortly pedicellate, ebracteate, up to 50 mm in diameter; opening at midday. **Sepals** 4 or 5. **Petals** free, yellow, golden, pink or reddish purple (often purplish outside and golden inside). **Stamens** often papillate towards base; staminodes present. **Nectary**: glands sometimes united into a crenulate ring. **Ovary** flat on top; placentas parietal; stigmas 8–12, small, plumose. **Fruit** a 8–12-locular capsule, of Drosanthemum type; parietal placentas often ending distally in prominent, sometimes bipartite knobs acting as closing bodies; base of locules divided by false septum which, together with splitting proper septa, forms pockets containing 1 or 2

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

seeds; these schizocarpous units are then dispersed. **Seeds** flat, rough with tubercles in rows. $x = 9$ (1 report).

Flowering time: Some species flowering in winter some in summer.

Distinguishing characters: creeping to rarely upright perennials; leaves waxy; flowers yellow to red; capsule 8–12-locular, sometimes with bifid closing bodies.

Species 14, from S Namibia to Namaqualand in the Northern Cape, through the Great and Little Karoos to the Eastern Cape, some known from the S Free State.

Marlothistella Schwantes 2405175

(Ruschioideae: 10. Ruschia Group).
Schwantes: 599 (1928c); Hammer: 82 (1995b); Smith *et al.*: 222 (1998).

Ruschia Schwantes in part.

Low succulent perennials, ± stemless or with short branches ± hidden by leaf bases, with tufts of long leaves arising from a large caudex. **Leaves** decussate, long, awl-shaped, smooth, dotted, easily desiccating. **Flowers** large, showy, single, sessile, with two small bracteoles strongly keeled on back. **Sepals** 5, of nearly equal length, inner ones bordered with a broad membrane, outer ones not so, all segments becoming ± dry. **Petals** lanceolate, purple with a line of darker purple running down the centre; opening in morning, closing at night. **Stamens** with thick, round, basally long-papillate filaments; staminodes basally shortly papillate. **Nectary** a very high, deeply crenate, dark green ring. **Ovary** with 5 (rarely 6) very high, grooved protuberances; placentas parietal; stigmas 5, greenish yellow, broadly awl-shaped, externally smooth, internally long-haired. **Fruit** a 5-locular capsule; covering membranes stiff, translucent; expanding keels widely divergent, reddish; closing bodies very large, whitish; valve wings 0. **Seeds** large, round, papillately sculptured.

Flowering winter.

Distinguishing characters: tufted perennials with tuberous roots; flowers solitary, large, with purple, striped petals; fruit 5-locular with large, white closing bodies.

Species 1: *Marlothistella stenophylla* (L.Bolus) S.A.Hammer, restricted to the Little Karoo in the Western Cape, in the districts of Calitzdorp, De Rust, Joubertina, Prince Albert, Uniondale and Willowmore.

Mesembryanthemum L. emend. L.Bolus 2405073

(Mesembryanthemoideae).
Linnaeus: 480 (1753); Bolus: 164–168 (1939); Friedrich: 81 (1970); Herre: 204 (1971); Smith *et al.*: 38 (1998); Gerbaulet (in press).

Callistigma Dinter & Schwantes: 644 (1928c). *Cryophytum* N.E.Br: 412 (1925). *Derenbergiella* Schwantes: 599 (1928c). *Eurystigma* L.Bolus: 179 (1930); Herre: 154 (1971). *Halenbergia* Dinter: 158, 200 (1937); Herre: 166 (1971). *Hydrodea* N.E.Br.: 412 (1925); Herre: 174 (1971). *Opophytum* N.E.Br.: 412 (1925); Herre: 240 (1971).

Annual to perennial (in the large species) fleshy herbs, prostrate, decumbent or erect; stems herbaceous, terete, angled or winged; with fibrous roots. **Leaves** decussate throughout or becoming alternate in inflorescences or alternate throughout, flat and tapering to a pseudopetiole, or terete, club-shaped or almost globular, shortly fused towards bases, margins occasionally undulate, epidermal bladder cells large to much flattened. **Flowers** in dichasia, rarely solitary, 10–60 mm in diameter; open in daylight hours. **Sepals** 5, 2 often foliaceous. **Petals** united at base into a short tube or sometimes free towards base; pink, yellow or white. **Stamens** arising within corolla tube; staminodes 0 or present. **Nectary** consisting of 5 shallow or deep grooves. **Ovary** semi-inferior; placentas axile; stigmas (4)5, filiform, erect. **Fruit** a 5-locular capsule, of Mesembryanthemum type; expanding keels extending to centre of fruit; covering membranes 0; valve wings present, either inflexed over valves or reflexed and fused in pairs. **Seeds** D-shaped or triangular, 0.5–1 mm long, black, brown, ochre or whitish, surface rough or ± smooth. $x = 9$ (polyploidy).

Flowering mainly in spring and summer.

Distinguishing characters: stems herbaceous, surfaces conspicuously covered with bladder cells.

Species 16; Southern Angola, Namibia, western and central South Africa with the distribution extending eastwards to the Eastern Cape. Species of *Mesembryanthemum* occur in North Africa, the Mediterranean region, California, along the western coast of South America and in Australia, but are likely to have been introduced to these areas.

Mestoklema N.E.Br. ex Glen 2405074

(Ruschioideae: 4. Delosperma Group).
Brown: 164 (1936); Friedrich: 87 (1970); Herre: 206 (1971); Glen: 454 (1981); Smith *et al.*: 308 (1998).

Densely branched shrubs up to 1 m high, with large, tuberous storage roots; branchlets minutely papillose, becoming pallid and slightly rough when dry; inflorescences persisting and becoming subspinose. **Leaves** opposite, free, trigonous to subterete; papulose when young, tufted in axils of old leaves, often leaving tooth-like projection on falling. **Flowers** small, pedicellate, in very rich dichasia. **Sepals** 5. **Petals** 1-seriate, linear, yellow, orange, salmon, or pink to purple, rarely white. **Stamens**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

many, inner ones papillate; staminodes conically collected. **Nectary** a crenulate ring. **Ovary** semi-inferior, conical or convex; placentas parietal; stigmas 5, erect, subulate. **Fruit** a 5-locular capsule, of Drosanthemum type; small, valves recurved when expanded; expanding keels contiguous and diverging towards tips, with narrow, membranous, acute wings; covering membranes present, but sometimes reduced by half; closing bodies 0. **Seeds** ovoid, smooth, brown.

Flowering spring to mid-summer.

Distinguishing characters: densely branched shrubs, with tuberous roots; flowers often in coppery shades, without filamentous staminodes; fruit with covering membranes which may be reduced.

Species 6, Namibia and South Africa and is widely distributed in a broad north-south band in South Africa, stretching southward from the central North-West through the Free State and Northern Cape to the coast of the Eastern and Western Cape. It extends into the Little Karoo in the west and occurs at two outlying localities in eastern and central Namibia.

Meyerophytum Schwantes 2405075

(Ruschioideae: 3. Mitrophyllum Group).
Schwantes: 436 (1927a); Bolus: 345–346 (1958c); Herre: 208 (1971); Smith *et al.*: 238 (1998).

Depacarpus N.E.Br.: 71 (1930a).

Low, compact shrublets with prostrate to ascending branches, internodes well visible, old dry leaf sheaths persistent. **Leaves** opposite, of 2 kinds: first leaf pair of season globose, grey-green; second united for a third to half length, deeper green, with conspicuous bladder cell idioblasts, base of latter developing into a papery parchment-like sheath enclosing first (assimilating) leaf pair of next season during dry period. **Flowers** solitary, terminal, long-pedicelled, thus well exserted above a long leaf pair, up to 40 mm in diameter; opening at midday, closing in afternoon. **Sepals** 5, subequal. **Petals** 3- or 4-seriate, linear, violet-purple or white. **Stamens** erect, inner ones papillate at base; staminodes 0. **Nectary** a crenulate ring. **Ovary** flat to concave on top; placentas parietal; stigmas 5, broad, plumose. **Fruit** a 5-locular capsule, of Mitrophyllum type but with deeply concave covering membranes with a prominent distal bulge touching the protuberance reaching from base of expanding sheet into locule; closing bodies 0; valve wings ample; expanding keels flat. **Seeds** ovoid or pear-shaped, smooth. $x = 9$.

Flowering after good rains in spring.

Distinguishing characters: compact shrublets with weak, repeatedly branching stems; resting leaf bodies conspicuous.

Species 1: *Meyerophytum meyeri* (Schwantes) Schwantes, restricted to the Northern Cape, from the Richtersveld to S Namaqualand.

Mitrophyllum Schwantes 2405078

(Ruschioideae: 3. Mitrophyllum Group).
Schwantes: 181 (1926b); Herre: 214 (1971); Poppendieck: 339 (1976); Smith *et al.*: 240 (1998).

Conophyllum Schwantes: 321 (1928b); Herre: 118 (1971). *Mimetophytum* L.Bolus: 252 (1954a); Herre: 212 (1971).

Loose shrubs or shrublets with a compact centre and long shoots; internodes woody or fleshy, often articulated; branches often decumbent. **Leaves** opposite, very large, 2 leaf pairs per season differing in length of basal sheath: first pair slightly united, flat above, rounded or keeled below; second pair a third to nearly completely united, forming a conical or cylindrical body, the connate one turning into a papery, parchment-like skin protecting the free one during dry months; minutely crystalline-papulose mainly towards tips. **Flowers** solitary or in lax cymes, terminal, pedicellate, bracteate, up to ± 30 mm in diameter; opening at midday, closing in late afternoon. **Sepals** 5, subequal. **Petals** 3- or 4-seriate, white, yellow or pale violet-red. **Stamens** collected into a cone and spreading later, basally only rarely papillate. **Nectary** a crenate ring. **Ovary** flat on top with 5(–7) prominent ridges; placentation parietal; stigmas 5(–7), subulate, often slightly plumose. **Fruit** a 5(–7)-locular capsule, of Mitrophyllum type with or without covering membranes; with or without closing ledges or bosses. **Seeds** ovoid or pear-shaped. $x = 9$.

Flowering from February to November.

Distinguishing characters: shrubs with very large, oblong, floppy leaf pairs with papery leaf sheaths, borne on erect woody stems.

Species 6, Richtersveld in the Northern Cape.

Monilaria (Schwantes) Schwantes 2405079

(Ruschioideae: 3. Mitrophyllum Group).
Schwantes: 69 (1929a); Herre: 216 (1971); Ihlenfeldt & Jörgensen: 49 (1973); Smith *et al.*: 242 (1998).

Freely branched, compact shrublets up to 200 mm high, with a short and a long leaf pair per season; branches constricted at nodes into short, often bead- or button-like segments covered by parchment-like remnants of old leaf pairs. **Leaves** opposite, glistening, soft, papillate, of 2 kinds: first pair small or rudimentary, forming a fleshy, almost completely closed sheath through which second pair emerges; second pair consisting of 2 long, cylindrical leaves somewhat flattened on upper side and fused only at

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

base; when long leaves eventually shrivel this base develops into a persistent sheath covering bead-like stem segments and protecting next leaf pair. **Flowers** terminal, solitary, on elongated pedicel, papillate, ± 40 mm in diameter; bibracteate; opening midday, closing late afternoon; highly scented. **Sepals** 5, unequal, papulose or papillate. **Petals** in 3 or 4 series, white, yellow or pale violet-red. **Stamens** with or without hairs. **Nectary** a crenulate ring. **Ovary** shallow; flat on top with 5(–7) prominent sutural ridges; placentas basal or parietal; stigmas 5(–7), stout, ovate to subulate. **Fruit** a 5(–7)-locular capsule, of Mitrophyllum type, with prominent sutural ridges; valves widely spreading or reflexed; expanding keels ± widely diverging, broad at base, with inner ridges raised and with narrow, marginal wings; locules shallow, with or without covering membranes; closing devices 0. **Seeds** many in each locule, acutely ovoid, smooth. $x = 9$ (polyploidy).

Flowering autumn to winter.

Distinguishing characters: small shrublets with succulent constricted stems and persistent leaf bases, resembling a string of large beads.

Species 5, Namaqualand, in the Western and Northern Cape.

Mossia N.E.Br. 2405080

(Ruschioideae: ? 5. Stomatium Group).
Brown: 71, 151 (1930b); Herre: 218 (1971); Smith, Hartzer & Van Wyk: 16 (1997); Smith *et al.*: 272 (1998).

Dwarf, prostrate perennials; stems wiry to slightly woody, 1–1.5 mm in diameter, with distinct nodes and internodes; pinkish green when young, brown when old. **Leaves** opposite, similar, connate at base, trigonous to club-shaped, usually shorter than 10 mm, glabrous, dull sea-green to dark green; epidermis with tanniniferous idioblasts, resulting in a slightly verrucose surface. **Flowers** solitary, terminal, subsessile or shortly pedicellate, ± 10 mm in diameter; opening at night; faintly sweet-scented. **Sepals** 5, subequal, united at base to form a short tube, ovate-triangular, longer than petals, pinkish green. **Petals** 1- or 2-seriate, inserted at base of calyx tube, free, narrowly linear to subspatulate, obtuse or occasionally acuminate, ± 4 × 1.0–1.5 mm, papery, off-white with a slight cream tinge. **Stamens** erect to slightly inflexed, inner whorl bearded at base; staminodes present or 0; pollen yellowish, tricolpate, semitectate with reticulate sculpture and supratectal spinules. **Nectary** a dark green, crenulate ring, broken ± clearly into 5 parts corresponding with sepals. **Ovary** deeply concave on top; placentas basal to parietal; stigmas 5(6), subulate, 2 mm long, curved outwards. **Fruit** a 5(6) locular capsule, ± of Delosperma type but without valve wings; expanding tissue composed of radial, contiguous keels to apex of each valve and expanding sheet; covering membranes 0 but ledges of deeply split septa may cover locules slightly; closing bodies 0 but funicles conspicuous, swelling when wet. **Seeds** ovoid, smooth.

Flowering early to mid-summer.

Distinguishing characters: creeping, very small perennials; flowers with hypanthium, white, opening at night.

Species 1: *Mossia intervallaris* (L.Bolus) N.E.Br., in a narrow band more or less to the west of the Drakensberg massif, from Barkly East in the Eastern Cape to the E Free State and NW Lesotho. Isolated populations have been recorded from the Free State, Mpumalanga and Gauteng.

Muiria N.E.Br. 2405081

(Ruschioideae: 4. Delosperma Group).
Brown: 116 (1927a); Herre: 220 (1971); Smith *et al.*: 118 (1998).

Dwarf, stemless, single-bodied or sparsely clustered perennials; seasonally covered by withered, whitish felt-like leaf sheaths; roots fibrous. **Leaves** fused into pairs forming a somewhat spherical, soft body, with a small fissure near apex, and fine, velvety hairs covering stomata. **Flowers** solitary, rupturing top of body when emerging; pedicel clavate, short, ebracteate; flowers ± 20 mm in diameter; open during day. **Petals** in several series, free, linear to filiform, whitish to purple. **Stamens** ± epapillate. **Sepals** 6, oblong, with membranous tips. **Nectary** a crenate ring ± clearly broken into 6 parts corresponding with sepals. **Ovary** half-inferior, partly immersed in stout pedicel; placentas parietal; stigmas 6, short, stout, recurving. **Fruit** a 6-locular capsule, of Delosperma type; placenta prominent; forming pockets; valves deltoid, expanding horizontally; expanding keels contiguous with broad, marginal valve wings as long as valves; valve wings connate at base, forming pockets; covering membranes or closing devices 0. **Seeds** many in each locule, ovoid, slightly compressed, smooth, brown. $x = 9$ (1 report).

Flowering early summer.

Distinguishing characters: single-bodied perennials with leaf pairs entirely fused, hairy; flowers rupturing tips of bodies when emerging.

Species 1: *Muiria hortenseae* N.E.Br., confined to a small region on the northern side of the Langeberg range in the Barrydale District of the Little Karoo, Western Cape.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Namaquanthus L.Bolus 2405082

(Ruschioideae: 9. Lampranthus Group).
Bolus: 257 (1954b); Herre: 222 (1971); Smith *et al.*: 334 (1998).

Shrublets up to ± 300 mm high; branches with short internodes, up to 15 mm in diameter, covered by persistent, dry leaves. **Leaves** opposite, ± terete to subcylindric, up to ± 60 mm long, 10 mm in diameter, united at base into sheath, surface smooth; stomata not sunken. **Flowers** solitary, terminal, pedicellate, bibracteate, up to 60 mm in diameter; open from morning till evening. **Sepals** 4(–6), unequal. **Petals** 4-seriate, outer ones narrowly spatulate, inner ones becoming shorter towards centre of flower, purple. **Stamens** crowded; filaments purple, epapillate. **Nectary** a finely crenulate pink ring. **Ovary** flat or convex on top; stigmas (8–)12(–16), subulate, purple. **Fruit** a (8–)12(–16)-locular capsule, of Lampranthus type, woody and rounded; valve wings present, narrow; covering membranes radially thickened; expanding keels parallel, diverging at tips; closing bodies 0. **Seeds** echinate with very long papillae along back.

Flowering in winter.

Distinguishing characters: compact perennials; leaves cylindrical, fused at the bases; flowers magenta with spoon-shaped outer petals; seeds echinate.

Species 1: *Namaquanthus vanheerdii* L.Bolus, restricted to a small area northwest of Springbok in Namaqualand, Northern Cape.

Namibia (Schwantes) Schwantes 2405083

(Ruschioideae: 7. Dracophilus Group).
Schwantes: 106 (1927d); Walgate: 171 (1939); Herre: 224 (1971); Smith *et al.*: 120 (1998).

Juttadinteria subg. *Namibia* Schwantes: 182 (1926b).

Dwarf perennials forming dense, compact clumps up to 100 mm high, 200 mm in diameter. **Leaves** opposite, 4–6 per branch, connate at base, semi-ovoid to trigonous, velvety, greyish from flaky wax cover; epidermis xeromorphic, papillae longer than their basal diameter, uniform over entire surface. **Flowers** solitary, terminal, sessile or shortly pedicellate, up to 30 mm in diameter; often not perfectly round but somewhat 4-sided in appearance; opening in morning and closing in evening (*N. cinerea* opens in morning and remains open thereafter). **Sepals** 5, unequal, finely papillate. **Petals** 1-seriate, pink, rarely white. **Stamens** collected in a cone, with bearded filaments; staminodes 0. **Nectary** a crenulate ring. **Ovary** concave on top with a central cone; placentas parietal; stigmas (9–)12(–28), subulate. **Fruit** a (9–)12(–28)-locular capsule, close to Delosperma type; convex; expanding keels parallel along base and diverging and lacerate towards tips, with oblong valve wings; covering membranes reduced to limb or 0; closing devices 0.

Flowering mid-winter to late spring.

Distinguishing characters: dense, compact perennials; leaves thick, basally fused, velvety, waxy; flowers solitary, pink or white, square-looking; opening in the morning or perpetually open.

Species 2, occurs in the surroundings of Lüderitz in SW Namibia and also a few kilometres east of Prince of Wales Bay, ± 60 km south of Lüderitz.

Nananthus N.E.Br. 2405084

(Ruschioideae: 6. Titanopsis Group).
Brown: 433 (1925); Bolus: 382 (1958d); Friedrich: 88 (1970); Herre: 226 (1971); Smith *et al.*: 162 (1998).

Prepodesma N.E.Br.: 279 (1930b).

Dwarf, tufted, glabrous perennials, with tuberous roots. **Leaves** opposite, united at base and ground-hugging with bases often buried in soil, boat-shaped, ± depressed-trigonous in section, spreading, dull green; surface rough, punctate with whitish dots. **Flowers** solitary, pedicelled to subsessile, bracteate, 20–30 mm in diameter; opening after noon, closing at dusk. **Sepals** 5. **Petals** 2- or 3-seriate, yellow, rarely white, often with a central red stripe. **Stamens**: inner filaments bearded near base; staminodes present or 0. **Nectary** a crenate ring. **Ovary** flattish to conical on top; placentas basal or parietal; stigmas 6–10, slender, papillate. **Fruit** a 6–10-locular capsule, resembling Delosperma type, but the rounded, semiglobose base of capsule differs from typical form, sometimes as tumble fruit; expanding keels strictly radial; closing bodies 0; rims of septa very narrow. **Seeds** ovoid or somewhat pear-shaped, smooth. $x = 9$.

Flowering almost throughout the year, but not in winter in habitat.

Distinguishing characters: small rosette-forming perennials with tuberous roots; leaves pointed at tips, with almost concave upper surfaces and pale dots; flowers in shades of yellow, often with striped petals.

Species 10, widespread in the climatically severe interior of sthn Afr., from near Graaff-Reinet in the Great Karoo (Eastern Cape), northward through the Northern Cape and the central Free State to around Potchefstroom in the North-West, extending into the south of Gauteng. To the west the distribution stretches to near Upington and Bushmanland in the Northern Cape. The occurrence of an apparently isolated population in Namibia, due east of Windhoek, near the border with Botswana, highlights a lack of collections from the Northern Cape and Botswana.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Nelia Schwantes 2405085

(Ruschioideae: 7. Dracophilus Group).
Schwantes: 92 (1928d); Herre: 228 (1971); Smith *et al.*: 150 (1998).

Sterropetalum N.E.Br.: 266 (1928d).

Dwarf, tufted, ± stemless perennials; with fibrous roots. **Leaves** opposite, ± free, trigonous, elongate, apically rounded, greyish to light green; epidermis ± smooth, with a thick crystal layer in outer wall, stomata at base of slightly elevated subsidiary cells. **Flowers** 1–3, often in ternate dichasia, shortly pedunculate, bibracteate (laterals also), ± 20 mm in diameter; opening for first time in morning and remaining open continuously for ± 3 weeks. **Sepals** 5, unequal, shortly connate above ovary. **Petals** in several series, linear-spatulate, often shorter than sepals, emarginate, relatively stiff with short hairs at base, white, rarely pale pink; passing into white staminodes and stamens, and all fused into a short tube or hypanthium. **Stamens** and **staminodes** stiff, remaining in that position during entire anthesis. **Nectary** obscure. **Ovary** flattish or slightly convex; placentas basal; stigmas 5, small, broadly 3-angled, green. **Fruit** a 5-locular capsule, of Delosperma type, but expanding keels parallel, stout, yellow, diverging distally; covering membranes vestigial, developed as rather broad rectangular rims of septa; sutures slightly raised in centre; valves recurved when expanded; valve wings broad; closing devices 0. **Seeds** ± 1 mm long, somewhat pear-shaped to cordate, light yellow, minutely textured.

Flowering sporadically over a long period during winter months.

Distinguishing characters: compact, clump-forming perennials; leaves smooth; petals stiff; flowers, once open, do not close again.

Species 4, Richtersveld in the northwestern part of the Northern Cape, and extends southwards into Namaqualand.

Neohenricia L.Bolus 2405086

(Ruschioideae: 5. Stomatium Group).
Bolus: 251 (1931); Bolus: 51 (1938a); Herre: 230 (1971); Hammer: 84 (1994a); Smith *et al.*: 166 (1998).

Henricia L.Bolus: 39 (1936).

Freely branching, **dwarf**, prostrate perennials, forming mats less than 20 mm high, often rooting at nodes; mimicking its surroundings and difficult to find; adventitious roots thickened as storage organs. **Leaves** opposite, 4–6 pairs per branch, ± erect, somewhat connate at base, trigonous to club-shaped or terete, up to ± 10 mm long, apex broad, covered by bands of reddish green, orange or greyish green warts. **Flowers** solitary, ± 12 mm in diameter, on short, slender, curved pedicels, ± 20 mm long, without bracts; opening at twilight and closing before dawn; pleasantly scented like pineapple or liquorice. **Sepals** 5, subequal. **Petals** 2-seriate, yellowish, pinkish or greenish. **Stamens** glabrous, epapillate. **Nectary** an obscurely crenulate ring. **Ovary** somewhat convex on top; placentation basal to parietal; stigmas 4–6, slender, golden yellow. **Fruit** a 4–6-locular capsule, of Delosperma type with erect septa; expanding keels parallel, diverging slightly at tips; valve wings 0; covering membranes sometimes well developed, otherwise reduced to a limb; closing devices 0. **Seeds** pear-shaped, coarse-textured, attached to floor and walls of capsule.

Flowering over a long period in summer.

Distinguishing characters: minute perennials with strongly textured leaves; pedicels long and slender; flowers nocturnal, highly scented.

Species 2, occurs in a belt stretching from Victoria West in the Northern Cape to Fauresmith in the Free State. The recently discovered species: *Neohenricia spiculata* S.A.Hammer, occurs in small isolated populations near Sterkstroom, in the Eastern Cape.

Octopoma N.E.Br. 2405087

(Ruschioideae: 11. Leipoldtia Group).
Brown: 72, 126 (1930a); Herre: 232 (1971); Smith *et al.*: 374 (1998); Hartmann: 44 (1998c).

Dwarf shrubs becoming woody with age, up to 250 mm high, to 250 mm in diameter; branches erect to spreading; internodes ochre to darker. **Leaves** opposite, united at base, decurrent on stem, short, thick, ± triquetrous, often inflated, margins and keel ± serrate or with small teeth, surfaces rough to smooth; dark green. **Flowers** 1(–3), terminal, shortly pedicellate or subsessile, often embraced by bracts. **Sepals** 4(5), unequal. **Petals** 2- or 3-seriate, white to purple. **Stamens** arranged in a cone, filaments sometimes bearded; staminodes present. **Nectary** a crenulate, dark green ring. **Ovary** convex above; placentas parietal; stigmas 6–8, subulate. **Fruit** a 6–8-locular capsule, close to Leipoldtia type, brown, markedly convex on top in most cases; expanding keels diverging, lacerate towards tips; valve wings absent or narrow, broadest in middle; closing bodies large, white, flat; covering membranes rising towards centre; distal closing devices 0. **Seeds** rough-textured.

Flowering mainly in winter.

Distinguishing characters: fruit firm, brown, 8-locular.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Species 8, in two separate areas in South Africa, one in northern Namaqualand, Northern Cape; the other in the Little Karoo, Western Cape. The species in this genus do not form a natural group since they have been included merely on the number of locules in the fruit (mostly 8).

Odontophorus N.E.Br. 2405088

(Ruschioideae: 11. Leipoldtia Group).
Brown: 12 (1927a); Herre: 234 (1971); Hartmann 161 (1976); Hammer 75 (1993a); Hammer: 59 (1995g); Smith *et al.*: 190 (1998).

Dwarf, compact perennials, forming small clumps or mats, rarely forming large cushions up to 500 mm in diameter, with or without long shoots or trailing branches, or caespitose; with fleshy rootstock. **Leaves** opposite, united in basal parts, in 1 or 2 pairs, trigonous, elongate, soft and fleshy, margins and keel with white, rarely pinkish teeth, greyish green, often hairy; surface with prominent elevations above tannin idioblasts, stomata in valleys. **Flowers** solitary, sessile or shortly pedicellate, up to ± 30 mm in diameter; opening by midday, closing by twilight; strongly scented. **Sepals** 4 or 5. **Petals** 3–6-seriate, free, pale yellow to deep yellowish orange, rarely pink or white. **Stamens** with filaments papillate towards base. **Nectary** a crenulate ring. **Ovary**: placentas parietal; stigmas (8–)10(11), subulate. **Fruit** a (8–)10(11)-locular capsule, of Leipoldtia type with a thick semiglobose hairy base; expanding keels parallel, toothed, terminating in diverging membranous points; covering membranes stiff; closing bodies large, nearly closing the opening. **Seeds** compressed, light brown. $x = 9$.

Flowering late winter to early spring.

Distinguishing characters: perennials forming small clumps or mats; leaves keeled, greyish green, often hairy, dentate; flowers yellow to orange; fruit 11-locular.

Species 5, found in the vicinity of Steinkopf in the Richtersveld, Northern Cape.

Oophytum N.E.Br. 2405089

(Ruschioideae: 3. Mitrophyllum Group).
Brown: 413 (1925); Herre: 236 (1971); Ihlenfeldt: 303 (1978); Smith *et al.*: 122 (1998).

Dwarf, compact, heterophyllous perennials less than 25 mm high. **Leaves** opposite, largely connate and united into small ovoid bodies with a somewhat gaping fissure, with visible bladder cell idioblasts on surfaces, bright brownish red towards end of growing season, otherwise dark green to brownish green or yellowish green; gradually absorbed by following leaf pair and leaving whitish sheath; two leaf pairs develop per season on each of up to 20 branches per individual. **Flowers** solitary, with bracts exserted from orifice, ± 25 mm in diameter; opening midday, closing in evening. **Sepals** 6(7), shortly tubular. **Petals** 2- or 3-seriate, white, pink or pale violet. **Stamens** with filaments papillate at base, white, pink or pale violet; staminodes present, coloured as petals. **Nectary** a crenulate ring. **Ovary** somewhat convex with (5)6 ridges on top; placentas basal/parietal; stigmas (5)6, filiform. **Fruit** a (5)6-locular capsule, of Delosperma type; developing directly on top of drying plant body; valve wings broad; covering membranes rarely present as narrow rims over locules; closing bodies 0. **Seeds** many in each locule, small, compressed. $x = 9$.

Flowering in winter.

Distinguishing characters: stemless perennials, with clusters of ovoid, papillate leaves; old leaves forming papery sheaths enclosing the emerging young leaf pair.

Species 3, restricted to the quartz fields of the Knersvlakte north of Vanrhynsdorp in the Western Cape.

Orthopterum L.Bolus 2405092

(Ruschioideae: 5. Stomatium Group).
Bolus: 280 (1927h); Bolus: 130 (1928); Bolus: 109 (1937/1938); Herre: 242 (1971); Smith *et al.*: 192 (1998).

Dwarf, compact perennials, forming small, cushion-like clumps; branches with 6–8 leaves. **Leaves** opposite, slightly unequal, elongate-trigonous, spreading, up to ± 30 mm long, 8 mm broad, with few or no teeth on margins, smooth, old leaves persistent, shiny; no crystals in outer epidermal wall. **Flowers** solitary, sessile to subsessile, ± 50 mm in diameter, ebracteolate; opening in afternoon, closing by evening. **Sepals** 5, subequal. **Petals** 3- or 4-seriate, golden yellow within, reddish outside. **Stamens** collected into a cone, epapillate. **Nectary** of 5 separate, greenish brown crenulate glands. **Ovary** obtusely conical on top; placentas parietal; stigmas 5 or 6, filiform. **Fruit** a 5- or 6-locular capsule; septa of fruit separated into two, their upper part not flat as in *Faucaria* but arching on top of capsule; valve wings basally connate with valves, moving upwards into an erect position when fruit opens and valves fold back. **Seeds** pear-shaped, tuberculate.

Flowering during late autumn and winter.

Distinguishing characters: plants cushion-forming; leaves smooth, soft, unmarked; flowers yellow; fruit with septa arching over expanded capsules.

Species 2, subtropical thickets of the Eastern Cape.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Oscularia Schwantes 2405093

(Ruschioideae: 4. Delosperma Group).
Schwantes: 187 (1927c); Herre: 244 (1971); Glen: 693 (1980); Smith *et al.*: 336 (1998); Hartmann: 44 (1998c).

Densely branched shrublets, with erect or spreading reddish stems. **Leaves** opposite, subequal, somewhat united at base, triquetrous to trigonous, short, up to ± 20 mm long and 13 mm broad, mostly with prominently dentate keel and margins (red-toothed in one species), greyish green to pale blue waxy leaves. **Flowers** solitary or in rich cymes, mostly on bibracteate peduncles, rarely sessile, up to ± 15 mm in diameter; remaining open; almond-scented. **Sepals** 5. **Petals** not much more than 1-seriate, white to pink. **Stamens** and short **staminodes** collected into a cone, both papillate near base. **Nectary** of 5 ± separate, dark green, crenulate glands. **Ovary** convex to conical on top; placentas parietal; stigmas 5, concealed by stamens. **Fruit** a 5-locular capsule, of Lampranthus type; grey to brown; expanding keels diverging from base, more than half as long as valves; valve wings very broad and rectangular; covering membranes with inconspicuous closing ledges at distal ends; closing devices 0, but placenta ending in a tiny to small knob. **Seeds** ovoid, verrucose, brown. $x = 9$.

Flowering mid-winter to mid-summer.

Distinguishing characters: small shrubs with greyish green, waxy, sometimes dentate leaves; flowers scented; stamens and staminodes collected into a cone.

Species 23, typically in the fynbos vegetation of the Western Cape, extending slightly into the Northern Cape, a single species: *Oscularia deltoides* (L.) Schwantes, has been collected just east of Albertinia in the Western Cape.

Ottosonderia L.Bolus 2405094

(Ruschioideae: 11. Leipoldtia Group).
Bolus: 292 (1958e); Herre: 246 (1971); Smith *et al.*: 376 (1998).

Compact shrublets with short vegetative growth and prominent, elongated floral branches with persistent inflorescences/infructescences. **Leaves** of two markedly different types: (1) on vegetative growth: opposite, ± united at base, digitiform, subterete, up to ± 60 mm long, 5 mm broad, stomata slightly sunken; outer epidermal wall with a thin to moderate crystal layer; (2) hypsophylls or bracts on fertile branches: opposite, leaf pairs fused ± halfway, basal part sheathing stem, free parts ± boat-shaped but not keeled, much shorter than type (1). **Inflorescence** unique. **Flowers** solitary per season, but inflorescence at length developing into a wide-spreading perennial cyme by annual addition of one pair of bracteate flowers below each terminal fruit, with hardened remnants of bracts and fruits remaining throughout. **Sepals** 4, apiculate; outer ones compressed and keeled, inner ones with brown, membranous margins. **Petals** 1–2-seriate, purplish pink. **Stamens** and **staminodes** ± 5-seriate, papillate at base. **Nectary** a fairly prominent crenate ring. **Ovary** convex on top; placentas parietal; stigmas (6–)8, narrowly subulate. **Fruit** a (6–)8-locular capsule, close to Ruschia type but valves with low rims, yet forming a rounded dome, valves erect when open, without wings; expanding keels erect, thick; covering membranes well developed; closing bodies large. **Seeds** ± ovoid, ± 1.25 mm long, brown.

Flowering in winter.

Distinguishing characters: perennials with compact vegetative growth and elongated reproductive parts; inflorescences persistent.

Species 2, very localised distribution in Namaqualand, with two separate distributions, the one to the north and the other just south of the border between the Northern and Western Cape.

Phyllobolus N.E.Br. 2405152

(Mesembryanthemoideae).
Brown: 413 (1925); Brown: 1 (1926a); Gerbaulet: 385 (1995); Gerbaulet: 145 (1997); Smith *et al.*: 42 (1998).

Amoebophyllum N.E.Br.: 433 (1925); Herre: 68 (1971). *Sphalmanthus* N.E.Br.: 433 (1925); Friedrich: 126 (1970); Herre: 290 (1971).

Decumbent to erect shrublets or subshrubs, often with thickened roots, or prostrate to decumbent geophytes; stems corky or lignified throughout or only basally so, epidermal bladder cells conspicuous, occasionally hair-like, rarely flattened. **Leaves** decussate throughout or becoming alternate in inflorescences or alternate throughout, subcylindrical, rarely flattened, shortly fused towards bases, deciduous or drying and persistent (marcescent). **Flowers** in dichasia or solitary, (10–)20–30(–40) mm in diameter; in most species flowers close at night, some open at night and others never close. **Sepals** 4 or 5, often fused basally into a short tube. **Petals** in various shades of green, yellow, orange, red, pink or whitish. **Staminodes** present or 0. **Nectary** consisting of 5 separate grooves. **Ovary** mostly conical on top; placentas axile; stigmas 4 or 5, subulate. **Fruit** a 4- or 5-locular capsule, of Mesembryanthemum type; expanding keels extending to centre of fruit; covering membranes 0; valve wings mostly present and inflexed over valves or rarely reflexed and fused in pairs or 0. **Seeds** D-shaped or horseshoe-shaped, 1.1–1.8 mm long, usually black without a crest, or brown with a crest, surface rough, rarely smooth.

Flowering from mid-winter to mid-summer.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Distinguishing characters: perennials, with conspicuous bladder cell idioblasts on leaves; if rootstock is tuberous, leaves are summer-deciduous.

Species 31, widespread in S Namibia, and in the western and central parts of South Africa (Northern, Western, and Eastern Cape and Free State).

Pleiospilos N.E.Br. 2405097

(Ruschioideae: 11. Leipoldtia Group).
Brown: 433 (1925); Herre: 252 (1971); Hartmann & Liede: 433 (1986); Smith *et al.*: 124 (1998).

Punctillaria N.E.Br.: 212 (1926c).

Dwarf, compact to caespitose, sometimes unbranched perennials, with 1–4 pairs of leaves on each branchlet. **Leaves** opposite, equal, connate at base, broad, thick and firmly fleshy, flat above, rounded on back, grey-green or brownish, usually dotted, covered with a thick, irregular wax layer. **Flowers** 1–3 on a plant, terminal between leaves, sessile or shortly pedicellate, bracteate, up to ± 80 mm in diameter; opening mid-afternoon until after dusk. **Sepals** (4)5 or 6(–8), sometimes united into a short tube above ovary. **Petals** free, yellow to orange, rarely white or pinkish. **Stamens** epapillate, rising from a short pulvinate tube above annular, dark green holonectary. **Ovary** ± flat on top with conical centre; placentas parietal; stigmas 10–12, filiform, diverging. **Fruit** a 10–12-locular capsule, a derived version of Leipoldtia type with broad, apically tapering valve wings; very firm covering membranes; large white to brown closing bodies of endocarpal or placental origin. **Seeds** compressed-ovoid, minutely tuberculate, dark brown. $x = 9$.

Flowering in winter (*P. nelii* Schwantes) or autumn.

Distinguishing characters: compact perennials; leaves keeled, resembling stones, distinctly pellucid-dotted, waxy.

Species 4, main distribution in the Little Karoo, straddling the border between the Western and Eastern Cape, also extends further north into the arid south-central parts of the Great Karoo in the Northern Cape.

Polymita N.E.Br. 2405098

(Ruschioideae: 10. Ruschia Group).
Brown: 72 (1930a); Herre: 254 (1971); Hartmann: 29 (1996b); Smith *et al.*: 352 (1998).

Glabrous shrubs up to 400 mm high. **Leaves** opposite, united for ± half their length into a sheath with longitudinal lines, apical portion spreading, acute or mucronate, triangular in cross section, with margins and keel somewhat horny, often serrate; stomatal apparatus sunken, hidden under a dome of connate peristomatal papillae. **Flowers** solitary or in cymes, pedicellate, ± 20 mm in diameter; bracts enclosing lower part of flower. **Sepals** 5, subequal. **Petals** often in 5 groups, filiform-linear, white. **Stamens** incurved, concealed by longer and many more white staminodes in 3 or 4 series. **Nectary** a crenulate ring. **Ovary** with placentas parietal; stigmas (8–) 10(–18), subulate. **Fruit** a (8–)10(–18)-locular capsule, with top elevated and white, and base ± funnel-shaped; close to Ruschia type, but with valve wings and rather shallow locules; expanding keels abruptly diverging towards apex, with broad, terminal wings; covering membranes straight, without a rim at top; closing bodies large and white (*P. albiflora*) or smaller and dark (*P. steenbokensis*). **Seeds** smooth.

Flowering in summer.

Distinguishing characters: shrubby perennials with leaves fused at their bases, stem-sheathing, diverging at tips; flowers white; fruit 10–18-locular.

Species 2, northern Namaqualand in the Northern Cape.

Prenia N.E.Br. 2405099

(Mesembryanthemoideae).
Brown: 412, 413 (1925); Friedrich: 93 (1970); Herre: 256 (1971); Gerbaulet: 25 (1996b); Smith *et al.*: 46 (1998).

Phyllobolus N.E.Br. in part; Hartmann: 47 (1993).

Prostrate to erect subshrubs with fibrous roots; branches weakly lignified, green parts of stem becoming dry and remaining on stem as a thick whitish layer, smooth. **Leaves** decussate or becoming alternate in inflorescences, shortly fused towards bases, ± flat, somewhat triquetrous, or subcylindrical, with a thick wax layer which can easily be wiped off. **Flowers** in bracteose dichasia, 20–40 mm in diameter; open in daylight. **Sepals** 4 or 5, fused at base into a short tube. **Petals** white, yellow or pink; petals, stamens and staminodes fused into a short tube towards bases. **Staminodes** present. **Nectary** consisting of 4 separate grooves. **Ovary** with axile placentas. **Fruit** a 4-locular capsule of Mesembryanthemum type, lower part funnel-shaped with deep locules; expanding keels extending to centre of fruit; covering membranes 0; valve wings present. **Seeds** D- or kidney-shaped, ± 1.3 mm long, black, without or with indistinct crest, surface rough. $x = 9$ (polyploidy).

Flowering from spring through summer to autumn.

Distinguishing characters: soft, smooth, creeping (except *P. sladeniana* (L.Bolus) L.Bolus) stems.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Species 6, in the karroid areas of the Western, Eastern, and Northern Cape and in S Namibia.

Psammophora Dinter & Schwantes 2405100

(Ruschioideae: 7. Dracophilus Group).
Schwantes: 188 (1926b); Friedrich: 94 (1970); Herre: 258 (1971); Hartmann: 29 (1996b); Smith *et al.*: 224 (1998).

Shrubs up to 600 mm high or compactly tufted, dwarf shrubs ± 150 mm high, sometimes with stem-crown drawn below ground. **Leaves** decussate, elongate to short, fleshy, 3-angled to rounded in cross section, with a rounded keel and often a pinkish base, dull green to bluish grey-green; epidermis with prominent cells with secondary anticlinal walls, stomatal apparatus and normal cells in a sunken position, surface producing a viscous mucilage to which sand grains adhere and cover leaves. **Flowers** solitary, terminal, pedicellate, up to ± 25 mm in diameter, bibracteate; opening at midday, closing by dusk; scented. **Sepals** 4, subequal, sticky. **Petals** linear, obtuse, white to light violet. **Stamens** and **staminodes** present. **Nectary** a crenulate ring. **Ovary**: placentas parietal; stigmas 5 or 6(7), filiform. **Fruit** a 5- or 6(7)-locular capsule, of Delosperma type; flattish; expanding keels parallel, ending in rather long, rounded, light yellow, crenulate wings, lacerate at apex; covering membranes vestigial; closing bodies 0. **Seeds** pear-shaped, minutely tuberculate, light brown with orange tint.

Flowering in winter.

Distinguishing characters: tufted or shrubby perennials; leaves with sticky epidermis to which sand adheres; fruit with rudimentary covering membranes, without closing bodies.

Species 4, in full sun on rocky slopes and plains from Lüderitz, Namibia, to the Richtersveld, Northern Cape.

Psilocaulon N.E.Br. 2405101

(Mesembryanthemoideae).
Brown: 433 (1925); Herre: 260 (1971); Ihlenfeldt & Bittrich: 289 (1985); Klak & Linder: 301 (1998); Smith *et al.*: 28 (1998).

Herbs, subshrubs or shrubs, perennial or annual to biennial, prostrate, decumbent or erect; stems (young) articulate, succulent and green, old ones becoming woody; bladder cells inconspicuous, hair-like, dome-shaped or much flattened. **Leaves** decussate and becoming alternate in inflorescence, free or shortly fused at base, semiterete or terete, dry and persistent or deciduous, sometimes with mucro. **Flowers** terminal or lateral, in cymes or solitary, less than 20 mm in diameter. **Sepals** 4 or 5, fused into a short tube. **Petals** free or shortly fused towards base, white, pink, puce or rarely pale yellow to greenish. **Staminodes** gathered around stamens, thus forming a cone. **Nectary** consisting of 4 or 5 narrow grooves or absent. **Ovary** with axile placentas. **Fruit** a 4- or 5-locular capsule, of Mesembryanthemum type, expanding keels extending to centre of fruit; valve wings inflexed over valves. **Seeds** D-shaped or obtusely triangular in outline, 0.5–1.2 mm long, rough or almost smooth, ochre or brown. $x = 9$ (1 report, polyploidy).

Flowering from early- to mid-summer.

Distinguishing characters: stems succulent, smooth or with minute bladder cell idioblasts; flowers with broad filamentous staminodes which are ragged at tips, transparent and gathered into a cone.

Species 13, widespread in southern, central and western South Africa, W Namibia and S Angola and occurs in both summer- and winter-rainfall regions.

Rabiea N.E.Br. 2405102

(Ruschioideae: 5. Stomatium Group).
Brown: 92 (1927b); Bolus: 369 (1958f); Herre: 262 (1971); Smith *et al.*: 226 (1998).

Compact, tufted, dwarf perennials with fleshy or tuberous rootstock. **Leaves** 4–6 on a branch, 2 of a pair ± dissimilar, flattish on upper surface and distinctly to indistinctly keeled on lower surface, pointed from a rather broad base, rarely cylindrical, trigonous to triquetrous; surface rough, with prominent white or blackish green spots or elevations above tannin idioblasts. **Flowers** solitary, bibracteate, subsessile to shortly pedicelled; opening at midday, closing by evening. **Sepals** 5(6 or 7) ± equal, fused at base to form a short hypanthium on which petals and stamens arise. **Petals** 3- or 4-seriate, obtuse or emarginate, bright yellow to yellowish orange. **Stamens** papillate below; placentas parietal; stigmas 7–10, slender, papillate. **Nectary** positioned at upper rim of hypanthium. **Ovary** bowl-shaped on top; placentas parietal; stigmas 7–10, linear. **Fruit** a 7–10-locular capsule, close to Titanopsis type but with a rather rounded top and base, also browner and firmer than typical form; valves with wings reaching above halfway up; expanding keels contiguous in basal section, then diverging widely, shortly aristate, almost reaching apex of valve; covering membranes present; closing bodies 0. **Seeds** ± pear-shaped, minutely muricate, dark brown.

Flowering in spring and summer.

Distinguishing characters: compact perennials, forming rosette; leaves dotted; flowers yellow.

Species 6, occurs from the central Eastern Cape through the central parts of the Free State, an outlier in the distribution has been recorded from the E Northern Cape.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Rhinephyllum N.E.Br. 2405103

(Ruschioideae: 5. Stomatium Group).
Brown: 92 (1927b); Herre: 264 (1971); Smith *et al.*: 168 (1998).

Peersia L.Bolus: t. 264 (1927f). *Neorhine* Schwantes: 22 (1930).

Dwarf, tufted perennials up to 100 mm high or shrublets with visible, woody internodes; sometimes with woody or tuberous rootstocks. **Leaves** opposite, slightly united at base, clavate to semiterete, upper surface ± flat, lower surface rounded or slightly keeled, rarely with teeth, apical surface with hard, white tubercles. **Flowers** solitary, terminal, pedicellate, up to ± 30 mm in diameter, without bracts; opening midday, afternoon or evening; scented. **Sepals** 5, free or forming short tube above ovary in *R. pillansii*. **Petals** 1–5-seriate, free, white to yellow. **Stamens** with some filaments bearded at base. **Nectary** varying from a ring to 5 separate, sometimes conspicuous, crenate glands. **Ovary** slightly convex on top; placentas parietal; stigmas 5, subulate, somewhat plumose. **Fruit** a 5-locular capsule, small, with sutures slightly raised and gaping; valves deltoid, reflexed when expanded; of Delosperma type but with diverging expanding keels and marginal valve wings; covering membranes often 0 or much reduced; closing bodies 0. **Seeds** many in each locule, globose-ovoid, slightly compressed, ± smooth. $x = 9$.

Flowering from spring to mid-summer.

Distinguishing characters: dwarf succulents, often with textured leaves; flowers white to yellow; pedicels ebracteate.

Species 12, occurs mainly in the Little and Great Karoos of the Northern, Western and Eastern Cape.

Rhombophyllum (Schwantes) Schwantes 2405104

(Ruschioideae: 8. Bergeranthus Group).
Schwantes: 180 (1926b); Schwantes: 179 (1926b); Schwantes: 16, 23 (1927d); Herre: 266 (1971); Smith *et al.*: 228 (1998).

Low, compact, densely branched shrublets, or tufted perennials; main roots tuberous. **Leaves** decussate, crowded, slightly connate, sickle-shaped, dull-green and bearing a prominent tooth or hump on lower distal surface (*R. dolabriforme*), or flat, brighter green, white-margined, boat-shaped (*R. rhomboideum*); epidermis ± smooth with superficial stomata, outer epidermal walls thick, with a crystal layer, central water tissue milky-white as in *Hereroa*. **Flowers** 1–3, up to ± 40 mm in diameter, on dichotomously branched, bracteate, long, persistent peduncles; opening in afternoon or evening. **Sepals** 5, subequal, lanceolate. **Petals** ± 3-seriate, linear, yellow, reddish on back towards tips. **Stamens** with glabrous or bearded filaments. **Nectary** of 5 separate crenulate glands. **Ovary** flat on top; placentas parietal; stigmas 5, filiform. **Fruit** a 5-locular capsule, valves with high rims; close to Mitrophyllum type but with bipartite, flat, large closing bodies; locules deep; covering membranes complete with closing ledges at distal lower surfaces; expanding keels mostly basally separate; valve wings very narrow. **Seeds** ovoid, brown to dark brown.

Flowering in spring and early summer.

Distinguishing characters: tufted perennials; leaves sickle- or boat-shaped; fruit with bipartite closing bodies.

Species 5, this eastern Cape genus is practically confined to the subtropical thicket vegetation around Uitenhage and Port Elizabeth, and further afield near Graaff-Reinet in the Great Karoo, an outlying population has been recorded from the southeastern corner of the Northern Cape.

Ruschia Schwantes 2405105

(Ruschioideae: 10. Ruschia Group).
Schwantes: 186 (1926b); Friedrich: 109 (1970); Herre: 268 (1971); Dehn: 91 (1992); Hartmann & Stüber: 1 (1993); Smith *et al.*: 354 (1998).

Shrublets or shrubs with mostly erect, rarely curving or creeping branches, some species with spines, derived from sterile branches of inflorescence; roots woody, rarely tuberous. **Leaves** opposite, free to connate at base to more than halfway, triangular in cross section, flat above and rounded or keeled on lower surface, keel sometimes toothed towards apex; bluish green, usually with darker dots, glabrous or ciliate, rarely papillate on margins. **Flowers** axillary or terminal, solitary to many in inflorescence, usually bracteate, medium-sized. **Sepals** 4 or 5. **Petals** pink to purple, rarely white, 1–several-seriate, sometimes arranged in 5 bundles. **Stamens** arranged in a cone; filaments often hairy at base; staminodes few to many. **Nectary** a continuous, crenulate, dark green ring. **Ovary** ± conical on top; placentas parietal; stigmas 5(6). **Fruit** a 5(6)-locular capsule, of Ruschia type; with a deep base and no valve wings; valves opening into upright position; closing bodies small, hook- hood- or rodlet-shaped, rarely larger and sometimes 0; expanding keels short, widely diverging; additional closing rodlets at distal lower surfaces of covering membranes. **Seeds** variable in shape, yellowish or brownish, smooth to papillate. $x = 9$ (polyploidy).

Flowering throughout the year with peaks in spring and autumn.

Distinguishing characters: mostly shrubby, sometimes creeping perennials; fruit with small hook-shaped closing bodies, short tangentially arranged expanding keels.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Species 224, very wide distribution from near Helmeringhausen in Namibia and eastward in South Africa to Vereeniging in Gauteng and to Harrismith in the Free State, down to the western and southern coasts, also including the mountains of Lesotho.

Ruschianthemum Friedrich 2405106

(Ruschioideae: 12. Eberlanzia Group).
Friedrich: 554 (1960); Friedrich: 121 (1970); Herre: 270 (1971); Smith *et al.*: 362 (1998).

Erect shrubs, up to 1.2 m high, with whitish grey branches. **Leaves** decussate, connate at base, ± club-shaped, ± flat above and keeled towards apex; stomata somewhat sunken or superficial. **Flowers** in rich terminal inflorescence composed of highly branched cymes; small, pedicellate, bracteate. **Sepals** 5, triangular, fleshy, 2 outer the largest. **Petals** ± 1-seriate and ± equal to sepals; short, purple to white. **Stamens** and **staminodes** present, collected in a cone. **Nectary** a crenulate ring. **Ovary** ± convex on top, obtusely 5-lobed; placentas parietal; stigmas 5, short. **Fruit** a capsular schizocarp, 5-locular; turbinate, breaking into nutlets consisting of parts of real and false septum enclosing one seed, with remains of valve wings and expanding keels adhering to it, persistent dorsal and apical connecting bundles forming a fibrous, basket-like skeleton remaining on plant; expanding keels with ornate, rudimentary wings; closing bodies large, filling greater part of locules. **Seeds** 1 or 2 in each locule.

Flowering winter to early spring.

Distinguishing characters: shrubs with club-shaped leaves; mature fruit split into nutlets which break away, leaving behind basket-like remains of the capsules; locules with only 1 or 2 seeds contained in each.

Species 1: *Ruschianthemum gigas* (Dinter) Friedrich, confined to a small area of the winter-rainfall region of the lower Orange River Valley of the Northern Cape and Namibia.

Ruschianthus L.Bolus 2405107

(Ruschioideae: 7. Dracophilus Group).
Bolus: 62 (1961); Friedrich: 121 (1970); Herre: 272 (1971); Smith *et al.*: 230 (1998).

Tufted, compact perennials; rootstock woody or tuberous and old stems covered with dry leaf bases; flowering branches usually with 4 leaves, pale green and finely rough-papillate. **Leaves** falcate, much deeper than broad, flat above, lower surface keeled in upper half and rounded towards base, pinkish grey-green, waxy; epidermis with slightly papillate to ± flat cells, subsidiary cells raised, outer epidermal wall with a thick layer of crystal sand. **Flowers** 1–3-nate, with short peduncle and foliaceous bracts at base; opening around midday, after a few days flowers do not close again. **Sepals** 5, keeled, acuminate, inner ones with narrow, membranous margins; fused at base to form short hypanthium. **Petals** several-seriate, connate at base, obtuse, not spreading widely due to position of flower amongst leaves, pale lemon-yellow to white. **Stamens** and **staminodes** 8-seriate; anterior filaments without papillae, posterior ones with papillae; petals, stamens and staminodes positioned on thick, swollen, ring-shaped cushion above hypanthium in which copious amounts of nectar accumulate. **Nectary** of 5 slightly separated crenulate glands. **Ovary** obconic, concave from outer rim; placentas parietal; stigmas 5, subulate, incurved. **Fruit** a capsule of Delosperma type; with a slightly raised basal placenta; with narrow valve wings; covering membranes 0; closing bodies 0; stalk elongates as fruit ripens. **Seeds** light brown, oval.

Flowering in winter.

Distinguishing characters: compact perennials with sickle-shaped, smooth leaves; flowers with hypanthium; petals greenish white.

Species 1: *Ruschianthus falcatus* L.Bolus, very restricted area in S Namibia, at the edge of the Namib Desert.

Saphesia N.E.Br. 2405108

(Ruschioideae: 1. Apatesia Group).
Brown: 205 (1932); Herre: 274 (1971); Ihlenfeldt & Gerbaulet: 457 (1990); Van Jaarsveld: 98 (1994b); Smith *et al.*: 76 (1998).

Spreading, glabrous perennial herbs, up to 600 mm wide, 200 mm high; branches procumbent to decumbent, often supported by surrounding vegetation, terete, up to 300 mm long, 3–4 mm in diameter, from a persistent tuberous base; branches, leaves and fruit grey green becoming purplish green with age; older subterranean branches becoming brown, longitudinally fissured; tubers oblong, divided, resprouting after a fire. **Leaves** alternate, crowded and rosulate at base at first, laxly arranged on flowering sideshoots, linear, oblanceolate, 45–160 × 6–10 mm, dorsiventrally flattened, becoming channelled in lower half, ascending, apices bending upwards. **Flowers** solitary, terminal, ± 40 mm in diameter; pedicels slender, 30–90 mm long. **Sepals** 5, unequal. **Petals** 3- or 4-seriate, shorter than sepals, pure white. **Stamens** surrounded by staminodes. **Nectary** a low, crenulate ring. **Ovary**: placentas basal, in shallow locules; stigmas 5, filiform. **Fruit** a 5-locular capsule; opening apically when drying (xerochastic); floor of capsule distally widened to form a covered ring of semipockets. **Seeds** dimorphic, the smaller type probably sterile; compressed horseshoe- to bean-shaped, verrucose, dark brown; dispersal by scattering.

Flowering in spring and early summer.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Distinguishing characters: perennial herbs with tubers; leaves alternate, flat; flowers white; fruit 5-locular, cone-shaped, ends of valves split upon drying and remain so; seeds dimorphic.

Species 1: *Saphesia flaccida* (Jacq.) N.E.Br., in sandy soil on the plains north of Cape Town, from Malmesbury and Clanwilliam districts, Western Cape.

Sceletium N.E.Br. 2405109

(Mesembryanthemoideae).
Brown: 412 (1925); Herre: 276 (1971); Gerbaulet: 9 (1996c); Smith *et al.*: 52 (1998).

Phyllobolus subgen. *Sceletium* (N.E.Br.) Bittrich: 75 (1986); Bittrich: 5 (1986); Hartmann: 47 (1993). *Pentacoilanthus* Rappa & Camarrone: 13 (1962) name invalidly published.

Decumbent or climbing perennials, rarely erect subshrubs; branches slender, basal ones often robust with age; bladder cells of stem and leaves conspicuous or inconspicuous. **Leaves** decussate or becoming alternate in inflorescence, shortly fused towards bases, flat, ± succulent, apex recurved or incurved, veins lignified, dry leaves skeleton-like, persistent and enclosing young buds. **Flowers** in few-flowered dichasia, sometimes solitary, stalked or sessile, 20–40 mm in diameter. **Sepals** 4 or 5(6), persistent. **Petals** white, pale to bright yellow, pale pink, or pale salmon; sepals and petals shortly fused towards bases; rarely stamens and stigmas concealed by staminodes. **Nectary** consisting of 4 or 5 separate grooves. **Ovary** half-inferior; placentas axile; stigmas 4 or 5, acicular. **Fruit** a 4- or 5(6)-locular capsule, of Mesembryanthemum type; expanding keels extending to centre of fruit; valve wings present or 0; breaking off readily to be dispersed by wind as tumble fruit. **Seeds** D-shaped, to 2 mm long, black or brown, with distinct or indistinct crest, surface rough.

Flowering autumn to early summer.

Distinguishing characters: persistent dry leaves which become skeletonised with only veins persisting.

Species 8, occurs in karroid areas of the Northern, Western and Eastern Cape.

Schlechteranthus Schwantes 2405110

(Ruschioideae: 11. Leipoldtia Group).
Schwantes: 16 (1929b); Herre: 278 (1971); Smith *et al.*: 286 (1998).

Dwarf shrubs, up to 400 mm high; branchlets densely leafy, internodes not visible. **Leaves** opposite, united up to half their length into bodies 5 mm long and wide; upper surface flat, keeled on back, usually with 1 or 2 short teeth on keels, mucronate, smooth, glossy with greyish, bluish or reddish colour; stomatal apparatus sunken, overarched by a dome of peristomatal papillae. **Flowers** solitary, subsessile; pedicel bibracteate in middle. **Sepals** 6, unequal. **Petals** 2- or 3-seriate, white, or pink to purple. **Stamens** with surrounding staminodes collected in a central cone; filaments papillate. **Nectary** a crenulate ring. **Ovary** convex on top; placentas parietal; stigmas 10–12, subulate. **Fruit** a 10–12-locular capsule close to Leipoldtia type but with a variable and sometimes complete recurving of covering membranes, with spur-like processes which nearly close opening; expanding keels parallel, diverging towards acute apex; closing bodies present. **Seeds** pear-shaped, somewhat flattened and rough, reddish yellow.

Flowering in winter.

Distinguishing characters: compact perennials, with grey-green short leaves; flowers white or pink to purple, with staminodes collected in a cone.

Species 2, occurs in the Richtersveld, Northern Cape.

Schwantesia Dinter 2405111

(Ruschioideae: 6. Titanopsis Group).
Dinter: 234 (1927); Friedrich: 122 (1970); Herre: 280 (1971); Zimmermann: 81 (1996a); Zimmermann: 257 (1996c); Smith *et al.*: 152 (1998).

Compact, dwarf perennials forming tufts with many branches bearing a cluster of long-lived leaf pairs. **Leaves** opposite, those of a pair dissimilar, ± boat-shaped, keeled, flat or slightly convex on upper surface, often widened towards apex and lobed or toothed on margins, light grey to bluish green; epidermis papillate; outer epidermal wall with a thick crystal layer. **Flowers** solitary, terminal, ± 60 mm in diameter, with ebracteate pedicel up to 50 mm long; opening around mid-afternoon and staying open until nightfall. **Sepals** 5, unequal. **Petals** 1-seriate, light- to golden-yellow, rarely white. **Stamens** 4-seriate, epapillate. **Nectary** a crenulate, yellowish green ring. **Ovary** convex on top; placentas parietal; stigmas 5, greenish, reflexed towards tips. **Fruit** a 5-locular capsule of Delosperma type; covering membranes vestigial, as narrow ledges spreading from septa, with weak, central column; expanding keels parallel but not touching, yellowish, broadening towards tips; valve wings broad; closing bodies 0. **Seeds** glittering, minutely textured. $x = 9$.

Flowering in autumn.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Distinguishing characters: compact perennials with internodes enclosed by leaves which are asymmetric, toothed, erect, sometimes whitish.

Species 8, occurs in the Northern Cape, from Bushmanland in the east, through the Richtersveld, to the southern parts of Namibia.

Scopelogena L.Bolus 2405112

(Ruschioideae: 9. Lampranthus Group).
Bolus: 9 (1962); Herre: 282 (1971); Smith *et al.*: 338 (1998).

Shrubby perennials forming cushions when old; young stems smooth, bluish green. **Leaves** opposite, fused towards base, erect, terete, semiterete or 3-angled, blunt, to 35 mm long, epidermis smooth. **Flowers** in a many-flowered dichasium, pedicellate, up to 15 mm in diameter. **Sepals** 5, subequal, acute or pointed. **Petals** yellow. **Staminodes** 0. **Nectary** a crenulate ring. **Ovary** with parietal placentas; stigmas 5, filiform, longer than stamens, green. **Fruit** a 5-locular capsule, probably close to Drosanthemum type, woody, top convex; valves once opened do not close again; valve wings 0; expanding keels diverging from base; covering membranes short; closing bodies 0. **Seeds** brown to black, surface rough.

Flowering in early summer.

Distinguishing characters: shrubs with smooth, cylindrical leaves; flowers yellow; fruit without valve wings, covering membranes partially covering locules.

Species 2, restricted to two areas, one near Cape Town and another near Riversdale, Western Cape.

Skiatophytum L.Bolus 2405114

(Ruschioideae: 1. Apatesia Group).
Bolus: 433 (1927); Leistner: 89 (1958); Herre: 286 (1971); Ihlenfeldt & Gerbaulet: 457 (1990); Smith *et al.*: 78 (1998).

Gymnopoma N.E.Br.: 194 (1928d).

Annual or usually perennial herbs with prostrate annual branches from a short, rosette-bearing perennial stem; sometimes suckering from extensive root system. **Leaves** alternate but often apparently opposite on young branches; ± spatulate-lanceolate, up to ± 100 × 20 mm on branches, up to ± 200 × 30 mm in rosette, 2–3 mm thick, soft, smooth, slightly fleshy, margins undulate when young. **Flowers** solitary, with ebracteate pedicel up to 60 mm long, up to ± 45 mm in diameter; opening at noon. **Sepals** 5, unequal. **Petals** in several series, margins papillate, snow-white. **Stamens** and **staminodes** present. **Nectary** a crenulate ring. **Ovary** shortly conical; placentas parietal; stigmas (4)5(–7), subulate, ± as long as stamens. **Fruit** a (4)5–7-locular capsule, large, obconic; valves without expanding keels or marginal wings, with upper distal seed chambers; valves open on drying (xerochastically) and remain open. **Seeds** somewhat kidney-shaped, tuberculate; dispersal as a tumble fruit and by scattering.

Flowering during spring and summer.

Distinguishing characters: annuals or perennials with flat, alternate leaves which have undulated margins when young and may appear opposite; flowers white; capsule valves open upon drying and remain open.

Species 1: *Skiatophytum tripolium* (L.) L.Bolus, only in the SW Western Cape, it has become rare near the Cape Peninsula due to urban expansion.

Smicrostigma N.E.Br. 2405115

(Ruschioideae: 9. Lampranthus Group).
Brown: 72 (1930a); Herre: 288 (1971); Smith *et al.*: 340 (1998).

Low shrublets up to 400 mm high; young stems smooth, succulent, becoming woody with age. **Leaves** decussate, lower parts fused, sheathing stem down to node below, free part deltoid-trigonous, tips recurved; glabrous, up to 13 mm long. **Flowers** solitary, terminal, subsessile, up to 30 mm in diameter, remaining open after first opening. **Sepals** 5, unequal, acuminate. **Petals** white or pink, free towards base. **Staminodes** present, gathered around stamens, pink or purple, rarely white. **Nectary** inconspicuous. **Ovary** ± flat on top; placentas parietal; stigmas 7–10, minute. **Fruit** a 7–10-locular, woody capsule, of Lampranthus type but valves with very narrow wings; expanding keels parallel at base, with diverging awned tips; covering membranes stout; closing bodies 0. **Seeds** brown to black, surface rough.

Flowering spring to summer.

Distinguishing characters: shrubs with stem-sheathing, partially fused leaf pairs; fruit with 7–10 locules.

Species 1, *Smicrostigma viride* (Haw.) N.E.Br. The distribution of *Smicrostigma* stretches from Riversdale in the Western Cape to the Eastern Cape border. It is a typical Little Karoo element found in arid areas north of the Langeberg and Outeniqua Mountains.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Stayneria L.Bolus 2405117

(Ruschioideae: 10. Ruschia Group).
Bolus: 47 (1961); Herre: 292 (1971); Smith *et al.*: 364 (1998).

Erect, stout shrubs up to 800 mm high, with persistent, hardened remains of old leaves on branches, with internodes 30–40 mm long. **Leaves** opposite, connate at base and stem-sheathing, 3-angled, linear-lanceolate, with acute keel, ± 70 × 8 mm; epidermal cells convex, stomata sunken. **Flowers** 3–7 in dichasia on short peduncles, bracteate. **Sepals** 5 or 6, ± equal. **Petals** 1- or 2-seriate, white. **Stamens** with many staminodes; inner filaments papillate up to middle. **Nectary** a ± obscure ring. **Ovary** slightly convex on top; placentas parietal; stigmas (6)7 or 8(9), narrowly subulate. **Fruit** a (6)7 or 8(9)-locular capsule, obconic-globose; close to Ruschia type, but valves connate at base, therefore opening only partially and remaining open; expanding keels contiguous at base, widely diverging, without wings; covering membranes well developed; closing bodies 0. **Seeds** ovate, ± 1 mm long, brown.

Flowering winter to early spring.

Distinguishing characters: erect and woody shrubs with long internodes and stem-sheathing cylindrical leaves with a ridged bottom edge; flowers pink or white with stamens and staminodes collected in a cone; fruit 6–9-locular; once open, remaining so.

Species 1: *Stayneria neilii* (L.Bolus) L.Bolus, confined to the Breede River Valley, Western Cape, from Worcester in the west to McGregor in the east.

Stoeberia Dinter & Schwantes 2405118

(Ruschioideae: 12. Eberlanzia Group).
Schwantes: 14, 17 (1927d); Friedrich: 554 (1960); Friedrich: 128 (1970); Herre: 294 (1971); Van Jaarsveld: 68 (1994a); Hartmann: 29 (1996b); Smith *et al.*: 366 (1998).

Sturdy shrubs, or even trees (Von Breitenbach 1990: 30) up to 3 m tall and 3.5 m wide, usually with a solitary main stem; branches succulent at first, soon becoming woody. **Leaves** decussate, slightly connate at base, boat-shaped or somewhat clavate, with somewhat flattened upper surface and keeled towards apex, mucronate; epidermal cells convex, stomata slightly sunken. **Flowers** many (up to 50), in dense, rounded, compound dichasia, pedicellate, bibracteate; bracts club-shaped. **Sepals** 5 or 6, triangular. **Petals** ± 1-seriate, short, white to light-pink. **Stamens** and **staminodes** papillate at base, in a dense cone. **Nectary** a crenulate ring. **Ovary** top-shaped; placentas parietal; stigmas 5(6), short, slightly plumose. **Fruit** a 5(6)-locular capsule, nearest Ruschia type, top-shaped, upper part domed; valve margins slightly raised in most species; locules deep and wide; valves opening once; valve wings broad, sclerotinised; closing bodies absent or present. **Seeds** flat to pear-shaped and shortly winged; testa cells vaulted, rough; dispersed by wind (anemochoric).

Flowering winter to spring.

Distinguishing characters: shrublets or large bushes; fruit with hard valve wings, and recurved valve rims, not closing completely once they have opened.

Species 5, Namaqualand (Northern Cape) and Namibia.

Stomatium Schwantes 2405119

(Ruschioideae: 5. Stomatium Group).
Schwantes: 175 (1926b); Herre: 296 (1971); Smith *et al.*: 194 (1998).

Compact, small, tufted or clumped perennials, very short-stemmed. **Leaves** opposite, fused to base, often of different length, thick, fleshy, shortly triangular or broadly spatulate, semicylindrical at base, ± keeled towards apex, margins and keel with many small white teeth, rarely not toothed, olive-green to drab grey, often purple when stressed but sometimes permanently reddish or purple. **Flowers** solitary, sessile or with short pedicel, without bracts, with a distinct hypanthium; opening late afternoon or early evening, staying open until ± midnight; scented. **Sepals** 4–6. **Petals** yellow or white. **Stamens** epapillate. **Nectary** usually of 5 distinct crenulate glands, near base of hypanthium. **Ovary** with parietal placentas; stigmas 5(6), clavate, rounded, short. **Fruit** a 5(6)-locular capsule, of Delosperma type; with very narrow rims along septa and with seed pockets derived from basal false septa; locules deep; expanding keels parallel, thick, yellowish, diverging at tips; valve wings narrow or broad; covering membranes vestigial; closing bodies 0. **Seeds** ± 1 mm long, light brown to brown. $x = 9$ (polyploidy).

Flowering early spring to early summer.

Distinguishing characters: small perennial clumps; leaves with many marginal, short teeth; leaf surfaces highly textured.

Species 39, occur in three east-west bands across the arid South African interior. These areas include parts of Namaqualand, Bushmanland and the Great Karoo in the Northern Cape. Further south, species grow in the arid Great Karoo which stretches across the Northern, Western and Eastern Cape. The third area is mostly confined to the central Free State.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Synaptophyllum N.E.Br. 2405120

(Mesembryanthemoideae).
Brown: 412 (1925); Friedrich: 129 (1970); Herre: 298 (1971); Bittrich: 5 (1986); Smith *et al.*: 54 (1998).

Prostrate to decumbent, purple or salmon-red annual herbs; stems herbaceous, branching from base. **Leaves** decussate, sessile, flat, roundish or oval, united at base, forming a scutelliform, amplexicaul dish, upper ones much smaller and free; epidermis smooth or with small bladder cells at margins. **Flowers** in dichasia, up to 15 mm in diameter. **Sepals** 4, unequal, 2 foliaceous, fused into a short tube. **Petals** free at base, white. **Staminodes** 0. **Nectary** consisting of 4 separate narrow grooves. **Ovary** with axile placentas; stigmas 4, subulate. **Fruit** a 4-locular capsule, of Mesembryanthemum type; expanding keels extend to centre of fruit; covering membranes 0; valves with large, erect, incurved wings. **Seeds** up to 0.6 mm long, whitish, surface smooth, crest absent.

Flowering in mid-summer.

Distinguishing characters: paired leaves flat, roundish, stem-clasping; size and shape differences between basal and upper leaves.

Species 1: *Synaptophyllum juttae* (Dinter & A.Berger) N.E.Br., restricted to the fog zone of the southern Namib Desert, near Lüderitz in SW Namibia.

Tanquana H.E.K.Hartmann & Liede 2405160

(Ruschioideae: 6. Titanopsis Group).
Hartmann & Liede: 479 (1986); Smith *et al.*: 128 (1998).
Pleiospilos N.E.Br. in part.

Dwarf, compact, tufted to densely shortly branched perennials, rarely sunken, slightly anisophyllous. **Leaves** opposite, connate at base, thick and firmly fleshy, triangular-boat-shaped, flat to concave above, rounded below; surface bright green to purple, smooth; outer epidermal walls without crystals. **Flowers** solitary, shortly pedicellate, bracteate; opening in afternoon, closing by evening, highly scented. **Sepals** 4 or 5. **Petals** free, slender, yellow. **Stamens** papillate at base. **Nectary** a dark green to yellow, regularly crenate ring. **Ovary** with parietal placentas; stigmas 9 or 10, thread-like. **Fruit** a 9- or 10-locular capsule, of Titanopsis type; convex on top; expanding keels parallel, diverging at tips, ending in aristate valve wings; covering membranes present; closing bodies tiny, endocarpal.

Flowering in autumn.

Distinguishing characters: compact perennials with smooth, unkeeled leaves; fruit 10-locular with tiny closing bodies.

Species 3, occurs in the central part of the Western Cape, it grows in the arid Tanqua Karoo and southwestern Great Karoo, just entering the Little Karoo south of Laingsburg.

Titanopsis Schwantes 2405121

(Ruschioideae: 6. Titanopsis Group).
Schwantes: 178 (1926b); Friedrich: 130 (1970); Herre: 300 (1971); Smith *et al.*: 172 (1998).
Verrucifera N.E.Br.: 278, 513 (1930b).

Dwarf, tufted perennials forming small clumps of densely clustered rosettes usually comprising 3 or 4 leaf pairs, with bases mostly sunken in the ground; rootstock somewhat thickened but occasionally tuberous in old plants. **Leaves** opposite, ± free, spatulate to trigonously clavate, usually with truncate or rounded apex, covered with raised, white, green, copper, pink or reddish calcareous pustules, overlying tannin idioblasts, with a thick crystal layer absent in surface depressions. **Flowers** solitary, sessile or shortly pedicellate, ebracteate, up to ± 20 mm in diameter; opening in late afternoon and closing at dusk. **Sepals** 5 or 6, subequal, with pustules as on leaves. **Petals** 1- or 2-seriate, narrow, mostly yellow or amber, but pink or white forms of some species are known, sometimes with a red central stripe. **Stamens** with filaments sometimes bearded. **Nectary** a sometimes crenulate ring. **Ovary** inferior to half- or more superior; placentas basal or parietal; stigmas (5)6(–10), filiform to subulate. **Fruit** a (5)6(–10)-locular capsule, of Titanopsis type; with prominent sutures; expanding keels subcontiguous and diverging towards awn-like apex, minutely toothed on inner, membranous margin; covering membranes membranous, semitransparent, not entirely covering locules; closing bodies 0. **Seeds** many in each locule, subglobose, with small point, minutely tuberculate, pale. $x = 9$ (1 report).

Flowering in winter (western species) and late spring and summer (eastern species).

Distinguishing characters: perennials forming rosettes of highly textured, pustulate, spoon-shaped leaves.

Species 5, distributed in three main areas of sthn Afr., in S Namibia they grow as far north as Lüderitz. To the east, the range straddles the Orange River in a broad north-south belt extending into Bushmanland; in central South Africa, the distribution extends from the Northern Cape into the Free State.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Trichodiadema Schwantes 2405122

(Ruschioideae: 4. Delosperma Group).
Schwantes: 187 (1926b); Friedrich: 133 (1970); Herre: 302 (1971); Ihlenfeldt: 145 (1980); Niesler: 13 (1997); Smith *et al.*: 310 (1998).

Shrubs with long, slender, trailing, arched branches or short-stemmed dwarf shrubs, 30–600 mm high; roots woody or tuberous and clusters of tubers may be present. **Leaves** opposite, slightly connate at base, ± cylindric, up to 30 mm long, usually tipped with a tuft of spreading, bristle-like hairs forming a diadem, surfaces glistening, papillate, bladder cells elevated and pointed at one or both ends. **Flowers** solitary, with short pedicels, up to ± 50 mm in diameter, without bracts. **Sepals** 5–8, papillate, and often with tuft of bristles at tips. **Petals** 1–several-seriate, white, cream, yellow, light to dark pink. **Stamens** and **staminodes** sometimes hairy near base, in a central cone. **Nectary** of 5–8 separate, crenate glands. **Ovary** flat or convex; placentas parietal; stigmas 5–8, lanceolate, much shorter than stamens. **Fruit** a 5–8-locular capsule, of Drosanthemum type; expanding keels contiguous, winged, diverging towards tips; valve wings broad and rounded; covering membranes present or reduced to a limb; closing bodies 0. **Seeds** pear-shaped, minutely warty and grooved, brown or yellowish.

Flowering winter to early summer.

Distinguishing characters: short- or long-stemmed shrubs; leaves crowned with a diadem of bristles; fruit with well-developed covering membranes.

Species 34, widespread in the more arid areas of sthn Afr., in S Namibia, the Richtersveld, Bushmanland and the Great and Little Karoos, in South Africa covering extensive areas in the Northern, Western and Eastern Cape as well as the W Free State.

Vanheerdea L.Bolus ex H.E.K.Hartmann 2405123

(Ruschioideae: 6. Titanopsis Group).
Bolus: 136 (1938b); Herre: 304 (1971); Hartmann: 15 (1992c); Hartmann: 5 (1992c); Smith *et al.*: 198 (1998).
Rimaria N.E.Br.: 134 (1926b) illegitimate name; Bolus: 66 (1937).

Compact, dwarf perennials, forming dense clumps with up to ± 40 very short branches each bearing a pair of leaves in the dry season; plants sometimes almost completely sunken into the ground; rootstock deep. **Leaves** opposite, united at base and pressed together forming subglobose or ovoid bodies, sometimes keeled or with windowed tips (*V. primosii*), glabrous (*V. primosii*) or minutely puberulous (*V. roodiae*); margins and keels with short, stout teeth; characteristically light yellowish green, sometimes tinged with red or entirely flushed with purple. **Flowers** solitary or up to 3 together from between leaves, shortly pedicellate, bibracteate, up to 50 mm in diameter; opening in afternoon, closing at night; strongly scented. **Sepals** 5–9, unequal, with rounded apices. **Petals** ± 3-seriate, orange-yellow to yellow. **Stamens**: filaments of inner ones papillate. **Nectary** a crenulate ring. **Ovary** slightly convex on top; placentas parietal or basal; stigmas 7–15, filiform, papillate. **Fruit** a 7–15-locular capsule, of Titanopsis type; conical, not closing entirely after seeds have been released; expanding keels ± diverging, fringed with broad membranous valve wings; covering membranes with flat, flexible membranous wings; closing bodies 0. **Seeds** many in each locule, subglobose, smooth, brown. $x = 9$ (polyploidy).

Flowering late winter.

Distinguishing characters: compact perennials; leaf pairs often forming bodies; leaves thick, yellowish green, with short, stout teeth on margins and keel; flowers single or up to three together, yellowish orange.

Species 2, Bushmanland, Northern Cape.

Vanzijlia L.Bolus 2405124

(Ruschioideae: 11. Leipoldtia Group).
Bolus: 262 (1927i); Herre: 306 (1971); Hartmann: 85 (1982b); Hartmann: 499 (1983b); Smith *et al.*: 378 (1998).

Low, glabrous perennials with many short shoots forming compact clumps with several long shoots which may be trailing. **Leaves** opposite, leaf pairs dimorphic: leaf pairs on short shoots and first leaf pair on long shoots fused into long sheaths with only short free tips, less connate leaf pairs with pointed free leaf portions on long shoots; without tannin idioblasts (a rare condition in Ruschioideae), stomata not sunken. **Flowers** solitary, pedicellate or sessile, bracteate, up to ± 60 mm in diameter. **Sepals** 5. **Petals** 2-seriate, white. **Stamens** with 2 or 3 series of papillate, pink or purple staminodes; surrounding stamens in a cone, distinctly elongating during anthesis. **Nectary** a crenulate ring. **Ovary** flattish on top; placentas parietal; stigmas 10, subulate. **Fruit** a 10-locular capsule of Leipoldtia type, with additional closing devices such as inconspicuous ledges or bulges; expanding keels diverging, with wings; covering membranes present; closing bodies present, large, white. **Seeds** smooth. $x = 9$ (polyploidy).

Flowering winter to early spring.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Distinguishing characters: compact perennial clumps with trailing or climbing long shoots; leaf pairs dimorphic; flowers with distinctly elongating filamentous staminodes.

Species 1: *Vanzijlia annulata* (A.Berger) L.Bolus, western coast of the Northern and Western Cape, with an extension inland into the Knersvlakte.

Vlokia S.A.Hammer 2405185

(Ruschioideae: 9. Lampranthus Group).
Hammer: 255 (1994b); Smith *et al.*: 130 (1998).

Dwarf, tufted perennials, sparsely branched, with age forming prostrate stems up to 100 mm long, ± 4 mm thick; internodes 2–5 mm long, old leaves persisting for 8–10 years, shrunken but retaining their shape; roots wiry, thin, brownish, running laterally to 300 mm. **Leaves** of the current season opposite, basally connate, ± equal, ± 10 mm long, 8 mm broad, 8 mm thick, boat-shaped, keeled, firm, greyish green to brownish green, glabrous, slightly shining when turgid, very smooth, with a thin wax layer, finely and vaguely maculate, margins slightly reddened. **Flowers** solitary; pedicel up to 6 mm long, 2–2.5 mm thick, pale green with a reddish flush; bracts shaped like leaves but half their size; diurnal, expanding at noon, closing by late afternoon; scentless. **Sepals** 6, equal, reddish green with thin translucent margins. **Petals** 22–25 in a single series or with a second partial series, 4–5 mm long, to 1.5 mm broad, often obtuse, not widely spreading, mauve to rose-pink. **Stamens** sparse, ± 16, shorter than staminodes, papillate; anthers whitish yellow; staminodes conically collected, up to 80, up to 4 mm long, recurved above, pink or white. **Nectary** composed of ± 20 dark green, contiguous tiny glands forming a ring. **Ovary** with basal-parietal placentas; stigmas (5)6(7), concealed within staminal cone, up to 2 mm long, free, pale green. **Fruit** a 5–7-locular capsule of ± Lampranthus type, up to 6 mm in diameter (up to 10 mm when expanded), firm, blackish, flat above, half globose below; expanding keels parallel at base, divergent towards tips; covering membranes present, flat; closing bodies 0; valve wings 0. **Seeds** ± 20 per locule, fattish-pyriform, very finely rugulose, dark brown.

Flowering late winter to early spring.

Distinguishing characters: perennials with persistent trailing stems; old persistent leaves blackish; capsules blackish.

Species 1, only a few populations on a mountain near Montagu in the western Little Karoo of the Western Cape.

Wooleya L.Bolus 2405125

(Ruschioideae: 9. Lampranthus Group).
Bolus: 48 (1961); Herre: 308 (1971); Smith *et al.*: 342 (1998).

Moderately branched sprawling shrubs, up to 200 mm high; young branches and leaves ash-grey to purplish becoming grey-brown; woody stems up to 10 mm in diameter; roots fibrous. **Leaves** opposite, fused towards base, erect or spreading, obscurely 3-angled to cylindrical with upper surface slightly flattened, lower surface convex, blunt, up to 35 mm long, 9 mm in diameter, appearing as if dusted with powder, ash-grey to purplish, keels and margins reduced to red lines and tip ending in a point. **Flowers** solitary, terminal, shortly pedicellate, bracteate; opening in morning, closing in evening. **Sepals** 4, unequal, outer ones rounded and inner ones without membranous margins. **Petals** free towards base, white. **Stamens** papillose in basal part; staminodes gathered in a cone around stamens. **Nectary** consisting of a series of small teeth in a continuous ring. **Ovary** concave around margin, conical in centre above; placentas parietal; stigmas 11 or 12, subulate. **Fruit** a 11- or 12-locular capsule of Lampranthus type, woody, reddish at first, convex on top; valves with spreading wings; expanding keels parallel at base, diverging slightly towards apex; covering membranes small, not covering entire locule; closing bodies 0. **Seeds** smooth.

Flowering March to August in habitat.

Distinguishing characters: robust sprawling plants with leaves seemingly dusted with flour (hence the specific name *farinosa* = floury); flowers solitary, white; fruit 11- or 12-locular.

Species 1: *Wooleya farinosa* (L.Bolus) L.Bolus, restricted to the coastal plains of Namaqualand, Northern Cape.

Zeuktophyllum N.E.Br. 2405126

(Ruschioideae: 6. Titanopsis Group).
Brown: 12 (1927a); Herre: 310 (1971); Smith *et al.*: 288 (1998).

Sturdy dwarf shrublets, up to 100 mm high with woody stems and 3 or 4 leaf pairs per branch; roots fibrous. **Leaves** decussate, fused towards base, ascending, 3-angled, tapering, up to 30 mm long; epidermis smooth. **Flowers** solitary, terminal, shortly pedicellate, bracteate. **Sepals** 4, unequal. **Petals** free towards bases, white. **Staminodes** present. **Nectary** a series of small teeth in a continuous ring. **Ovary** with parietal placentas; stigmas 10, subulate. **Fruit** a 10-locular capsule of Lampranthus type, woody, top flat, expanding keels divergent, ending with a small stiff, aristate wing, covering membranes present, closing bodies 0. **Seeds** muricate.

Flowering in summer.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Distinguishing characters: compact shrublets with partially fused leaves; flowers solitary with short pedicels; fruit flat-topped, 10-locular.

Species 2. On quartzitic slopes in the vicinities of Ladismith and Laingsburg, Western Cape.

References

ADANSON, M. 1763. *Manettia. Familles des Plantes* 2. Vincent, Paris.
BITTRICH, V. 1986. Untersuchungen zu Merkmalsbestand, Gliederung und Abgrenzung der Unterfamilie Mesembryanthemoideae (Mesembryanthemaceae Fenzl). *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 21: 5–116.
BITTRICH, V. & HARTMANN, H.E.K. 1988. The Aizoaceae—a new approach. *Botanical Journal of the Linnean Society* 97: 239–254.
BOLUS, H.M.L. 1927a. *Crocanthus thunbergii. Flowering Plants of South Africa* 7: t. 255.
BOLUS, H.M.L. 1927b. *Delosperma tradescantioides. Flowering Plants of South Africa* 7: t. 261.
BOLUS, H.M.L. 1927c. *Echinus apiculatus. Flowering Plants of South Africa* 7: t. 266.
BOLUS, H.M.L. 1927d. *Leipoldtia constricta. Flowering Plants of South Africa* 7: t. 256.
BOLUS, H.M.L. 1927e. Novitates Africanae. *Annals of the Bolus Herbarium* 4: 99, 100.
BOLUS, H.M.L. 1927f. *Peersia macradenia. Flowering Plants of South Africa* 7: t. 264.
BOLUS, H.M.L. 1927g. *Schonlandia lehmannii. Flowering Plants of South Africa* 7: t. 259
BOLUS, H.M.L. 1927h. South African succulents: *Mesembryanthemum* and allied genera. *South African Gardening and Country Life* 17: 280, 281, 326, 327, 365, 433–435.
BOLUS, H.M.L. 1927i. *Vanzijlia annulata. Flowering Plants of South Africa* 7: t. 262.
BOLUS, H.M.L. 1928. Latin description of a hundred new species. *Notes on* Mesembrianthemum *and some allied genera.* 1. University of Cape Town, Cape Town.
BOLUS, H.M.L. 1930. *Notes on* Mesembrianthemum *and allied genera.* 2. University of Cape Town, Cape Town.
BOLUS, H.M.L. 1931. *Mesembryanthemum* (?) *sibbettii. Notes on* Mesembrianthemum *and allied genera.* 2. University of Cape Town, Cape Town.
BOLUS, H.M.L. 1932. *Berrisfordia* gen. nov. *Notes on* Mesembrianthemum *and allied genera.* University of Cape Town, Cape Town. Vol. 2: 313.
BOLUS, H.M.L. 1936. *Henricia* gen. nov. *Notes on* Mesembryanthemum *and allied genera.* 3. University of Cape Town, Cape Town.
BOLUS, H.M.L. 1937. *Notes on* Mesembryanthemum *and allied genera.* 3. University of Cape Town, Cape Town.
BOLUS, H.M.L. 1937/1938. Note on *Faucaria* and *Orthopterum. Notes on* Mesembryanthemum *and allied genera.* 3. University of Cape Town, Cape Town.
BOLUS, H.M.L. 1938a. *Neohenricia. Journal of South African Botany* 4: 51.
BOLUS, H.M.L. 1938b. *Notes on* Mesembryanthemum *and allied genera.* 3. University of Cape Town, Cape Town.
BOLUS, H.M.L. 1939. *Mesembryanthemum* L. (emend.). *Notes on* Mesembryanthemum *and allied genera.* 3. University of Cape Town, Cape Town.
BOLUS, H.M.L. 1954a. *Mitrophyllum*, *Conophyllum* and *Mimetophytum. Notes on* Mesembryanthemum *and allied genera.* 3. University of Cape Town, Cape Town.
BOLUS, H.M.L. 1954b. *Namaquanthus* gen. nov. *Notes on* Mesembryanthemum *and allied genera.* 3. University of Cape Town, Cape Town.
BOLUS, H.M.L. 1958a. *Aloinopsis* Schwantes. *Notes on* Mesembryanthemum *and allied genera.* 3. University of Cape Town, Cape Town.
BOLUS, H.M.L. 1958b. *Anisocalyx* gen. nov. *Notes on* Mesembryanthemum *and allied genera.* 3. University of Cape Town, Cape Town.
BOLUS, H.M.L. 1958c. *Meyerophytum* Schwant. *Notes on* Mesembryanthemum *and allied genera.* 3. University of Cape Town, Cape Town.
BOLUS, H.M.L. 1958d. *Nananthus* N. E. Brown. *Notes on* Mesembryanthemum *and allied genera.* 3. University of Cape Town, Cape Town.
BOLUS, H.M.L. 1958e. *Ottosonderia* gen. nov. *Notes on* Mesembryanthemum *and allied genera.* 3. University of Cape Town, Cape Town.
BOLUS, H.M.L. 1958f. *Rabiea* N.E. Brown. *Notes on* Mesembryanthemum *and allied genera.* 3. University of Cape Town, Cape Town.
BOLUS, H.M.L. 1961. Notes on *Mesembryanthemum* and allied genera. *Journal of South African Botany* 27: 47, 48, 62, 63, 264.
BOLUS, H.M.L. 1962. Notes on Mesembryanthemum and allied genera. *Journal of South African Botany* 28: 9–11, 14.
BOLUS, H.M.L. 1965. Notes on Mesembryanthemum and allied genera. *Journal of South African Botany* 31: 169–174.
BOLUS, H.M.L. 1967. Notes on Mesembryanthemum and allied genera. *Journal of South African Botany* 33: 303, 306, 308.
BOLUS, H.M.L. & SCHWANTES, G. 1954. *Jacobsenia* L.Bol. et Schwant. In H.M.L. Bolus, *Notes on* Mesembryanthemum *and allied genera.* 3. University of Cape Town, Cape Town.
BROWN, N.E. 1921. *Mesembryanthemum* and some new genera separated from it. *Gardeners' Chronicle*: 70: 273, 311.
BROWN, N.E. 1922a. *Mesembryanthemum* and some new genera separated from it. *Gardeners' Chronicle*: 71: 44, 92, 105, 129, 151, 198.
BROWN, N.E. 1922b. *Roodia digitifolia. Flowering Plants of South Africa* 2: t. 78.
BROWN, N.E. 1925. *Mesembryanthemum* and some new genera separated from it. *Gardeners' Chronicle* 78: 412, 413, 433.
BROWN, N.E. 1926a. *Phyllobolus.* In E.P. Phillips, The genera of South African flowering plants. *Memoirs of the Botanical Survey of South Africa* No. 25.
BROWN, N.E. 1926b. *Mesembryanthemum* and some new genera separated from it. *Gardeners' Chronicle* 79: 134, 135, 406.
BROWN, N.E. 1926c. *Mesembryanthemum* and some new genera separated from it. *Gardeners' Chronicle* 80: 212.
BROWN, N.E. 1927a. *Mesembryanthemum* and some new genera separated from it. *Gardeners' Chronicle* 81: 12, 116, 251.
BROWN, N.E. 1927b. *Mesembryanthemum* and some new genera separated from it. *Gardeners' Chronicle* 82: 92, 113, 114
BROWN, N.E. 1927c. Two new Mesembryanthemaceae. *Journal of Botany, British and Foreign* 65: 348.
BROWN, N.E. 1928a. *Cerochlamys*: a new genus of Mesembryanthemeae. *Journal of Botany, British and Foreign* 66: 171.
BROWN, N.E. 1928b. Ergänzungen zu dem Mesembriaceen-Aufsatz. Die Gattung *Cleretum* N.E.Br. *Möllers Deutsche Gärtner-Zeitung* 43: 400.
BROWN, N.E. 1928c. *Mesembryanthemum* and allied genera. *Journal of Botany, British and Foreign* 66: 76, 80, 141, 267.
BROWN, N.E. 1928d. *Mesembryanthemum* and some new genera separated from it. *Gardeners' Chronicle* 83: 194, 266.
BROWN, N.E. 1928e. *Mesembryanthemum* and some new genera separated from it. *Gardeners' Chronicle* 84: 472, 492.
BROWN, N.E. 1930a. *Mesembryanthemum* and some new genera separated from it. *Gardeners' Chronicle* 87: 71, 72, 126, 151, 211.
BROWN, N.E. 1930b. *Mesembryanthemum* and some new genera separated from it. *Gardeners' Chronicle* 88: 278, 279, 513.
BROWN, N.E. 1930c. *Mesembryanthemum. Gardeners' Chronicle*, ser. III, 87: 13–211.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

BROWN, N.E. 1931a. A strange new plant. *Journal of the Cactus and Succulent Society of America* 2: 389, 390.
BROWN, N.E. 1931b. *Mesembryanthemum* and some new genera separated from it. *Gardeners' Chronicle* 89: 137, 259.
BROWN, N.E. 1932. *Mesembryanthemum* and some new genera separated from it. *Gardeners' Chronicle* 91: 205, 262, 263.
BROWN, N.E. 1936. *Mesembryanthemum* and some new genera separated from it. *Gardeners' Chronicle* 100: 164.
BRUSSE F.A. 1996. A new species of *Dorotheanthus* (Aizoaceae, Ruschioideae) from limestone areas of the south-western Cape, South Africa. *Bradleya* 14: 89–93.
BURGOYNE, P.M. 1998. Finding a place in the sun: where does *Ruschia purpureostyla* belong? *Aloe* 35: 60, 61.
BURGOYNE, P.M., SMITH, G.F. & CHESSELET, P. 1998. *Hammeria*, a new genus of Aizoaceae from South Africa. *Cactus and Succulent Journal (U.S)* 70: 203–208.
BURGOYNE, P.M., SMITH, G.F. & DU PLESSIS, F. 2000. Notes on the genus *Frithia* (Mesembryanthemaceae) and the description of a new species, *F. humilis*, in South Africa. *Bothalia* 30: 1–7.
CHESSELET, P. & HARTMANN, H.E.K. 1995. *Khadia alticola* Chess. & H.E.K.Hartm. spec. nov. (Mesembryanthema, Aizoaceae). *Aloe* 32: 46–49.
CHESSELET, P., HARTMANN, H.E.K., HAHN, N., BURGOYNE, P. & SMITH, G.F. 1998. Studies in *Khadia* (Mesembryanthemaceae/Aizoaceae). *Bothalia* 28: 25–33.
CHESSELET, P., MÖSSMER, M. & SMITH, G.F. 1995. Research priorities in the succulent plant family Mesembryanthemaceae Fenzl. *South African Journal of Science* 91: 197–209.
CHINNOCK, R.J. 1971. Studies in *Disphyma*—a genus related to *Mesembryanthemum*. 1. A revision of *Disphyma australe* (Ait.) J.M.Black. *New Zealand Journal of Botany* 9: 331–344.
CHINNOCK, R.J. 1986. Studies in *Disphyma* 2. Infraspecific subdivision of *Disphyma australe* and notes on the Australian species of *Disphyma*. *New Zealand Journal Botany* 14: 77–78.
CHINNOCK, R.J. 1996. To the limits of *Disphyma* (Aizoaceae: Ruschioideae) and beyond. *Aloe* 33: 59–61.
CLARK, J.Y. 1996. A key to *Lithops* (Aizoaceae). *Bradleya* 14: 1–9.
COLE, D. 1988. *Lithops. Flowering stones*. Acorn Books in association with Russel Friedman Books, South Africa.
DEHN, M. 1988. Untersuchungen zum Merkmalsbestand und zur Stellung der Gattung *Antimima* N.E.Br. emend. Dehn (Mesembryanthemaceae Fenzl). *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 22: 189–215.
DEHN, M. 1992. Untersuchungen zum Verwandtschaftskreis der Ruschiinae (Mesembryanthemaceae Fenzl). *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 24: 91–198.
DINTER, K. 1926. Twenty days in a botanist's paradise. *Gardeners' Chronicle* 80: 430, 431, 447.
DINTER, K. 1927. *Schwantesia rüdebuschii* Dtr. gen. novum. *Möllers Deutsche Gärtner-Zeitung* 42: 234.
DINTER, K. 1937. *Halenbergia. Kakteen und andere Sukkulenten* 1937: 158.
DINTER, K. & SCHWANTES, G. 1927. *Hymenocyclus. Möllers Deutsche Gärtner-Zeitung* 42: 27.
DUPONT, S. 1968. Épidermes et plantules des Mésembryanthemacées. Systématique. Évolution. *Bulletin de la Société d'Histoire Naturelle de Toulouse* 104: 7–64.
DYER, R.A. 1975. *The genera of southern African flowering plants*, Vol. 1. Botanical Research Institute, Pretoria.
FEDDE, F. 1940. Nomenklatorische Notizen. 1. *Repertorium specierum novarum regni vegetabilis* 48: 11.
FENZL, E. 1836. Monographie der Mollugineen und Steudelieen, zweier Unterabtheilungen der Familie der Portulacaceen. *Annalen des Wiener Museums der Naturgeschichte* 1: 349.
FRANDSEN, R. 1998. The genus *Gibbaeum* and its habitat at the Little Karoo. *Aloe* 35: 14–17.
FRIEDRICH, H.C. 1960. Mesembryanthemenstudien I. Beitrag zur Kenntnis der Gattungen *Stoeberia* Dtr. et Schw. und *Ruschianthemum* Friedr. gen. nov. *Mitteilungen aus der Botanischen Staatssammlung. München* 3: 554–567.
FRIEDRICH, H.C. 1970. Aizoaceae. *Prodromus einer Flora von Südwestafrika* 27: 1–135.
GERBAULET, M. 1995. *Phyllobolus* N.E.Br. emend. Bittrich (Aizoaceae): A reassessment of generic boundaries. *Botanische Jahrbücher* 117: 385–399.
GERBAULET, M. 1996a. Revision of the genus *Aridaria* N.E.Br. (Aizoaceae) *Botanische Jahrbücher* 118: 41–58.
GERBAULET, M. 1996b. Revision of the genus *Prenia* N.E.Br. (Aizoaceae). *Botanische Jahrbücher* 118: 25–40.
GERBAULET, M. 1996c. Revision of the genus *Sceletium* N.E.Br. (Aizoaceae) *Botanische Jahrbücher* 118: 9–24.
GERBAULET, M. 1997. Revision of the genus *Phyllobolus* N.E.Br. (Aizoaceae). *Botanische Jahrbücher* 119: 145–211.
GERBAULET, M. (in press). *Aptenia*—Mesembryanthemoideae. In H.E.K. Hartmann, *IOS Lexicon of Succulent Plants*. Fischer, Jena.
GERBAULET, M. (in press). *Mesembryanthemum*—Mesembryanthemoideae. In H.E.K. Hartmann, *IOS Lexicon of Succulent Plants*. Fischer, Jena.
GERBAULET, M. & IHLENFELDT, H.-D. 1990. Lectotypification of *Thyrasperma* N.E.Br. (Mesembryanthemaceae). *Taxon* 39: 511, 512.
GIESS, W. 1974. Zwei Fahrten zur *Jensenobotrya lossowiana* Herre. *Dinteria* 10: 3–12.
GLEN, H.F. 1980. Proposal (537) to conserve the generic name 2405 *Lampranthus* N.E.Br. (1930) against *Oscularia* Schwantes (1927) (Mesembryanthemaceae). *Taxon* 29: 693, 694.
GLEN, H.F. 1981. Mesembryanthemaceae. Nomenclature in the genus *Mestoklema*. *Bothalia* 13: 454, 455.
GLEN, H.F. 1986. Numerical taxonomic studies in the subtribe Ruschiinae (Mesembryanthemaceae)—*Astridia*, *Acrodon* and *Ebracteola*. *Bothalia* 16: 203–226.
GROEN, L.E. & VAN DER MAESEN, L.J.G. 1999. Revision of the genus *Faucaria* (Ruschioideae: Aizoaceae) in South Africa. *Bothalia* 29: 35–58.
HAMMER, S.A. 1989. Big and little Frithias, and a fiery *Fenestraria*. *Cactus and Succulent Journal (US)* 61: 199–201.
HAMMER, S.A. 1991. Friendly daggers, or, notes on *Machairophyllum*. *Mesemb Study Group Bulletin* 4: 77, 78.
HAMMER, S.A. 1993a. Macro-observations on *Cheiridopsis* N.E.Br. and *Odontophorus* N.E.Br. (Aizoaceae). *Bradleya* 11: 75–85.
HAMMER, S.A. 1993b. *The genus* Conophytum: *a conograph*. Succulent Plant Publications, Pretoria.
HAMMER, S.A. 1994a. A novel *Neohenricia*. *Cactus and Succulent Journal (U.S.)* 66: 84–86.
HAMMER, S.A. 1994b. *Vlokia*, a new genus in Aizoaceae. *Cactus and Succulent Journal (US)* 66: 255–258.
HAMMER, S.A. 1995a. *Hartmanthus*, a new genus in Aizoaceae. *Haseltonia* 3: 77–82.
HAMMER, S.A. 1995b. *Marlothistella* Schwantes: A rising star. *Bradleya* 13: 82–87.
HAMMER, S.A. 1995c. Mastering the art of growing mesembs. *Cactus and Succulent Journal (US)* 67: 195–247.
HAMMER, S.A. 1995d. New nothogenera, and a new combination in *Mesembryanthema*. *Cactus and Succulent Journal (U.S.)* 67: 172, 173.
HAMMER, S.A. 1995e. Notes on the *Conophytum obscurum* complex. *Piante Grasse Supplement* 15: 23–34.
HAMMER, S.A. 1995f. The married bean (with apologies to Henry Purcell). *Piante Grasse Supplement* 15: 34–38.
HAMMER, S.A. 1995g. Up a sleeve: Further observations on *Cheiridopsis* N.E.Br. and *Odontophorus* N.E.Br. (Aizoaceae). *Piante Grasse Supplement* 15: 59–87.
HAMMER, S.A. 1997. Mesembs from A–Z: *Ectotropis alpina*. *Aloe* 33: 96, 97.
HARTMANN, H.E.K. 1976. Monographie der Gattung *Odontophorus* N.E.Br. (Mesembryanthemaceae Fenzl). *Botanische Jahrbücher* 97: 161–225.
HARTMANN, H.E.K. 1977. Monographie der Gattung *Argyroderma* N.E.Br. (Mesembryanthemaceae Fenzl). *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 15: 121–235.
HARTMANN, H.E.K. 1978. Zur Kenntnis der Gattung *Cephalophyllum*. *Botanische Jahrbücher* 99: 264–302.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

HARTMANN, H.E.K. 1982a. Monographien der Subtribus Leipoldtiinae. III. Monographie der Gattung *Fenestraria* (Mesembryanthemaceae). *Botanische Jahrbücher* 103: 145–183.
HARTMANN, H.E.K. 1982b. Zur Frage von Gattungsabgrenzungen in der Familie Mesembryanthemaceae Fenzl am Beispiel der Gattungen *Cephalophyllum* N.E.Br. und *Vanzijlia* L.Bol. *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 18: 85–101.
HARTMANN, H.E.K. 1983a. Monographien der Subtribus Leipoldtiinae. V. Monographie der Gattung *Hallianthus* (Mesembryanthemaceae). *Botanische Jahrbücher* 104: 143–169.
HARTMANN, H.E.K. 1983b. Monographien der Subtribus Leipoldtiinae. IV. Monographie der Gattung *Vanzijlia* (Mesembryanthemaceae). *Botanische Jahrbücher* 103: 499–538.
HARTMANN, H.E.K. 1983c. Untersuchungen zum Merkmalsbestand und zur Taxonomie der Subtribus Leipoldtiinae (Mesembryanthemaceae). *Bibliotheca Botanica* 136: 1–67.
HARTMANN, H.E.K. 1983d. Interaction of ecology, taxonomy and distribution in some Mesembryanthemaceae. *Bothalia* 14: 653–659.
HARTMANN, H.E.K. 1984a. Monographien der Subtribus Leipoldtiinae VI. Monographie der Gattung *Jordaaniella* (Mesembryanthemaceae). *Botanische Jahrbücher* 104: 321–360.
HARTMANN, H.E.K. 1984b. Zur Biologie und Taxonomie des *Cephalophyllum-curtophyllum*-Komplexes. *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 19: 141–163.
HARTMANN, H.E.K. 1986: Chromosome numbers in the genus *Cephalophyllum* N.E.Br. (Mesembryanthemaceae). Notes on *Cephalophyllum* V. *Cactus and Succulent Journal (U.S)* 58: 263–266.
HARTMANN, H.E.K. 1988a. Fruit types in Mesembryanthema. *Beiträge zur Biologie der Pflanzen* 63: 313–349.
HARTMANN, H.E.K. 1988b. Monographien der Subtribus Leipoldtiinae. VIII. Monographie der Gattung *Cephalophyllum* (Mesembryanthemaceae). *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 22: 93–187.
HARTMANN, H.E.K. 1991a. Mesembryanthema. *Contributions from the Bolus Herbarium* 13: 75–157.
HARTMANN, H.E.K. 1991b. Keys to the genera of Mesembryanthema. *South African Journal of Botany* 57: 95–106.
HARTMANN, H.E.K. 1992a. A new name for *Bijlia cana* (Mesembryanthema). *Cactus and Succulent Journal (U.S.)* 64: 173–180.
HARTMANN, H.E.K. 1992b. *Ihlenfeldtia*, a new genus in Mesembryanthema (Aizoaceae). *Botanische Jahrbücher* 114: 29–50
HARTMANN, H.E.K. 1992c. Revision of the genus *Vanheerdea* L.Bolus ex H.E.K.Hartmann (Aizoaceae). *Bradleya* 10: 5–16.
HARTMANN, H.E.K. 1993. Aizoaceae. In K. Kubitzki, J.G. Rohwer & V. Bittrich, *The families and genera of vascular plants—Dicotyledons* 2. Springer-Verlag, Berlin.
HARTMANN, H.E.K. 1996a. *Antimima aurasensis* H.E.K.Hartmann (Aizoaceae), eine neue Art aus Namibia. *Kakteen und andere Sukkulenten* 47: 229–234.
HARTMANN, H.E.K. 1996b. Miscellaneous taxonomic notes on Aizoaceae. *Bradleya* 14: 29–56.
HARTMANN, H.E.K. 1998a. A Letter to the MSG. *Mesemb Study Group Bulletin* 2: 32–34.
HARTMANN, H.E.K. 1998b. New combinations in *Antimima* (Ruschioideae, Aizoaceae) from southern Africa. *Bothalia* 28: 67–82.
HARTMANN, H.E.K. 1998c. New combinations in Ruschioideae, based on studies in *Ruschia* (Aizoaceae). *Bradleya* 16: 44–91.
HARTMANN, H.E.K. & DEHN, M. 1987. Monographien der Subtribus Leipoldtiinae. VII. Monographie der Gattung *Cheiridopsis* (Mesembryanthemaceae). *Botanische Jahrbücher* 108: 567–663.
HARTMANN, H.E.K. & DEHN, M. 1989. A re-examination of the genus *Amphibolia* (Mesembryanthemaceae). *Bothalia* 19: 179–182.
HARTMANN, H.E.K. & GÖLLING, H. 1993. A monograph of the genus *Glottiphyllum* (Mesembryanthema, Aizoaceae). *Bradleya* 11: 1–49.
HARTMANN, H.E.K. & LIEDE, S. 1986. Die Gattung *Pleiospilos* s.lat. (Mesembryanthemaceae). *Botanische Jahrbücher* 106: 433–485.
HARTMANN, H.E.K. & RUST, S. 1994. Monographien der Leipoldtiinae IX. Monographie der Gattung *Leipoldtia* L.Bolus s.lat. (Aizoaceae). *Verhandlungen des Naturwissenschaftlichen Vereins in Hamburg* 34: 275–351.
HARTMANN, H.E.K. & STÜBER, D. 1993. On spiny *Mesembryanthema* and the genus *Eberlanzia* (Aizoaceae). *Contributions from the Bolus Herbarium* 15: 1–75.
HARTMANN, H.E.K. & STÜBER, D. 1994. Erweiterung der Gattung *Leipoldtia* um zwei dornentragende Arten (Mesembryanthema, Aizoaceae). *Verhandlungen des Naturwissenschaftlichen Vereins in Hamburg* 34: 353–372.
HAWORTH, A.H. 1821. *Revisiones plantarum succulentarum*. R. & A. Taylor, London.
HERRE, H. 1948. *Arenifera* Herre gen. nov. *Sukkulentenkunde* 2: 35.
HERRE, H. 1951. *Jensenobotrya. Sukkulentenkunde* 4: 79.
HERRE, H. 1970. Notes on South African succulents. *Cactus and Succulent Journal (US)* 42: 17–18.
HERRE, H. 1971. *The genera of the Mesembryanthemaceae*. Tafelberg, Cape Town.
HERRE, H. & VOLK, O.H. 1948. Mesembryanthemaceae Herre et Volk, familia nova. *Sukkulentenkunde* 2: 38.
IHLENFELDT, H.-D. 1978. Morphologie und Taxonomie der Gattung *Oophytum* N.E.Br. (Mesembryanthemaceae). Monographie der Mitrophyllinae Schwantes III. *Botanische Jahrbücher* 99: 303–328.
IHLENFELDT, H.-D. 1980. Der Haarapparat ('Diadem') der Gattung *Trichodiadema* Schwant. *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg*. 17: 145–163.
IHLENFELDT, H.-D. 1988. Morphologie und Taxonomie der Gattungen *Diplosoma* Schwantes und *Maughaniella* L.Bolus (Mesembryanthemaceae). *Beiträge zur Biologie der Pflanzen* 63: 375–401.
IHLENFELDT, H-.D. 1997. The systematic position of the genus *Drosanthemopsis* Rauschert and a revision of the genus *Jacobsenia* L.Bolus & Schwantes (Mesembryanthemaceae). *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 27: 109–126.
IHLENFELDT, H.-D. & BITTRICH, V. 1985. Morphologie, Gliederung und Abgrenzung der Gattung *Psilocaulon* N.E.Br. s.l. (Mesembryanthemaceae). *Botanische Jahrbücher* 105: 289–322.
IHLENFELDT, H.-D. & GERBAULET, M. 1990. Untersuchungen zum Merkmalsbestand und zur Taxonomie der Gattungen *Apatesia* N.E.Br., *Carpanthea* N.E.Br., *Conicosia* N.E.Br., *Herrea* Schwantes und *Hymenogyne* Haw. (Mesembryanthemaceae Fenzl). *Botanische Jahrbücher* 111: 457–498.
IHLENFELDT, H.-D. & JÖRGENSEN, S. 1973. Morphologie und Taxonomie der Gattung *Monilaria* (Schwantes) Schwantes s. str. (Mesembryanthemaceae) (Monographie der Mitrophyllinae Schwantes I). *Mitteilungen aus dem Staatsinstitut für Allgemeine Botanik. Hamburg* 14: 49–94.
IHLENFELDT, H.-D. & STRUCK, M. 1986. Morphologie und Taxonomie der Dorotheanthinae Schwantes (Mesembryanthemaceae). *Beiträge zur Biologie der Pflanzen* 61: 411–453.
JACOBSEN, H. 1935. *Succulent plants. Description, cultivation and uses of succulent plants, other than cacti.* Williams & Norgate, London.
JACOBSEN, H. & ROWLEY, G.D. 1958. Some name changes in succulent plants, Part IV. *National Cactus and Succulent Journal* 13: 77, 78.
KLAK, C. & LINDER, H.P. 1998. Systematics of *Psilocaulon* N.E.Br. and *Caulipsolon* Klak gen. nov. (Mesembryanthemoideae, Aizoaceae). *Botanische Jahrbücher* 120: 301–375.
KOUTNIK, D. & O'CONNOR-FENTON, M. 1984. Notes on the genus *Mesembryanthemum* L. *Journal of South African Botany* 50: 365–371.
LAVIS, M. 1966. Notes on the genus *Delosperma* (Mesembrieae). *Journal of South African Botany* 32: 209.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

LEISTNER, O.A. 1958a. A new monotypic genus of the Mesembryanthemaceae. In H.M.L. Bolus, *Notes on* Mesembryanthemum *and allied genera*. 3. University of Cape Town, Cape Town.
LEISTNER, O.A. 1958b. *Skiatophytum* L.Bol.: 'n morfologies-taksonomiese studie. *Journal of South African Botany* 24: 89–102.
LIEDE, S. 1989. Untersuchungen zum Merkmalsbestand und zur Taxonomie der 'Erepsiinae' (Mesembryanthemaceae). *Beiträge zur Biologie der Pflanzen* 64: 391–479.
LIEDE, S. 1990. Untersuchungen zur Ökologie der Gattung *Erepsia* N.E.Br. (Mesembryanthemaceae). *Beiträge zur Biologie der Pflanzen* 65: 1–98.
LINNAEUS, C. 1753. Species Plantarum. Laurentius Salvius, Stockholm.
NEL, C.G. 1953. In P.G. Jordaan & E.W. Shurly (eds), *The* Gibbaeum *handbook. A genus of highly succulent plants, native to South Africa*. Blanford Press, London.
NIESLER, I.M. 1997. Is *Trichodiadema* Schwantes one genus only?—Problems in delimitation or 'what is a diadem?' *Bradleya* 15: 13–27.
PIERCE, S.M. & GERBAULET, M. 1997. *Brownanthus* Schwantes (Mesembryanthemoideae, Aizoaceae): two new species and a new combination from the Richtersveld and southwestern Namibia. *Aloe* 34: 42–44.
POPPENDIECK, H.-H. 1976. Untersuchungen zur Morphologie und Taxonomie der Gattung *Mitrophyllum* Schwantes s. lat. Mesembryanthemaceae. *Botanische Jahrbücher* 97: 339–413.
RAPPA, F. & CAMARRONE, V. 1962. La classificazione naturale delle Mesembriantemacee. *Lavori dell' Istituto Botanico e Giardino Coloniale Palermo* 18: 13.
RAUSCHERT, S. 1982. Nomina nova generica et combinationes novae Spermatophytorum et Pteridophytorum. *Taxon* 31: 555.
ROTHMALER, W. 1941. Zur Nomenklatur der Mesembryanthemen. *Notizblatt des Botanischen Gartens Berlin-Dahlem* 15: 413.
SAUER, N. 1975. *Dinteranthus*. *Aloe* 13: 9–24.
SAUER, N. 1978. *Dinteranthus pole-evansii*, *D. microspermus* subsp. *microspermus*, *D. microspermus* subsp. *puberulus*, *D. wilmotianus* subsp. *wilmotianus* and *D. wilmotianus* subsp. *impunctatus*. *Flowering Plants of Africa* 45: t. 1778A–1780B.
SCHWANTES, G. 1925. *Derenbergia*. *Zeitschrift für Sukkulentenkunde* 8: 137, 138.
SCHWANTES G. 1926a. Einige neue Mesembrianthemaceen. *Zeitschrift für Sukkulentenkunde* 2: 186.
SCHWANTES, G. 1926b. Zur Systematik der Mesembrianthemen. *Zeitschrift für Sukkulentenkunde* 2: 175–189.
SCHWANTES, G. 1927a. Einige neue Mesembrianthemaceen. *Möllers Deutsche Gärtner-Zeitung* 42: 436.
SCHWANTES, G. 1927b. *Ophthalmophyllum* Dinter et Schwantes. *Möllers Deutsche Gärtner-Zeitung* 42: 64.
SCHWANTES, G. 1927c. Einige neue Mesembrianthemaceen. *Möllers Deutsche Gärtner-Zeitung* 42: 187, 283.
SCHWANTES, G. 1927d. Zur Systematik der Mesembrianthemen. *Zeitschrift für Sukkulentenkunde* 3: 14–17, 23, 24, 27, 28, 106.
SCHWANTES, G. 1928a. Einige neue Mesembrianthemaceen. *Möllers Deutsche Gärtner-Zeitung* 43: 17.
SCHWANTES, G. 1928b. Mesembrianthema Moniliformia. *Zeitschrift für Sukkulentenkunde* 3: 321.
SCHWANTES, G. 1928c. Aus unseren Pflanzenschätzen. Mesembriaceen-Studien. *Die Gartenwelt* 32: 514, 599, 644.
SCHWANTES, G. 1928d. *Nelia* Schwantes gen. nov. *Möllers Deutsche Gärtner-Zeitung* 43: 92.
SCHWANTES, G. 1929a. Aus unseren Pflanzenschätzen. Mesembriaceen-Studien. *Die Gartenwelt* 33: 69.
SCHWANTES, G. 1929b. Neue Mesembriaceen IV. *Monatsschrift der Deutschen Kakteen Gesellschaft* 1: 16.
SCHWANTES, G. 1930. *Neorhine* Schwantes. *Monatsschrift der Deutschen Kakteen Gesellschaft* 2: 22.
SCHWANTES, G. 1951. Zur Systematik der Mesembrianthemen. *Zeitschrift für Sukkulentenkunde* 4: 78.
SCHWANTES, G. 1952. Die Früchte der Mesembryanthemaceen. *Mitteilungen aus dem Botanischen Museum der Universität Zürich* 39: 1–38.
SCHWANTES, G. 1954. *Jacobsenia* L.Bol. et Schwant. gen nov. *Kakteen und andere Sukkulenten* 5: 69–71.
SCHWANTES, G. 1957. *Flowering stones and mid-day flowers*. Ernest Benn Limited, London.
SMITH, G.F., CHESSELET, P., VAN JAARSVELD, E.J., HARTMANN, H., HAMMER, S., VAN WYK, B-.E., BURGOYNE, P., KLAK, C. & KURZWEIL, H. 1998. *Mesembs of the world*. Briza, Pretoria.
SMITH, G.F., HARTZER, P. & VAN WYK, A.E. 1997. Plate 310. *Mossia intervallaris*. *Curtis's Botanical Magazine* 14: 16–22.
TOELKEN, H.R. & JESSOP, J.P. 1976. Mesembryanthemaceae. Nomenclature of the genus *Amphibolia*. *Bothalia* 12: 64.
VAN JAARSVELD, E.J. 1982. *Sineoperculum* Van Jaarsveld: 'n nuwe monotipiese genus in die familie Mesembryanthemacae. *Journal of South African Botany* 48: 5–10.
VAN JAARSVELD, E.J. 1994a. A synopsis of the genus *Stoeberia*. *Aloe* 31: 68–76.
VAN JAARSVELD, E.J. 1994b. *Saphesia flaccida* and its conservation. *Cactus and Succulent Journal of Great Britain* 12: 98–103.
VAN JAARSVELD, E.J. & HAMMER, S.A. 1996. *Gibbaeum johnstonii*, a new species from the Little Karoo. *Bradleya* 14: 14–16.
VON BREITENBACH, F. 1990. *National list of indigenous trees*. Dendrological Foundation, Pretoria.
WALGATE, 1939. A revision of *Juttadinteria* Schwant., *Dracophilus* Dint. et Schwant., and *Namibia* Dint. et Schwant. In H.M.L. Bolus, *Notes on* Mesembryanthemum *and allied genera*. 3. University of Cape Town, Cape Town.
WALLACE, R.S. 1998. Systematic implications of evolutionary relationships within the Aizoaceae *s.l. Proceedings: Programme & Abstracts of the 25th Congress of the International Organization for Succulent Plant Study*. 31 August to 4 September 1998.
WEBER, C. 1968. Notes on the nomenclature of some Aizoaceae. *Baileya* 16: 9–11.
WINKLER, D.G. 1957. Bydrae tot die kennis van *Micropterum* Schwant.—subgenus *Aethephyllum* (N.E.Br.) Schwantes. *Journal of South African Botany* 23: 19–37.
WINTER, P.J.D. & HAHN, N. 1999. A new species of *Khadia* N.E.Br. (Mesembryanthemaceae) from the Northern Province of South Africa. *Aloe* 36: 16–19.
WISURA, W. & GLEN, H.F. 1993. The South African species of *Carpobrotus* (Mesembryanthema—Aizoaceae). *Contributions from the Bolus Herbarium* 15: 76–107.
ZIMMERMANN, N.F.A. 1996a. *Schwantesia constanceae* N.Zimm., spec. nov.—eine neue Art aus dem südlichen Namibia. *Kakteen und andere Sukkulenten* 47: 81–86.
ZIMMERMANN, N.F.A. 1996b. *Frithia pulchra* N.E.Br. Eine Reise zu zwei Populationen im Transvaal mit Besprechung der sukkulenten Begleitvegetation. *Kakteen und andere Sukkulenten* 47: 7.
ZIMMERMANN, N.F.A. 1996c. The genus *Schwantesia* Dinter. *Cactus and Succulent Journal (U.S.)* 68: 257–266.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 3

Chesselet, P., Smith, G.F. & Van Wyk, A.E. 2000. Systematic and evolutionary significance of morphology in the Mesembryanthemaceae: interactive database and illustrated atlas for identification. *Aloe* 37: 46–51.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Systematic and evolutionary significance of morphology in the Mesembryanthemaceae: interactive database and illustrated atlas for identification

Pascale Chesselet, Gideon F. Smith and Abraham E. van Wyk

Introduction

The Mesembryanthemaceae, popularly known as mesembs, is the largest family of succulent plants in southern Africa (Smith *et al.* 1993; Chesselet & De Wet 1997). Exceptional diversification resulted in ± 1680 species currently grouped into 123 genera (Smith *et al.* 1998; Chesselet *et al.* 2000). The family is comparable in size and diversity to the predominantly New World Cactaceae (Barthlott & Hunt 1993). Mesembs are largely endemic to southern Africa – one genus and 18 species occur outside this core area, namely in East and North Africa, Australasia, America, Madagascar and around the Mediterranean Sea (Smith *et al.* 1998). In South Africa, mesembs dominate parts of the Succulent Karoo, notably in Namaqualand, but schlerophyllous plants gradually replace leaf succulent shrubs in areas where winter night frost occurs (Desmet & Cowling 1999).

A remarkable feature of the mesembs is the high degree of endemism at both genus and species level. An analysis of the numbers of species per genus in the mesembs showed that, as in most modern classifications, the number of monotypic genera is greater than the number of genera with two species; and the number of genera with two species exceeds the number of genera with three and so forth, with few large genera comprising more than 200 species (Chesselet *et al.* 1995). This pattern of decreasing numbers of genera with increasing numbers of species indicates that the family is composed of taxa of different ages, with well defined and isolated taxa (especially genera) often of limited distribution showing signs of being relicts of ancient evolutionary levels (Ihlenfeldt 1994; Hartmann 1991). The large genera are often composed of complexes of closely related taxa that are difficult to delimit; they generally have larger distribution areas. Although data on endemism at species level is scant, Cowling *et al.* (1999) suggest that range-restricted species that belong to large and widespread genera such as *Ruschia*, for example, are most probably neo-endemics. The rapid diversification inferred for the mesembs (Ihlenfeldt 1994) is attributed to a number of factors including short generation times, narrow dispersal ranges and limited gene flow in populations (Desmet & Cowling 1999).

Despite its significance in terms of number of species, endemism, arid land agriculture, medicinal value (Van Wyk & Gericke 2000) and horticultural appeal (Hammer 1993, Cole 1988), the Mesembryanthemaceae remains a problematic group, particularly from a taxonomic perspective – less than a third of the species have been revised since first description (Chesselet *et al.* 1995). The consequence of this unsatisfactory state of its taxonomy is multifaceted and affects a number of aspects of botanical research. Most important, however, is the effect of this multitude of taxa on the basic activity of plant identification. Even generic identifications are difficult, often discouraging potential researchers. Reasons for these problems are a lack of fundamental taxonomic work, difficulties in finding reliable morphological characters in a highly succulent group and poorly understood or ill-defined generic boundaries in a number of genera (Chesselet *et al.* 1995). But, plant identification is a fundamental taxonomic practice which needs to be addressed.

A major new project on the mesembs

The sheer size of the Mesembryanthemaceae justifies a computer-based approach to its documentation and inventory – over 6 000 names, including current names and synonyms, have been applied to mesemb species and sub-specific taxa. In attempting to organize and interpret the diversity of forms manifested in this group, appropriate programs such as LucID Professional (1999) greatly facilitate the input and analysis of morphological data. Recently, such a project, the first of its kind for the mesembs, has been started by the senior author and co-workers. The primary aim of the study is to develop a method for the rapid identification of mesemb genera by creating an illustrated atlas of morphological characters for use in interactive keys. Results of this study will be published in a user-friendly electronic format on CD, and made accessible on the World Wide Web, thus enabling on-line identification within a larger mesemb web site that will include both genus- and species-level data.

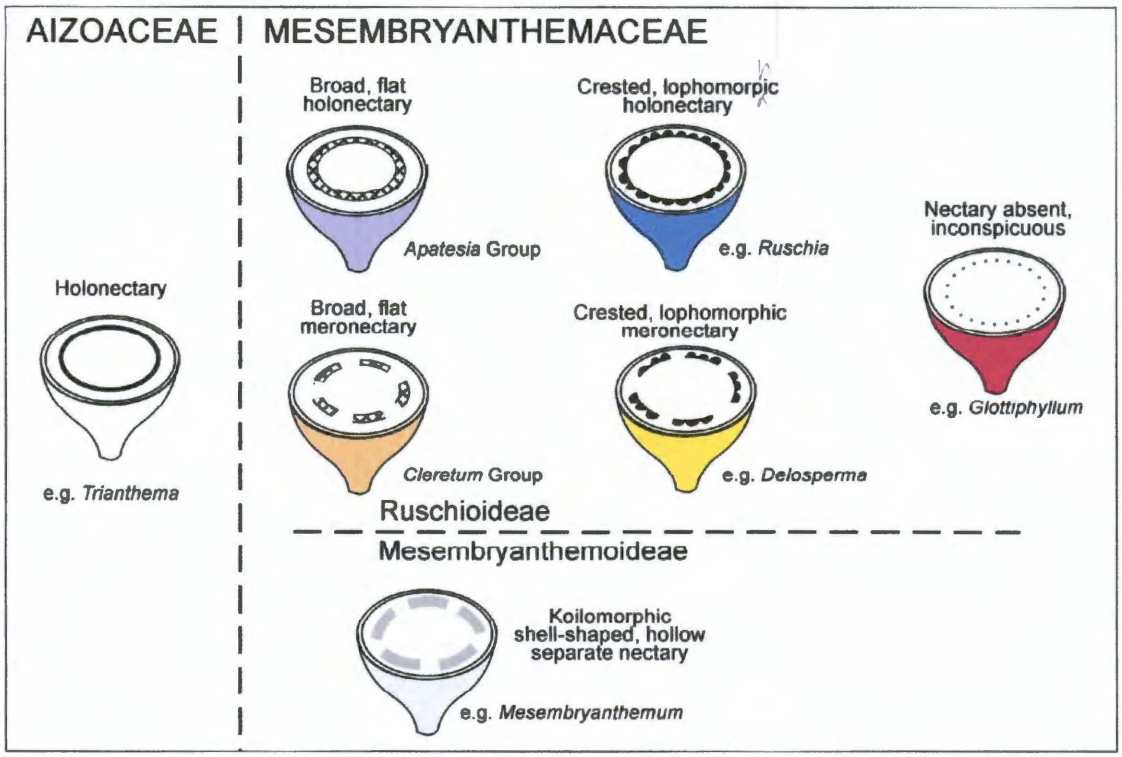
In the present paper we will provide a brief outline of the project, especially the approach (methods) to be employed, and some thoughts on the taxonomic significance of (macro)morphological characters in the Mesembryanthemaceae. Finally we use the morphological character states of the floral nectaries as an example of how the various characters of the group would be analysed to assess their systematic value.

Classification in the mesembs is far from stable. Consensus cannot even be reached on the familial status of the group. Many botanists prefer the concept Mesembryanthemaceae Fenzl to the alternative Aizoaceae Rudolphi *sensu stricto* – reasons outlined in Chesselet *et al.* (1995) and Chesselet *et al.* (2000). The latter concept contains the subfamilies Aizooideae, Sesuvioideae and Tetragonioideae in addition to the two subfamilies that make up the mesembs, the Mesembryanthemoideae and the Ruschioideae. Supragenetic grouping of the mesembs is also not steadfast. The classification of the Mesembryanthemaceae proposed by Schwantes, subsequently revised and adjusted by Straka and Ihlenfeldt (Herre 1971), represents the last formally published classification of the mesembs. Although changes in rank, clarification of generic boundaries, and relationships among genera have been the focus of a number of studies in both the Mesembryanthemoideae and Ruschioideae, some genera and their relationships are still not resolved.

ALOE 37, No 2 & 3, 2000. ISSN 0002-6301

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Figure 1. Simplified representation of floral nectaries in the mesembs and outgroup showing the states recognized for the purposes of this study. Colour coding matches character state distribution in Figure 2.



Approach and methods to be followed

The new project focuses on individual characters and their states. Data are sourced primarily from available published data synthesised in Chesselet *et al.* (2000). The aim is not to erect new generic limits at this stage, but to use currently accepted genus concepts as working hypotheses. The coding of morphological data requires that observations be transformed, without loss of information, into a format suitable for the generation of interactive keys. This process is termed character construction and involves a partitioning of observed variation into discrete characters and character states. Data are stored in a taxon–character state data matrix. For the mesemb genera the matrix contains 37 characters, 224 states and 122 taxa. The key comprises a list of illustrated and annotated characters and taxa with descriptions, distribution maps and illustrations. During identification, the user provides the key with information on the characteristics of the organism to be identified. Character states are chosen and the program then searches the data matrix for all taxa that match the selected character state. Successive selection of character states narrows down the list of possible taxa, until few or a single taxon remains.

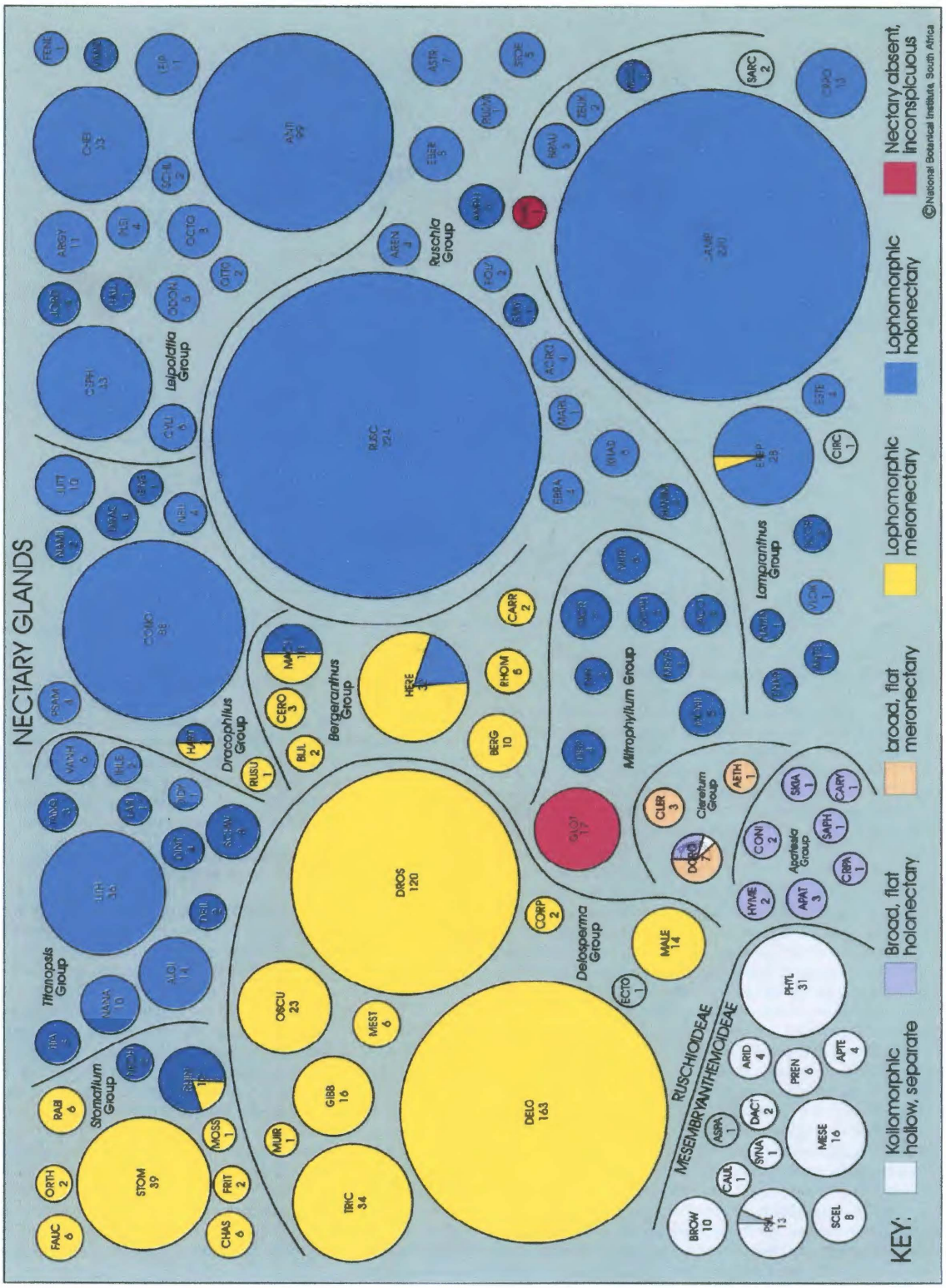
Characters that are useful in identification are not necessarily those that are phylogenetically informative. To facilitate comparative studies and to assess the taxonomic significance of characters at the generic level, character states are plotted graphically on "bubble diagrams". A similar approach has been used successfully by Dahlgren *et al.* (1985) to plot character distribution in the monocots. For the purposes of the present project a bubble diagram has been constructed for all mesemb genera based on currently used suprageneric grouping systems (Hartmann 1988, 1991, 1993, 1998, Chesselet *et al.* 2000). This diagram is the first of its kind for the group. The relative position of taxa in the diagram is not absolute, but the assignment of genera to a group more or less follows current concepts of grouping within the Ruschioideae. The relationships of groups to each other are based on the combined experience of the authors with the group; although subjective in part, it should simply be regarded as an attempt at proposing a working hypothesis.

General notes on the systematic significance of morphological characters in the mesembs

The most obvious characteristic of mesembs is that they are succulent plants, mostly succulent-leaved shrublets. This growth form has been extremely successful, as supported by the fact that members of this family dominate the vegetation in many of the arid and semi-arid parts of South Africa, and especially that of the Succulent Karoo Biome. For the taxonomist succulence is one of the main factors that make the basic process of mesemb identification so difficult, especially when dealing with dried, pressed specimens in herbaria. Morphological convergence is more apparent in succulents than in any other plant type and the identification of homologeous characters is obscured by the superficial similarities of convergent features. A further problem to mesemb taxonomists is that of environmentally induced morphological change, so-called plasticity. In addition, the poor quality of succulent plant herbarium material often necessitates the study of live specimens for taxonomic revisions and plant identification. It is therefore necessary to search for the invariable, more constant characters to facilitate the process of identification.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Figure 2. Distribution of nectary types in a graphic representation of relationships among genera of the Mesembryanthemaceae. The size of bubbles reflects the number of species as indicated for each genus.



ALOE 37, No 2 & 3, 2000. ISSN 0002-6301

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Figure 2: Acronyms for mesemb genera:

MESEMBRYANTHEMOIDEAE:
APTE Aptenia
ARID Aridaria
ASPA Aspazoma
BROW Brownanthus
CAUL Caulipsolon
DACT Dactylopsis
MESE Mesembryanthemum
PHYL Phyllobolus
PREN Prenia
PSIL Psilocaulon
SCEL Sceletium
SYNA Synaptophyllum

RUSCHIOIDEAE:
ACRO Acrodon
AETH Aethephyllum
ALOI Aloinopsis
AMPH Amphibolia
ANTE Antegibbaeum
ANTI Antimima
APAT Apatesia
AREN Arenifera
ARGY Argyroderma
ASTR Astridia
BERG Bergeranthus
BIJL Bijlia
BRAU Braunsia
CRPA Carpanthea
CRPO Carpobrotus
CARR Carruanthus
CARY Caryotophora
CEPH Cephalophyllum
CERO Cerochlamys
CHAS Chasmatophyllum
CHEI Cheiridopsis
CIRC Circandra
CLER Cleretum
CONI Conicosia
CONO Conophytum
CORP Corpuscularia
CYLI Cylindrophyllum
DEIL Deilanthe
DELO Delosperma
DICR Dicrocaulon
DIDY Didymaotus
DINT Dinteranthus
DIPL Diplosoma
DISP Disphyma
DORO Dorotheanthus
DRAC Dracophilus
DROS Drosanthemum
EBER Eberlanzia
EBRA Ebracteola
ECTO Ectotropis
ENAR Enarganthe
EREP Erepsia
ESTE Esterhuysenia
FAUC Faucaria
FENE Fenestraria
FRIT Frithia
GIBB Gibbaeum
GLOT Glottiphyllum
HALL Hallianthus
HAMM Hammeria
HART Hartmanthus
HERE Hereroa
HYME Hymenogyne
IHLE Ihlenfeldtia
JACO Jacobsenia
JENS Jensenobotrya
JORD Jordaaniella
JUTT Juttadinteria
KHAD Khadia
LAMP Lampranthus
LAPI Lapidaria
LEIP Leipoldtia
LITH Lithops
MACH Machairophyllum
MALE Malephora
MARL Marlothistella
MEST Mestoklema
MEYE Meyerophytum
MITR Mitrophyllum
MONI Monilaria
MOSS Mossia
MUIR Muiria
NAMA Namaquanthus
NAMI Namibia
NANA Nananthus
NELI Nelia
NEOH Neohenricia
OCTO Octopoma
ODON Odontophorus
OOPH Oophytum
ORTH Orthopterum
OSCU Oscularia
OTTO Ottosonderia
PLEI Pleiospilos
POLY Polymita
PSAM Psammophora
RABI Rabiea
RHIN Rhinephyllum
RHOM Rhombophyllum
RUSC Ruschia
RUSM Ruschianthemum
RUSU Ruschianthus
SAPH Saphesia
SARC Sarcozona
SCHL Schlechteranthus
SCHW Schwantesia
SCOP Scopelogena
SKIA Skiatophytum
SMIC Smicrostigma
STAY Stayneria
STOE Stoeberia
STOM Stomatium
TANQ Tanquana
TITA Titanopsis
TRIC Trichodiadema
VANH Vanheerdea
VANZ Vanzijlia
VLOK Vlokia
WOOL Wooleya
ZEUK Zeuktophyllum

Unlike traditional dichotomous keys which have a single path with choices at the dichotomies leading to the identification of taxa, interactive computer keys enable the selection of any characters in the list, in any sequence, thus accommodating the possibility of missing information on the specimen to be identified, e.g. no flowering material available. In addition to this multi-access facility, the key-generating programme LucID (1999) has the facility to select, from the character list, those characters that are most likely to segregate taxa. Using "best" characters shows the fastest route through the key and sorts the list of Characters Available from "best" to "worst". The ten best characters listed by LucID for the segregation of mesemb genera are, in order: 1) Overall appearance; 2) Leaf surface characteristics; 3) Leaf shape; 4) Number of locules of fruit; 5) Flower colour; 6) Visibility of internodes; 7) Presence or absence of covering membranes in fruit; 8) Absence or presence and type of exit closing mechanism in fruit; 9) Presence or absence of petaloid staminodes; and 10) Flower size.

Systematics is essentially a process of pattern recognition based on the multiple correlation of character states. Character analysis involves assessing the systematic value of characters on a comparative basis and the hierarchical level at which they will serve to define groups. The mesembs, as most other plant groups, are characterised by a reticulate distribution of characters. Data sets from different sources have been shown to be incongruous in the Mesembryanthemaceae. For example, groups based on fruit types (Hartmann 1988) often do not coincide with groups made using a combination of vegetative and reproductive organs (Hartmann 1991; 1993). Likewise, Dupont (1968) found that groups based on seedling ontogeny do not correspond with those based on epidermal characteristics. Careful consideration of the relative importance assigned to character sets, and in particular their relevance at a particular rank in the taxonomic hierarchy, is therefore necessary in the evaluation of generic limits, and in relationships among genera. Over the past 80 years the mesembs have undergone extensive splitting at the generic level and today 123 genera are recognised (Smith *et al.* 1998; Chesselet *et al.* 2000). The mainstay of these splits has relied mainly on various characters of the mesemb capsule, described by Schwantes (1957: 343) as "...not only the most complicated but also the most beautiful fruits of this type in the whole plant kingdom". Although the fruit of the mesembs are indeed very useful in generic delimitation (Hartmann 1988; Smith *et al.* 1998: 20-25), the emphasis that has been placed on them in the past has tended to obscure the potential systematic importance of other characters.

Taxonomic significance of floral nectaries in mesemb classification

Rappa and Camarrone (1962) used the characteristics of floral nectaries to devise a classification for the mesembs that was never broadly accepted. They recognised the importance of this character in establishing relationships among genera but the classification is floored by the combination of nectary characters with number of parts of the ovary, for example *Gibbaeum* is placed in the group "Hexameronectarlinae" on account of its six nectary segments. Zandonella (1977) considers floral nectaries as structures representative of floral morphology and views their comparative study as contributing to a better understanding of phylogeny in the order Centrospermales, the group in which the Mesembryanthemaceae is classified. He concludes that the evolution of the nectary reflects floral evolution and can be an excellent phylogenetic guide that should no longer be ignored in natural classifications.

Mesemb flowers with their brightly coloured, shiny petals and nectaries are obviously adapted to insect pollination (Ihlenfeldt 1994). The nectary is situated at the base of the flower, on the receptacle, between the petals and the androecium. In the

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Aizoaceae *s.str.* the nectary forms a continuous ring (Zandonella 1977). Rappa (1912) distinguishes two types of nectary in the mesembs: the shell-shaped hollow nectary (koilomorphic), the depth of which can vary (Bittrich 1987) and the crest-shaped nectary (lophomorphic). The latter can form a continuous ring (holonectary) or can be segmented (meronectary). In some cases the separate glands extend so far laterally that they almost touch each other, appearing annular, e.g. in some species of *Delosperma*, *Malephora* (Hartmann 1991) and *Mossia* (Smith *et al.* 1997).

Rappa (1912) interprets holonectaries, such as those found in the Aizoaceae *s.str.* (Figure 1), as ancestral, and meronectaries and koilomorphic nectaries as derived. Ihlenfeldt (1960) and Zandonella (1977) consider the koilomorphic type, unique to the subfamily Mesembryanthemoideae, as most primitive in the Mesembryanthemaceae. Outgroup comparison shows that a flat nectary is the primitive condition, with the shell-shaped (koilomorphic) and crest-shaped (lophomorphic) nectaries being advanced (Bittrich & Struck 1989). Whether the holonectary or the meronectary is more advanced in Ruschioideae is uncertain. Holonectaries are found in all other taxa belonging to the Centrospermae (Zandonella 1977), so the segmentation of the nectary (meronectary) found in both Mesembryanthemoideae and Ruschioideae is unique to the mesembs. In the Ruschioideae the meronectary is found in taxa showing other primitive features, suggesting the primitiveness of this feature within this subfamily (Bittrich & Struck 1989). The holonectary of ruschioid taxa should therefore be regarded as advanced. It differs from the aizoaceous holonectary in that it is crested (lophomorphic).

The systematic distribution of nectary type in the mesembs is depicted graphically in Figure 2. The various types (states) recognised for the purposes of this paper are illustrated in Figure 1. The following are the conclusions or hypotheses that can be derived from the interpretation of the diagram:

- The structure of the nectary is a very conservative character, showing a distinctive pattern without much convergence or parallelism.
- The Ruschioideae are split into two large groups, those with an annular nectary (holonectary) and those with a segmented nectary (meronectary). Species belonging to the *Cleretum* and *Apatesia* Groups need further investigation to gain a better understanding of nectary structure and variation in the more primitive ruschioid taxa.
- The groups of genera that are predominantly summer rainfall species have the more "primitive" segmented nectary. Contrary to popular assumptions that the high genus frequencies of mesembs in the winter-rainfall region reflect the original distribution of the mesembs, Hartmann (1994) has suggested that the origin of Mesembryanthemaceae has lain outside the winter rainfall region. Centres of diversity are not necessarily centres of origin, and the stock from which the Ruschioideae evolved may have been the summer rainfall groups. Here, less diversification occurred, with a greater stability and the absence of the driving force that led to immense diversification known for the mesembs in the more recently evolved winter-rainfall area.
- Plotting a conservative character such as the nectary on a diagram representing the family can highlight certain discrepancies in the present classification. For example, the meronectary present in the genus *Erepsia* represents *Semnanthe lacera* (Haw.) N.E.Br., a species that was recently included in *Erepsia* (Liede 1989). *Erepsia* belongs in the *Lampranthus* Group which is characterised by annular nectary glands. Characteristics of the nectary suggest that lumping *Semnanthe* into *Erepsia* is a taxonomic decision that should be reconsidered.
- *Neohenricia* and *Ruschianthus* need to be reassessed, either in terms of nectary type (possible misinterpretation of structure), or their assignment to supra-generic groups. *Ruschianthus*, for example, may not be well placed in the *Dracophilus* Group.
- *Rhinephyllum*, a genus in need of formal revision, has both holo- and meronectaries present. This apparent heterogeneity provides further justification for the resurrection of the genus *Peersia* (Hartmann 1998) of which both species have separate nectary glands. *Rhinephyllum s.str.* may then be better placed in a group characterised by holonectaries.

The above brief discussion of the taxonomic significance of floral nectaries in mesembs serves as an example of how various other morphological characters in the mesembs will be considered on a comparative basis in the project which is currently in progress. It is hoped that such a systematic treatment of characters would lead to an improved understanding of the evolution of this diverse group of succulents. Insights thus gained can then be translated into an improved classification of the group that is not only natural but also reflects possible phylogenetic relationships.

Acknowledgements

We thank Prof. Peter Linder, Bolus Herbarium, University of Cape Town, for useful discussions about interactive keys, and Steven Hammer for emergency dissections of *Nelia* flowers.

Literature

Barthlott, W. & Hunt, D.R. 1993. Cactaceae. Pp. 161–197 in: Kubitzki, K., Rohwer, J.G. & Bittrich, V. (eds.), *The families and genera of vascular plants*, 2. Springer-Verlag, Berlin.

Bittrich, V. & Struck, M. 1989. What is primitive in the Mesembryanthemaceae? An analysis of evolutionary polarity of character states. *South African Journal of Botany* 55: 321–331.

Bittrich, V. 1986. Untersuchungen zu Merkmalsbestand, Gliederung und Abgrenzung der Unterfamilie Mesembryanthemoideae (Mesembryanthemaceae Fenzl). *Mitteilungen aus dem Institut für Allgemeine Botanik Hamburg* 21: 5–116.

Chesselet, P. & De Wet, B.C. 1997. Mesembryanthemaceae Fenzl (vygie or ice plant family). Pp. 89–122 in: Smith, G.F., Van Jaarsveld, E.J., Arnold, T.H., Steffens, F.E., Dixon, R.D. & Retief, J.A. (eds.), *List of southern African succulent plants*. Umdaus Press, Pretoria.

Chesselet, P., Mossmer, M. & Smith, G.F. 1995. Research priorities in the succulent plant family Mesembryanthemaceae Fenzl. *South African Journal of Science* 91: 197–209.

Chesselet, P., Smith, G.F., Burgoyne, P.M., Klak, C., Hammer, S.A., Hartmann, H.E.K., Kurzweil, H., Van Jaarsveld, E.J., Van Wyk, B-E., & Leistner, O.A. 2000. Mesembryanthemaceae. In: Leistner O.A. (ed.). *Seed plants of southern Africa: families and genera. Strelitzia* 10 (in press).

Cole, D. 1988. *Lithops. Flowering stones*. Acorn Books in association with Russel Friedman Books, South Africa.

Cowling, R.M., Esler K.J. & Rundell., P.W. 1999. Namaqualand, South Africa – an overview of a unique winter-rainfall desert ecosystem. *Plant Ecology* 142: 3–21.

Dahlgren, R., Clifford, H.T. & Yeo, P.F. 1985. *The families of the Monocotyledons. Structure, evolution and taxonomy*. Springer-Verlag, Berlin.

Desmet, P.G. & Cowling, R.M. 1999. Biodiversity, habitat and range-size aspects of a flora from a winter-rainfall desert in north-western Namaqualand, South Africa. *Plant Ecology* 142: 23–33.

Dupont, S. 1968. Épidermes et plantules des Mésembryanthemacées. Systématique. Évolution. *Bulletin de la Société d'Histoire Naturelle de Toulouse* 104: 7–64.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Hammer, S.A. 1993. *The genus* Conophytum: *a conograph*. Succulent Plant Publications, Pretoria.

Hartmann, H.E.K. 1988. Fruit types in Mesembryanthema. *Beiträge zur Biologie der Pflanzen* 63: 313–349.

Hartmann, H.E.K. 1991. Mesembryanthema. *Contributions from the Bolus Herbarium* 13: 75–157.

Hartmann, H.E.K. 1993. Aizoaceae. Pp. 37–69 in: Kubitzki, K., Rohwer, J.G. & Bittrich, V. (eds.), *The families and genera of vascular plants*, 2. Springer-Verlag, Berlin.

Hartmann, H.E.K. 1998. A letter to the MSG. *Mesemb Study Group Bulletin* 2: 32–34.

Herre, H. 1971. *The genera of the Mesembryanthemaceae*. Tafelberg, Cape Town.

Ihlenfeldt, H-D. 1994. Diversification in an arid world: The Mesembryanthemaceae. *Annual Review of Ecology and Systematics* 25: 521–546.

Liede, S. 1989. Untersuchungen zum Merkmalsbestand und zur Taxonomie der 'Erepsiinae' (Mesembryanthemaceae). *Beiträge zur Biologie der Pflanzen* 64: 391–479.

LucID Professional. Contemporary Identification Tools (1999). Centre for Pest Information and Technology Transfer. The University of Queensland, Brisbane. CSIRO Publishing.

Rappa, F. 1912. Per una classificazione naturale dei Mesembriantemi. *Bollettino delle reale orto botanico e giardino coloniale de Palermo* 11: 21–36.

Rappa, F. & Camarrone, V. 1962. La classificazione naturale delle Mesembriantemacee. *Lavori dell' Istituto Botanico e Giardino Coloniale Palermo* 18: 11–32.

Schwantes, G. 1957. *Flowering stones and mid-day flowers*. Ernest Benn Limited, London.

Smith, G.F., Chesselet, P., Van Jaarsveld, E.J., Hartmann, H., Hammer, S., Van Wyk, B-E., Burgoyne, P., Klak, C. & Kurzweil, H. 1998. *Mesembs of the world*. Briza, Pretoria.

Smith, G.F., Hartzer, P. & Van Wyk, A.E. 1997. Plate 310. *Messa intervallaris*. *Curtis's Botanical Magazine* 14: 16–22.

Smith, G.F., Hobson, S.R., Meyer, N.L., Chesselet, P., Archer, R.H., Burgoyne, P.M., Glen, H.F., Herman, P.P.J., Retief, E., Smithies, S.J., Van Jaarsveld, E.J. & Welman, W.G. 1993. Southern African succulent plants – an updated synopsis. *Aloe* 30: 31–74.

Van Wyk, B-E. & Gericke, N. 2000. *People's plants*. Briza, Pretoria.

Zandonella, P. 1977. Apports de l'étude comparée des nectaires floraux à la conception phylogénétique de l'ordre des Centrospermales. *Berichte der Deutschen Botanischen Gesellschaft* 90: 105–125.

Pascale Chesselet

Compton Herbarium, National Botanical Institute, Private Bag X7, Claremont 7735, South Africa.

Gideon F. Smith

Office of the Research Director, National Botanical Institute, Private Bag X101, Pretoria 0001, South Africa.

Abraham E. Van Wyk

H.G.W.J. Schweickerdt Herbarium, Department of Botany, University of Pretoria, Pretoria 0002, South Africa.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 4

Chesselet, P., Smith, G. F. & Van Wyk, A.E. 2002. A new tribal classification of the Mesembryanthemaceae: evidence from floral nectaries. *Taxon*: 295–308.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

A new tribal classification of Mesembryanthemaceae: evidence from floral nectaries

Pascale Chesselet[1], Gideon F. Smith[2] & Abraham E. van Wyk[3]

[1] *Compton Herbarium, National Botanical Institute, Private Bag X7, Claremont 7735, South Africa. E-mail: chesselet@nbict.nbi.ac.za; http://www.nbi.ac.za (author for correspondence)*
[2] *Office of the Research Director, National Botanical Institute, Private Bag X101, Pretoria 0001, South Africa. E-mail: gfs@nbipre.nbi.ac.za; http://www.nbi.ac.za*
[3] *H. G. W. J. Schweickerdt Herbarium, Department of Botany, University of Pretoria, Pretoria 0002, South Africa. E-mail: avanwyk@scientia.up.ac.za*

Mesembryanthemaceae Fenzl, here defined as excluding Aizoaceae Rudolphi s.str., are divided into five major groups, primarily on the basis of characters of the floral nectary. In terms of nectary type, the meronectary is considered a synapomorphy for the family Mesembryanthemaceae. The koilomorphic meronectary is a synapomorphy for subfamily Mesembryanthemoideae, considered the basal group; it is not further divided at tribal level. Four distinct nectary types characterize the more specialized subfamily Ruschioideae Schwantes in Ihlenf., Schwantes & Straka emend. Bittrich & H.E.K. Hartmann, and are used here to establish a new tribal classification for the group. Tribe Apatesieae Schwantes emend. Chesselet, G.F. Sm. & A.E. van Wyk (seven genera) is characterized by a broad, flat holonectary. Fruits in this tribe have diversified and several have lost hygrochastic properties. The group is regarded as primitive among Ruschioideae. Subtribe Dorotheanthinae Schwantes ex Ihlenf. & Struck (three genera) is raised to tribal level as Dorotheantheae (Schwantes ex Ihlenf. & Struck) Chesselet, G.F. Sm. & A.E. van Wyk. Plants in this tribe have semi-succulent leaves and all are annuals. The group has flowers with broad, flat meronectaries, and is not defined by any synapomorphy in terms of nectary type. Tribe Delospermeae Chesselet, G.F. Sm. & A.E. van Wyk (27 genera) is newly proposed to include all taxa with a lophomorphic meronectary; it has diversified mostly in the summer-rainfall region of southern Africa. Tribe Ruschieae, as emended here, incorporates 71 genera. It is characterized by a lophomorphic holonectary and has diversified mostly in the arid winter-rainfall region of southern Africa. Nectary types suggest primitiveness of Delospermeae in relation to Ruschieae among the highly succulent ruschioid taxa and support previous hypotheses suggesting that more derived Ruschioideae originated in the summer-rainfall region of southern Africa.

KEYWORDS: Aizoaceae, classification, evolution, flower, Mesembryanthemaceae, nectary, nomenclature, phylogeny, Ruschioideae.

INTRODUCTION AND BACKGROUND

Mesembryanthemaceae Fenzl, commonly known as ice plants, mesembs or vygies, are the largest succulent plant family in the world. They are mostly endemic to southern Africa and are concentrated in the arid to semi-arid western parts of the subcontinent, dominating the vegetation and flora in parts of the Succulent Karoo Biome, notably in Namaqualand along the West Coast. Only one genus and 18 species occur naturally outside this core area (Smith & al., 1998). The family's evolutionary success is evident in its richness of species: exceptional diversification has produced ± 1680 extant species currently grouped into 123 genera (Chesselet & al., 2000a). The mesembs are comparable in size (Barthlott & Hunt, 1993), succulent adaptations, and floral features (Zandonella, 1977) to the New World Cactaceae.

The taxonomy of mesembs is controversial, especially at higher ranks, and is still unresolved for many groups, particularly with regard to specific and generic delimitation; for a discussion see Chesselet & al. (1995). Two alternative family concepts are available: mesembs are either included (as subfamilies Mesembryanthemoideae and Ruschioideae; also referred to as the monophyletic Mesembryanthema) in the Aizoaceae Rudolfi s. str. excluding Molluginaceae (Bittrich & Hartmann, 1988; Hartmann, 1991, 1993) or are accorded family status, namely Mesembryanthemaceae (Herre & Volk, 1948; Herre, 1971). For reasons outlined in Chesselet & al. (1995, 2000a), we view mesembs as a family distinct

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

from Aizoaceae s. str. and follow this concept throughout this paper. Mesembryanthemaceae are classified in the order Caryophyllales sensu Cronquist (1981) and have traditionally been subdivided into two subfamilies, Mesembryanthemoideae and Ruschioideae. Subfamily Mesembryanthemoideae comprises 12 genera and about 95 species and is distinguished from Ruschioideae primarily by the axile position of the placenta in the ovary and the semi-epigynous flowers. Species are mostly flat-leaved and often weedy, but a few are highly succulent. Ruschioideae comprise 111 genera and about 1585 species. In this subfamily the ovary is inferior and the placenta is parietal to basal, sometimes with a central portion, and very rarely axile (Hartmann, 1991), e.g., in *Hymenogyne*. Most members of Ruschioideae are leaf succulent subshrubs, but a diversity of succulent growth forms occurs, ranging from minute "stone plants" to tree-like shrubs.

A formal supra-generic classification, based on contemporary evolutionary views and reliable morphological characters, is lacking for mesembs: Schwantes's tribal and subtribal classification (Schwantes, 1947; Ihlenfeldt & al., 1962; Herre, 1971) is now largely outdated. For presumed generic affinities, current research relies primarily on the provisional system for grouping genera proposed by Hartmann (1991, 1993, 1998a). She draws on extensive studies of fruit, flower and seed morphology, epidermal characters, and growth form for subdividing the subfamily Ruschioideae into 12 groups. Loculicidal hygrochastic capsules, which in most members open when wet and close when dry, are characteristic of most Mesembryanthemaceae (Hartmann, 1988). Fruit morphological characters are useful in the delimitation of genera (Brown, 1925; Hartmann & Stüber, 1993) and infrageneric groups (Hartmann & Bruckmann, 2000), yet the considerable emphasis placed on them in the past tended to obscure the potential systematic importance of other characters, especially at supragenerie level. Recently, Chesselet & al. (2000b, 2001), in a broader study aiming to analyze morphological characters for use in interactive keys to genera of Mesembryanthemaceae, found that floral nectaries are particularly informative for defining major groups within the family.

Aspects of floral nectaries have been included in a number of studies on the classification of mesembs (Rappa, 1912; Brown, 1925; Schwantes, 1927; Ihlenfeldt, 1960; Rappa & Camarrone, 1962; Bittrich & Struck, 1989; Hartmann, 1998b), but the potential of these structures for systematic resolution was not fully realized. Nectary structure is widely documented in species descriptions (Bolus, 1928, 1928–1935, 1936–1958) and, graphically, in the large collection of paintings of mesemb type specimens (Smith & Walker, 2001) held at the Bolus Herbarium (BOL), Cape Town.

In general, floral nectaries have been neglected in plant systematic studies. Yet, for most angiosperms, characters of the nectary are very constant in higher order groups, and there is a close association between nectary type and the position of the ovary (Brown, 1938). Brown attributes the apparent lack of interest in the systematic significance of nectaries to the fact that herbarium specimens are usually used in taxonomic studies. Being generally soft-tissued structures in mesembs, features of the nectary are easily lost upon drying. In Mesembryanthemaceae, the floral nectary is situated on the receptacle at the base of the petals and stamens, to the inside of the inner whorl of filaments. An aggregation of nectariferous tissue as a ring and in the same position, is characteristic of Caryophyllales, Polygonales, and nectariferous Chenopodiales, and characters of the nectary alone could be used to justify placement of Nyctaginaceae in Caryophyllales (Brown, 1938), a position recently substantiated by molecular evidence (APG, 1998). Zandonella (1977) used nectary characters to establish a basis for a phylogenetic system of Caryophyllales (= Centrospermales).

In Aizoaceae s. str. (excluding Mesembryanthemaceae) the nectary forms a continuous ring (Zandonella, 1977). Early work on mesemb flowers led Rappa (1912) to distinguish two types of nectaries: a shell-shaped, hollow nectary termed "koilomorphic" and a crest-shaped or lobed nectary termed "lophomorphic". Koilomorphic nectaries always occur as separate units (meronectary), each as a depression in which nectar presumably accumulates. Ihlenfeldt (1960) and Zandonella (1977) consider the koilomorphic type, unique to the subfamily Mesembryanthemoideae, as the most primitive state in Mesembryanthemaceae. Bittrich & Hartmann (1988), on the other hand, interpret the koilomorphic nectary as a synapomorphy for the subfamily Mesembryanthemoideae. Lophomorphic nectaries either form a continuous ring termed a "lophomorphic holonectary" or are segmented into separate areas of glandular tissue, usually corresponding to the number of parts (carpels) of the gynoecium, then termed a "lophomorphic meronectary". Among Caryophyllales, segmentation of the nectary (meronectary) is unique to mesembs and has been proposed as a synapomorphy for Mesembryanthemaceae (Bittrich & Struck, 1989). To explain the transition from annular to segmented nectaries observed in mesembs, Zandonella (1977) suggested that the previously annular nectaries were interrupted in the vicinity of the septa with the increasing fusion of the receptacle and ovary during the change of position from superior to (half-) inferior. In some mesembs the separate glands extend so far laterally that they almost join, superficially appearing annular, e.g., in some species of *Delosperma*, *Malephora* (Hartmann, 1991), *Neohenricia* (H.E.K. Hartmann, pers.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

comm.), and in *Mossia intervallaris* (L.Bolus) N.E.Br. (Smith & al., 1997). Hitherto no well-defined nectaries have been detected in the genus *Glottiphyllum*.

On the basis of nectary type, Rappa (1912) demarcated and informally named three major groups for mesembs: Coilomorphi, Lophomorphi and Anettari, which were later formally proposed as subfamilies (Rappa & Camarrone, 1962). Hartmann & Bittrich (1990) pointed out that these higher-level taxa lacked Latin descriptions and were thus not validly published. Rappa & Camarrone (1962) provided further subdivisions of these subfamilies and devised a classification for mesembs that was not widely accepted as it did not arrange taxa into a workable system and did not include all taxa. It is also somewhat artificial in that it relies on a combination of nectary type and number of parts of the meronectary, and proved unworkable owing to variation in locule number evident in many mesemb genera, as reflected by degree of nectary segmentation. For example, they placed *Gibbaeum* in the group "Hexameronectariinae" on account of the six segments of the nectary, corresponding to the six locules of the few species they had studied. Members of *Gibbaeum*, however, may have 6–9 locules and, hence, 6–9 segments to the nectary (Chesselet & al., 2000a).

In subfamily Mesembryanthemoideae the number of carpels (four or five) agrees with the number of calyx lobes as well as the number of nectary segments (Bittrich, 1986). In Ruschioideae, a similar pattern is known for *Pleiospilos* with five or six calyx lobes corresponding to 10 or 12 locules, respectively (Hartmann & Liede, 1986) and for *Oophytum* with six parts in both calyx and gynoecium (Ihlenfeldt, 1978). The putative primitive mesembs have 5 (or 4) parts to the gynoecium, and in the order Caryophyllales, pentamerous flowers with five carpels have been proposed as the primitive pattern (Hofmann, 1994). A remarkable feature of Mesembryanthemaceae is that contrary to general evolutionary trends towards reduction in the number of floral parts evident in many plant groups, the number of carpels in the gynoecium has increased in many putatively derived genera. For example, *Namibia* may have up to 28 locules, and *Argyroderma*, *Conicosia* and *Jordaaniella* up to 25. The general trend towards increasing oligomerization is rarely replaced by polymerization. Intriguingly, this reversed trend in mesembs is also manifested in Cactaceae (Takhtajan, 1991). Endress (1990) points out that diversity of floral structure occurs at different levels of organization, with emphasis either on number and position or on synorganization (the structural connection between neighbouring elements to form a functional unit).

In the present study, flowers of all mesemb genera have been investigated for organ number variation including, in particular, number of locules and number of sepals; at the same time these observations were related to nectary type. Numbers of "petals" (staminodes) and stamens are not considered, as Mesembryanthemaceae flowers are characterized by the multiplication of parts of the "corolla" and of the androecium, as are the flowers of Cactaceae (Zandonella, 1977).

In angiosperms, floral nectaries originate from different tissues: they may, for example, represent a modified and usually reduced corolla (in apetalous flowers), modified stamens, or they may be derived from parts of the carpel (Cronquist, 1968). Based on extensive ontogenetic studies, Ihlenfeldt (1960) suggests that in mesembs nectaries form part of the gynoecium and not of the androecium as interpreted by Zandonella (1977). Hence, in the present paper we follow the interpretation of Ihlenfeldt, a view also supported by Hartmann (pers. comm.).

Functionally, nectaries of mesembs are presumably involved in pollination biology. Mesemb flowers with their bright-coloured, shiny petals are apparently always insect-pollinated. Although few observations are available on the pollination biology of mesembs (Hartmann, 1991), known pollen vectors include bees, butterflies, moths and wasps (Vogel, 1954; Gess & Gess, 1989). Nectar and/or pollen may serve as a reward to pollinators. Nectar visible as liquid is rare in mesembs, but has been reported in the genus *Nelia* (Smith & al., 1998), *Dicrocaulon*, and in *Ruschia dichroa* (Rolfe) L.Bolus (present study). Nectar has also been noted in *Astridia* and *Dactylopsis* (S. A. Hammer, pers. comm.). Considering the arid environment under which most mesembs grow, it is perhaps not surprising that liquid nectar is not generally seen.

In this paper, the taxonomic significance of floral nectaries in Mesembryanthemaceae is assessed and a formal tribal classification, based on these structures, is proposed. Cladistic methods are used to depict the distribution of various nectary structural types within the groups and to propose a hypothesis on their evolutionary interrelationships.

MATERIAL AND METHODS

Data on nectaries (Table 1) were obtained primarily from available published sources, already synthesized in Chesselet & al. (2000a). Live material was used for checking information when necessary. The range of nectary types was analyzed (Fig. 1) and discrete character states were established. To interpret the significance of the observed variation in nectary characters, data on related aspects of the flower, including sepal and carpel numbers, were summarized in a comparable format for each genus (Table 1). For comparative purposes, charac-

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Table 1. List of mesemb genera showing acronyms used in Fig. 2, genus and author citation, variation in floral organ number (locules and sepals), and nectary type.

Acronym	Genus & author citation	Number of locules	Number of sepals	Nectary type				
				holonectary		meronectary		
				flat	lopho.	flat	kollo.	lopho.
Subfamily Mesembryanthemoideae Ihlenf., Schwantes & Straka								
APTE	*Aptenia* N.E. Br.	4	4				X	
ARID	*Aridaria* N.E. Br.	4, 5	4				X	
ASPA	*Aspazoma* N.E. Br.	4, 5	4, 5				X	
BROW	*Brownanthus* Schwantes	3, 4, 5	4, 5				X	
CAUL	*Caulipsolon* Klak	5	5				X	
DACT	*Dactylopsis* N.E. Br.	5	5				X	
MESE	*Mesembryanthemum* L. emend. L. Bolus	(4) 5	5				X	
PHYL	*Phyllobolus* N.E. Br.	4, 5	4, 5				X	
PREN	*Prenia* N.E. Br.	4	4, 5				X	
PSIL	*Psilocaulon* N.E. Br.	4, 5	4, 5				X	
SCEL	*Sceletium* N.E. Br.	4, 5 (6)	4, 5 (6)				X	
SYNA	*Synaptophyllum* N.E. Br.	4	4				X	
Subfamily Ruschioideae Schwantes in Ihlenf., Schwantes & Straka emend. Bittrich & H.E.K. Hartmann								
Apatesieae Schwantes emend. Chesselet, G.F. Sm. & A.E. van Wyk								
APAT	*Apatesia* N.E. Br.	8–12	5	X				
CRPA	*Carpanthea* N.E. Br.	12–18	5	X				
CARY	*Caryotophora* Leistner	3, 4	5	X				
CONI	*Conicosia* N.E. Br.	10–25	5	X				
HYME	*Hymenogyne* Haw.	8–12	5	X				
SAPH	*Saphesia* N.E. Br.	5	5	X				
SKIA	*Skiatophytum* L. Bolus	(4) 5–7	5	X				
Dorotheantheae (Schwantes ex Ihlenf. & Struck) Chesselet, G.F. Sm. & A.E. van Wyk								
AETH	*Aethephyllum* N.E. Br.	(4) 5 (6)	5			X		
CLER	*Cleretum* N.E. Br.	5 (6)	5			X		
DORO	*Dorotheanthus* Schwantes	5	5	(?X)		X		
Delospermeae Chesselet, G.F. Sm. & A.E. van Wyk								
BERG	*Bergeranthus* Schwantes	5	5					X
BIJL	*Bijlia* N.E. Br.	5	5					X
CARR	*Carruanthus* (Schwantes) Schwantes	5	5					X
CERO	*Cerochlamys* N.E. Br.	5, 6	5, 6					X
CHAS	*Chasmatophyllum* Dinter & Schwantes	5	5					X
CORP	*Corpuscularia* Schwantes	6	6					X
DELO	*Delosperma* N.E. Br. em. Lavis	(4) 5 (6)	5					X
DROS	*Drosanthemum* Schwantes	5 (6)	5 (6)					X
ECTO	*Ectotropis* N.E. Br.	5	5					X
FAUC	*Faucaria* Schwantes	5, 6	5					X
FRIT	*Frithia* N.E. Br.	5, 6	5					X
GIBB	*Gibbaeum* Haw.	6–9	6–9					X
HERE	*Hereroa* (Schwantes) Dinter & Schwantes	5	5					X
MACH	*Machairophyllum* Schwantes	(5–) 12 (–15?)	5–8					X
MALE	*Malephora* N.E. Br.	8–12	4, 5					X
MEST	*Mestoklema* N.E. Br. ex Glen	5	5					X
MOSS	*Mossia* N.E. Br.	5 (6)	5					X
MUIR	*Muiria* N.E. Br.	6	6					X
NEOH	*Neohenricia* L. Bolus	4–6	5					X
ORTH	*Orthopterum* L. Bolus	5, 6	5					X
OSCU	*Oscularia* Schwantes	5	5					X
RABI	*Rabiea* N.E. Br.	7–10	5 (–7)					X
RHIN	*Rhinephyllum* N.E. Br.	5	5					X
RHOM	*Rhombophyllum* (Schwantes) Schwantes	5	5					X
RUSU	*Ruschianthus* L. Bolus	5	5					X

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Table 1 (continued).

Acronym	Genus & author citation	Number of locules	Number of sepals	Nectary type				
				holonectary		meronectary		
				flat	lopho.	flat	kollo.	lopho.
STOM	*Stomatium* Schwantes	5 (6)	4, 5, 6					X
TRIC	*Trichodiadema* Schwantes	5–8	5–8					X
Ruschieae Schwantes emend. Chesselet, G.F. Sm. & A.E. van Wyk								
ACRO	*Acrodon* N.E. Br.	5	5, 6		X			
ALOI	*Aloinopsis* Schwantes	6–14	5, 6		X			
AMPH	*Amphibolia* L. Bolus	5	5		X			
ANTE	*Antegibbaeum* Schwantes ex C. Weber	6	6		X			
ANTI	*Antimima* N.E. Br. emend. Dehn	5 (6)	5		X			
AREN	*Areniferu* A.G.J. Herre	8	4		X			
ARGY	*Argyroderma* N.E. Br.	12–25	6, 7, 8		X			
ASTR	*Astridia* Dinter	6	6		X			
BRAU	*Braunsia* Schwantes	(4) 5 (–7)	5		X			
CRPO	*Carpobrotus* N.E. Br.	4–20	5		X			
CEPH	*Cephalophyllum* N.E. Br.	10–21	5		X			
CHEI	*Cheiridopsis* N.E. Br.	10–20	4, 5		X			
CIRC	*Circandra* N.E. Br.	5	5		(?X)			
CONO	*Conophytum* N.E. Br.	3–8	4, 5, 6		X			
CYLI	*Cylindrophyllum* Schwantes	5–11	5		X			
DEIL	*Deilanthe* N.E. Br.	8–12	5		X			
DICR	*Dicrocaulon* N.E. Br.	(4–) 5 (6–9)	4, 5		X			
DIDY	*Didymaotus* N.E. Br.	6	6		X			
DINT	*Dinteranthus* Schwantes	6–15	(6) 7 (8)		X			
DIPL	*Diplosoma* Schwantes	5–7	5–7		X			
DISP	*Disphyma* N.E. Br.	5	5		X			
DRAC	*Dracophilus* (Schwantes) Dinter & Schwantes	(8–) 11 (14)	5		X			
EBER	*Eberlanzia* Schwantes	5	5		X			
EBRA	*Ebracteola* Dinter & Schwantes	5	5		X			
ENAR	*Enarganthe* N.E. Br.	8	4		X			
EREP	*Erepsia* N.E. Br.	5 (9–13)	5		X			
ESTE	*Esterhuysenia* L. Bolus	5	5		X			
FENE	*Fenestraria* N.E. Br.	8–16	5		X			
GLOT	*Glottiphyllum* (Haw.) N.E. Br.	5–14	4		(?)			(?)
HALL	*Hallianthus* H.E. K.Hartmann	10	5		X			
HAMM	*Hammeria* Burgoyne	5	5		X			
HART	*Hartmanthus* S.A. Hammer	6	5		(X)			(X)
IHLE	*Ihlenfeldtia* H.E.K. Hartmann	10–15	5		X			
JACO	*Jacobsenia* L. Bolus & Schwantes emend. Ihlenf.	5	(4) 5,6 (–8)		X			
JENS	*Jensenobotrya* A.G.J. Herre	5 (6)	5		X			
JORD	*Jordaaniella* H.E.K. Hartmann	10–25	(4) 5 (6)		X			
JUTT	*Juttadinteria* Schwantes	8 (–11)	4		X			
KHAD	*Khadia* N.E. Br.	(4) 5–11	5, 6		X			
LAMP	*Lampranthus* N.E. Br.	5–7	5		X			
LAPI	*Lapidaria* (Dinter & Schwantes) N.E.Br.	6–8	6–8		X			
LEIP	*Leipoldtia* L.Bolus	10 (–16)	5 (6)		X			
LITH	*Lithops* N.E. Br.	4–7 (9)	4–7		X			
MARL	*Marlothistella* Schwantes	5	5		X			
MEYE	*Meyerophytum* Schwantes	5	5		X			
MITR	*Mitrophyllum* Schwantes	5 (–7)	5		X			
MONI	*Monilaria* (Schwantes) Schwantes	5 (–7)	5		X			
NAMA	*Namaquanthus* L. Bolus	(8–) 12 (–16)	4 (5, 6)		X			
NAMI	*Namibia* (Schwantes) Schwantes	(9–) 12 (–28)	5		X			
NANA	*Nananthus* N.E. Br.	6–10	5		X			
NELI	*Nelia* Schwantes	5	5		X			
OCTO	*Octopoma* N.E. Br.	6–8	4 (5)		X			
ODON	*Odontophorus* N.E. Br.	(8–) 10 (–11)	4, 5		X			

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Table 1 (continued).

Acronym	Genus & author citation	Number of locules	Number of sepals	Nectary type				
				holonectary		meronectary		
				flat	lopho.	flat	kolle.	lopho.
OOPH	*Oophytum* N.E. Br.	(5) 6	6 (7)		X			
OTTO	*Ottosonderia* L. Bolus	(6–) 8	4		X			
PLEI	*Pleiospilos* N.E. Br.	10–12			X			
POLY	*Polymita* N.E. Br.	(8–) 10 (–18)	(4) 5, 6 (–8)		X			
PSAM	*Psammophora* Dinter & Schwantes	5, 6 (7)	4		X			
RUSC	*Ruschia* Schwantes	5 (6)	(4) 5		X			
RUSM	*Ruschianthemum* Friedrich	5	5		X			
SARC	Sarcozona J.M. Black	4, 5	5		(?X)			
SCHL	*Schlechteranthus* Schwantes	10–12	6		X			
SCHW	*Schwantesia* Dinter	5	5		X			
SCOP	Scopelogena L. Bolus	5	5		X			
SMIC	*Smicrostigma* N.E. Br.	7–10	5		X			
STAY	*Stayneria* L. Bolus	(6–) 7, 8 (–9)	5, 6		X			
STOE	*Stoeberia* Dinter & Schwantes	5 (6)	5, 6		X			
TANQ	*Tanquana* H.E.K. Hartmann & Liede	9, 10	4, 5		X			
TITA	*Titanopsis* Schwantes	(5) 6 (–10)	5, 6		X			
VANH	*Vanheerdea* L. Bolus ex H.E.K. Hartmann	7–15	5–9		X			
VANZ	*Vanzijlia* L. Bolus	10	5		X			
VLOK	*Vlokia* S.A. Hammer	5–7	6		X			
WOOL	*Wooleya* L. Bolus	11–12	4		X			
ZEUK	*Zeuktophyllum* N.E. Br.	10	4		X			

ters of the nectary were assessed for their taxonomic significance by plotting nectary types graphically on a so-called bubble diagram representing all mesemb genera (Fig. 2). A similar approach has been used successfully by, amongst others, Dahlgren & al. (1985) to plot character distribution in the monocotyledons. The diagram presented in Chesselet & al. (2000b), the first of its kind for mesembs, is reproduced in Fig. 2 of the present paper.

Table 2. Characters and states used in the cladistic analysis of Mesembryanthemaceae.

1. Basic chromosome number (0, $n = 8$; 1, $n = 9$)
2. Perianth (0, petals absent; 1, petals present)
3. Gynoecium (0, superior; 1, half inferior; 2, inferior)
4. Calcium oxalate crystals (0, druses; 1, raphide bundles)
5. Tepals (0, bases fused to form short tube; 1, free)
6. Cortical bundles (0, absent; 1, present)
7. Stamens and petals (0, forming a tube; 1, free)
8. Filaments (0, naked; 1, papillate)
9. Expanding keels—location in capsule (0, centre of fruit to tip of valve; 1, restricted to valves; 2, reduced or absent)
10. Nectary shape (0, holonectary; 1, meronectary)
11. Nectary surface (0, flat or smooth; 1, pits or hollows; 2, crests or lobes)
12. Placenta (0, axile; 1, basal to parietal)
13. Covering membranes in capsule (0, absent; 1, present)
14. Leaves (0, semi-succulent; 1, succulent)

The size of the "bubbles" reflects the size of genera. The relative position of taxa in the diagram is not absolute but follows current concepts of groupings within Ruschioideae (Hartmann 1988, 1991, 1993, 1998a; Chesselet & al. 2000a). The relationship of groups to one another is based on the combined experience of the authors with the family; although subjective in part, it should be regarded as a working hypothesis. Following initial character assessment, nectary characters were further broken down into two distinct characters, each with a number of states. A taxon/ character matrix was constructed (Table 3) and analyzed according to cladistic methods using Hennig86. States considered synapomorphic were plotted on the resultant cladogram of the family (Fig. 3).

Table 3. Data matrix used for generation of cladogram in Mesembryanthemaceae.

Hypothetical ancestor	000000??000000
Mesembryanthemoideae	11110100011000
Apatesieae	11211011200100
Dorotheantheae	11211011110110
Delospermeae	11211011112111
Ruschieae	11211011102111

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

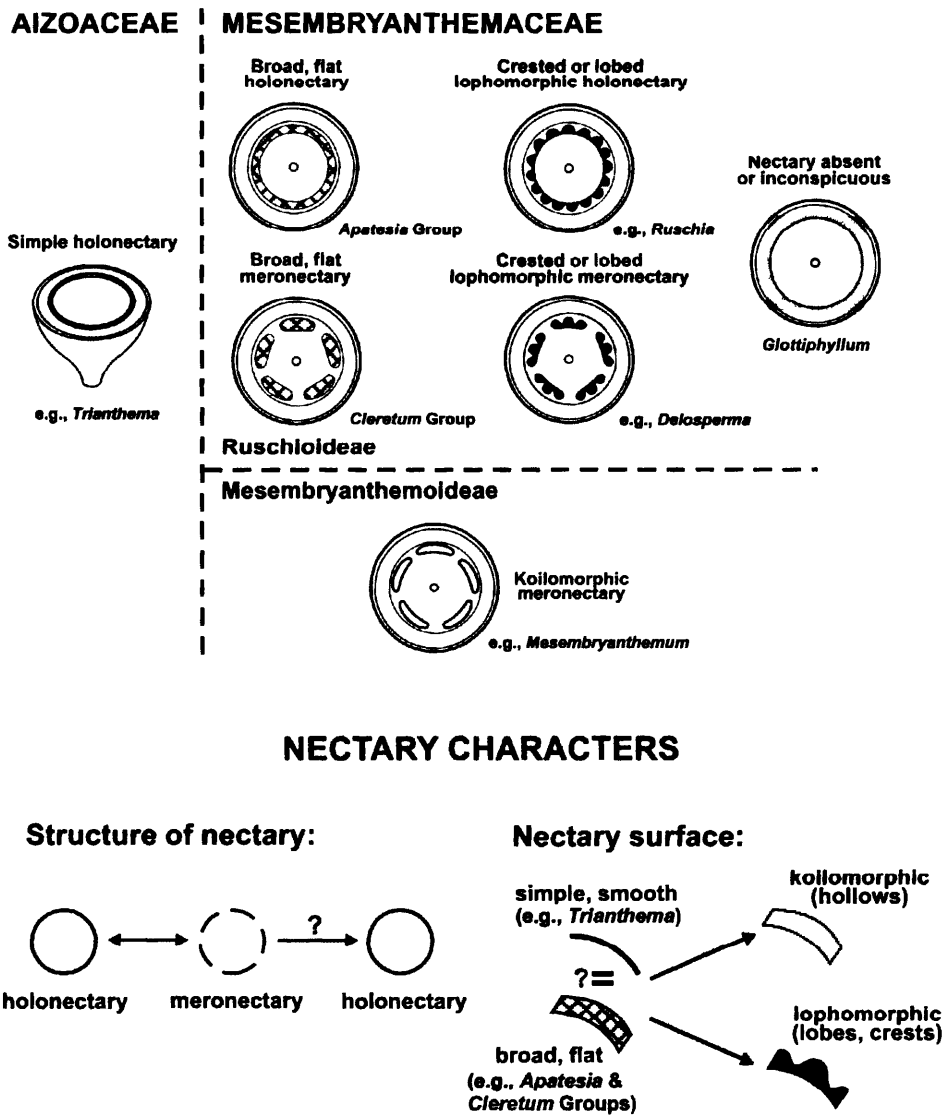


Fig. 1. Simplified representation of nectary types in mesembs and outgroup (Aizoaceae s.str.), as well as nectary characters and states.

RESULTS AND DISCUSSION

Taxonomic distribution of nectary types in Mesembryanthemaceae. — Six distinct morphological types of floral nectaries are recognized in mesembs (Fig. 1). These are, with taxonomic distribution in parentheses: (1) hollow or shell-shaped and separate ("koilomorphic meronectary"; Mesembryanthemoideae); (2) broad, flat and annular ("broad, flat holonectary"; *Apatesia* Group); (3) broad, flat and divided ("broad, flat

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

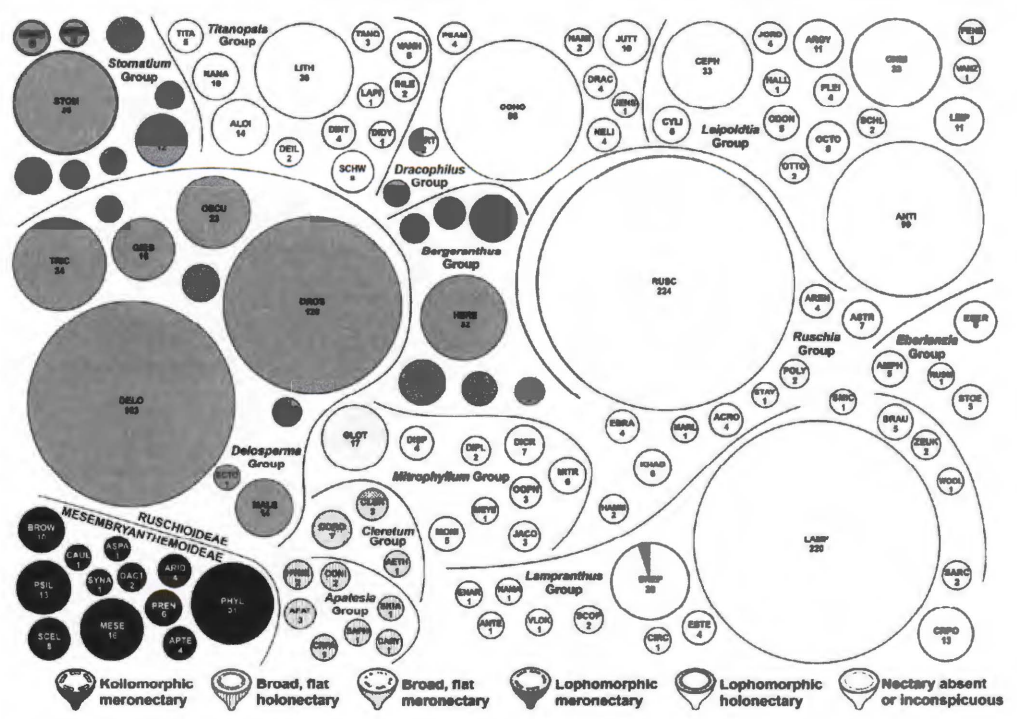


Fig. 2. Taxonomic distribution of floral nectary types in a graphic representation of relationships among mesemb genera. The size of bubbles reflects the number of species as indicated for each genus. Shading codes for nectary types as in Fig. 3.

meronectary"; *Cleretum* Group); (4) crested or lobed and composed of segments ("lophomorphic meronectary"; *Bergeranthus*, *Delosperma* and *Stomatium* Groups); (5) crested or lobed and annular ("lophomorphic holonectary"; *Dracophilus*, *Eberlanzia*, *Lampranthus*, *Leipoldtia*, *Mitrophyllum*, *Ruschia* and *Titanopsis* Groups); (6) inconspicuous (either relictual or absent; *Glottiphyllum*). Aizoaceae s.str. (excluding Mesembryanthemaceae), here considered sister to mesembs, have ring-shaped holonectaries.

By plotting the taxonomic distribution of nectary types on the bubble diagram of mesemb genera (Fig. 2), it emerges that the nectary is a conservative structure. A distinctive pattern prevails without obvious convergence or parallelism (homoplasy). Five major groups of genera are discerned on the basis of nectary type (Fig. 3). Subfamily Mesembryanthemoideae is defined by a koilomorphic meronectary (Bittrich, 1986; Bittrich & Hartmann, 1988). In the *Cleretum* Group the nectary is composed of discrete, broad, flat segments in a ring-like arrangement. In the *Apatesia* Group the nectary is a broad flat continuous ring. The existence and significance of these flat nectary types has largely been neglected in previous publications, including those of Rappa & Camarrone (1962) and Zandonella (1977), and they are only briefly mentioned by Ihlenfeldt & Struck (1987), Ihlenfeldt & Gerbaulet (1990) and Hartmann (1991). The bulk of Ruschioideae is split into two large groups, namely a group comprising taxa with a segmented, crested (or lobed) nectary (lophomorphic meronectary), and a group with an annular, crested (or lobed) nectary (lophomorphic holonectary). Both these groups are defined by the lophomorphic (crested/ lobed) state. The apparent lack of nectaries, a rare state reported for the genus *Glottiphyllum*, needs further investigation to determine whether the nectary is in fact lost, or expressed in another way. We therefore provisionally do not assign this genus to any particular tribe.

In addition to showing distinct groups, data plotted in Fig. 2 serve to highlight seemingly aberrant taxa or discrepancies in the present classification of mesemb genera. For example, three species with a meronectary

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

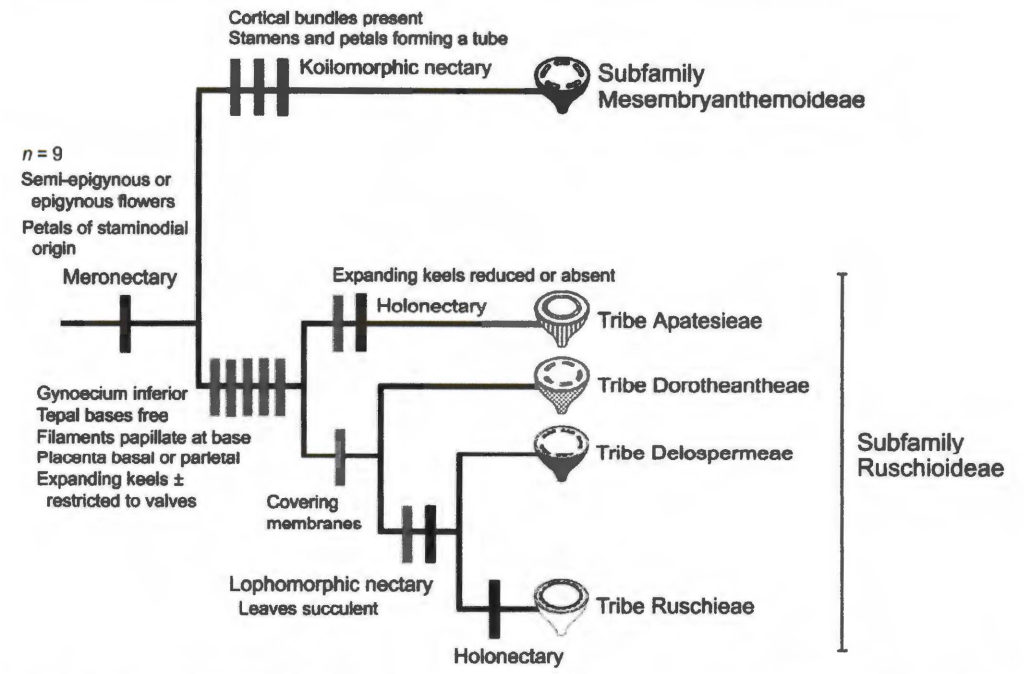


Fig. 3. Floral nectary character distribution mapped on a cladogram of the basal groups of Mesembryanthemaceae (data presented in Table 3). Nectary synapomorphies shown as black bars; other synapomorphies indicated by grey bars. Shading codes for nectary types as in Fig. 2 with the inconspicuous nectary of *Glottiphyllum* excluded from this scheme.

are at present placed in the genus *Erepsia*: *Semnanthe lacera* (Haw.) N.E. Br., representing a monotypic genus recently merged with *Erepsia* (Liede, 1989), *Erepsia forficata* (L.) Schwantes, and *E. heteropetala*. All other members of *Erepsia* are characterized by a lophomorphic holonectary. Hence the reinstatement of *Semnanthe* N.E. Br. should be considered. This genus may accomodate the other two aberrant species in *Erepsia*, although more data are needed before a decision can be made. The current placement of *Ruschianthus* in the *Dracophilus* Group also needs to be reassessed, as its lophomorphic meronectary is inconsistent with that group. *Dorotheanthus maughanii* (N.E. Br.) Ihlenf. & Struck, previously in its own genus *Pherolobus* N.E. Br., and some members of the subgenus *Dorotheanthus* (Ihlenfeldt & Struck, 1987), need reinvestigation to gain a better understanding of transitional types in primitive flat-leaved mesembs.

Character analysis. — Previous studies on nectaries in mesembs have failed to yield phylogenetically useful data primarily because the definitions of morphological characters and character states were not adequately resolved. In a discussion on methods and problems of character construction, Wilkinson (1995) suggests that two important questions be posed initially: (1) Can smaller units or components that are subsumed within the character be identified? (2) Does the variation in these units indicate or suggest that they have evolved independently? Nectary types described above are based on two separate characters that appear to have evolved independently of each other. Transformations in one are not logically coupled to transformations in the other.

The first character relates to the structure of the nectary, namely whether it is in a continuous ring (holonectary) or whether it is segmented (meronectary) into as many parts as there are carpels in the gynoecium (Fig. 1). Outgroup comparison shows that the ancestral condition, in the context of mesembs, is the simple ring-shaped holonectary (Rappa, 1912; Brown, 1938; Zandonella, 1977). Holonectaries are found in all other members of Caryophyllales (Zandonella, 1977). Segmentation of the ring into a meronectary is interpreted as derived (Rappa,

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

1912) and represents a synapomorphy for Mesembryanthemaceae (Bittrich & Struck, 1989; Fig. 3). The *Cleretum* Group has broad, flat meronectaries, presumably the plesiomorphic state; it is not defined by any synapomorphy in terms of nectary type. The nectary forms a continuous flat ring in the *Apatesia* Group. This re-appearance of the holonectary, a synapomorphy for the group, may represent a reversal to the ancestral state for the family (Fig. 1). In the major ruschioid group comprising the *Dracophilus, Eberlanzia, Lampranthus, Leipoldtia, Mitrophyllum, Ruschia* and *Titanopsis* Groups, the annular state (holonectary) is combined with a crested or lobed surface (lophomorphic), which is here interpreted as representing an evolutionary innovation rather than a reversal. Whether the holonectary or the meronectary is more advanced in those Ruschioideae with the lophomorphic state is still the subject of debate. Association of characters suggests primitiveness of the meronectary within this subfamily as it is found in taxa showing other supposedly primitive features (Bittrich & Struck, 1989). This observation is substantiated by outgroup comparison, which shows that the sister group, Mesembryanthemoideae, characteristically has a segmented nectary, albeit hollow rather than lobed or crested.

The second character describing mesemb nectaries pertains to shape of the nectary surface. In mesembs, nectaries are either flat, or sunken as pits and hollows (koilomorphic), or raised and crested/lobed (lophomorphic). Outgroup comparison shows that a relatively narrow, flat nectary is the primitive condition and the hollow, shell-shaped (koilomorphic) and crested or lobed (lophomorphic) states are more advanced (Bittrich & Struck, 1989). Currently, unequivocal polarization of states is not possible for this character, and whether the broad, flat nectary characteristic of the *Apatesia* and *Cleretum* Groups should be interpreted as a separate state from the primitive, relatively flat nectary found in other Aizoaceae is uncertain. Hence, in Table 1 these two conditions are coded as a single character state.

Association of characters and interpretation of nectary states. — Nectaries of Mesembryanthemoideae form separate hollows in the upper surface of the ovary. In this group they are associated with a half-inferior ovary and axile placentation. In Ruschioideae, the ovary is inferior, the placenta is generally basal or parietal, and the nectaries are primitively composed of separate glandular units. However, in two groups the nectary is an entire ring of glandular tissue. To interpret the latter state it is hypothesized that the development of the holonectary in these two ruschioid groups may be related to the extreme multiplication of carpels in the gynoecium of certain species. The annular nectary therefore seems to have preceded the evolution of multilocularity, a condition that has contributed towards the explosive diversification and elaboration of fruit types in mesembs.

Variation in floral organ number among mesembs is shown in Table 1. As Bittrich (1986) pointed out for Mesembryanthemoideae, the number of carpels, number of sepals, and number of parts to the nectary are consistently the same (either four or five) in this subfamily. A similar pattern occurs in those ruschioid genera with meronectaries comprising more than five parts, e.g. (locule; sepal merosity), *Cerochlamys* (5 or 6; 5 or 6), *Corpuscularia* (6; 6), *Gibbaeum* (6–9; 6–9) and *Trichodiadema* (5–8; 5–8). Amongst the ruschioid taxa with meronectaries, only the genera *Malephora* (8–12 locules) and *Rabiea* (7–10 locules) have attained higher numbers of locules in the fruit. Ruschioid taxa with lophomorphic meronectaries, i.e., members of the *Bergeranthus, Delosperma,* and *Stomatium* Groups, may represent an earlier branch in mesemb evolution than those genera with the lophomorphic holonectary.

The *Bergeranthus* and *Stomatium* Groups, particularly, are taxa from the summer-rainfall region of southern Africa (Hartmann, 1994). The *Delosperma* Group is equally well represented in both summer- and winter-rainfall regions. However, the distribution of *Delosperma* extends into East Africa as far as Arabia and Yemen, and onto Madagascar and Réunion (Smith & al., 1998). The primitiveness of *Delosperma* is suggested not only by its nectary structure and growth form, but also by its wide geographical distribution. The *Cleretum* Group, which has meronectaries, consistently has five sepals and usually five carpels. It comprises annual plants with semi-succulent, highly papillate, flat leaves and is regarded as sufficiently different from all other mesemb groups (Ihlenfeldt & Struck, 1987). The primitive *Apatesia* Group, despite its characteristic holonectary, apparently represents an early experimental stage in mesemb evolution. In this group, plants are mostly flat-leaved annuals or perennials, with fruits that are structurally diverse and elaborate, with a tendency towards reduction or loss of hygrochastic tissue accompanied by the acquirement of storage space for a few seeds in "seed pockets", the latter condition being referred to as paraspermy (Schwantes, 1957a). The genera *Hymenogyne* (8–12 locules), *Apatesia* (8–12 locules), *Carpanthea* (12–18 locules) and *Conicosia* (10–25 locules) have evolved multilocular fruits. Hartmann (1994) has suggested that the predecessors of the *Apatesia* and *Cleretum* Groups may have diverged from the remaining stock of Ruschioideae at an early stage.

The bulk of Ruschioideae falls into the group with the lophomorphic holonectary and comprises species of the *Dracophilus, Eberlanzia, Lampranthus, Leipoldtia, Mitrophyllum, Ruschia* and *Titanopsis* Groups.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Multilocularity has evolved independently in numerous genera of this group, particularly genera currently placed in the *Leipoldtia* and *Titanopsis* Groups. In the multilocular groups, the number of locules seems to be disassociated from the number of sepals with the exception of taxa retaining five (or four) as their basic pattern. Locule and sepal numbers (in parentheses) appear to be linked (associated) in species of *Antegibbaeum* (6; 6), *Arenifera* (8; 4), *Didymaotus* (6; 6), *Diplosoma* (5–7; 5–7), *Enarganthe* (8; 4), *Hallianthus* (10; 5), *Lapidaria* (6–8; 6–8), *Lithops* [4–7(9); 4–7], *Pleiospilos* (10–12; 5 or 6) and *Vanzijlia* (10; 5). In this larger group of ruschioid genera there appear to be two main trends. On the one hand, the number of floral elements appears to be congruent, with the number of sepals and carpels either matching or as multiples of each other. In the rest of the group, these numbers appear to be disassociated and large numbers of locules are associated with the basic number of sepals.

Overall, mesembs appear to have a low evolutionary potential for synorganization of floral elements, as reflected by the variability in organ number. In angiosperms this tendency towards higher merosity is generally regarded as primitive. The group of ruschioid taxa that includes the *Dracophilus, Eberlanzia, Lampranthus, Leipoldtia, Mitrophyllum, Ruschia* and *Titanopsis* Groups has diversified in the winter-rainfall Succulent Karoo Biome of southern Africa, notably Namaqualand, but certain genera do extend into the predominantly summer-rainfall interior of southern Africa. Taxonomic distribution of nectary types supports the hypothesis put forward by Hartmann (1994) that the ancestral stock from which the bulk of ruschioid taxa evolved most probably was located outside the winter-rainfall region, the latter being the region where the group is extremely species-rich today.

SYSTEMATIC IMPLICATIONS

For the first time in mesemb classification, the highly diverse ruschioid genera can be subdivided on the basis of clear synapomorphies relating to nectary type. Just as the subfamilies can be distinguished by the position of the placenta in the ovary, tribes can be distinguished according to types of floral nectaries.

Two tribal names previously proposed by Schwantes (1947) can be used. The name Apatesieae Schwantes is applied to Hartmann's (1991, 1993) *Apatesia* Group. The *Cleretum* group is formalized under the new tribal name Dorotheantheae trib. et stat. nov. The genera belonging to the *Bergeranthus, Delosperma* and *Stomatium* Groups are assigned to the tribe Delospermeae trib. nov. The remainder of Ruschioideae is assigned to the previously named tribe Ruschieae Schwantes.

TRIBAL CLASSIFICATION OF MESEMBRYANTHEMACEAE

Family: Mesembryanthemaceae Fenzl, Ann. Wiener Mus. Naturgesch. 1: 349 (1836) emend. A.G.J.Herre & Volk, Sukkulentenkunde 2: 38 (1948).

Subfamily: Mesembryanthemoideae Ihlenf., Schwantes & Straka, Taxon 11: 53 (1962).

= Aptenioideae Schwantes Sukkulentenkunde 1: 6 (1947), *non rite publ.*

= Schwantes ex Bittrich & H.E.K.Hartmann, Bot. J. Linn Soc. 97: 251 (1988), nom. illeg.

= Coilomorfoideae Rappa & Camarrone ("Coilomorfi"), Lav. Ist. Bot. Giard. Colon. Palermo 14: 30 (1953), *non rite publ.*

Subfamily: Ruschioideae Schwantes in Ihlenf., Schwantes & Straka, Taxon 11: 54 (1962) emend. Bittrich & H.E.K.Hartmann, S. Afr. J. Bot. 57: 74 (1991).

= Ruschioideae Schwantes, Sukkulentenkunde 1: 6 (1947), *non rite publ.*

= Ruschioideae Schwantes ex Bittrich & H.E.K.Hartmann, Bot. J. Linn. Soc. 97: 251 (1988), nom. illeg.

= Annettaroideae Rappa & Camarrone ("Anettari"), Lav. Ist. Bot. Giard. Colon. Palermo 14: 30 (1953), *non rite publ.*

= Caryotophoroideae Ihlenf., Schwantes & Straka in Schwantes in H. Jacobsen, A Handbook of Succulent Plants 3: 962 (1960), *non rite publ.*

= Caryotophoroideae Ihlenf., Schwantes & Straka, Taxon 11: 54 (1962).

= Hymenogynoideae Schwantes, Kakteen Sukk. 8: 168 (1957b), *non rite publ.*

= Hymenogynoideae Schwantes in Ihlenf., Schwantes & Straka, Taxon 11: 54 (1962).

= Lofomorfoideae Rappa & Camarrone ("Lofomorfi"), Lav. Ist. Bot. Giard. Colon. Palermo 14: 30 (1953), *non rite publ.*

It was shown by Bittrich (1986) that the recognition of Caryotophoroideae and Hymenogynoideae was based on misinterpretation of their placentation and that the constituent genera are better placed in subfamily Ruschioideae.

TRIBES

In 1947, Gustav Schwantes proposed the first formal classification of mesemb genera into tribes and subtribes in an article entitled *System der Mesembryanthemaceen* (Schwantes, 1947). These names are published with a

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

brief German description and types were not specified. According to Article 36.1 (Greuter & al., 2000), these names are not validly published as Latin descriptions were not provided. Subsequently, Latin descriptions were provided by Ihlenfeldt & al. (1962) for the tribal names of Schwantes' classification. Details of publication of mesemb genera are not included here; for these refer to Chesselet & al. (1995).

Apatesieae Schwantes, Ihlenf., Schwantes & Straka, Taxon 11: 55 (1962) emend. Chesselet, G.F. Sm. & A.E. van Wyk. – Type: *Apatesia* N.E.Br.

Plants annual to perennial. Leaves mostly flat; bladder cells present in some taxa, confined to leaf margins. Flowers with flat, broad nectariferous ring (holonectary). Fruit usually a capsule with expanding tissue reduced or absent, sometimes breaking into mericarps, often with seed pockets derived from false septa (paraspermy), rarely a nut.

Equivalent to the *Apatesia* Group of Hartmann (1991, 1993).

Includes tribes: Skiatophyteae (Straka) Ihlenf., Saphesieae (Schwantes) Ihlenf.

Includes subtribes: Carpantheinae Schwantes, Skiatophyteae (Straka) Ihlenf., Saphesieae (Schwantes) Ihlenf.

Genera: *Apatesia*, *Carpanthea*, *Caryotophora*, *Conicosia*, *Hymenogyne*, *Saphesia*, *Skiatophytum*. Total number of species: 11.

Dorotheantheae (Schwantes ex Ihlenf. & Struck) Chesselet, G.F. Sm. & A.E. van Wyk **trib. et stat. nov.** – Type: *Dorotheanthus* Schwantes.

Basionym: subtrib. Dorotheanthinae Schwantes ex Ihlenf. & Struck, Beitr. Biol. Pfl. 61, 1986: 433 (1987).

Plants annual. Leaves flat; bladder cells prominent, occurring all over leaf surface and other herbaceous parts. Flowers with a broad, flat, segmented nectary (meronectary). Capsules hygrochastic, usually 5-carpellate.

Genera: *Aethephyllum*, *Cleretum*, *Dorotheanthus*. Total number of species c. 11.

Equivalent to the *Cleretum* Group of Hartmann (1991, 1993).

Delospermeae Chesselet, G.F. Sm. & A.E. van Wyk, **trib. nov.** – Type: *Delosperma* N.E. Br. emend. Lavis.

Plantae perennes, interdum caudice dilatato. Folia cellulis vesicariis prominentibus vel pilis, aut superficiebus homocellularibus xeromorphis. Flores nectariis cristatis vel lobatis disjunctis. Capsula hygrochastica, raro carinis expansoriis deminutis, tum schizocarpica.

Plants perennial, sometimes with enlarged rootstock. Leaves with prominent bladder cells and/or hairs or with homocellular xeromorphic surfaces. Flowers with crested or lobed (lophomorphic) separate nectaries (meronectary). Capsules hygrochastic, rarely with reduced expanding keels, and breaking up when dry (schizocarpic).

Comprises the *Bergeranthus*, *Delosperma* and *Stomatium* Groups of Hartmann (1991, 1993), consisting of 27 genera, c. 524 species.

Includes subtribes: Delospermatinae Schwantes, Erepsiinae Schwantes p.p., Faucariinae Schwantes, Frithiinae Schwantes, Gibbaeinae Schwantes p.p., Lampranthinae Schwantes p.p., Malephorinae p.p., Nananthinae Schwantes p.p., Ruschiinae Schwantes p.p., Stomatiinae Schwantes.

Genera: *Bergeranthus*, *Bijlia*, *Carruanthus*, *Cerochlamys*, *Chasmatophyllum*, *Corpuscularia*, *Delosperma*, *Drosanthemum*, *Ectotropis*, *Faucaria*, *Frithia*, *Gibbaeum*, *Hereroa*, *Machairophyllum*, *Malephora*, *Mestoklema*, *Mossia*, *Muiria*, *Neohenricia*, *Orthopterum*, *Oscularia*, *Rabiea*, *Rhinephyllum*, *Rhombophyllum*, *Ruschianthus*, *Stomatium*, *Trichodiadema*..

Ruschieae Schwantes, Ihlenf., Schwantes & Straka, Taxon 11: 54 (1962), emend. Chesselet, G.F. Sm. & A.E. van Wyk. – Type: *Ruschia* Schwantes.

Plants perennial. Leaves with or without prominent bladder cells, or surfaces homocellular or heterocellular, xeromorphic or mesomorphic. Flowers with a crested/lobed (lophomorphic) annular nectary (holonectary). Capsules hygrochastic, the fruit rarely a berry.

Comprises the *Dracophilus*, *Eberlanzia*, *Lampranthus*, *Leipoldtia*, *Mitrophyllum*, *Ruschia* and *Titanopsis* Groups of Hartmann (1991, 1993), consisting of 71 genera and c. 1013 species.

Includes subtribes: Carpobroteae Schwantes, Conophytinae Schwantes, Dracophilinae Schwantes, Erepsiinae Schwantes p.p., Gibbaeinae Schwantes p.p., Jacobseniinae Schwantes, Jensenobotryinae Schwantes, Leipoldtiinae Schwantes, Lithopinae Schwantes, Lampranthinae Schwantes p.p., Mitrophyllinae Schwantes, Nananthinae Schwantes p.p., Pleiospilinae Schwantes, Psammophorinae Schwantes, Ruschiinae Schwantes p.p., Stoeberiinae Friedrich.

Genera: *Acrodon*, *Aloinopsis*, *Amphibolia*, *Antegibbaeum*, *Antimima*, *Arenifera*, *Argyroderma*, *Astridia*, *Braunsia*, *Carpobrotus*, *Cephalophyllum*, *Cheiridopsis*, *Circandra*, *Conophytum*, *Cylindrophyllum*, *Deilanthe*, *Dicrocaulon*, *Didymaotus*, *Dinteranthus*, *Diplosoma*, *Disphyma*, *Dracophilus*, *Eberlanzia*, *Ebracteola*, *Enarganthe*, *Erepsia*, *Esterhuysenia*, *Fenestraria*, *Hallianthus*, *Hammeria*, *Hartmanthus*, *Ihlenfeldtia*, *Jacobsenia*, *Jensenobotrya*, *Jordaaniella*, *Juttadinteria*, *Khadia*, *Lampranthus*, *Lapidaria*, *Leipoldtia*, *Lithops*, *Marlo-*

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

thistella, Meyerophytum, Mitrophyllum, Monilaria, Namaquanthus, Namibia, Nananthus, Nelia, Octopoma, Odontophorus, Oophytum, Ottosonderia, Pleiospilos, Polymita, Psammophora, Ruschia, Ruschianthemum, Schlechteranthus, Schwantesia, Scopelogena, Smicrostigma, Stayneria, Stoeberia, Tanquana, Titanopsis, Vanheerdea, Vanzijlia, Vlokia, Wooleya, Zeuktophyllum.

Incertae sedis: *Glottiphyllum* (17 species).

ACKNOWLEDGEMENTS

We thank Dr. Otto Leistner (National Botanical Institute, South Africa) for valuable advice and discussion, Prof. Hans Ihlenfeldt and Dr. Heidi Hartmann (University of Hamburg, Germany), Mr. Steven Hammer (U.S.A.) for communicating valuable information on mesemb nectaries to us, and Dr. Hugh Glen for Latin translations. We thank Prof. Norbert Jürgens (University of Hamburg) for project SFB 389 and GTZ counterpart funds.

POSTSCRIPT

Since the completion of this article, evidence from anatomy (Landrum, 2001) provides support for the tribal classification presented here. Provisional molecular data supports the tribes Apatesieae and Dorotheantheae with little resolution for the rest of the ruschioid taxa (G. Reeves, pers. comm.). Also, the family name Aizoaceae Rudolfi s.str. is now Aizoaceae Martynov nom. cons. (Hartmann, 2001).

LITERATURE CITED

APG (Angiosperm Phylogeny Group). 1998. An ordinal classification for the families of flowering plants. *Ann. Missouri Bot. Gard.* 85: 531–553.

Barthlott, W. & Hunt, D. R. 1993. Cactaceae. Pp. 161–197 in: Kubitzki, K., Rohwer, J. G. & Bittrich, V. (eds.), *The Families and Genera of Vascular Plants*, ed. 2. Springer-Verlag, Berlin.

Bittrich, V. 1986. Untersuchungen zu Merkmalsbestand, Gliederung und Abgrenzung der Unterfamilie Mesembryanthemoideae (Mesembryanthemaceae Fenzl). *Mitt. Inst. allg. Bot., Hamb.* 21: 5–116.

Bittrich, V. & Hartmann, H. E. K. 1988. The Aizoaceae—a new approach. *Bot. J. Linn. Soc.* 97: 239–254.

Bittrich, V. & Struck, M. 1989. What is primitive in the Mesembryanthemaceae? An analysis of evolutionary polarity of character states. *S. African J. Bot.* 55: 321–331.

Bolus, H. M. L. 1928. *Notes on* Mesembryanthemum *and some Allied Genera.* 1. University of Cape Town, Cape Town.

Bolus, H. M. L. 1928–1935. *Notes on* Mesembryanthemum *and Allied Genera.* 2. University of Cape Town, Cape Town.

Bolus, H. M. L. 1936–1958. *Notes on* Mesembryanthemum *and Allied Genera.* 3. University of Cape Town, Cape Town.

Brown, N. E. 1925. *Mesembryanthemum* and some new genera separated from it. *Gard. Chron.* 78: 272–273, 412.

Brown, W. H. 1938. The bearing of nectaries on the phylogeny of flowering plants. *Proc. Amer. Philos. Soc.* 79: 549–594.

Chesselet, P., Mössmer, M. & Smith, G. F. 1995. Research priorities in the succulent plant family Mesembryanthemaceae Fenzl. *S. African J. Sci.* 91: 197–209.

Chesselet, P., Smith, G. F., Burgoyne, P. M., Klak, C., Hammer, S. A., Hartmann, H. E. K., Kurzweil, H., Van Jaarsveld, E. J., van Wyk, B.-E. & Leistner, O. A. 2000a. Mesembryanthemaceae. *In* Leistner, O. A. (ed.), Seed plants of Southern Africa: families and genera. *Strelitzia* 10: 360–410.

Chesselet, P., Smith, G. F. & van Wyk, A. E. 2000b. Systematic and evolutionary significance of morphology in the Mesembryanthemaceae: interactive database and illustrated atlas for identification. *Aloe* 37: 46–51.

Chesselet, P., Smith, G. F. & van Wyk, A. E. 2001. A new tribal classification for the Mesembryanthemaceae Fenzl based on characters of the floral nectary. *Aloe* 38: 25–28.

Cronquist, A. 1968. *The Evolution and Classification of Flowering Plants.* Thomas Nelson and Sons, Great Britain.

Cronquist, A. 1981. *An Integrated System of Classification of Flowering Plants.* Columbia University Press, New York.

Dahlgren, R., Clifford, H. T. & Yeo, P. F. 1985. *The Families of the Monocotyledons. Structure, Evolution and Taxonomy.* Springer-Verlag, Berlin.

Endress, P. K. 1990. Patterns of floral construction in ontogeny and phylogeny. *Biol. J. Linn. Soc.* 39: 153–175.

Fenzl, E. 1836. Monographie der Mollugineen und Steudelieen, zweier Unterabtheilungen der Familie der Portulacaceen. *Ann. Wiener Mus. Naturgesch.* 1: 349.

Gess, S. K. & Gess, F. W. 1989. Flower-visiting masarid wasps in Southern Africa (Hymenoptera: Vespoidea: Masaridae). *Ann. Cape Prov. Mus., Nat. Hist.* 18: 95–134.

Greuter, W., McNeill, J. Barrie, F. R., Burdet, H. M., Demoulin, V., Filgueiras, T. S., Nicolson, D. H., Silva, P. C., Skog, J. E., Trehane, P., Turland, N. J. & Hawksworth, D. L. 2000. *International Code of Botanical Nomenclature (Saint Louis Code) adopted by the Sixteenth International Botanical Congress, St. Louis, Missouri, July–August 2000.* Koeltz, Königstein [*Regnum Veg.* 138.]

Hartmann, H. E. K. 1988. Fruit types in Mesembryanthema. *Beitr. Biol. Pfl.* 63: 313–349.

Hartmann, H. E. K. 1991. Mesembryanthema. *Contr. Bol. Herb.* 13: 75–157.

Hartmann, H. E. K. 1993. Aizoaceae. Pp. 37–69 in: Kubitzki, K., Rohwer, J. G. & Bittrich, V. (eds.), *The Families and Genera of Vascular Plants*, ed. 2. Springer-Verlag, Berlin.

Hartmann, H. E. K. 1994. On the phytogeography and evolution of Mesembryanthema (Aizoaceae). Pp. 1165–1180 in: Seyani, J. H. & Chikuni, A. C., *Proc. XIIIth Plenary Meeting AETFAT*, Malawi, vol. 2.

Hartmann, H. E. K. 1998a. A letter to the MSG. *Mesemb Study Group Bull.* 2: 32–34.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Hartmann, H. E. K. 1998b. New combinations in Ruschioideae, based on studies in *Ruschia* (Aizoaceae). *Bradleya* 16: 44–91.

Hartmann, H. E. K. 2001. *Illustrated Handbook of Succulent Plants: Aizoaceae A–E*. Springer, Berlin.

Hartmann, H. E. K. & Bittrich, V. 1990. Nomenclature in Mesembryanthema (Aizoaceae): the generic names by Rappa & Camarrone. *Bothalia* 20: 153–157.

Hartmann, H. E. K. & Bittrich, V. 1991. Typification of suprageneric names—some nomenclatural changes in Aizoaceae. *S. Afr. J. Bot.* 57: 73–75.

Hartmann, H. E. K. & Bruckmann, C. 2000. The capsules of *Drosanthemum* Schwantes (Ruschioideae, Aizoaceae). *Bradleya* 18: 75–112.

Hartmann, H. E. K. & Liede, S. 1986. Die Gattung *Pleiospilos* s. lat. (Mesembryanthemaceae). *Bot. Jahrb. Syst.* 106: 433–485.

Hartmann, H. E. K. & Stüber, D. 1993. On spiny Mesembryanthema and the genus *Eberlanzia* (Aizoaceae). *Contr. Bol. Herb.* 15: 1–75.

Herre, H. 1971. *The Genera of the Mesembryanthemaceae*. Tafelberg, Cape Town.

Herre, H. & Volk, O. H. 1948. Mesembryanthemaceae Herre et Volk, familia nova. *Sukkulentenkunde* 2: 38.

Hofmann, U. 1994. Flower morphology and ontogeny. Pp. 123–166 in: Behnke H.-D. & Mabry, T. J. (eds.), *Caryophyllales. Evolution and Systematics*. Springer-Verlag, Berlin.

Ihlenfeldt, H.-D. 1960. Entwicklungsgeschichtliche, morphologische und systematische Untersuchungen an Mesembryanthemen. *Fedd. Rep. Spec. Nov. Regni Veg.* 63: 1–104.

Ihlenfeldt, H.-D. 1978. Morphologie und Taxonomie der Gattung *Oophytum* N.E.Br. (Mesembryanthemaceae). Monographie der Mitrophyllinae Schwantes III. *Bot. Jahrb. Syst.* 99: 303–328.

Ihlenfeldt, H.-D., Schwantes, G. & Straka, H. 1962. Die höheren Taxa der Mesembryanthemaceae. *Taxon* 11: 52–56.

Ihlenfeldt, H.-D. & Struck, M. 1987. Morphologie und Taxonomie der Dorotheanthinae Schwantes (Mesembryanthemaceae). *Beitr. Biol. Pfl.* 61: 411–453.

Ihlenfeldt, H.-D. & Gerbaulet, M. 1990. Untersuchungen zum Merkmalsbestand und zur Taxonomie der Gattungen *Apatesia* N.E.Br., *Carpanthea* N.E.Br., *Conicosia* N.E.Br., *Herrea* Schwantes und *Hymenogyne* Haw. (Mesembryanthemaceae Fenzl). *Bot. Jahrb. Syst.* 111: 457–498.

Jacobsen, H. 1960. *A Handbook of Succulent Plants*, vol. 3. Blandford, London.

Landrum, J. V. 2001. Wide-band tracheids in leaves of genera in Aizoaceae: the systematic occurrence of a novel cell type and its implications for the monophyly of the subfamily Ruschioideae. *Plant Syst. Evol.* 227: 49–61.

Liede, S. 1989. Untersuchungen zum Merkmalsbestand und zur Taxonomie der 'Erepsiinae' (Mesembryanthemaceae). *Beitr. Biol. Pfl.* 64: 391–479.

Rappa, F. 1912. Per una classificazione naturale dei Mesembriantemi. *Lav. Reale Ist. Bot. Palermo* 11: 21–36.

Rappa, F. & Camarrone, V. 1953. Mesembrianthemum e Mesembryanthemum. Una rivendicazione. *Lav. Ist. Bot. Giard. Colon. Palermo* 14: 1–39.

Rappa, F. & Camarrone, V. 1962. La classificazione naturale delle Mesembriantemacee. *Lav. Ist. Bot. Giard. Colon. Palermo* 18: 11–32.

Schwantes, G. 1927. Zur Systematik der Mesembryanthemen. *Sukkulentenkunde* 3: 14–30.

Schwantes, G. 1947. System der Mesembryanthemaceen. *Sukkulentenkunde* 1: 34–40.

Schwantes, G. 1957a. *Flowering Stones and Mid-day Flowers*. Ernest Benn Limited, London.

Schwantes, G. 1957b. Ficoidaceae (Juss.) em. Hutchinson. *Kakteen Sukk.* 8: 167–169.

Smith, G. F., Chesselet, P., Van Jaarsveld, E. J., Hartmann, H., Hammer, S., van Wyk, B.-E., Burgoyne, P., Klak, C. & Kurzweil, H. 1998. *Mesembs of the World*. Briza Publications, Pretoria.

Smith, G. F., Hartzer, P. & van Wyk, A. E. 1997. Plate 310. *Mossia intervallaris*. *Bot. Mag.* 14: 16–22.

Smith, G. F. & Walker, C. C. 2001. The botanical paintings of Mary Maud Page. *Bradleya* 19: 124.

Takhtajan, A. 1991. *Evolutionary Trends in Flowering Plants*. Columbia University Press, New York.

Vogel, S. 1954. Blütenbiologische Typen als Elemente der Sippengliederung. In: Troll, W. & Von Guttenberg, H. (eds.), *Bot. Stud. 1*. Fischer, Jena.

Wilkinson, M. 1995. A comparison of two methods of character construction. *Cladistics* 11: 297–308.

Zandonella, P. 1977. Apports de l'étude comparée des nectaires floraux à la conception phylogénétique de l'ordre des Centrospermales. *Ber. Deutsch. Bot. Ges.* 90: 105–125.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 5

Chesselet, P., Van Wyk, A.E. & Smith, G. F. 2004. Notes on African plants. Mesembryanthemaceae. A new tribe and adjustments to infrafamilial classification. *Bothalia* 34: 47–51.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

MESEMBRYANTHEMACEAE

A NEW TRIBE AND ADJUSTMENTS TO INFRAFAMILIAL CLASSIFICATION

Recently the tribal classification of Mesembryanthemaceae Fenzl has been the focus of attention in contributions based on both morphological (Chesselet *et al.* 2001, 2002) and molecular (Klak *et al.* 2003) evidence. Molecular data provides an independent character set for testing the congruence of morphological characters. When contrasting these data sets we find that molecular data largely support the broad infrafamilial classification based primarily on nectary type proposed by Chesselet *et al.* (2002), except in the case of tribe Delospermeae (Figure 15).

Delosperma N.E.Br. (± 163 species) and *Drosanthemum* Schwantes (± 120 species) are the largest of several genera placed by Chesselet *et al.* (2002) in the Delospermeae. Klak *et al.* (2003), however, do not maintain the Delospermeae, but place all taxa assigned to this tribe in an expanded concept of Ruschieae (Chesselet *et al.* 2002). Although the molecular phylogeny of Klak *et al.* (2003) is not fully resolved, four distinct clades do emerge for subfamily Ruschioideae, three of which are formally recognized taxonomically by these authors. The fourth clade includes all investigated members of *Drosanthemum* and a single species of *Delosperma*, namely *D. asperulum* (Salm-Dyck) L.Bolus (= *Drosanthemum asperulum* (Salm-Dyck) Schwantes). The latter taxon has since been transferred back to *Drosanthemum* by Klak (2003) on the grounds that it resolves with *Drosanthemum* in a distinct evolutionary lineage within the tribe Ruschieae (Klak *et al.* 2003). This clade is, however, not given any formal taxonomic status despite it having 95% bootstrap support in a strict

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

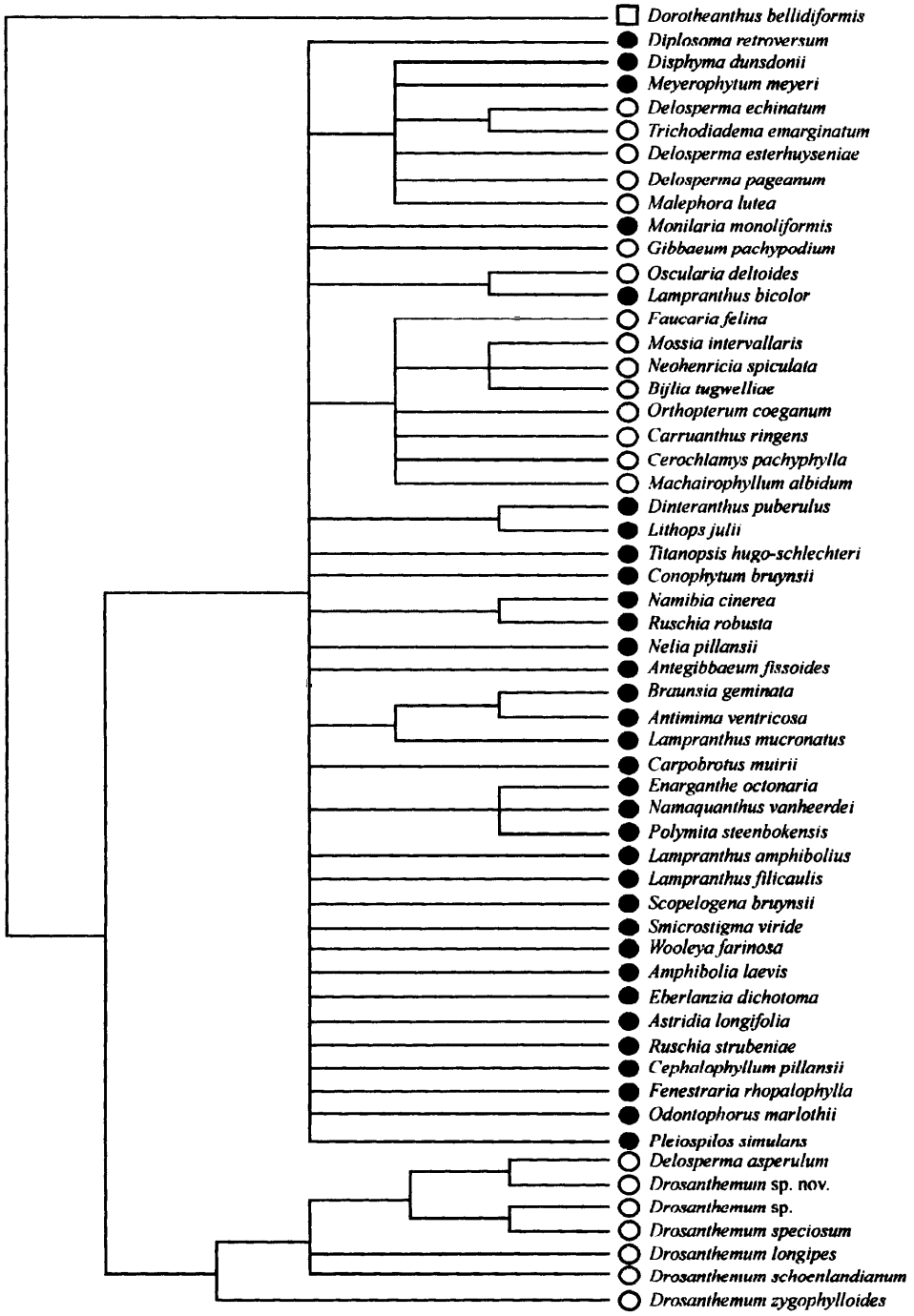


FIGURE 15.—Nectary characters from Chesselet *et al.* (2002) plotted on molecular phylogeny for mesembs from Klak *et al.* (2003). The most striking result is that the *Delosperma* Group of Hartmann (1991, 1993) is polyphyletic. Note the molecular resolution obtained for members of the newly described tribe Drosanthemeae in contrast to polytomy obtained for the Ruschieae, indicating the greater age of the former group. Members of the *Bergeranthus* and *Stomatium* groups of Hartmann (1991, 1993) resolve as a distinct clade within Ruschieae and are characterized by a lophomorphic meronectary. Key: □, broad flat meronectary; ○, lophomorphic meronectary; ●, lophomorphic holonectary.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

consensus tree of the 5000 most parsimonious trees based on a four-gene-region analysis. Here we propose the latter clade as a distinct new tribe, the Drosanthemeae. The molecular phylogeny nevertheless shows that some other *Delosperma* species as well as several other genera included in Delospermeae by Chesselet *et al.* (2002) are clearly better placed in Ruschieae.

The most unexpected result of the molecular phylogeny provided by Klak *et al.* (2003) is that the '*Delosperma* group' of Hartmann (1991, 1993) is polyphyletic. Since Schwantes (1947), in his *System der Mesembryanthemaceen*, defined Subtribe Delospermatinae, *Delosperma* and *Drosanthemum* have been uncritically associated with each other. Despite the simple hygrochastic fruit, papillate epidermis, often broad, flat mesophytic leaves, and an exceptionally wide (for mesembs) distribution range that extends from southern Africa to East Africa and the Indian Ocean islands of Reunion and Madagascar, the genus *Delosperma* is not as 'primitive' as has been widely accepted. In contrast, *Drosanthemum*, with its characteristic basally-free leaves that bear large, water-filled bladder cells, emerges as being more basal than hitherto surmised. The wide distribution range of *Drosanthemum* and its strong presence in the Fynbos Biome supports this hypothesis. Recently, Chesselet *et al.* (2003) argued that basal tribes in Ruschioideae have their origins in the Fynbos Biome, which is considered the older biome in relation to the Succulent Karoo (Stuckenberg 1998).

At present the distinct clade named here as tribe Drosanthemeae contains the single genus *Drosanthemum*. Following extensive work on the flowers and fruit of *Drosanthemum* (Hartmann & Bruckmann 2000; Rust *et al.* 2002) a single possible synapomorphy involving the fruit stalk was found for the genus. *Drosanthemum* is a large and morphologically heterogeneous taxon characterized by no less than 13 different fruit types and five floral types. Congruence between these character sets exists in only three cases. The genus remains one of the most problematic in terms of identification. The fact that some *Drosanthemum* species tend to show free leaves, supports their more primitive position in the phylogeny. This characteristic is shared with other more primitive ruschioid taxa in tribes Apatesieae and Dorotheantheae and it can thus be regarded as a symplesiomorphic feature. *Enargianthe* N.E.Br. is reported to have basally-free leaves (Brown 1930), although examination of leaf material does not confirm this unambiguously. We therefore consider basally fused leaves as a possible synapomorphy for tribe Ruschieae (Figure 16). Those species of *Drosanthemum* that appear to have leaves that are fused at the base may indicate convergence with taxa in Ruschieae.

Both *Delosperma* and *Drosanthemum* are characterized by flowers with a 'lophomorphic meronectary' and were placed by Chesselet *et al.* (2002) in Delospermeae together with all other genera with this type of nectary. The inclusion, into this tribe, of the *Bergeranthus* and *Stomatium* groups of Hartmann (1991, 1993), was counter-intuitive, though justified according to the principle of parsimony, in the absence of other character sets at the time. The molecular study of Klak *et al.* (2003) has shown that taxa belonging in the latter two groups are better placed in tribe Ruschieae. The presence of a lophomorphic meronectary indicates a possible reversal, switching of major genes or the persistence of the pleisiomorphic condition in genera allied to *Bergeranthus* and *Stomatium*.

Following the reassessment of the tribal classification based on nectary types and together with insights gained from molecular data, we propose the following nomenclatural adjustments. For a comprehensive tribal classification refer to Chesselet *et al.* (2002).

Drosanthemeae *Chesselet, Gideon F.Sm. & A.E.van Wyk*, trib. nov. Type: *Drosanthemum* Schwantes

Plantae perennes. Paria foliorum plerumque basi discreta; folia saepeque caules plerumque cum cellulis vesicariis prominentibus vel pilis. Flores semper cum meronectariis lophomorphis. Capsulae hygrochasticae, plerumque 5(6)-carpellatae, interdum cum locellis seminalibus basalibus.

Plants perennial. *Leaf pairs* mostly basally free, leaves and often stems, usually with prominent bladder cells or hairs. *Flowers* always with crested or lobed (lophomorphic) separate nectaries (meronectary). *Capsules* hygrochastic, usually 5(6)-carpellate sometimes with basal seed chambers.

Includes tribe Delospermeae Chesselet, Gideon F.Sm. & A.E.van Wyk p.p.

Includes subtribe: Delospermatinae Schwantes p.p.

Comprises the *Delosperma* Group of Hartmann (1991, 1993) p.p.

Genera: *Drosanthemum* [at least as to species investigated by Klak *et al.* (2003)]. Note: the inclusion of additional species currently placed in *Delosperma* and/or *Mestoklema* is uncertain at this stage, as is the possible exclusion of some species currently placed in *Drosanthemum*.

Ruschieae *Schwantes* in Ihlenf., Schwantes & Straka in Taxon 11: 54 (1962), emend. Klak, Khunou, Reeves & Hedderson: 1443 (2003). Type: *Ruschia* Schwantes. Note: the spelling of 'Ruschiae' in Klak *et al.* (2003) is an orthographic error.

Plants perennial, sometimes with enlarged rootstock. *Leaves* mesomorphic or xeromorphic, always basally fused, with or without prominent bladder cells and/or hairs or with homocellular or heterocellular xeromorphic surfaces. *Flowers* with crested or lobed (lophomorphic) separate nectaries (meronectary) or annular nectaries (holonectary). *Capsules* hygrochastic, rarely with reduced expanding keels, and breaking up when dry (schizocarpic); *fruit* rarely a berry.

Comprises the *Bergeranthus, Delosperma p.p., Dracophilus, Eberlanzia, Lampranthus, Leipoldtia, Mitrophyllum, Ruschia, Stomatium* and *Titanopsis* Groups of Hartmann (1991, 1993).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

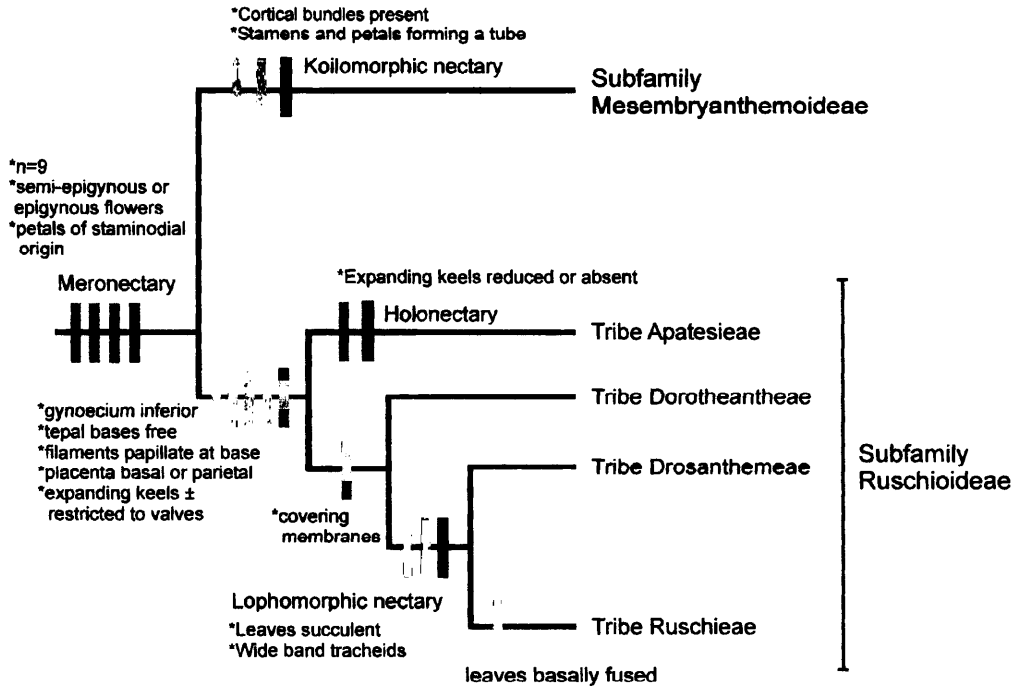


FIGURE 16.—Cladogram of the basal groups of Mesembryanthemaceae. The previously named tribe Delospermeae has been replaced with Tribe Drosanthemeae. Genera previously included in Delospermeae have been redistributed in Drosanthemeae and Ruschieae. From Chesselet *et al.* (2002), with modification. Note: characters of the floral nectary indicated as black bars.

Includes subtribes: Carpobrotinae Schwantes, Conophytinae Schwantes, Delospermatinae Schwantes p.p., Dracophilinae Schwantes, Erepsiinae Schwantes, Faucariinae Schwantes, Frithiinae Schwantes, Gibbaeinae Schwantes, Jacobseniinae Schwantes, Jensenobotryinae Schwantes, Leipoldtiinae Schwantes, Lithopinae Schwantes, Lampranthinae Schwantes, Malephorinae Schwantes, Mitrophyllinae Schwantes, Nananthinae Schwantes, Pleiospilinae Schwantes, Psammophorinae Schwantes, Ruschiinae Schwantes, Stoeberiinae Friedrich, Stomatiinae Schwantes.

Genera: *Acrodon, Aloinopsis, Amphibolia, Antegibbaeum, Antimima, Arenifera, Argyroderma, Astridia, Bergeranthus, Bijlia, Braunsia, Carpobrotus, Carruanthus, Cephalophyllum, Cheiridopsis, Cerochlamys, Chasmatophyllum, Circandra, Conophytum, Corpuscularia, Cylindrophyllum, Deilanthe, Delosperma, Dicrocaulon, Didymaotus, Dinteranthus, Diplosoma, Disphyma, Dracophilus, Eberlanzia, Ebracteola, Ectotropis, Enarganthe, Erepsia, Esterhuysenia, Faucaria, Fenestraria, Frithia, Gibbaeum, Glottiphyllum, Hallianthus, Hammeria, Hartmanthus, Hereroa, Ihlenfeldtia, Jacobsenia, Jensenobotrya, Jordaaniella, Juttadinteria, Khadia, Lampranthus, Lapidaria, Leipoldtia, Lithops, Machairophyllum, Malephora, Marlothistella, Mestoklema, Meyerophytum, Mitrophyllum, Monilaria, Mossia, Muiria, Namaquanthus, Namibia, Nananthus, Nelia, Neohenricia, Octopoma, Odontophorus, Oophytum, Orthopterum, Oscularia, Ottosonderia, Pleiospilos, Polymita, Psammophora, Rabiea, Rhinephyllum, Rhombophyllum, Ruschia, Ruschianthemum, Ruschianthus, Schlechteranthus, Schwantesia, Scopelogena, Smicrostigma, Stayneria, Stoeberia, Stomatium, Tanquana, Titanopsis, Trichodiadema, Vanheerdea, Vanzijlia, Vlokia, Wooleya, Zeuktophyllum.*

REFERENCES

BROWN, N.E. 1930. *Mesembryanthemum. Gardeners' Chronicle* 87: 151.

CHESSELET, P., SMITH, G.F. & VAN WYK, A.E. 2001. A new tribal classification for the Mesembryanthemaceae Fenzl based on characters of the floral nectary. *Aloe* 38: 25–28.

CHESSELET, P., SMITH, G.F. & VAN WYK, A.E. 2002. A new tribal classification of the Mesembryanthemaceae: evidence from floral nectaries. *Taxon* 51: 295–308.

CHESSELET, P., VAN WYK, A.E., GRIFFIN, N. & SMITH, G.F. 2003. Patterns of floristic diversity in Mesembryanthemaceae. *Aloe* 40: 80–85.

HARTMANN, H.E.K. 1991. Mesembryanthema. *Contributions from the Bolus Herbarium* 13: 75–157.

HARTMANN, H.E.K. 1993. Aizoaceae. In K. Kubitzki, J.G. Rohwer & V. Bittrich. *The families and genera of vascular plants* 2: 37–69. Springer-Verlag, Berlin.

HARTMANN, H.E.K. & BRUCKMANN, C. 2000. The capsules of *Drosanthemum* Schwantes (Ruschioideae, Aizoaceae). *Bradleya* 18: 75–112.

IHLENFELDT, H.D., SCHWANTES, G. & STRAKA, H. 1962. Die höheren Taxa der Mesembryanthemaceae. *Taxon* 11: 52–56.

KLAK, C. 2003. New combinations, a new genus and five new species in Aizoaceae. *Bradleya* 21: 107–120.

KLAK, C., KHUNOU, A., REEVES, G. & HEDDERSON, T. 2003. A phylogenetic hypothesis for the Aizoaceae (Caryophyllales) based on four plastid DNA regions. *American Journal of Botany* 90: 1433–1445.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

RUST, S., BRUCKMANN, C. & HARTMANN, H.E.K. 2002. The flowers of *Drosanthemum* Schwantes (Ruschioideae, Aizoaceae). *Bradleya* 20: 121–147.

SCHWANTES, G. 1947. System der Mesembryanthemaceen. *Sukkulentenkunde, Jahrbücher der Schweizerischen Kakteengesellschaft* 1: 34–40.

STUCKENBERG, B.R. 1998. A new Namibian wormlion species, with an account of the biogeography of *Leptynoma* Westwood *s. str.* and its association with anthophily in the Fynbos and Succulent Karoo Biomes (Diptera, Vermileonidae). *Annals of the Natal Museum* 39: 165–183.

P. CHESSELET*†, A.E. VAN WYK** and G.F. SMITH***

* Compton Herbarium, National Botanical Institute, Private Bag X7, 7735 Claremont, Cape Town. E-mail: chesselet@nbi.ac.za
† Student affiliation: Department of Botany, University of Pretoria, 0002 Pretoria.
** H.G.W.J. Schweickerdt Herbarium, Department of Botany, University of Pretoria, 0002 Pretoria. E-mail: avanwyk@scientia.up.ac.za
*** National Botanical Institute, Private Bag X101, 0001 Pretoria. Acocks Chair, Department of Botany, University of Pretoria, 0002 Pretoria. E-mail: gfs@nbi.ac.za

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 6

Chesselet, P., Burgoyne, P.M., Klak, C., Kurzweil, H., Griffin, N.J. & Smith G.F. 2003a. Mesembryanthemaceae. In: Germishuizen, G. & Meyer, N. (eds), *Plants of southern Africa: names and distribution. Strelitzia*: 633–738.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

MESEMBRYANTHEMACEAE

Compiled by P. Chesselet, P.M. Burgoyne, C. Klak, H. Kurzweil, A.P. Dold, N.J. Griffin & G.F. Smith

ABRYANTHEMUM Neck. 2405162
acinaciforme (L.) Rothm., illegitimate name = **Carpobrotus acinaciformis**
edule (L.) Rothm. = **Carpobrotus edulis** subsp. **edulis**

ACRODON N.E.Br. 2405001
(1) Glen. 1986. *Bothalia* 16: 212–218.
(2) Hartmann. 1996. *Bradleya* 14: 29–34.
(3) Burgoyne. 1998. *Aloe* 35: 60, 61.
(4) Hartmann. 1998. *Bradleya* 16: 48–56.
(5) Hartmann. 1999. *Bradleya* 17: 38–74.
(6) Klak. 2000. *Bothalia* 30: 35–42.
(7) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 23–25.
bellidiflorus (L.) N.E.Br.
A. bellidiflorus (L.) N.E.Br. var. *striatus* (Haw.) N.E.Br. (1)
A. bellidiflorus (L.) N.E.Br. var. *viridis* (Haw.) N.E.Br. (1)
A. duplessiae (L.Bolus) Glen (2)
Ruschia constricta L.Bolus (2)
Ruschia duplessiae L.Bolus (2)
Ruschia graminea H.Jacobsen (5)
Ruschia longifolia L.Bolus (1)
Ruschia macrophylla L.Bolus (2)
Perennial. Succulent. Ht ± 0.05–0.12 m. Alt up to 300 m. WC
bellidiflorus (L.) N.E.Br. var. *striatus* (Haw.) N.E.Br. = **A. bellidiflorus**
bellidiflorus (L.) N.E.Br. var. *viridis* (Haw.) N.E.Br. = **A. bellidiflorus**
duplessiae (L.Bolus) Glen = **A. bellidiflorus**
leptophyllus (L.Bolus) Glen = **A. subulatus**
parvifolius R.du Plessis
Perennial. Succulent. Ht ± 0.1 m. Alt up to 200 m. WC
purpureostylus (L.Bolus) Burgoyne
Cerochlamys purpureostyla (L.Bolus) H.E.K.Hartmann (6)
Erepsia purpureostyla (L.Bolus) Schwantes (4)
Mesembryanthemum purpureostylum L.Bolus (3)
Ruschia forficata in sense of L.Bolus in part, misapplied name (3)
Ruschia purpureostyla (L.Bolus) Bruyns (3)
Perennial. Succulent. Ht ± 0.15 m. Alt 100–500 m. WC
quarcicola H.E.K.Hartmann
Perennial. Succulent. Ht ± 0.08 m. Alt up to 100 m. WC
subulatus (Mill.) N.E.Br.
A. leptophyllus (L.Bolus) Glen (2)
Mesembryanthemum bellidiflorum L. var. *subulatum* (Mill.) Haw. (7)
Ruschia leptophylla L.Bolus (7)
Perennial. Succulent. Ht 0.05–0.1 m. Alt 100–650 m. WC

AETHEPHYLLUM N.E.Br. 2405002
(1) Ihlenfeldt & Struck. 1986. *Beiträge zur Biologie der Pflanzen* 61: 411–453.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 26, 27.
pinnatifidum (L.f.) N.E.Br.
Annual. Succulent. Ht ± 0.1 m. Alt 80–600 m. WC

ALOINOPSIS Schwantes 2405003
(1) Phillips. 1922. *The Flowering Plants of South Africa* 2: t. 73.
(2) Bolus. 1947. *The Flowering Plants of Africa* 26: t. 1035.
(3) Bolus. 1958. *Notes on* Mesembryanthemum *and allied genera,* part 3: 372–381.
(4) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 33–37.
acuta L.Bolus
Perennial. Succulent. Ht ± 0.03–0.05 m. Alt 80–600 m. NC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

hilmarii (L.Bolus) L.Bolus = **Deilanthe hilmarii**
jamesii L.Bolus = **A. rubrolineata**
lodewykii L.Bolus = **A. luckhoffii**
loganii (L.Bolus) L.Bolus
Perennial. Succulent. Ht ± 0.03–0.06 m. Alt 700–1000 m. WC
luckhoffii (L.Bolus) L.Bolus
A. lodewykii L.Bolus (4)
A. setifera (L.Bolus) L.Bolus (4)
A. villetii (L.Bolus) L.Bolus (4)
Titanopsis luckhoffii L.Bolus (4)
Perennial. Succulent. Ht ± 0.03–0.05 m. Alt 700–900 m. NC
malherbei (L.Bolus) L.Bolus
Perennial. Succulent. Ht ± 0.03–0.05 m. Alt 1000–1200 m. NC
orpenii (N.E.Br.) L.Bolus = **Prepodesma orpenii**
peersii (L.Bolus) L.Bolus = **Deilanthe peersii**
rosulata (Kensit) Schwantes
Perennial. Succulent. Ht ± 0.02–0.05 m. Alt 900–1200 m. EC
rubrolineata (N.E.Br.) Schwantes
A. jamesii L.Bolus (4)
Perennial. Succulent. Ht ± 0.04–0.07 m. Alt 600–1300 m. EC
schooneesii L.Bolus
A. schooneesii L.Bolus var. *acutipetala* L.Bolus (4)
A. schooneesii L.Bolus var. *willowmorensis* L.Bolus (4)
Perennial. Succulent. Ht ± 0.03–0.05 m. Alt 900–1200 m. EC
schooneesii L.Bolus var. *acutipetala* L.Bolus = **A. schooneesii**
schooneesii L.Bolus var. *willowmorensis* L.Bolus = **A. schooneesii**
setifera (L.Bolus) L.Bolus = **A. luckhoffii**
spathulata (Thunb.) L.Bolus
Mesembryanthemum crassipes Marloth (4)
Perennial. Succulent. Ht ± 0.02–0.04 m. Alt 1200–1800 m. NC
thudichumii L.Bolus = **Deilanthe thudichumii**
villetii (L.Bolus) L.Bolus = **A. luckhoffii**

AMOEBOPHYLLUM N.E.Br. 2405004
angustum N.E.Br., illegitimate name = **Phyllobolus roseus**
guerichianum (Pax) N.E.Br. = **Mesembryanthemum guerichianum**
rangei N.E.Br. = **Phyllobolus oculatus**
roseum L.Bolus = **Phyllobolus roseus**

AMPHIBOLIA L.Bolus ex A.G.J.Herre 2405005
(1) Hartmann & Dehn. 1989. *Bothalia* 19: 179–182.
(2) Hartmann. 1996. *Bradleya* 14: 29–56.
(3) Hartmann. 1998. *Bradleya* 16: 47, 48.
(4) Hartmann. 1999. *Bradleya* 17: 38–74.
(5) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 37–39.
gydouwensis (L.Bolus) L.Bolus ex Toelken & Jessop = **Lampranthus gydouwensis**
hallii (L.Bolus) L.Bolus ex Toelken & Jessop = **Lampranthus amphibolius**
hutchinsonii (L.Bolus) H.E.K.Hartmann = **A. laevis**
laevis (Aiton) H.E.K.Hartmann
A. hutchinsonii (L.Bolus) H.E.K.Hartmann (5)
A. maritima L.Bolus ex Toelken & Jessop, invalid name (3)
Mesembryanthemum hutchinsonii (L.Bolus) N.E.Br. (3)
Mesembryanthemum laeve Aiton (5)
Mesembryanthemum pansifolium N.E.Br. (3)
Ruschia hutchinsonii L.Bolus (3)
Ruschia maritima (L.Bolus ex Toelken & Jessop) G.D.Rowley (3)
Perennial. Succulent. Ht 0.2–0.4 m. Alt 5–100 m. NC, WC
littlewoodii (L.Bolus) L.Bolus ex Toelken & Jessop = **Lampranthus mutatus**
maritima L.Bolus ex Toelken & Jessop, invalid name = **A. laevis**
obscura H.E.K.Hartmann
Perennial. Succulent. Ht up to 0.4 m. Alt 110–490 m. N, NC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

rupis-arcuatae (Dinter) H.E.K.Hartmann
Mesembryanthemum namaquanum (L.Bolus) N.E.Br. (3)
Mesembryanthemum rupis-arcuatae Dinter (2)
Ruschia namaquana L.Bolus (4)
Ruschia rupis-arcuatae (Dinter) Friedrich (2)
Stoeberia rupis-arcuatae (Dinter) Dinter & Schwantes (2)
Perennial. Succulent. Ht up to 0.5 m. Alt 10–550 m. N, NC
saginata (L.Bolus) H.E.K.Hartmann
Ruschia saginata L.Bolus (3)
Ruschia stricta L.Bolus var. *turgida* L.Bolus (3)
Perennial. Succulent. Ht up to 0.4 m. Alt 750–1150 m. N
stayneri L.Bolus ex Toelken & Jessop = **Lampranthus dissimilis**
stayneri L.Bolus, illegitimate name = **Lampranthus dissimilis**
succulenta (L.Bolus) H.E.K.Hartmann
Mesembryanthemum succulentum (L.Bolus) N.E.Br. (3)
Ruschia succulenta L.Bolus (3)
Perennial. Succulent. Ht up to 0.4 m. Alt 50–460 m. NC

ANISOCALYX L.Bolus 2405163
salarius L.Bolus = **Jacobsenia vaginata**
vaginatus (L.Bolus) L.Bolus = **Jacobsenia vaginata**

ANTEGIBBAEUM Schwantes ex C.Weber 2405007
(1) Glen. 1974. *A revision of the Gibbaeinae (Mesembryanthemaceae).* Unpublished M.Sc. thesis, University of Cape Town.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 40, 41.
fissoides (Haw.) Schwantes ex C.Weber
Perennial. Succulent. Ht 0.05–0.08 m. Alt 300–700 m. WC

ANTIMIMA N.E.Br. emend. Dehn 2405129
(1) Brown 1930. *The Gardeners' Chronicle* 87: 32, 33.
(2) Brown 1930. *The Gardeners' Chronicle* 87: 211.
(3) Dehn. 1988. *Mitteilungen aus dem Institut für Allgemeine Botanik, Hamburg* 22: 189–215.
(4) Hartmann & Stüber. 1993. *Contributions from the Bolus Herbarium* 15: 1–75.
(5) Hartmann. 1996. *Kakteen und andere Sukkulenten* 47: 229–234.
(6) Hartmann. 1998. *Bothalia* 28: 67–82.
(7) Klak. 2000. *Bothalia* 30: 35–42.
(8) Chesselet. 2001. *Aloe* 38: 17.
(9) Chesselet & Smith. 2001. *Bradleya* 19: 121–123.
(10) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 41–65.
addita (L.Bolus) H.E.K.Hartmann
Ruschia addita L.Bolus (6)
Perennial. Succulent. Ht up to 0.065 m, when in flower. Alt 600–1200 m. NC
alborubra (L.Bolus) Dehn
Ruschia alborubra L.Bolus (3)
Perennial. Succulent. Ht up to 0.19 m. Alt 300–750 m. NC
amoena (Schwantes) H.E.K.Hartmann
Ruschia amoena Schwantes (6)
Perennial. Succulent. Ht up to 0.05 m. Alt up to 1100 m. NC
androsacea (Marloth & Schwantes) H.E.K.Hartmann
Mesembryanthemum androsaceum Marloth, naked name (6)
Mesembryanthemum androsaceum (Schwantes) N.E.Br. (6)
Ruschia androsacea Marloth & Schwantes (6)
Ruschia androsacea Marloth & Schwantes, naked name (6)
Perennial. Succulent. Ht up to 0.08 m. Alt 1200–1800 m. NC
argentea (L.Bolus) H.E.K.Hartmann
Ruschia argentea L.Bolus (6)
Perennial. Succulent. Ht? Alt 20–400 m. N
aristulata (Sond.) Chesselet & G.F.Sm.
Mesembryanthemum aristulatum Sond. (9)
Ruschia aristulata (Sond.) Schwantes (9)
Ruschia pulchella (Haw.) Schwantes var. *caespitosa* L.Bolus (9)
Perennial. Succulent. Ht 0.02–0.05 m. Alt 400–1050 m. WC
aurasensis H.E.K.Hartmann

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.25 m. Alt 300–900 m. N
biformis (N.E.Br.) H.E.K.Hartmann
Mesembryanthemum biforme N.E.Br. (6)
Ruschia biformis (N.E.Br.) Schwantes (6)
Perennial. Succulent. Ht up to 0.025 m. Alt 190–300 m. WC
bina (L.Bolus) H.E.K.Hartmann
Ruschia bina L.Bolus (6)
Perennial. Succulent. Ht up to 0.9 m. Alt 200–850 m. WC
bracteata (L.Bolus) H.E.K.Hartmann
Ruschia bracteata L.Bolus (6)
Perennial. Succulent. Ht up to 0.2 m. Alt 50–400 m. NC
brevicarpa (L.Bolus) H.E.K.Hartmann
Ruschia brevicarpa L.Bolus (6)
Perennial. Succulent. Ht up to 0.2 m. Alt 300–2000 m. WC
brevicollis (N.E.Br.) H.E.K.Hartmann
Mesembryanthemum brevicolle N.E.Br. (6)
Ruschia brevicollis (N.E.Br.) Schwantes (6)
Perennial. Succulent. Ht up to 0.027 m. Alt 600–900 m. WC
buchubergensis (Dinter) H.E.K.Hartmann
Ruschia buchubergensis Dinter (6)
Perennial. Succulent. Ht up to 0.2 m. Alt 500–1000 m. N
compacta (L.Bolus) H.E.K.Hartmann
Ruschia compacta L.Bolus (6)
Perennial. Succulent. Ht up to 0.08 m. Alt up to 1200 m. NC
compressa (L.Bolus) H.E.K.Hartmann
Ruschia compressa L.Bolus (6)
Perennial. Succulent. Ht up to 0.12 m. Alt up to 1200 m. NC
concinna (L.Bolus) H.E.K.Hartmann
Mesembryanthemum comptum N.E.Br. (6)
Ruschia concinna L.Bolus (6)
Perennial. Succulent. Ht up to 0.07 m. Alt 200–400 m. WC
condensa (N.E.Br.) H.E.K.Hartmann
Mesembryanthemum condensum N.E.Br. (6)
Ruschia condensa (N.E.Br.) Schwantes (6)
Perennial. Succulent. Ht up to 0.03 m. Alt 500–1100 m. WC
crassifolia (L.Bolus) H.E.K.Hartmann
Ruschia crassifolia L.Bolus (6)
Perennial. Succulent. Ht up to 0.6 m. Alt 400–700 m. NC
dasyphylla (Schltr.) H.E.K.Hartmann
Mesembryanthemum ciliolatum N.E.Br. (6)
Mesembryanthemum dasyphyllum Schltr. (6)
Ruschia concava L.Bolus (6)
Ruschia dasyphylla (Schltr.) Schwantes (6)
Perennial. Succulent. Ht up to 0.2 m. Alt 600–1800 m. WC
defecta (L.Bolus) H.E.K.Hartmann
Ruschia defecta L.Bolus (6)
Ruschia deflecta L.Bolus (6)
Perennial. Succulent. Ht up to 0.13 m. Alt up to 1200 m. NC
dekenahi (N.E.Br.) H.E.K.Hartmann
Mesembryanthemum dekenahi N.E.Br. (6)
Ruschia dekenahi (N.E.Br.) Schwantes (6)
Perennial. Succulent. Ht up to 0.03 m. Alt 1200–1800 m. NC
distans (L.Bolus) H.E.K.Hartmann
Mesembryanthemum distans L.Bolus (6)
Ruschia distans (L.Bolus) L.Bolus (6)
Perennial. Succulent. Ht 0.1–0.2 m. Alt 300–1600 m. NC, WC
dolomitica (Dinter) H.E.K.Hartmann
Corpuscularia dolomitica (Dinter) Schwantes (6)
Mesembryanthemum dolomiticum Dinter (6)
Ruschia dolomitica (Dinter) Dinter & Schwantes (6)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.35 m. Alt 50–200 m. N
dualis (N.E.Br.) N.E.Br.
Argyroderma duale (N.E.Br.) N.E.Br. (6)
Mesembryanthemum duale N.E.Br. (3)
Ruschia dualis (N.E.Br.) L.Bolus (3)
Ruschia villetii L.Bolus (6)
Perennial. Succulent. Ht up to 0.08 m. Alt 50–400 m. NC, WC
eendornensis (Dinter) H.E.K.Hartmann
Mesembryanthemum eendornense Dinter (6)
Perennial. Succulent. Ht up to 0.3 m. Alt 800–1000 m. N
elevata (L.Bolus) H.E.K.Hartmann
Ruschia elevata L.Bolus (6)
Perennial. Succulent. Ht up to 0.06 m. Alt up to 1200 m. NC
emarcescens (L.Bolus) H.E.K.Hartmann
Ruschia emarcescens L.Bolus (6)
Ruschia emarcidens L.Bolus ex Jacobsen (6)
Perennial. Succulent. Ht 0.21–0.23 m. Alt 1200–1400 m. NC
erosa (L.Bolus) H.E.K.Hartmann
Ruschia erosa L.Bolus (6)
Perennial. Succulent. Ht up to 0.12 m. Alt 500–800 m. WC
evoluta (N.E.Br.) H.E.K.Hartmann
Mesembryanthemum evolutum N.E.Br. (6)
Ruschia evoluta (N.E.Br.) L.Bolus (6)
Perennial. Succulent. Ht up to 0.1 m. Alt 200–400 m. NC, WC
excedens (L.Bolus) Klak
Ruschia excedens L.Bolus (7)
Perennial. Succulent. Ht up to 0.024 m. Alt 200–400 m. WC
exsurgens (L.Bolus) H.E.K.Hartmann
Ruschia exsurgens L.Bolus (6)
Perennial. Succulent. Ht up to 0.2 m. Alt 300–850 m. NC, WC
fenestrata (L.Bolus) H.E.K.Hartmann
Ruschia fenestrata L.Bolus (6)
Perennial. Succulent. Ht up to 0.12 m. Alt 200–400 m. WC
fergusoniae (L.Bolus) H.E.K.Hartmann
Mesembryanthemum fergusoniae (L.Bolus) N.E.Br. (6)
Ruschia fergusoniae L.Bolus (6)
Perennial. Succulent. Ht up to 0.08 m. Alt 200–1000 m. WC
gracillima (L.Bolus) H.E.K.Hartmann
Ruschia gracillima L.Bolus (6)
Perennial. Succulent. Ht 0.05–0.25 m. Alt 900–1600 m. NC
granitica (L.Bolus) H.E.K.Hartmann
Mesembryanthemum graniticum L.Bolus (6)
Ruschia granitica (L.Bolus) L.Bolus (6)
Perennial. Succulent. Ht up to 0.1 m. Alt 20–100 m. NC
hallii (L.Bolus) H.E.K.Hartmann
Ruschia hallii L.Bolus (6)
Perennial. Succulent. Ht up to 0.2 m. Alt 900–1600 m. NC
hamatilis (L.Bolus) H.E.K.Hartmann
Mesembryanthemum hamatile (L.Bolus) N.E.Br. (6)
Ruschia hamatilis L.Bolus (6)
Perennial. Succulent. Ht 0.08–0.12 m. Alt 200–800 m. WC
hantamensis (Engl.) H.E.K.Hartmann & Stüber
Eberlanzia disarticulata (L.Bolus) L.Bolus (4)
Eberlanzia stellata L.Bolus, naked name (6)
Mesembryanthemum hantamense Engl. (4)
Mesembryanthemum stellans (L.Bolus) N.E.Br. (6)
Ruschia disarticulata L.Bolus (4)
Ruschia stellata L.Bolus (6)
Perennial. Succulent. Ht up to 0.5 m. Alt 600–1800 m. NC, WC
herrei (Schwantes) H.E.K.Hartmann

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Mesembryanthemum herrei (Schwantes) N.E.Br. (6)
Ruschia herrei Schwantes (6)
Perennial. Succulent. Ht up to 0.16 m. Alt 1000–1900 m. WC
insidens (L.Bolus) Chesselet
Mesembryanthemum insidens (L.Bolus) N.E.Br. (8)
Ruschia insidens L.Bolus (8)
Perennial. Succulent. Ht up to 0.25 m. Alt 600–800 m. NC
intervallaris (L.Bolus) H.E.K.Hartmann
Ruschia intervallaris L.Bolus (6)
Perennial. Succulent. Ht 0.15–0.2 m. Alt 200–400 m. WC
ivori (N.E.Br.) H.E.K.Hartmann
Mesembryanthemum ivori N.E.Br. (6)
Ruschia ivori (N.E.Br.) Schwantes (6)
Perennial. Succulent. Ht up to 0.03 m. Alt 900–1800 m. NC
karroidea (L.Bolus) H.E.K.Hartmann
Ruschia karroidea L.Bolus (6)
Perennial. Succulent. Ht up to 0.07 m. Alt 800–1100 m. WC
klaverensis (L.Bolus) H.E.K.Hartmann
Mesembryanthemum klaverense L.Bolus (6)
Ruschia klaverensis (L.Bolus) Schwantes (6)
Perennial. Succulent. Ht up to 0.08 m. Alt 200–400 m. NC
koekenaapensis (L.Bolus) H.E.K.Hartmann
Ruschia koekenaapensis L.Bolus (6)
Perennial. Succulent. Ht up to 0.25 m. Alt 200–400 m. NC, WC
komkansica (L.Bolus) H.E.K.Hartmann
Ruschia komkansica L.Bolus (6)
Perennial. Succulent. Ht up to 0.6 m. Alt 300–500 m. NC
lawsonii (L.Bolus) H.E.K.Hartmann
Mesembryanthemum lawsonii L.Bolus (6)
Ruschia lawsonii (L.Bolus) L.Bolus (6)
Perennial. Succulent. Ht up to 0.25 m. Alt 1300–1600 m. NC
leipoldtii (L.Bolus) H.E.K.Hartmann
Mesembryanthemum leipoldtii (L.Bolus) N.E.Br. (6)
Ruschia leipoldtii L.Bolus (6)
Perennial. Succulent. Ht 0.15–0.2 m. Alt 800–1100 m. WC
leucanthera (L.Bolus) H.E.K.Hartmann
Mesembryanthemum leucantherum L.Bolus (6)
Ruschia leucanthera (L.Bolus) L.Bolus (6)
Perennial. Succulent. Ht up to 0.03 m. Alt 700–1800 m. WC
limbata (N.E.Br.) H.E.K.Hartmann
Mesembryanthemum limbatum N.E.Br. (6)
Ruschia limbata (N.E.Br.) Schwantes (6)
Perennial. Succulent. Ht 0.03–0.1 m. Alt 5–100 m. WC
lodewykii (L.Bolus) H.E.K.Hartmann
Ruschia lodewykii L.Bolus (6)
Perennial. Succulent. Ht up to 0.03 m. Alt 200–400 m. NC, WC
loganii (L.Bolus) H.E.K.Hartmann
Ruschia loganii L.Bolus (6)
Perennial. Succulent. Ht ± 0.1 m. Alt 400–1100 m. WC
lokenbergensis (L.Bolus) H.E.K.Hartmann
Ruschia lokenbergensis L.Bolus (6)
Perennial. Succulent. Ht ± 0.45 m. Alt 800–1500 m. NC
longipes (L.Bolus) Dehn
Mesembryanthemum longipes (L.Bolus) N.E.Br. (6)
Ruschia longipes L.Bolus (3)
Perennial. Succulent. Ht ± 0.08 m. Alt up to 1200 m. NC
luckhoffii (L.Bolus) H.E.K.Hartmann
Ruschia luckhoffii L.Bolus (6)
Perennial. Succulent. Ht up to 0.05 m. Alt 500–700 m. WC
maleolens (L.Bolus) H.E.K.Hartmann

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Mesembryanthemum maleolens (L.Bolus) N.E.Br. (6)
Ruschia maleolens L.Bolus (6)
Perennial. Succulent. Ht 0.12–0.25 m. Alt 50–300 m. NC

maxwellii (L.Bolus) H.E.K.Hartmann
Mesembryanthemum maxwellii (L.Bolus) N.E.Br. (6)
Ruschia maxwellii L.Bolus (6)
Perennial. Succulent. Ht 0.06–0.2 m. Alt 900–1400 m. EC

menniei (L.Bolus) H.E.K.Hartmann
Ruschia menniei L.Bolus (6)
Perennial. Succulent. Ht ± 0.25 m. Alt 200–400 m. WC

mesklipensis (L.Bolus) H.E.K.Hartmann
Ruschia mesklipensis L.Bolus (6)
Perennial. Succulent. Ht ± 0.1 m. Alt 300–1200 m. NC

meyerae (Schwantes) H.E.K.Hartmann
Ruschia meyerae Schwantes (6)
Perennial. Succulent. Ht up to 0.05 m. Alt up to 1200 m. NC

microphylla (Haw.) Dehn
Mesembryanthemum microphyllum Haw. (3)
Ruschia microphylla (Haw.) Schwantes (3)
Perennial. Succulent. Ht ± 0.1 m. Alt 300–1800 m. WC

minima (Tischer) H.E.K.Hartmann
Cheiridopsis minima Tischer (6)
Perennial. Succulent. Ht 0.05–0.06 m. Alt up to 1200 m. NC

minutifolia (L.Bolus) H.E.K.Hartmann
Ruschia minutifolia L.Bolus (6)
Perennial. Succulent. Ht ± 0.08–0.15 m. Alt 300–900 m. WC

modesta (L.Bolus) H.E.K.Hartmann
Ruschia modesta L.Bolus forma *glabrescens* L.Bolus (6)
Ruschia modesta L.Bolus forma *modesta* (6)
Perennial. Succulent. Ht ± 0.2 m. Alt 50–300 m. N

mucronata (Haw.) H.E.K.Hartmann
Mesembryanthemum mucronatum Haw. (6)
Ruschia mathewsii L.Bolus (6)
Ruschia mucronata (Haw.) Schwantes (6)
Perennial. Succulent. Ht ± 0.04 m. Alt 180–300 m. WC

mutica (L.Bolus) H.E.K.Hartmann
Mesembryanthemum muticum (L.Bolus) N.E.Br. (6)
Ruschia mutica L.Bolus (6)
Perennial. Succulent. Ht ± 0.12 m. Alt 300–600 m. WC

nobilis (Schwantes) H.E.K.Hartmann
Ruschia nobilis Schwantes (6)
Perennial. Succulent. Ht ± 0.3 m. Alt 200–900 m. NC

nordenstamii (L.Bolus) H.E.K.Hartmann
Ruschia nordenstamii L.Bolus (6)
Perennial. Succulent. Ht ± 0.4 m. Alt 200–400 m. WC

oviformis (L.Bolus) H.E.K.Hartmann
Ruschia oviformis L.Bolus (6)
Perennial. Succulent. Ht ± 0.06 m. Alt 100–300 m. NC

papillata (Bolus) H.E.K.Hartmann
Ruschia meyeri Schwantes (6)
Ruschia papillata L.Bolus (6)
Perennial. Succulent. Ht ± 0.2 m. Alt 300–1200 m. NC, WC

paucifolia (L.Bolus) H.E.K.Hartmann
Ruschia paucifolia L.Bolus (6)
Perennial. Succulent. Ht ± 0.2 m. Alt 200–1400 m. NC, WC

pauper (L.Bolus) H.E.K.Hartmann
Ruschia pauper L.Bolus (6)
Perennial. Succulent. Ht ± 0.35 m. Alt up to 1100 m. NC

peersii (L.Bolus) H.E.K.Hartmann
Mesembryanthemum formosulum N.E.Br. (6)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Ruschia peersii L.Bolus (6)
Perennial. Succulent. Ht ± 0.08 m. Alt 200–800 m. WC
perforata (L.Bolus) H.E.K.Hartmann
Mesembryanthemum perforatum (L.Bolus) N.E.Br. (6)
Ruschia paripetala (L.Bolus) L.Bolus var. *occultans* L.Bolus (6)
Ruschia perforata L.Bolus (6)
Perennial. Succulent. Ht ± 0.2 m. Alt 50–200 m. N
persistens (L.Bolus) H.E.K.Hartmann
Ruschia persistens L.Bolus (1963), not of L.Bolus (1932), illegitimate name (6)
Perennial. Succulent. Ht ± 0.07–0.15 m. Alt 300–800 m. WC
pilosula (L.Bolus) H.E.K.Hartmann
Ruschia pilosula L.Bolus (6)
Perennial. Succulent. Ht ± 0.24 m. Alt 200–600 m. NC
piscodora (L.Bolus) H.E.K.Hartmann
Ruschia piscodora L.Bolus (6)
Perennial. Succulent. Ht ± 0.54 m. Alt 800–1800 m. NC, WC
prolongata (L.Bolus) H.E.K.Hartmann
Ruschia prolongata L.Bolus (6)
Perennial. Succulent. Ht ± 0.3 m. Alt 400–1600 m. NC
propinqua (N.E.Br.) H.E.K.Hartmann
Mesembryanthemum propinquum N.E.Br. (6)
Ruschia propinqua (N.E.Br.) Schwantes (6)
Perennial. Succulent. Ht ± 0.027 m. Alt 500–800 m. WC
prostrata (L.Bolus) H.E.K.Hartmann
Mesembryanthemum prostratum (L.Bolus) N.E.Br. (6)
Ruschia prostrata L.Bolus (6)
Perennial. Succulent. Ht ± 0.15 m. Alt 100–500 m. WC
pumila (Fedde & K.Schust.) H.E.K.Hartmann
Mesembryanthemum levynsiae L.Bolus (6)
Mesembryanthemum pumilum L.Bolus (6)
Mesembryanthemum pumilum (L.Bolus) N.E.Br., illegitimate name (6)
Ruschia levynsiae (L.Bolus) Schwantes (6)
Ruschia pumila L.Bolus (6)
Perennial. Succulent. Ht ± 0.1 m. Alt 300–600 m. WC
pusilla (Schwantes) H.E.K.Hartmann
Mesembryanthemum parvum N.E.Br. (6)
Ruschia pusilla Schwantes (6)
Perennial. Succulent. Ht ± 0.075 m. Alt up to 1000 m. NC
pygmaea (Haw.) H.E.K.Hartmann
Mesembryanthemum pygmaeum Haw. (6)
Ruschia pygmaea (Haw.) Schwantes (6)
Perennial. Succulent. Ht ± 0.15 m. Alt 300–1100 m. WC
quarzitica (Dinter) H.E.K.Hartmann
Corpuscularia quarzitica (Dinter) Schwantes (6)
Mesembryanthemum quarziticum Dinter (6)
Ruschia quarzitica (Dinter) Dinter & Schwantes (6)
Perennial. Succulent. Ht ± 0.3 m. Alt 50–400 m. N
roseola (N.E.Br.) H.E.K.Hartmann
Mesembryanthemum roseolum N.E.Br. (6)
Ruschia roseola (N.E.Br.) Schwantes (6)
Perennial. Succulent. Ht ± 0.2 m. Alt 200–800 m. WC
saturata (L.Bolus) H.E.K.Hartmann
Mesembryanthemum atrocinctum N.E.Br. (6)
Ruschia saturata L.Bolus (6)
Perennial. Succulent. Ht ± 0.12 m. Alt 200–800 m. WC
saxicola (L.Bolus) H.E.K.Hartmann
Mesembryanthemum saxicolum (L.Bolus) N.E.Br. (6)
Ruschia saxicola L.Bolus (6)
Perennial. Succulent. Ht ± 0.7 m. Alt 1400–1600 m. FS
schlechteri (Schwantes) H.E.K.Hartmann

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Mesembryanthemum schlechteri (Schwantes) N.E.Br. (6)
Ruschia schlechteri Schwantes (6)
Perennial. Succulent. Ht 0.05–0.1 m. Alt ± 1200 m NC
simulans (L.Bolus) H.E.K.Hartmann
Ruschia simulans L.Bolus (6)
Perennial. Succulent. Ht ± 0.05 m. Alt 200–400 m. WC
sobrina (N.E.Br.) H.E.K.Hartmann
Mesembryanthemum sobrinum N.E.Br. (6)
Ruschia sobrina (N.E.Br.) Schwantes (6)
Perennial. Succulent. Ht ± 0.027 m. Alt 200–300 m. WC
solida (L.Bolus) H.E.K.Hartmann
Mesembryanthemum solidum L.Bolus (6)
Ruschia solida (L.Bolus) L.Bolus var. *solida* (6)
Ruschia solida (L.Bolus) L.Bolus var. *stigmatosa* L.Bolus (6)
Perennial. Succulent. Ht ± 0.08 m. Alt 100–400 m. WC
stayneri (L.Bolus) H.E.K.Hartmann
Ruschia stayneri L.Bolus (6)
Perennial. Succulent. Ht ± 0.3 m. Alt 900–1600 m. NC
stokoei (L.Bolus) H.E.K.Hartmann
Ruschia stokoei L.Bolus (6)
Perennial. Succulent. Ht ± 0.05 m. Alt 400–600 m. WC
subtruncata (L.Bolus) H.E.K.Hartmann
Ruschia subtruncata L.Bolus var. *minor* L.Bolus (6)
Ruschia subtruncata L.Bolus var. *subtruncata* (6)
Perennial. Succulent. Ht ± 0.1 m. Alt 700–900 m. NC
triquetra (L.Bolus) H.E.K.Hartmann
Mesembryanthemum triquetrum (L.Bolus) N.E.Br. (6)
Ruschia triquetra L.Bolus (6)
Perennial. Succulent. Ht ± 0.15 m. Alt 300–600 m. NC, WC
tuberculosa (L.Bolus) H.E.K.Hartmann
Mesembryanthemum enorme N.E.Br. (6)
Ruschia tuberculosa L.Bolus (6)
Perennial. Succulent. Ht ± 0.08 m. Alt 300–600 m. WC
turneriana (L.Bolus) H.E.K.Hartmann
Ruschia turneriana L.Bolus (6)
Perennial. Succulent. Ht 0.02–0.04 m. Alt 200–400 m. WC
vanzylii (L.Bolus) H.E.K.Hartmann
Ruschia vanzylii L.Bolus (6)
Perennial. Succulent. Ht ± 0.2 m. Alt 800–950 m. NC
varians (L.Bolus) H.E.K.Hartmann
Ruschia varians L.Bolus (6)
Perennial. Succulent. Ht ± 0.18 m. Alt 800–1200 m. NC
ventricosa (L.Bolus) H.E.K.Hartmann
Cheiridopsis ventricosa (L.Bolus) N.E.Br. (6)
Mesembryanthemum ventricosum L.Bolus (6)
Ruschia ventricosa (L.Bolus) Schwantes (6)
Perennial. Succulent. Ht ± 0.1 m. Alt 300–600 m. WC
verruculosa (L.Bolus) H.E.K.Hartmann
Mesembryanthemum verruculosum (L.Bolus) N.E.Br. (6)
Ruschia verruculosa L.Bolus (6)
Perennial. Succulent. Ht ± 0.07 m. Alt 200–400 m. WC
virgata (Haw.) Dehn = **Ruschia virgata**
watermeyeri (L.Bolus) H.E.K.Hartmann
Ruschia obtusifolia L.Bolus (6)
Ruschia stenopetala L.Bolus (6)
Ruschia watermeyeri L.Bolus (6)
Perennial. Succulent. Ht ± 0.1 m. Alt 200–300 m. WC
wittebergensis (L.Bolus) H.E.K.Hartmann
Mesembryanthemum wittebergense L.Bolus (6)
Ruschia wittebergensis (L.Bolus) Schwantes (6)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht ± 0.025–0.05 m. Alt 800–1100 m. WC

ANYSOCALYX L.Bolus 2405006
vaginatus (L.Bolus) L.Bolus = **Jacobsenia vaginata**

APATESIA N.E.Br. 2405008
(1) Ihlenfeldt & Gerbaulet. 1990. *Botanische Jahrbücher* 111: 457–498.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 65, 66.
helianthoides (Aiton) N.E.Br.
Annual. Succulent. Ht ± 0.25 m, when in flower. Alt 170–900 m. WC
maughanii N.E.Br. = **A. sabulosa**
pillansii N.E.Br.
Annual. Succulent. Ht ± 0.25 m, when in flower. Alt 20–200 m. WC
sabulosa (Thunb.) L.Bolus
A. maughanii N.E.Br. (1)
Annual. Succulent. Ht up to 0.3 m, when in flower. Alt 300–600 m. WC

APTENIA N.E.Br. 2405009
(1) Gerbaulet. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 66–68.
cordifolia (L.f.) Schwantes
Perennial. Succulent. Ht ± 0.25 m. Alt 20–800 m. KZN, EC
geniculiflora (L.) Bittrich ex Gerbaulet
Psilocaulon melanospermum (A.Berger) N.E.Br. (1)
Sphalmanthus decussatus (Thunb.) L.Bolus (1)
Sphalmanthus geniculiflorus (L.) L.Bolus (1)
Perennial. Succulent. Ht ± 0.45 m. Alt 800–1800 m. N, NC, EC
haeckeliana (A.Berger) Bittrich ex Gerbaulet
Platythyra haeckeliana (A.Berger) N.E.Br. (1)
Perennial. Succulent. Ht ± 0.25 m. Alt 50–500 m. EC
lancifolia L.Bolus
Perennial. Succulent. Ht ± 0.3 m. Alt 900–1100 m. NP

ARENIFERA A.G.J.Herre 2405010
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 280A.
(2) Hartmann & Stüber. 1993. *Contributions from the Bolus Herbarium* 15: 1–75.
(3) Hartmann. 1996. *Bradleya* 14: 35–38.
(4) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 68–70.
pillansii (L.Bolus) A.G.J.Herre
Psammophora pillansii L.Bolus (3)
Perennial. Succulent. Ht ± 0.4 m. Alt up to 1000 m. NC
pungens H.E.K.Hartmann
Perennial. Succulent. Ht ± 0.15 m. Alt 800–1500 m. NC
spinescens (L.Bolus) H.E.K.Hartmann
Ruschia spinescens L.Bolus (3)
Perennial. Succulent. Ht ± 0.4 m. Alt 300–1100 m. WC
stylosa (L.Bolus) H.E.K.Hartmann
Eberlanzia armata (L.Bolus) L.Bolus (3)
Eberlanzia stylosa (L.Bolus) L.Bolus (3)
Ruschia armata L.Bolus (3)
Ruschia stylosa L.Bolus (3)
Perennial. Succulent. Ht ± 0.25 m. Alt up to 1200 m. NC

ARGYRODERMA N.E.Br. 2405011
(1) Brown. 1922. *The Flowering Plants of South Africa* 2: t. 78.
(2) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 268.
(3) Maass. 1927. In Schwantes, *Zeitschrift für Sukkulentenkunde* 3: 294, 295.
(4) Bolus. 1949. *The Flowering Plants of Africa* 27: t. 1057.
(5) Hartmann. 1973. *The National Cactus and Succulent Journal* 28: 48–50.
(6) Hartmann. 1977. *Mitteilungen aus dem Institut für Allgemeine Botanik, Hamburg* 15: 121–235.
(7) Van Jaarsveld. 1997. *Aloe* 34: 12, 13.
(8) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 70–75.
amoenum Schwantes = **A. pearsonii**
angustipetalum L.Bolus = **A. congregatum**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

aureum L.Bolus = **A. delaetii**
australe L.Bolus = **A. delaetii**
blandum L.Bolus = **A. delaetii**
boreale L.Bolus = **A. delaetii**
braunsii (Schwantes) Schwantes = **A. fissum**
brevipes (Schltr.) L.Bolus = **A. fissum**
brevitubum L.Bolus = **A. delaetii**
carinatum L.Bolus in part = **A. delaetii**
carinatum L.Bolus in part = **A. testiculare**
citrinum L.Bolus = **A. delaetii**
concinnum Schwantes = **A. delaetii**
congregatum L.Bolus
A. angustipetalum L.Bolus (6)
A. jacobsenianum Schwantes (6)
A. nortieri L.Bolus (6)
A. peersii L.Bolus (6)
A. rooipanense L.Bolus in part (6)
Perennial. Succulent. Ht ± 0.04 m. Alt 120–400 m. WC
crateriforme (L.Bolus) N.E.Br.
A. pulvinare L.Bolus (6)
A. subrotundum L.Bolus (6)
Perennial. Succulent. Ht ± 0.03 m. Alt 120–400 m. WC
cuneatipetalum L.Bolus in part = **A. delaetii**
cuneatipetalum L.Bolus in part = **A. pearsonii**
delaetii C.A.Maass
A. aureum L.Bolus (6)
A. australe L.Bolus (6)
A. blandum L.Bolus (6)
A. boreale L.Bolus (6)
A. brevitubum L.Bolus (6)
A. carinatum L.Bolus in part (6)
A. citrinum L.Bolus (6)
A. concinnum Schwantes (6)
A. cuneatipetalum L.Bolus in part (6)
A. delaetii C.A.Maass var. *purpureum* C.A.Maass (3)
A. densipetalum L.Bolus (6)
A. formosum L.Bolus (6)
A. gregarium L.Bolus (6)
A. latifolium L.Bolus (6)
A. lesliei R.Br. (6)
A. leucanthum L.Bolus (6)
A. longipes L.Bolus (6)
A. planum L.Bolus (6)
A. productum L.Bolus (6)
A. reniforme L.Bolus (6)
A. rooipanense L.Bolus in part (6)
A. roseum Schwantes var. *delaetii* G.D.Rowley (6)
A. roseum Schwantes var. *roseum* (6)
A. schuldtii Schwantes (6)
A. speciosum L.Bolus (6)
A. splendens L.Bolus (6)
Perennial. Succulent. Ht ± 0.02 m. Alt 120–400 m. WC
delaetii C.A.Maass var. *purpureum* C.A.Maass = **A. delaetii**
densipetalum L.Bolus = **A. delaetii**
digitifolium (N.E.Br.) Schwantes ex L.Bolus = **A. fissum**
duale (N.E.Br.) N.E.Br. = **Antimima dualis**
fissum (Haw.) L.Bolus
A. braunsii (Schwantes) Schwantes (6)
A. brevipes (Schltr.) L.Bolus (6)
A. digitifolium (N.E.Br.) Schwantes ex L.Bolus (6)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

A. hutchinsonii L.Bolus (6)
A. latipetalum L.Bolus var. *latipetalum* (6)
A. latipetalum L.Bolus var. *longitubum* L.Bolus (6)
A. litorale L.Bolus (6)
A. orientale L.Bolus (6)
Mesembryanthemum socium N.E.Br. (6)
Roodia digitifolia N.E.Br. (5)
Ruschia socia (N.E.Br.) Schwantes (6)
Perennial. Succulent. Ht ± 0.1 m. Alt 120–400 m. WC
formosum L.Bolus = **A. delaetii**
framesii L.Bolus var. *minus* L.Bolus = **A. framesii** subsp. **framesii**
framesii L.Bolus subsp. **framesii**
A. framesii L.Bolus var. *minus* L.Bolus (6)
Perennial. Succulent. Ht ± 0.03 m. Alt 120–400 m. WC
framesii L.Bolus subsp. **hallii** (L.Bolus) H.E.K.Hartmann
Perennial. Succulent. Ht ± 0.04 m. Alt 120–400 m. WC
framesii in sense of L.Bolus (1929), not of L.Bolus (1934) = **A. pearsonii**
gregarium L.Bolus = **A. delaetii**
hutchinsonii L.Bolus = **A. fissum**
jacobsenianum Schwantes = **A. congregatum**
latifolium L.Bolus = **A. delaetii**
latipetalum L.Bolus var. *latipetalum* = **A. fissum**
latipetalum L.Bolus var. *longitubum* L.Bolus = **A. fissum**
lesliei R.Br. = **A. delaetii**
leucanthum L.Bolus = **A. delaetii**
litorale L.Bolus = **A. fissum**
longipes L.Bolus = **A. delaetii**
luckoffii L.Bolus = **A. pearsonii**
nortieri L.Bolus = **A. congregatum**
orientale L.Bolus = **A. fissum**
ovale L.Bolus = **A. pearsonii**
patens L.Bolus
Perennial. Succulent. Ht ± 0.05 m. Alt 120–250 m. WC
pearsonii (N.E.Br.) Schwantes
A. amoenum Schwantes (5)
A. cuneatipetalum L.Bolus in part (6)
A. framesii in sense of L.Bolus (1929), not of L.Bolus (1934) (6)
A. luckoffii L.Bolus (6)
A. ovale L.Bolus (6)
A. schlechteri Schwantes (6)
Perennial. Succulent. Ht ± 0.05 m. Alt 120–400 m. WC
peersii L.Bolus = **A. congregatum**
planum L.Bolus = **A. delaetii**
productum L.Bolus = **A. delaetii**
pulvinare L.Bolus = **A. crateriforme**
reniforme L.Bolus = **A. delaetii**
ringens L.Bolus
Perennial. Succulent. Ht ± 0.07 m. Alt 120–400 m. WC
rooipanense L.Bolus in part = **A. congregatum**
rooipanense L.Bolus in part = **A. delaetii**
roseum Schwantes forma *delaetii* G.D.Rowley = **A. delaetii**
roseum Schwantes forma *roseum* = **A. delaetii**
schlechteri Schwantes = **A. pearsonii**
schuldtii Schwantes = **A. delaetii**
speciosum L.Bolus = **A. delaetii**
splendens L.Bolus = **A. delaetii**
subalbum (N.E.Br.) N.E.Br.
A. villetii L.Bolus (5)
Perennial. Succulent. Ht ± 0.08 m. Alt 120–400 m. WC
subrotundum L.Bolus = **A. crateriforme**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

testiculare (Aiton) N.E.Br.
A. carinatum L.Bolus in part (6)
Perennial. Succulent. Ht ± 0.05 m. Alt 120–400 m. WC
theartii Van Jaarsv.
Perennial. Succulent. Ht ± 0.04 m. Alt 450–590 m. WC
villetii L.Bolus = **A. subalbum**

ARIDARIA N.E.Br. 2405012
(1) Bolus. 1927. *The Flowering Plants of South Africa* 7: t. 258.
(2) Gerbaulet. 1996. *Botanische Jahrbücher* 118: 41–58.
(3) Gerbaulet. 1997. *Botanische Jahrbücher* 119: 145–211.
(4) Gerbaulet. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 75–80.
abbreviata L.Bolus = **Phyllobolus abbreviatus**
acuminata (Haw.) Schwantes = **Phyllobolus splendens** subsp. **splendens**
albertensis L.Bolus = **Phyllobolus pumilus**
albicaulis (Haw.) N.E.Br. = **Phyllobolus splendens** subsp. **splendens**
anguinea L.Bolus = **Phyllobolus oculatus**
arcuata L.Bolus = **A. noctiflora** subsp. **noctiflora**
arenicola L.Bolus = **Phyllobolus oculatus**
aurea (Thunb.) L.Bolus = **Phyllobolus nitidus**
ausana (Dinter & A.Berger) Dinter & Schwantes = **Prenia tetragona**
barkerae L.Bolus = **A. noctiflora** subsp. **defoliata**
beaufortensis L.Bolus = **A. noctiflora** subsp. **straminea**
bijliae N.E.Br. = **Phyllobolus splendens** subsp. **splendens**
blanda L.Bolus = **Phyllobolus splendens** subsp. **splendens**
brevicarpa L.Bolus
A. intricata L.Bolus (2)
A. klaverensis L.Bolus (2)
A. meyeri L.Bolus (2)
Nycteranthus brevicarpus (L.Bolus) Schwantes, illegitimate name (2)
Nycteranthus intricatus (L.Bolus) Schwantes, illegitimate name (2)
Nycteranthus meyeri (L.Bolus) Schwantes, illegitimate name (2)
Perennial. Succulent. Ht ± 1 m. Alt ± 1200 m. NC, WC
brevifolia L.Bolus = **Phyllobolus splendens** subsp. **splendens**
brevisepala L.Bolus = **Phyllobolus spinuliferus**
calycina L.Bolus = **A. noctiflora** subsp. **noctiflora**
canaliculata (Haw.) Friedrich = **Phyllobolus canaliculatus**
caudata (L.Bolus) L.Bolus = **Phyllobolus caudatus**
celans L.Bolus = **Phyllobolus splendens** subsp. **splendens**
compacta L.Bolus = **A. serotina**
congesta L.Bolus = **Phyllobolus congestus**
constricta L.Bolus = **Phyllobolus splendens** subsp. **splendens**
debilis L.Bolus = **A. noctiflora** subsp. **noctiflora**
decidua L.Bolus = **Phyllobolus deciduus**
decurvata L.Bolus = **Phyllobolus decurvatus**
defoliata (Haw.) Schwantes = **A. noctiflora** subsp. **defoliata**
dejagerae L.Bolus = **A. noctiflora** subsp. **straminea**
dela (L.Bolus) L.Bolus = **Phyllobolus delus**
dinteri L.Bolus, illegitimate name = **Phyllobolus melanospermus**
dyeri L.Bolus = **Phyllobolus splendens** subsp. **splendens**
ebracteata N.E.Br. = **Phyllobolus trichotomus**
ebracteata N.E.Br. var. *brevipetala* L.Bolus = **Phyllobolus trichotomus**
elongata L.Bolus = **Phyllobolus prasinus**
englishiae (L.Bolus) N.E.Br. = **Prenia englishiae**
esterhuyseniae L.Bolus = **A. noctiflora** subsp. **straminea**
fastigiata (Haw.) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
flexuosa (Haw.) Schwantes = **Phyllobolus splendens** subsp. **splendens**
floribunda L.Bolus = **A. noctiflora** subsp. **noctiflora**
fourcadei L.Bolus = **Phyllobolus splendens** subsp. **splendens**
fragilis (N.E.Br.) Friedrich = **Phyllobolus oculatus**
framesii L.Bolus = **Phyllobolus spinuliferus**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

fulva (Haw.) Schwantes = **A. noctiflora** subsp. **straminea**
gibbosa L.Bolus, illegitimate name = **Phyllobolus spinuliferus**
glandulifera L.Bolus = **Phyllobolus sinuosus**
globosa L.Bolus = **A. serotina**
godmaniae L.Bolus = **Phyllobolus sinuosus**
gracilis L.Bolus = **A. serotina**
gratiae L.Bolus = **Phyllobolus grossus**
grossa (Aiton) Friedrich = **Phyllobolus grossus**
herbertii (N.E.Br.) Friedrich = **Phyllobolus herbertii**
horizontalis (Haw.) Schwantes = **A. noctiflora** subsp. **defoliata**
inaequalis L.Bolus = **Phyllobolus nitidus**
intricata L.Bolus = **A. brevicarpa**
klaverensis L.Bolus = **A. brevicarpa**
latipetala L.Bolus = **Phyllobolus latipetalus**
laxa L.Bolus = **Phyllobolus decurvatus**
laxipetala L.Bolus = **Phyllobolus grossus**
leipoldtii L.Bolus = **A. noctiflora** subsp. **noctiflora**
leptopetala L.Bolus = **Phyllobolus splendens** subsp. **splendens**
lignea L.Bolus = **Phyllobolus melanospermus**
littlewoodii L.Bolus = **A. noctiflora** subsp. **straminea**
longisepala L.Bolus = **A. noctiflora** subsp. **defoliata**
longispinula (Haw.) L.Bolus = **Phyllobolus grossus**
longituba L.Bolus = **Phyllobolus tenuiflorus**
luteoalba L.Bolus = **Prenia tetragona**
macrosiphon L.Bolus = **Phyllobolus tenuiflorus**
meridiana L.Bolus = **A. noctiflora** subsp. **defoliata**
meyeri L.Bolus = **A. brevicarpa**
muirii N.E.Br. = **A. noctiflora** subsp. **defoliata**
multiseriata L.Bolus = **Phyllobolus prasinus**
mutans L.Bolus = **Prenia tetragona**
nevillei L.Bolus = **A. noctiflora** subsp. **noctiflora**
nitida (Haw.) N.E.Br. = **Phyllobolus nitidus**
nocta (N.E.Br.) N.E.Br. = **Phyllobolus splendens** subsp. **splendens**
noctiflora (L.) Schwantes subsp. **defoliata** (Haw.) Gerbaulet
A. barkerae L.Bolus (2)
A. defoliata (Haw.) Schwantes (2)
A. horizontalis (Haw.) Schwantes (2)
A. longisepala L.Bolus (2)
A. meridiana L.Bolus (2)
A. muirii N.E.Br. (2)
Mesembryanthemum defoliatum Haw. (2)
Mesembryanthemum horizontale Haw. (2)
Nycteranthus defoliatus (Haw.) Schwantes, illegitimate name (2)
Nycteranthus horizontalis (Haw.) Schwantes, illegitimate name (2)
Nycteranthus longisepalus (L.Bolus) Schwantes, illegitimate name (2)
Nycteranthus meridianus (L.Bolus) Schwantes, illegitimate name (2)
Nycteranthus muirii (L.Bolus) Schwantes, illegitimate name (2)
Peratetracoilanthus defoliatus (Haw.) Rappa & Camarrone, invalid name (2)
Sphalmanthus defoliatus (Haw.) L.Bolus (4)
Perennial. Succulent. Ht ± 1 m. Alt 500–1000 m. NC, WC, EC
noctiflora (L.) Schwantes subsp. **noctiflora**
A. arcuata L.Bolus (2)
A. calycina L.Bolus (2)
A. debilis L.Bolus (2)
A. floribunda L.Bolus (2)
A. leipoldtii L.Bolus (2)
A. nevillei L.Bolus (2)
A. pillansii L.Bolus (2)
Mesembryanthemum lindequistii Engl. (2)
Mesembryanthemum noctiflorum L. var. *elatum* Haw. (2)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Mesembryanthemum noctiflorum L. var. *noctiflorum* (2)
Mesembryanthemum noctiflorum L. var. *phoeniceum* Haw., illegitimate name (2)
Nycteranthus arcuatus (L.Bolus) Schwantes, illegitimate name (2)
Nycteranthus calycinus (L.Bolus) Schwantes, illegitimate name (2)
Nycteranthus debilis (L.Bolus) Schwantes, illegitimate name (2)
Nycteranthus floribundus (L.Bolus) Schwantes, illegitimate name (2)
Nycteranthus noctiflorus (L.) Rothm., illegitimate name (2)
Peratetracoilanthus noctiflorus (L.) Rappa & Camarrone, invalid name (2)
Phyllobolus noctiflorus (L.) Bittrich (2)
Psilocaulon lindequistii (Engl.) Schwantes (2)
Perennial. Succulent. Ht ± 1 m. Alt 120–900 m. N, NC, WC

noctiflora (L.) Schwantes subsp. **straminea** (Haw.) Gerbaulet
A. beaufortensis L.Bolus (2)
A. dejagerae L.Bolus (2)
A. esterhuyseniae L.Bolus (2)
A. fulva (Haw.) Schwantes (2)
A. littlewoodii L.Bolus (2)
A. noctiflora (L.) Schwantes var. *fulva* (Haw.) Herre & Friedrich (4)
A. straminea (Haw.) Schwantes (2)
A. subtruncata L.Bolus (2)
Mesembryanthemum fulvum Haw. (2)
Mesembryanthemum noctiflorum L. var. *fulvum* (Haw.) Salm-Dyck (2)
Mesembryanthemum noctiflorum L. var. *stramineum* (Haw.) Haw. (2)
Mesembryanthemum stramineum Haw. (2)
Nycteranthus dejagerae (L.Bolus) Schwantes, illegitimate name (2)
Nycteranthus esterhuyseniae (L.Bolus) Schwantes, illegitimate name (2)
Nycteranthus fulvus (Haw.) Schwantes, illegitimate name (2)
Nycteranthus stramineus (Haw.) Schwantes, illegitimate name (2)
Nycteranthus subtruncatus (L.Bolus) Schwantes, illegitimate name (2)
Perennial. Succulent. Ht ± 1 m. Alt 800–1800 m. N, NC, WC, EC

noctiflora (L.) Schwantes var. *fulva* (Haw.) Herre & Friedrich = **A. noctiflora** subsp. **straminea**
obtusa L.Bolus = **Phyllobolus decurvatus**
oculata (N.E.Br.) L.Bolus = **Phyllobolus oculatus**
odorata (L.Bolus) Schwantes ex H.Jacobsen = **Hereroa odorata**
oubergensis L.Bolus = **Phyllobolus pumilus**
ovalis L.Bolus = **A. serotina**
parvisepala L.Bolus = **Phyllobolus spinuliferus**
paucandra L.Bolus var. *gracillima* L.Bolus = **A. serotina**
paucandra L.Bolus var. *paucandra* = **A. serotina**
peersii L.Bolus = **Phyllobolus tenuiflorus**
pentagona L.Bolus = **Phyllobolus splendens** subsp. **pentagonus**
pentagona L.Bolus var. *occidentalis* L.Bolus = **Phyllobolus splendens** subsp. **pentagonus**
pillansii L.Bolus = **A. noctiflora** subsp. **noctiflora**
platysepala L.Bolus = **Phyllobolus grossus**
plenifolia (N.E.Br.) Stearn = **Phyllobolus splendens** subsp. **splendens**
pomonae L.Bolus = **Phyllobolus oculatus**
prasina L.Bolus = **Phyllobolus prasinus**
primulina L.Bolus = **Phyllobolus splendens** subsp. **splendens**
pumila L.Bolus = **Phyllobolus pumilus**
quartzitica L.Bolus = **Phyllobolus quartziticus**
quaterna L.Bolus = **Phyllobolus spinuliferus**
rabiei L.Bolus = **Phyllobolus rabiei**
rabiesbergensis L.Bolus = **Phyllobolus splendens** subsp. **splendens**
radicans L.Bolus = **Prenia radicans**
rangei (N.E.Br.) Friedrich = **Phyllobolus oculatus**
recurva L.Bolus = **Phyllobolus sinuosus**
reflexa (Haw.) N.E.Br. = **Phyllobolus splendens** subsp. **splendens**
resurgens (Kensit) L.Bolus = **Phyllobolus resurgens**
rhodandra L.Bolus = **Phyllobolus nitidus**
rosea L.Bolus = **Phyllobolus splendens** subsp. **splendens**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

saturata L.Bolus = **Phyllobolus saturatus**
scintillans (Dinter) Friedrich = **Phyllobolus oculatus**
serotina L.Bolus
A. compacta L.Bolus (2)
A. globosa L.Bolus (2)
A. gracilis L.Bolus (2)
A. ovalis L.Bolus (2)
A. paucandra L.Bolus var. *gracillima* L.Bolus (2)
A. paucandra L.Bolus var. *paucandra* (2)
A. tenuifolia L.Bolus var. *speciosa* (L.Bolus) L.Bolus (4)
A. tenuifolia L.Bolus var. *tenuifolia* (2)
Nycteranthus compactus (L.Bolus) Schwantes, illegitimate name (2)
Nycteranthus globosus (L.Bolus) Schwantes, illegitimate name (2)
Nycteranthus gracilis (L.Bolus) Schwantes, illegitimate name (2)
Nycteranthus ovalis (L.Bolus) Schwantes, illegitimate name (2)
Nycteranthus paucandrus L.Bolus var. *gracillima* (L.Bolus) Schwantes, illegitimate name (2)
Nycteranthus paucandrus (L.Bolus) Schwantes var. *paucandrus*, illegitimate name (2)
Nycteranthus serotinus (L.Bolus) Schwantes, illegitimate name (2)
Nycteranthus tenuifolius (L.Bolus) Schwantes var. *speciosa* L.Bolus, illegitimate name (2)
Nycteranthus tenuifolius (L.Bolus) Schwantes var. *tenuifolius*, illegitimate name (2)
Perennial. Succulent. Ht ± 0.3 m. Alt 100–1200 m. N, NC, WC
spinulifera (Haw.) N.E.Br. = **Phyllobolus spinuliferus**
splendens (L.) Schwantes = **Phyllobolus splendens** subsp. **splendens**
straminea (Haw.) Schwantes = **A. noctiflora** subsp. **straminea**
straminea L.Bolus = **Phyllobolus sinuosus**
straminicolor L.Bolus = **Phyllobolus sinuosus**
striata L.Bolus = **Phyllobolus splendens** subsp. **splendens**
stricta L.Bolus = **Phyllobolus spinuliferus**
subaequans L.Bolus = **Phyllobolus splendens** subsp. **pentagonus**
subpatens L.Bolus = **Phyllobolus splendens** subsp. **pentagonus**
subpetiolata L.Bolus = **Phyllobolus grossus**
subtruncata L.Bolus = **A. noctiflora** subsp. **straminea**
suffusa L.Bolus = **Prenia tetragona**
sulcata (Haw.) Schwantes = **Phyllobolus splendens** subsp. **splendens**
tenuifolia L.Bolus var. *speciosa* (L.Bolus) L.Bolus = **A. serotina**
tenuifolia L.Bolus var. *tenuifolia* = **A. serotina**
tetragona (Thunb.) L.Bolus = **Prenia tetragona**
tetramera L.Bolus var. *parviflora* L.Bolus = **Phyllobolus trichotomus**
tetramera L.Bolus var. *tetramera* = **Phyllobolus trichotomus**
trichosantha (A.Berger) N.E.Br. = **Phyllobolus viridiflorus**
trichotoma (Thunb.) L.Bolus = **Phyllobolus trichotomus**
umbelliflora (Jacq.) Schwantes = **Phyllobolus splendens** subsp. **splendens**
varians L.Bolus = **Phyllobolus oculatus**
vernalis L.Bolus = **Phyllobolus splendens** subsp. **splendens**
vespertina L.Bolus
Nycteranthus vespertinus (L.Bolus) Schwantes, illegitimate name (2)
Perennial. Succulent. Ht ± 0.3 m. Alt 20–300 m. NC
viridiflora (Aiton) L.Bolus = **Phyllobolus viridiflorus**
watermeyeri L.Bolus = **Phyllobolus spinuliferus**
willowmorensis L.Bolus = **Phyllobolus grossus**

ASPAZOMA N.E.Br. 2405013
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 80, 81.
amplectens (L.Bolus) N.E.Br.
Perennial. Succulent. Ht ± 0.4 m. Alt 50–1200 m. NC

ASTRIDIA Dinter 2405014
(1) Phillips. 1930. *The Flowering Plants of South Africa* 10: t. 397.
(2) Glen. 1984. *The Flowering Plants of Africa* 48: t. 1894.
(3) Glen. 1985. *The Flowering Plants of Africa* 48: t. 1917.
(4) Glen. 1986. *Bothalia* 16: 206–212.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

(5) Glen. 1988. *The Flowering Plants of Africa* 50: t. 1970.
(6) Hartmann. 1999. *Bradleya* 17: 38–74.
(7) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 81–84.

alba (L.Bolus) L.Bolus
A. rubra (L.Bolus) L.Bolus var. *alba* (7)
Perennial. Succulent. Ht up to 0.5 m. Alt 300–1100 m. N, NC

blanda L.Bolus var. *angusta* L.Bolus ex H.Jacobsen, invalid name = **A. velutina**

blanda L.Bolus var. *blanda* = **A. velutina**

blanda L.Bolus var. *latipetala* L.Bolus ex H.Jacobsen, invalid name = **A. velutina**

citrina (L.Bolus) L.Bolus
A. rubra (L.Bolus) L.Bolus var. *citrina* L.Bolus (7)
Perennial. Dwarf shrub, succulent. Ht ± 0.5 m. Alt 300–1100 m. N

dinteri (L.Bolus) L.Bolus var. *lutata* L.Bolus ex H.Jacobsen, invalid name = **A. lutata**

dulcis L.Bolus
Perennial. Succulent. Ht up to 0.5 m. Alt 200–900 m. NC

hallii L.Bolus
A. ruschii L.Bolus (4)
Perennial. Dwarf shrub, succulent. Ht ± 0.6 m. Alt 300–1100 m. N

herrei L.Bolus
Perennial. Dwarf shrub, succulent. Ht ± 0.4 m. Alt 200–1300 m. NC

hillii L.Bolus
Perennial. Succulent. Ht ± 0.3 m. Alt 300–1000 m. NC

latisepala L.Bolus = **A. longifolia**

longifolia (L.Bolus) L.Bolus
A. latisepala L.Bolus (4)
A. vanbredai L.Bolus (4)
Mesembryanthemum longifolium L.Bolus (4)
Ruschia jacobseniana L.Bolus (6)
Perennial. Dwarf shrub, succulent. Ht ± 0.5 m. Alt up to 1300 m. N, NC

lutata (L.Bolus) Friedrich ex H.E.K.Hartmann
A. dinteri (L.Bolus) L.Bolus var. *lutata* L.Bolus ex H.Jacobsen, invalid name (7)
A. velutina Dinter var. *lutata* L.Bolus (7)
Perennial. Succulent. Ht up to 0.5 m. Alt 100–900 m. N, NC

maxima (Haw.) Schwantes = **Ruschia maxima**

rubra (L.Bolus) L.Bolus
Lampranthus ruber (L.Bolus) L.Bolus (7)
Mesembryanthemum rubrum L.Bolus (7)
Ruschia rubra (L.Bolus) L.Bolus (7)
Perennial. Dwarf shrub, succulent. Ht up to 0.25 m. Alt ± 300 m. NC

rubra (L.Bolus) L.Bolus var. *alba* L.Bolus = **A. alba**

rubra (L.Bolus) L.Bolus var. *citrina* L.Bolus = **A. citrina**

ruschii L.Bolus = **A. hallii**

speciosa L.Bolus
A. swartpoortensis L.Bolus (7)
Perennial. Dwarf shrub, succulent. Ht up to 0.3 m. Alt 300–1000 m. N, NC

swartpoortensis L.Bolus = **A. speciosa**

vanbredai L.Bolus = **A. longifolia**

vanheerdei L.Bolus
Perennial. Dwarf shrub, succulent. Ht 0.15–0.2 m. Alt 300–1000 m. NC

velutina Dinter
A. blanda L.Bolus var. *angusta* L.Bolus ex H.Jacobsen, invalid name (4)
A. blanda L.Bolus var. *blanda* (4)
A. blanda L.Bolus var. *latipetala* L.Bolus ex H.Jacobsen, invalid name (4)
Mesembryanthemum velutinum Dinter (7)
Perennial. Dwarf shrub, succulent. Ht up to 0.5 m. Alt 300–1100 m. N

velutina Dinter var. *lutata* L.Bolus = **A. lutata**

BERGERANTHUS Schwantes 2405015
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 84–86.

addoensis L.Bolus = **B. multiceps**

artus L.Bolus = **B. multiceps**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

concavus L.Bolus
B. katbergensis L.Bolus (1)
B. leightoniae L.Bolus (1)
Perennial. Succulent. Ht 0.03–0.04 m, ± 0.1 m when in flower. Alt ± 20–1760 m. EC
firmus L.Bolus = **B. multiceps**
glenensis N.E.Br. = **Hereroa glenensis**
jamesii L.Bolus = **B. vespertinus**
katbergensis L.Bolus = **B. concavus**
leightoniae L.Bolus = **B. concavus**
longisepalus L.Bolus
Perennial. Succulent. Ht ± 0.1 m. Alt up to 400 m. EC
multiceps (Salm-Dyck) Schwantes
B. addoensis L.Bolus (1)
B. artus L.Bolus (1)
B. firmus L.Bolus (1)
Perennial. Succulent. Ht 0.04–0.12 m. Alt 10–1520 m. EC
rhomboideus (Salm-Dyck) Schwantes = **Rhombophyllum rhomboideum**
scapiger (Haw.) N.E.Br.
Perennial. Succulent. Ht 0.045–0.1 m, ± 0.2 m when in flower. Alt 15–853 m. EC
vespertinus (A.Berger) Schwantes
B. jamesii L.Bolus (1)
Perennial. Succulent. Ht 0.02–0.054 m. Alt 50–1798 m. EC

BERRISFORDIA L.Bolus 2405016
khamiesbergensis L.Bolus = **Conophytum khamiesbergense**

BIJLIA N.E.Br. 2405017
(1) Hartmann. 1992. *Cactus and Succulent Journal (US)* 64: 179.
(2) Hammer. 1995. *Cactus and Succulent Journal (US)* 67: 219.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 87, 88.
cana in sense of N.E.Br., misapplied name = **B. dilatata**
dilatata H.E.K.Hartmann
B. cana in sense of N.E.Br., misapplied name (1)
Hereroa cana in sense of L.Bolus, misapplied name (1)
Hereroa tugwelliae in sense of L.Bolus (1927, 1928), not of L.Bolus (1930), misapplied name (1)
Perennial. Succulent. Ht up to 0.04 m. Alt 800–1100 m. WC
tugwelliae (L.Bolus) S.A.Hammer
Hereroa tugwelliae (L.Bolus) L.Bolus (2)
Perennial. Succulent. Ht up to 0.08 m. Alt 700–1300 m. WC

BRAUNSIA Schwantes 2405018
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 266.
(2) Klak. 2000. *Bothalia* 30: 35–42.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 88–90.
apiculata (Kensit) L.Bolus
Echinus apiculatus (Kensit) L.Bolus (3)
Perennial. Dwarf shrub, succulent. Ht ± 0.2 m. Alt 500–1750 m. NC, WC
bina (N.E.Br.) Schwantes
Perennial. Dwarf shrub, succulent. Ht ± 0.15 m. Alt 20–1000 m. WC
edentula (Haw.) N.E.Br. = **Ruschia edentula**
geminata (Haw.) L.Bolus
Ruschia polita L.Bolus (2)
Perennial. Dwarf shrub, succulent. Ht ± 0.3 m. Alt 250–1000 m. WC
maximiliani (Schltr. & A.Berger) Schwantes
Perennial. Succulent. Ht ± 0.05 m. Alt 250–1100 m. NC, WC
nelii Schwantes, naked name (insufficiently known) (2)
stayneri (L.Bolus) L.Bolus
Perennial. Dwarf shrub, succulent. Ht ± 0.08 m. Alt 300–700 m. WC
vanrensburgii (L.Bolus) L.Bolus
Perennial. Dwarf shrub, succulent. Ht ± 0.08 m. Alt 20–150 m. WC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

BRIANHUNTLEYA Chesselet, S.A.Hammer & I.Oliver 2405217
(1) Chesselet *et al.* 2003. *Bothalia* 33: 160–164.
intrusa (Kensit) Chesselet, S.A.Hammer & I.Oliver
Mesembryanthemum intrusum Kensit (1)
Ruschia intrusa (Kensit) L.Bolus (1)
Perennial. Dwarf shrub, succulent. Ht 0.07–0.1 m. Alt 200–250 m. WC

BROWNANTHUS Schwantes 2405135
(1) Pierce & Gerbaulet. 1997. *Aloe* 34: 42–44.
(2) Klak. 2000. *Bothalia* 30: 35–42.
(3) Gerbaulet & Pierce. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 91–95.
arenosus (Schinz) Ihlenf. & Bittrich
B. schlichtianus (Sond.) Ihlenf. & Bittrich (3)
Mesembryanthemum arenosum Schinz (3)
Mesembryanthemum schlichtianum Sond. (3)
Psilocaulon arenosum (Schinz) L.Bolus (3)
Psilocaulon schlichtianum (Sond.) Schwantes (3)
Perennial. Succulent. Ht up to 0.5 m. Alt 100–1100 m. N, NC
ciliatus (Aiton) Schwantes subsp. **ciliatus**
Mesembryanthemum ciliatum Aiton (3)
Psilocaulon ciliatum (Aiton) Friedrich (3)
Trichocyclus ciliatus N.E.Br. (3)
Perennial. Succulent. Ht up to 0.25 m. Alt 500–1100 m. NC, WC
ciliatus (Aiton) Schwantes subsp. **schenckii** (Schinz) Ihlenf. & Bittrich
Mesembryanthemum schenckii Schinz (3)
Perennial. Succulent. Ht up to 0.3 m. Alt 100–1800 m. N, NC
corallinus (Thunb.) Ihlenf. & Bittrich
Mesembryanthemum corallinum Thunb. (3)
Psilocaulon corallinum (Thunb.) Schwantes (3)
Psilocaulon peersii L.Bolus (3)
Perennial, occ. annual. Succulent. Ht up to 0.5 m. Alt 200–1100 m. NC, WC
fraternus Klak
Perennial. Succulent. Ht 0.15–0.4 m. Alt up to 350 m. WC
glareicola Klak
Perennial. Succulent. Ht up to 0.17 m. Alt 140–350 WC
kuntzei (Schinz) Ihlenf. & Bittrich
Mesembryanthemum kuntzei Schinz (3)
Psilocaulon kuntzei (Schinz) Dinter & Schwantes (3)
Perennial. Succulent. Ht up to 1 m. Alt 20–250 m. N
marlothii (Pax) Schwantes
Mesembryanthemum marlothii Pax (3)
Psilocaulon marlothii (Pax) Friedrich (3)
Perennial. Succulent. Ht up to 0.15 m. Alt 100–800 m. N, NC
namibensis (Marloth) Bullock
Mesembryanthemum namibense Marloth (3)
Psilocaulon namibense (Marloth) Friedrich (3)
Perennial. Succulent. Ht up to 0.15 m. Alt 20–200 m. N
neglectus S.M.Pierce & Gerbaulet
Perennial. Dwarf shrub, succulent. Ht up to 0.4 m. Alt up to 800 m. N, NC
nucifer (Ihlenf. & Bittrich) S.M.Pierce & Gerbaulet
Pseudobrownanthus nucifer Ihlenf. & Bittrich (1)
Perennial. Succulent. Ht up to 0.4 m. Alt up to 350 m. N, NC
pseudoschlichtianus S.M.Pierce & Gerbaulet
Perennial. Succulent. Ht up to 0.7 m. Alt up to 900 m. N, NC
pubescens (N.E.Br. ex C.A.Maass) Bullock
Psilocaulon pillansii (L.Bolus) Friedrich (3)
Trichocyclus pubescens N.E.Br. ex C.A.Maass (3)
Perennial. Succulent. Ht up to 0.25 m. Alt 50–1000 m. N, NC
schlichtianus (Sond.) Ihlenf. & Bittrich = **B. arenosus**

CALAMOPHYLLUM Schwantes 2405019

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 95, 96.
cylindricum (Haw.) Schwantes
Mesembryanthemum cylindricum Haw. (1)
Perennial. Succulent. Ht up to 0.13 m. Alt? 'SA'
teretifolium (Haw.) Schwantes
Mesembryanthemum cylindricum Haw. var. *teretifolium* Haw. (1)
Mesembryanthemum teretifolium Haw. (1)
Perennial. Succulent. Ht up to 0.25 m. Alt? 'SA'
teretiusculum (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.08 m. Alt? 'SA'

CARPANTHEA N.E.Br. 2405020
(1) Bolus. 1958. *The Flowering Plants of Africa* 32: t. 1264.
(2) Ihlenfeldt & Gerbaulet. 1990. *Botanische Jahrbücher* 111: 457–498.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 96.
pilosa (Haw.) L.Bolus = **C. pomeridiana**
pomeridiana (L.) N.E.Br.
C. pilosa (Haw.) L.Bolus (2)
Annual. Succulent. Ht up to 0.3 m. Alt 50–900 m. NC, WC

CARPOBROTUS N.E.Br. 2405021
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 247.
(2) Bolus. 1927. *The Flowering Plants of South Africa* 7: t. 258.
(3) Wisura & Glen. 1993. *Contributions from the Bolus Herbarium* 15: 76–107.
(4) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 97–101.
acinaciformis (L.) L.Bolus
Abryanthemum acinaciforme (L.) Rothm., illegitimate name (4)
C. concavus L.Bolus (3)
C. laevigatus (Haw.) N.E.Br. (3)
C. laevigatus (Haw.) Schwantes (3)
C. rubrocinctus (Haw.) N.E.Br. (3)
C. subulatus (Haw.) N.E.Br. (3)
C. vanzijliae L.Bolus (3)
Mesembryanthemum acinaciforme Gouan (3)
Mesembryanthemum acinaciforme L. (3)
Mesembryanthemum acinaciforme L. var. *purpureum* L. (3)
Mesembryanthemum laevigatum Haw. (3)
Mesembryanthemum rubrocinctum Haw. (3)
Mesembryanthemum subalatum Haw. (3)
Perennial. Succulent. Ht 0.05–0.2 m. Alt 20–400 m. WC
concavus L.Bolus = **C. acinaciformis**
deliciosus (L.Bolus) L.Bolus
C. dulcis L.Bolus (3)
C. fourcadei L.Bolus var. *alba* L.Bolus (3)
C. fourcadei L.Bolus var. *fourcadei* (3)
Mesembryanthemum deliciosum L.Bolus (3)
Perennial. Succulent. Ht ± 0.25 m. Alt 20–800 m. WC, EC
dimidiatus (Haw.) L.Bolus
C. juritzii (L.Bolus) L.Bolus (3)
Mesembryanthemum dimidiatum Haw. (3)
Mesembryanthemum juritzii L.Bolus (3)
Perennial. Succulent. Ht ± 0.2 m. Alt 20–200 m. KZN, EC
dulcis L.Bolus = **C. deliciosus**
edulis (L.) L.Bolus subsp. **edulis**
Abryanthemum edule (L.) Rothm. (4)
Mesembryanthemum acinaciforme L. var. *ß flavum* L. (4)
Mesembryanthemum edule L. (3)
Perennial. Succulent. Ht ± 0.15 m. Alt up to 1100 m. NC, WC, EC
edulis (L.) L.Bolus subsp. **parviflorus** Wisura & Glen
Perennial. Succulent. Ht ± 0.15 m. Alt up to 800 m. WC
fourcadei L.Bolus var. *alba* L.Bolus = **C. deliciosus**
fourcadei L.Bolus var. *fourcadei* = **C. deliciosus**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

juritzii (L.Bolus) L.Bolus = **C. dimidiatus**
laevigatus (Haw.) N.E.Br. = **C. acinaciformis**
laevigatus (Haw.) Schwantes = **C. acinaciformis**
mellei (L.Bolus) L.Bolus
C. pageae L.Bolus (3)
C. pillansii L.Bolus (3)
Mesembryanthemum mellei L.Bolus (3)
Perennial. Succulent. Ht ± 0.2 m. Alt 200–900 m. WC
muirii (L.Bolus) L.Bolus
Mesembryanthemum muirii L.Bolus (3)
Perennial. Succulent. Ht ± 0.12 m. Alt 50–400 m. WC
pageae L.Bolus = **C. mellei**
pillansii L.Bolus = **C. mellei**
quadrifidus L.Bolus
C. quadrifidus L.Bolus forma *rosea* (L.Bolus) G.D.Rowley, semi-naked name (3)
C. quadrifidus L.Bolus var. *rosea* L.Bolus (3)
C. sauerae Schwantes (3)
Perennial. Succulent. Ht ± 0.25 m. Alt up to 1200 m. NC, WC
quadrifidus L.Bolus forma *rosea* (L.Bolus) G.D.Rowley, semi-naked name = **C. quadrifidus**
quadrifidus L.Bolus var. *rosea* L.Bolus = **C. quadrifidus**
rubrocinctus (Haw.) N.E.Br. = **C. acinaciformis**
sauerae Schwantes = **C. quadrifidus**
subulatus (Haw.) N.E.Br. = **C. acinaciformis**
vanzijliae L.Bolus = **C. acinaciformis**

CARRUANTHUS (Schwantes) Schwantes 2405022
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 101, 102.
peersii L.Bolus
Perennial. Succulent. Ht up to 0.1 m. Alt 800–1200 m. EC
ringens (L.) Boom
Perennial. Succulent. Ht ± 0.15 m. Alt 400–1200 m. WC

CARYOTOPHORA Leistner 2405023
(1) Leistner. 1958. *Notes on* Mesembryanthemum *and allied genera* 3: 289–291.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 102.
skiatophytoides Leistner
Perennial. Succulent. Ht ± 0.25 m. Alt up to 100 m. WC

CAULIPSOLON Klak 2405200
(1) Klak & Linder. 1998. *Botanische Jahrbücher* 120: 301–375.
(2) Klak & Gerbaulet. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 103.
rapaceum (Jacq.) Klak
Psilocaulon longipes L.Bolus (1)
Psilocaulon rapaceum (Jacq.) Schwantes (1)
Perennial, occ. annual. Succulent. Ht ± 0.1 m. Alt 200–350 m. NC, WC

CEPHALOPHYLLUM N.E.Br. 2405024
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 257.
(2) Bolus. 1962. *The Flowering Plants of Africa* 35: tt. 1396–1398.
(3) Hartmann. 1981. *Cactus and Succulent Journal of Great Britain* 43: 96–100.
(4) Hartmann. 1982. *Mitteilungen aus dem Institut für Allgemeine Botanik, Hamburg* 18: 85–101.
(5) Hartmann. 1983. *Bibliographica Botanica* 136: 1–67.
(6) Hartmann. 1983. *Bothalia* 14: 653–659.
(7) Hartmann. 1984. *Botanische Jahrbücher* 104: 321–360.
(8) Hartmann. 1984. *Mitteilungen aus dem Institut für Allgemeine Botanik, Hamburg* 19: 141–163.
(9) Hartmann. 1988. *Mitteilungen aus dem Institut für Allgemeine Botanik, Hamburg* 22: 93–187.
(10) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 103–113.
acutum (Haw.) L.Bolus = **C. subulatoides**
albertiniense (L.Bolus) Schwantes = **Jordaaniella dubia**
alstonii Marloth ex L.Bolus
C. franciscii L.Bolus (9)
Perennial. Succulent. Ht up to 0.15 m. Alt up to 600 m. NC, WC
anemoniflorum (L.Bolus) N.E.Br. = **Jordaaniella dubia**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

apiculatum L.Bolus = **C. loreum**
artum L.Bolus = **C. curtophyllum**
aurantiacum L.Bolus = **C. purpureo-album**
aureorubrum L.Bolus = **C. rigidum**
ausense L.Bolus = **C. ebracteatum**
baylissii L.Bolus = **C. diversiphyllum**
bredasdorpense L.Bolus = **C. diversiphyllum**
brevifolium L.Bolus = **C. pulchellum**
caespitosum H.E.K.Hartmann
Cheiridopsis cuprea (L.Bolus) N.E.Br. (9)
Mesembryanthemum cupreum L.Bolus (9)
Perennial. Succulent. Ht ± 0.06 m. Alt 200–350 m. WC
caledonicum L.Bolus = **C. diversiphyllum**
calvinianum L.Bolus = **Leipoldtia rosea**
cauliculatum (Haw.) N.E.Br. = **C. diversiphyllum**
cedrimontanum L.Bolus = **C. loreum**
ceresianum L.Bolus = **C. corniculatum**
clavifolium (L.Bolus) L.Bolus = **Jordaaniella clavifolia**
compactum L.Bolus = **C. loreum**
compressum L.Bolus
Perennial. Succulent. Ht ± 0.03 m. Alt 50–1000 m. N
comptonii N.E.Br. = **C. tricolorum**
concinnum L.Bolus = **C. curtophyllum**
confusum (Dinter) Dinter & Schwantes
Perennial. Succulent. Ht ± 0.08 m. Alt up to 1000 m. N
conicum L.Bolus ex H.Jacobsen = **C. curtophyllum**
corniculatum (L.) Schwantes
C. ceresianum L.Bolus (10)
Perennial. Succulent. Ht ± 0.08 m. Alt 300–800 m. WC
crassum L.Bolus = **C. tricolorum**
cupreum L.Bolus = **Jordaaniella cuprea**
curtophyllum (L.Bolus) Schwantes
C. artum L.Bolus (8)
C. concinnum L.Bolus (8)
C. conicum L.Bolus ex H.Jacobsen (10)
C. latipetalum L.Bolus (7)
C. platycalyx (L.Bolus) Schwantes (8)
C. rhodandrum L.Bolus (8)
Perennial. Succulent. Ht ± 0.05 m. Alt 300–1200 m. NC, WC
decipiens (Haw.) L.Bolus = **C. loreum**
densum N.E.Br. = **C. framesii**
diminutum (Haw.) L.Bolus = **C. subulatoides**
diversifolium (Haw.) Schwantes = **C. diversiphyllum**
diversiphyllum (Haw.) H.E.K.Hartmann
C. baylissii L.Bolus (9)
C. bredasdorpense L.Bolus (9)
C. caledonicum L.Bolus (9)
C. cauliculatum (Haw.) N.E.Br. (9)
C. diversifolium (Haw.) Schwantes (9)
C. vandermerwei L.Bolus (9)
Perennial. Succulent. Ht ± 0.1 m. Alt up to 800 m. WC
dubium (Haw.) N.E.Br. = **Jordaaniella dubia**
ebracteatum (Schltr.& Diels) Dinter & Schwantes
C. ausense L.Bolus (9)
C. ernii L.Bolus (9)
C. laetulum L.Bolus (9)
C. namaquanum L.Bolus (9)
C. rangei (Engl.) L.Bolus ex H.Jacobsen (9)
Perennial. Succulent. Ht ± 0.04 m. Alt up to 400 m. N, NC
ernii L.Bolus = **C. ebracteatum**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

framesii L.Bolus
C. densum N.E.Br. (10)
C. stayneri L.Bolus (9)
Perennial. Succulent. Ht ± 0.08 m. Alt 50–850 m. NC, WC
franciscii L.Bolus = **C. alstonii**
frutescens L.Bolus = **Leipoldtia frutescens**
frutescens L.Bolus var. *decumbens* L.Bolus = **Leipoldtia frutescens**
fulleri L.Bolus
Perennial. Succulent. Ht ± 0.09 m. Alt ± 1000 m. NC
goodii L.Bolus
Perennial. Succulent. Ht ± 0.06 m. Alt up to 450 m. NC
gracile L.Bolus = **C. purpureo-album**
gracile L.Bolus var. *longisepalum* L.Bolus = **C. purpureo-album**
hallii L.Bolus
Perennial. Succulent. Ht up to 0.1 m. Alt 600–900 m. NC
herrei L.Bolus
C. pallens L.Bolus (9)
Perennial. Succulent. Ht ± 0.4 m. Alt up to 1000 m. N, NC
herrei L.Bolus var. *decumbens* L.Bolus, naked name = **C. numeesense**
inaequale L.Bolus
Perennial. Succulent. Ht ± 0.1 m. Alt up to 1200 m. NC
insigne L.Bolus = **C. rigidum**
kliprandense L.Bolus = **C. parvibracteatum**
laetulum L.Bolus = **C. ebracteatum**
latipetalum L.Bolus = **C. curtophyllum**
littlewoodii L.Bolus = **C. purpureo-album**
loreum (L.) Schwantes
C. apiculatum L.Bolus (9)
C. cedrimontanum L.Bolus (9)
C. compactum L.Bolus (9)
C. decipiens (Haw.) L.Bolus (9)
C. primulinum (L.Bolus) Schwantes (9)
Perennial. Succulent. Ht ± 0.12 m. Alt ± 600 m. WC
luxurians Dinter, naked name = **Jordaaniella cuprea**
maritimum (L.Bolus) Schwantes = **Jordaaniella dubia**
middlemostii L.Bolus = **C. purpureo-album**
namaquanum L.Bolus = **C. ebracteatum**
niveum L.Bolus
C. truncatum L.Bolus (9)
Perennial. Succulent. Ht up to 0.12 m. Alt 150–800 m. NC, WC
numeesense H.E.K.Hartmann
C. herrei L.Bolus var. *decumbens* L.Bolus, naked name (9)
Perennial. Succulent. Ht up to 0.1 m. Alt 50–900 m. NC
pallens L.Bolus = **C. herrei**
parvibracteatum (L.Bolus) H.E.K.Hartmann
C. kliprandense L.Bolus (9)
Cheiridopsis parvibracteata L.Bolus (9)
Perennial. Succulent. Ht up to 0.07 m. Alt 600–1200 m. NC, WC
parviflorum L.Bolus
C. parviflorum L.Bolus var. *proliferum* L.Bolus (9)
Perennial. Succulent. Ht ± 0.07 m. Alt 20–300 m. WC
parviflorum L.Bolus var. *proliferum* L.Bolus = **C. parviflorum**
parvulum (Schltr.) H.E.K.Hartmann
Cheiridopsis parvula (Schltr.) N.E.Br. (10)
Mesembryanthemum parvulum Schltr. (10)
Perennial. Succulent. Ht ± 0.04 m. Alt 200–600 m. WC
paucifolium L.Bolus = **C. purpureo-album**
pillansii L.Bolus
C. pillansii L.Bolus var. *grandiflorum* L.Bolus (9)
Perennial. Succulent. Ht ± 0.2 m. Alt 300–1100 m. NC, WC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

pillansii L.Bolus var. *grandiflorum* L.Bolus = **C. pillansii**
pittenii L.Bolus = **Jordaaniella dubia**
platycalyx (L.Bolus) Schwantes = **C. curtophyllum**
primulinum (L.Bolus) Schwantes = **C. loreum**
procumbens (Haw.) Schwantes = **Jordaaniella dubia**
pulchellum L.Bolus
C. brevifolium L.Bolus (9)
Perennial. Succulent. Ht ± 0.05 m. Alt 200–350 m. WC
pulchrum L.Bolus
Perennial. Succulent. Ht ± 0.07 m. Alt 200–350 m. WC
punctatum (Haw.) N.E.Br. = **C. subulatoides**
purpureo-album (Haw.) Schwantes
C. aurantiacum L.Bolus (9)
C. gracile L.Bolus (9)
C. gracile L.Bolus var. *longisepalum* L.Bolus (9)
C. littlewoodii L.Bolus (9)
C. middlemostii L.Bolus (9)
C. paucifolium L.Bolus (9)
C. serrulatum L.Bolus (9)
C. worcesterense L.Bolus (9)
Perennial. Succulent. Ht ± 0.15 m. Alt 300–1000 m. WC
rangei (Engl.) L.Bolus ex H.Jacobsen = **C. ebracteatum**
regale L.Bolus
C. vanheerdei L.Bolus (9)
Perennial. Succulent. Ht ± 0.05 m. Alt 20–1200 m. NC
rhodandrum L.Bolus = **C. curtophyllum**
rigidum L.Bolus
C. aureorubrum L.Bolus (9)
C. insigne L.Bolus (9)
Perennial. Succulent. Ht up to 0.06 m. Alt 20–1100 m. NC
roseum (L.Bolus) L.Bolus = **Leipoldtia rosea**
rostellum (L.Bolus) H.E.K.Hartmann
Vanzijlia rostella L.Bolus (10)
Perennial. Succulent. Ht up to 0.025 m. Alt 20–260 m. WC
serrulatum L.Bolus = **C. purpureo-album**
spissum H.E.K.Hartmann
Perennial. Succulent. Ht up to 0.05 m, when in flower. Alt 200–350 m. WC
spongiosum (L.Bolus) L.Bolus = **Jordaaniella spongiosa**
staminodiosum L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 200–350 m. WC
stayneri L.Bolus = **C. framesii**
subulatoides (Haw.) N.E.Br.
C. acutum (Haw.) L.Bolus (10)
C. diminutum (Haw.) L.Bolus (9)
C. punctatum (Haw.) N.E.Br. (9)
Perennial. Succulent. Ht up to 0.04 m. Alt 60–690 m. WC
tenuifolium L.Bolus = **C. tricolorum**
tetrastichum H.E.K.Hartmann
Perennial. Succulent. Ht up to 0.1 m. Alt 10–200 m. NC
tricolorum (Haw.) Schwantes
C. comptonii N.E.Br. (9)
C. crassum L.Bolus (9)
C. tenuifolium L.Bolus (9)
Perennial. Succulent. Ht up to 0.12 m. Alt 20–600 m. WC
truncatum L.Bolus = **C. niveum**
uniflorum L.Bolus = **Jordaaniella uniflora**
vandermerwei L.Bolus = **C. diversiphyllum**
vanheerdei L.Bolus = **C. regale**
vanputtenii L.Bolus = **Jordaaniella dubia**
watermeyeri L.Bolus = **Jordaaniella dubia**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

weigangianum (Dinter) Dinter & Schwantes = **Leipoldtia weigangiana** subsp. **weigangiana**
worcesterense L.Bolus = **C. purpureo-album**

CEROCHLAMYS N.E.Br. 2405025
(1) Hartmann. 1998. *Bradleya* 16: 48–56.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 113–115.
gemina (L.Bolus) H.E.K.Hartmann
Mesembryanthemum geminum N.E.Br. (1)
Ruschia gemina L.Bolus (1)
Perennial. Succulent. Ht up to 0.04 m. Alt 300–950 m. WC
pachyphylla (L.Bolus) L.Bolus
C. pachyphylla (L.Bolus) L.Bolus var. *albiflora* H.Jacobsen (1)
Mesembryanthemum pachyphyllum L.Bolus (1)
Perennial. Succulent. Ht up to 0.05 m. Alt 400–780 m. WC
pachyphylla (L.Bolus) L.Bolus var. *albiflora* H.Jacobsen = **C. pachyphylla**
purpureostyla (L.Bolus) H.E.K.Hartmann = **Acrodon purpureostylus**
trigona N.E.Br.
Perennial. Succulent. Ht up to 0.05 m. Alt 190–650 m. WC

CHASMATOPHYLLUM Dinter & Schwantes2405026
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 115–117.
braunsii Schwantes
braunsii Schwantes var. *majus* L.Bolus (1)
Perennial. Succulent. Ht up to 0.02 m. Alt 800–1700 m. NC, WC
braunsii Schwantes var. *majus* L.Bolus = **C. braunsii**
maninum L.Bolus
Perennial. Succulent. Ht up to 0.02 m. Alt ± 1600 m. NC
musculinum (Haw.) Dinter & Schwantes
Mesembryanthemum dinterae Dinter (1)
Mesembryanthemum musculinum Haw. (1)
Stomatium musculinum Schwantes (1)
Perennial. Succulent. Ht up to 0.03 m. Alt 980–1700 m. N, NW, G, M, FS, NC, WC, EC
nelii Schwantes
Perennial. Succulent. Ht up to 0.1 m. Alt 800–1100 m. EC
rouxii L.Bolus
Rhinephyllum rouxii (L.Bolus) L.Bolus (1)
Perennial. Succulent. Ht up to 0.02 m. Alt 1300–1700 m. NC
stanleyi (L.Bolus) H.E.K.Hartmann
Hereroa stanleyi (L.Bolus) L.Bolus (1)
Perennial. Succulent. Ht up to 0.09 m. Alt 550–1200 m. WC, EC
verdoorniae (N.E.Br.) L.Bolus
Perennial. Succulent. Ht up to 0.02 m. Alt 1400–1600 m. FS
willowmorense (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.1 m. Alt 750–1050 m. EC

CHEIRIDOPSIS N.E.Br. 2405027
(1) Bolus. 1967. *The Flowering Plants of Africa* 38: t. 1507.
(2) Bolus. 1968. *The Flowering Plants of Africa* 39: t. 1529.
(3) Hartmann & Dehn. 1987. *Botanische Jahrbücher* 108: 567–663.
(4) Hammer. 1993. *Bradleya* 11: 75–85.
(5) Hammer. 1995. *Piante Grasse* 15,4 Suppl.: 59–87.
(6) Williamson. 2000. *Aloe* 37: 4–7.
(7) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 117–128.
(8) Hammer. 2002. *Cactus and Succulent Journal (U.S.)* 74: 112–115.
acuminata L.Bolus
C. carinata L.Bolus (3)
Perennial. Succulent. Ht up to 0.07 m. Alt 190–900 m. NC
alata L.Bolus = **C. robusta**
albiflora L.Bolus = **C. derenbergiana**
albirosea L.Bolus = **Ihlenfeldtia excavata**
altitecta Schwantes = **C. derenbergiana**
amabilis S.A.Hammer

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.03 m. Alt? NC
ampliata L.Bolus = **C. derenbergiana**
angustipetala L.Bolus = **C. derenbergiana**
aspera L.Bolus
Perennial. Succulent. Ht up to 0.08 m. Alt 460–1100 m. NC
aurea L.Bolus var. *aurea* = **C. robusta**
aurea L.Bolus var. *lutea* L.Bolus = **C. robusta**
ausensis L.Bolus = **C. caroli-schmidtii**
bibracteata (Haw.) N.E.Br. = **C. rostrata**
bifida (Haw.) N.E.Br. = **C. rostrata**
borealis L.Bolus = **C. caroli-schmidtii**
brachystigma L.Bolus = **C. pillansii**
breachiae L.Bolus = **C. namaquensis**
brevipes L.Bolus = **C. robusta**
brevis L.Bolus = **C. namaquensis**
brownii Schick & Tischer
C. hallii L.Bolus (3)
C. insignis Schwantes (3)
C. staminodifera L.Bolus (3)
C. turgida L.Bolus (3)
Perennial. Succulent. Ht up to 0.05 m. Alt 20–1100 m. N, NC
campanulata G.Will.
Perennial. Succulent. Ht ± 0.08 m. Alt ± 678 m. NC
candidissima (Haw.) N.E.Br. = **C. denticulata**
carinata L.Bolus = **C. acuminata**
carnea N.E.Br. = **C. rostrata**
caroli-schmidtii (Dinter & A.Berger) N.E.Br.
C. ausensis L.Bolus (3)
C. borealis L.Bolus (3)
Perennial. Succulent. Ht up to 0.05 m. Alt 600–1500 m. N
cigarettifera (A.Berger) N.E.Br. = **C. namaquensis**
citrina L.Bolus = **C. derenbergiana**
compressa L.Bolus = **C. derenbergiana**
cuprea (L.Bolus) N.E.Br. = **Cephalophyllum caespitosum**
curta L.Bolus = **C. namaquensis**
delphinoides S.A.Hammer
Perennial. Succulent. Ht up to 0.03 m. Alt 800–1100 m. NC
denticulata (Haw.) N.E.Br.
C. candidissima (Haw.) N.E.Br. (3)
C. denticulata (Haw.) N.E.Br. var. *glauca* (Haw.) N.E.Br. (3)
C. inconspicua N.E.Br. (3)
C. littlewoodii L.Bolus (3)
C. macrophylla L.Bolus (3)
C. vanheerdei L.Bolus (3)
Perennial. Succulent. Ht up to 0.15 m. Alt 300–1200 m. NC
denticulata (Haw.) N.E.Br. var. *glauca* (Haw.) N.E.Br. = **C. denticulata**
derenbergiana Schwantes
C. albiflora L.Bolus (3)
C. altitecta Schwantes (3)
C. ampliata L.Bolus (3)
C. angustipetala L.Bolus (3)
C. citrina L.Bolus (3)
C. compressa L.Bolus (3)
C. eburnea L.Bolus (3)
C. inaequalis L.Bolus (3)
C. macrocalyx L.Bolus (3)
C. quadrifolia L.Bolus (3)
C. subaequalis L.Bolus (3)
Perennial. Succulent. Ht up to 0.05 m. Alt 300–600 m. NC
difformis (Thunb.) N.E.Br. = **C. namaquensis**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

dilatata L.Bolus = **Ihlenfeldtia excavata**
duplessii L.Bolus = **C. namaquensis**
eburnea L.Bolus = **C. derenbergiana**
excavata L.Bolus = **Ihlenfeldtia excavata**
framesii L.Bolus = **C. namaquensis**
gamoepensis S.A.Hammer
Perennial. Succulent. Ht up to 0.03 m. Alt 1010–1150 m. NC
gibbosa Schick & Tischer = **C. pillansii**
glabra L.Bolus = **C. pearsonii**
glomerata S.A.Hammer
Perennial. Succulent. Ht up to 0.03 m. Alt? NC
grandiflora L.Bolus = **C. robusta**
hallii L.Bolus = **C. brownii**
herrei L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 300–600 m. NC
hutchinsonii L.Bolus = **C. namaquensis**
imitans L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 300–600 m. NC
inaequalis L.Bolus = **C. derenbergiana**
inconspicua N.E.Br. = **C. denticulata**
insignis Schwantes = **C. brownii**
inspersa (N.E.Br.) N.E.Br. = **C. rostrata**
intrusa L.Bolus = **C. namaquensis**
latifolia L.Bolus = **C. namaquensis**
lecta (N.E.Br.) N.E.Br. = **C. robusta**
leptopetala L.Bolus = **C. robusta**
littlewoodii L.Bolus = **C. denticulata**
longipes L.Bolus = **C. namaquensis**
luckhoffii L.Bolus = **C. namaquensis**
macrocalyx L.Bolus = **C. derenbergiana**
macrophylla L.Bolus = **C. denticulata**
marlothii N.E.Br. = **C. namaquensis**
meyeri N.E.Br.
Perennial. Succulent. Ht up to 0.03 m. Alt ± 300 m. NC
meyeri N.E.Br. var. *minor* L.Bolus = **C. minor**
minima Tischer = **Antimima minima**
minor (L.Bolus) H.E.K.Hartmann
C. meyeri N.E.Br. var. *minor* L.Bolus (7)
Perennial. Succulent. Ht up to 0.02 m. Alt? NC
multiseriata L.Bolus = **C. robusta**
namaquensis (Sond.) H.E.K.Hartmann
C. breachiae L.Bolus (7)
C. brevis L.Bolus (7)
C. cigarettifera (A.Berger) N.E.Br. (7)
C. curta L.Bolus (7)
C. difformis (Thunb.) N.E.Br. (7)
C. duplessii L.Bolus (7)
C. framesii L.Bolus (7)
C. hutchinsonii L.Bolus (7)
C. intrusa L.Bolus (7)
C. latifolia L.Bolus (7)
C. longipes L.Bolus (7)
C. luckhoffii L.Bolus (7)
C. marlothii N.E.Br. (7)
C. quaternifolia L.Bolus (7)
C. scabra L.Bolus var. *fera* L.Bolus (7)
C. scabra L.Bolus var. *scabra* (7)
C. serrulata L.Bolus (7)
C. subalba L.Bolus (7)
C. tenuifolia L.Bolus (7)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Mesembryanthemum difforme Thunb. (7)
Perennial. Succulent. Ht up to 0.04 m. Alt 300–900 m. NC, WC
nelii Schwantes
Perennial. Succulent. Ht? Alt? WC
papillata L.Bolus = **Ihlenfeldtia vanzylii**
parvibracteata L.Bolus = **Cephalophyllum parvibracteatum**
parvula (Schltr.) N.E.Br. = **Cephalophyllum parvulum**
paucifolia L.Bolus = **C. schlechteri**
pearsonii N.E.Br.
C. glabra L.Bolus (3)
C. resurgens L.Bolus (3)
Perennial. Succulent. Ht up to 0.05 m. Alt 1200–1700 m. NC
peculiaris N.E.Br.
Perennial. Succulent. Ht up to 0.04 m. Alt 600–1000 m. NC
peersii L.Bolus = **C. turbinata**
perdecora N.E.Br. = **C. robusta**
pillansii L.Bolus
C. brachystigma L.Bolus (3)
C. gibbosa Schick & Tischer (3)
C. pillansii L.Bolus var. *crassa* (L.Bolus) G.D.Rowley (3)
Perennial. Succulent. Ht up to 0.08 m. Alt 400–750 m. NC
pillansii L.Bolus var. *crassa* (L.Bolus) G.D.Rowley = **C. pillansii**
pilosula L.Bolus
Perennial. Succulent. Ht up to 0.12 m. Alt 850–1250 m. NC
ponderosa S.A.Hammer
Perennial. Succulent. Ht? Alt? NC
pressa (N.E.Br.) N.E.Br. = **C. robusta**
pulverulenta L.Bolus = **C. schlechteri**
purpurascens (Salm-Dyck) N.E.Br. var. *leipoldtii* L.Bolus = **C. rostrata**
purpurascens (Salm-Dyck) N.E.Br. var. *purpurascens* = **C. rostrata**
purpurea L.Bolus
C. splendens L.Bolus (3)
Perennial. Succulent. Ht up to 0.04 m. Alt ± 300 m. NC
quadrifolia L.Bolus = **C. derenbergiana**
quaternifolia L.Bolus = **C. namaquensis**
resurgens L.Bolus = **C. pearsonii**
richardiana L.Bolus = **Ihlenfeldtia vanzylii**
robusta (Haw.) N.E.Br.
C. alata L.Bolus (3)
C. aurea L.Bolus var. *aurea* (3)
C. aurea L.Bolus var. *lutea* L.Bolus (3)
C. brevipes L.Bolus (3)
C. grandiflora L.Bolus (3)
C. lecta (N.E.Br.) N.E.Br. (3)
C. leptopetala L.Bolus (3)
C. multiseriata L.Bolus (3)
C. perdecora N.E.Br. (3)
C. pressa (N.E.Br.) N.E.Br. (3)
C. roodiae N.E.Br. (3)
C. schickiana Tischer (3)
C. truncata L.Bolus (3)
Perennial. Succulent. Ht up to 0.1 m, when in flower. Alt 20–600 m. N, NC
roodiae N.E.Br. = **C. robusta**
rostrata (L.) N.E.Br.
C. bibracteata (Haw.) N.E.Br. (3)
C. bifida (Haw.) N.E.Br. (3)
C. carnea N.E.Br. (3)
C. inspersa (N.E.Br.) N.E.Br. (3)
C. purpurascens (Salm-Dyck) N.E.Br. var. *leipoldtii* L.Bolus (3)
C. purpurascens (Salm-Dyck) N.E.Br. var. *purpurascens* (3)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

C. rostratoides (Haw.) N.E.Br. (3)
C. tuberculata (Mill.) N.E.Br. (3)
C. velutina L.Bolus (3)
Perennial. Succulent. Ht up to 0.05 m, when in flower. Alt 20–600 m. WC
rostratoides (Haw.) N.E.Br. = **C. rostrata**
rudis L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt? NC
scabra L.Bolus var. *fera* L.Bolus = **C. namaquensis**
scabra L.Bolus var. *scabra* = **C. namaquensis**
schickiana Tischer = **C. robusta**
schlechteri Tischer
C. paucifolia L.Bolus (3)
C. pulverulenta L.Bolus (3)
Perennial. Succulent. Ht up to 0.05 m. Alt 300–600 m. NC
serrulata L.Bolus = **C. namaquensis**
speciosa L.Bolus
Perennial. Succulent. Ht up to 0.05 m. Alt 300–600 m. NC
splendens L.Bolus = **C. purpurea**
staminodifera L.Bolus = **C. brownii**
subaequalis L.Bolus = **C. derenbergiana**
subalba L.Bolus = **C. namaquensis**
tenuifolia L.Bolus = **C. namaquensis**
truncata L.Bolus = **C. robusta**
tuberculata (Mill.) N.E.Br. = **C. rostrata**
turbinata L.Bolus
C. peersii L.Bolus (3)
C. turbinata L.Bolus var. *minor* L.Bolus (3)
Perennial. Succulent. Ht up to 0.15 m. Alt 300–1000 m. NC, WC
turbinata L.Bolus var. *minor* L.Bolus = **C. turbinata**
turgida L.Bolus = **C. brownii**
umbrosa S.A.Hammer & P.Desmet
Perennial. Succulent. Ht up to 0.03 m. Alt 1000–1200 m. NC
umdausensis L.Bolus
Perennial. Succulent. Ht up to 0.08 m. Alt 600–1120 m. NC
vanbredai L.Bolus = **Ihlenfeldtia excavata**
vanheerdei L.Bolus = **C. denticulata**
vanzijlii L.Bolus = **Ihlenfeldtia vanzylii**
velox S.A.Hammer
Perennial. Succulent. Ht up to 0.1 m. Alt 800–1160 m. NC
velutina L.Bolus = **C. rostrata**
ventricosa (L.Bolus) N.E.Br. = **Antimima ventricosa**
verrucosa L.Bolus
C. verrucosa L.Bolus var. *minor* L.Bolus (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 20–300 m. NC
verrucosa L.Bolus var. *minor* L.Bolus = **C. verrucosa**

CIRCANDRA N.E.Br. 2405138
(1) Brown. 1930. *The Gardeners' Chronicle* 87: 126.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 129.
serrata (L.) N.E.Br.
Erepsia serrata (L.) L.Bolus (1)
Mesembryanthemum serratum L. (1)
Perennial. Succulent. Ht up to 0.6 m. Alt 350–850 m. WC

CLERETUM N.E.Br. 2405140
(1) Bolus. 1962. *The Flowering Plants of Africa* 35: t. 1366.
(2) Ihlenfeldt & Struck. 1986. *Beiträge zur Biologie der Pflanzen* 61: 411–453.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 129–131.
herrei (Schwantes) Ihlenf. & Struck
Annual. Succulent. Ht up to 0.05 m. Alt 20–350 m. WC
lyratifolium Ihlenf. & Struck

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Annual. Succulent. Ht up to 0.04 m. Alt 800–1000 m. WC
papulosum (L.f.) L.Bolus subsp. **papulosum**
C. papulosum (L.f.) N.E.Br., illegitimate name (2)
Mesembryanthemum papulosum L.f. (3)
Mesembryanthemum sessiliflorum Aiton (2)
Micropterum papulosum (L.f.) Schwantes (2)
Micropterum papulosum (L.f.) Schwantes subsp. *multiflorum* Schwantes, naked name (2)
Micropterum sessiliflorum (Aiton) Schwantes (2)
Annual. Succulent. Ht up to 0.08 m. Alt 800–1600 m. NC, WC
papulosum (L.f.) L.Bolus subsp. **schlechteri** (Schwantes) Ihlenf. & Struck
Annual. Succulent. Ht up to 0.1 m. Alt up to 1200 m. NC
papulosum (L.f.) N.E.Br., illegitimate name = **C. papulosum** subsp. **papulosum**

CONICOSIA N.E.Br. 2405028
(1) Ihlenfeldt & Gerbaulet. 1990. *Botanische Jahrbücher* 111: 457–498.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 131–133.
alborosea L.Bolus = **C. pugioniformis** subsp. **alborosea**
australis L.Bolus = **C. pugioniformis** subsp. **muirii**
bijlii N.E.Br. = **C. pugioniformis** subsp. **muirii**
brevicaulis (Haw.) Schwantes = **C. pugioniformis** subsp. **pugioniformis**
communis (Edwards) N.E.Br. = **C. pugioniformis** subsp. **pugioniformis**
coruscans (Haw.) Schwantes = **C. elongata**
elongata (Haw.) N.E.Br.
C. coruscans (Haw.) Schwantes (1)
C. robusta N.E.Br. (1)
Herrea acocksii L.Bolus (1)
Herrea affinis (N.E.Br.) L.Bolus (1)
Herrea alba L.Bolus (1)
Herrea albolutea L.Bolus (1)
Herrea blanda L.Bolus (1)
Herrea brevisepala L.Bolus (1)
Herrea elongata (Haw.) L.Bolus var. *elongata* (1)
Herrea elongata (Haw.) L.Bolus var. *minor* (Haw.) L.Bolus (1)
Herrea excavata L.Bolus (1)
Herrea fusiformis (Haw.) L.Bolus (1)
Herrea grandis L.Bolus (1)
Herrea gydouwensis L.Bolus (1)
Herrea inaequalis L.Bolus (1)
Herrea klaverensis L.Bolus (1)
Herrea laticalyx L.Bolus (1)
Herrea macrocalyx L.Bolus (2)
Herrea nelii Schwantes (2)
Herrea obtusa L.Bolus (1)
Herrea plana L.Bolus (1)
Herrea porcina L.Bolus (1)
Herrea robusta (N.E.Br.) L.Bolus (1)
Herrea ronaldii L.Bolus (1)
Herrea roodiae (N.E.Br.) L.Bolus (1)
Herrea stipitata L.Bolus (1)
Perennial. Succulent. Ht up to 0.3 m. Alt 200–950 m. NC, WC
muirii N.E.Br. = **C. pugioniformis** subsp. **muirii**
pugioniformis (L.) N.E.Br. subsp. **alborosea** (L.Bolus) Ihlenf. & Gerbaulet
C. alborosea L.Bolus (1)
Perennial. Succulent. Ht up to 0.6 m. Alt 20–600 m. NC
pugioniformis (L.) N.E.Br. subsp. **muirii** (N.E.Br.) Ihlenf. & Gerbaulet
C. australis L.Bolus (1)
C. bijlii N.E.Br. (1)
C. muirii N.E.Br. (1)
Perennial. Succulent. Ht up to 0.2 m. Alt 10–200 m. WC
pugioniformis (L.) N.E.Br. subsp. **pugioniformis**
C. brevicaulis (Haw.) Schwantes (1)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

C. communis (Edwards) N.E.Br. (1)
C. pulliloba N.E.Br. (1)
Herrea caledonica L.Bolus (1)
Perennial. Succulent. Ht up to 0.4 m, when in flower. Alt 20–350 m. WC
pulliloba N.E.Br. = **C. pugioniformis** subsp. **pugioniformis**
robusta N.E.Br. = **C. elongata**

CONOPHYLLUM Schwantes 2405029
globosum L.Bolus = **Meyerophytum globosum**

CONOPHYTUM N.E.Br. 2405030
(1) Phillips. 1930. *The Flowering Plants of South Africa* 10: t. 400.
(2) Lavis. 1933. *The Flowering Plants of South Africa* 13: tt. 509A–510B.
(3) Hammer. 1993. *The genus* Conophytum: 1–283.
(4) Pavelka. 1999. *Kaktusy* 35, Speciál 1999/1: 1–32.
(5) Smale. 2000. *Cactus and Succulent Journal of Great Britain* 18: 101–107.
(6) Hammer. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 134–175.
(7) Desmet *et al.* 2001. *Bradleya* 19: 15–18.
(8) Hammer. 2002. *Dumpling and his wife: new views of the genus* Conophytum: 1–398.
absimile L.Bolus forma *majus* L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
absimile L.Bolus forma *umbrosum* L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
absimile L.Bolus var. *absimile* = **C. bilobum** subsp. **bilobum** var. **bilobum**
achabense S.A.Hammer
Perennial. Succulent. Ht up to 0.01 m. Alt 1050–1160 m. NC
acutum L.Bolus
Perennial. Succulent. Ht up to 0.01 m. Alt 420–600 m. WC
admiraalii L.Bolus = **C. jucundum** subsp. **jucundum**
advenum N.E.Br. = **C. piluliforme** subsp. **piluliforme**
aequale L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
aequatum L.Bolus = **C. pageae**
aggregatum (Haw. ex N.E.Br.) N.E.Br. = **C. piluliforme** subsp. **piluliforme**
albertense (N.E.Br.) N.E.Br. = **C. truncatum** subsp. **truncatum** var. **truncatum**
albescens N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
albifissum Tischer = **C. minimum**
albiflorum (Rawe) S.A.Hammer
C. edwardsiae Lavis var. *albiflorum* Rawe (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 10–100 m. WC
altile (N.E.Br.) N.E.Br. = **C. ficiformе**
altum L.Bolus var. *altum* = **C. bilobum** subsp. **altum**
altum L.Bolus var. *plenum* L.Bolus = **C. bilobum** subsp. **altum**
ampliatum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
amplum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
andausanum N.E.Br. var. *andausanum* = **C. bilobum** subsp. **bilobum** var. **bilobum**
andausanum N.E.Br. var. *immaculatum* L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
angelicae (Dinter & Schwantes) N.E.Br. subsp. **angelicae**
Mesembryanthemum angelicae (Dinter & Schwantes) N.E.Br. (3)
Perennial. Succulent. Ht up to 0.01 m. Alt 900–1100 m. N, NC
angelicae (Dinter & Schwantes) N.E.Br. subsp. **tetragonum** Rawe & S.A.Hammer
Perennial. Succulent. Ht up to 0.01 m. Alt 700–980 m. NC
angustum N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
angustum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
anjametae de Boer = **C. violaciflorum**
anomalum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
apertum Tischer = **C. bilobum** subsp. **altum**
apiatum (N.E.Br.) N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
apiculatum N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
approximatum Lavis = **C. bilobum** subsp. **bilobum** var. **bilobum**
archeri Lavis var. *archeri* = **C. piluliforme** subsp. **piluliforme**
archeri Lavis var. *stayneri* L.Bolus = **C. truncatum** subsp. **viridicatum**
areolatum Littlew. = **C. pellucidum** subsp. **pellucidum**
armianum S.A.Hammer
Perennial. Succulent. Ht up to 0.01 m. Alt 650–1100 m. NC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

arthurolfago S.A.Hammer
C. lithopsoides L.Bolus subsp. *arthurolfago* S.A.Hammer (8)
Perennial. Succulent. Ht up to 0.04 m. Alt 900–1200 m. NC
asperulum L.Bolus var. *asperulum* = **C. bilobum** subsp. **bilobum** var. **bilobum**
asperulum L.Bolus var. *brevistylum* L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
assimile (N.E.Br.) N.E.Br. = **C. ficiforme**
astylum L.Bolus = **C. pellucidum** subsp. **cupreatum**
auctum N.E.Br. forma *approximatum* (Lavis) Rawe = **C. bilobum** subsp. **bilobum** var. **bilobum**
auctum N.E.Br. forma *auctum* = **C. bilobum** subsp. **bilobum** var. **bilobum**
auriflorum Tischer subsp. **auriflorum**
Perennial. Succulent. Ht up to 0.02 m. Alt 690–1000 m. NC
auriflorum Tischer subsp. **turbiniforme** (Rawe) S.A.Hammer
C. turbiniforme Rawe (3)
Perennial. Succulent. Ht up to 0.02 m. Alt 540–860 m. NC
australe L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
avenantii L.Bolus = **C. jucundum** subsp. **fragile**
bachelorum S.A.Hammer
Perennial. Succulent. Ht up to 0.02 m, when in flower. Alt 400–730 m. NC
bachelorum S.A.Hammer subsp. *sponsaliorum* S.A.Hammer = **C. obscurum** subsp. **sponsaliorum**
barbatum L.Bolus = **C. obscurum** subsp. **barbatum**
barkerae L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
batesii N.E.Br. = **C. minimum**
bicarinatum L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 700–1400 m. WC
bilobum (Marloth) N.E.Br. subsp. **altum** (L.Bolus) S.A.Hammer
C. altum L.Bolus var. *altum* (3)
C. altum L.Bolus var. *plenum* L.Bolus (3)
C. apertum Tischer (3)
C. connatum L.Bolus (3)
C. corniferum Schick & Tischer (3)
C. gracile N.E.Br. var. *gracile* (3)
C. gracile N.E.Br. var. *majusculum* L.Bolus (3)
C. graciliramosum L.Bolus (2)
C. luiseae Schwantes (3)
C. luiseae Schwantes var. *papillatum* L.Bolus, semi-naked name (3)
Perennial. Succulent. Ht up to 0.1 m with age. Alt 600–800 m. NC
bilobum (Marloth) N.E.Br. subsp. **bilobum** var. **bilobum**
C. absimile L.Bolus forma *absimile* (3)
C. absimile L.Bolus forma *majus* L.Bolus (3)
C. absimile L.Bolus forma *umbrosum* L.Bolus (3)
C. aequale L.Bolus (3)
C. albescens N.E.Br. (3)
C. ampliatum L.Bolus (3)
C. amplum L.Bolus (3)
C. andausanum N.E.Br. var. *andausanum* (3)
C. andausanum N.E.Br. var. *immaculatum* L.Bolus (3)
C. angustum L.Bolus (3)
C. angustum N.E.Br. (3)
C. anomalum L.Bolus (3)
C. apiatum (N.E.Br.) N.E.Br. (3)
C. apiculatum N.E.Br. (3)
C. approximatum Lavis (3)
C. asperulum L.Bolus var. *asperulum* (3)
C. asperulum L.Bolus var. *brevistylum* L.Bolus (3)
C. auctum N.E.Br. forma *approximatum* (Lavis) Rawe (3)
C. auctum N.E.Br. forma *auctum* (3)
C. australe L.Bolus (3)
C. barkerae L.Bolus (3)
C. brevisectum L.Bolus (3)
C. cauliferum N.E.Br. var. *cauliferum* (3)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

C. cauliferum N.E.Br. var. *lekkersingense* L.Bolus (3)
C. christiansenianum L.Bolus (3)
C. citrinum L.Bolus (3)
C. compressum N.E.Br. (3)
C. conradii L.Bolus (3)
C. convexum L.Bolus (3)
C. cordatum Schick & Tischer var. *cordatum* (3)
C. cordatum Schick & Tischer var. *macrostigma* L.Bolus (3)
C. coriaceum L.Bolus (3)
C. crassum L.Bolus (3)
C. curtum L.Bolus (3)
C. dennisii N.E.Br. (3)
C. difforme L.Bolus (3)
C. dilatatum Tischer (3)
C. dissimile L.Bolus (3)
C. distans L.Bolus (3)
C. divaricatum N.E.Br. (3)
C. diversum N.E.Br. (3)
C. dolomiticum Tischer (3)
C. ecarinatum L.Bolus var. *angustum* L.Bolus (3)
C. ecarinatum L.Bolus var. *ecarinatum* (3)
C. ecarinatum L.Bolus var. *mutabile* L.Bolus (3)
C. excisum L.Bolus (3)
C. exsertum N.E.Br. (3)
C. gonapense L.Bolus var. *gonapense* (3)
C. gonapense L.Bolus var. *numeesicum* L.Bolus (3)
C. grandiflorum L.Bolus (3)
C. inclusum L.Bolus (3)
C. incurvum N.E.Br. var. *incurvum* (3)
C. incurvum N.E.Br. var. *leucanthum* (Lavis) Tischer (3)
C. indefinitum L.Bolus (3)
C. insigne L.Bolus (3)
C. klipbokbergense L.Bolus (3)
C. lacteum L.Bolus (3)
C. largum L.Bolus (3)
C. latum L.Bolus (3)
C. lavisianum L.Bolus (3)
C. laxipetalum N.E.Br. (3)
C. lekkersingense L.Bolus (3)
C. leucanthum Lavis (3)
C. leucanthum Lavis var. *multipetalum* L.Bolus (3)
C. markoetterae Schwantes (3)
C. meyerae Schwantes forma *alatum* Tischer (3)
C. meyerae Schwantes forma *apiculatum* (N.E.Br.) Tischer, invalid combination (3)
C. meyerae Schwantes forma *asperulum* (L.Bolus) H.Jacobsen (3)
C. meyerae Schwantes forma *meyerae* (3)
C. meyerae Schwantes forma *pole-evansii* (N.E.Br.) Tischer, invalid combination (3)
C. nelianum Schwantes (3)
C. noisabisense L.Bolus (3)
C. nutaboiense Tischer (3)
C. obtusum N.E.Br. var. *amplum* (L.Bolus) Rawe (3)
C. obtusum N.E.Br. var. *obtusum* (3)
C. ovatum L.Bolus (3)
C. parvulum L.Bolus (3)
C. philippi L.Bolus (3)
C. piriforme L.Bolus (3)
C. plenum N.E.Br. (3)
C. pluriforme L.Bolus (3)
C. pole-evansii N.E.Br. (3)
C. proximum L.Bolus (3)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

C. recisum N.E.Br. (3)
C. simile N.E.Br. (3)
C. simplum N.E.Br. (3)
C. sitzlerianum Schwantes (3)
C. smithersii L.Bolus (3)
C. sororium N.E.Br. (3)
C. springbokense N.E.Br. (3)
C. strictum L.Bolus var. *inaequale* L.Bolus (3)
C. strictum L.Bolus var. *strictum* (3)
C. stylosum (N.E.Br.) Tischer (3)
C. subacutum L.Bolus (3)
C. subcylindricum L.Bolus (3)
C. subtenue L.Bolus (3)
C. supremum L.Bolus (3)
C. tectum N.E.Br. (3)
C. tumidum N.E.Br. (3)
C. tumidum N.E.Br. var. *asperulum* L.Bolus (3)
C. umdausense L.Bolus (3)
C. variabile L.Bolus (3)
C. vlakmynense L.Bolus (3)
Mesembryanthemum apiatum N.E.Br. (3)
Mesembryanthemum bilobum Marloth (3)
Mesembryanthemum elishae N.E.Br. (3)
Mesembryanthemum stylosum N.E.Br. (3)
Perennial. Succulent. Ht up to 0.1 m. Alt 50–1200 m. NC

bilobum (Marloth) N.E.Br. subsp. **bilobum** var. **elishae** (N.E.Br.) S.A.Hammer
C. elishae (N.E.Br.) N.E.Br. (8)
Perennial. Succulent. Ht up to 0.08 m. Alt 900–1200 m. NC

bilobum (Marloth) N.E.Br. subsp. **bilobum** var. **linearilucidum** (L.Bolus) S.A.Hammer
C. linearilucidum L.Bolus (8)
Perennial. Succulent. Ht up to 0.06 m. Alt 840–1100 m. NC

bilobum (Marloth) N.E.Br. subsp. **bilobum** var. **muscosipapillatum** (Lavis) S.A.Hammer
C. muscosipapillatum Lavis (8)
Perennial. Succulent. Ht up to 0.8 m. Alt 600–800 m. NC

bilobum (Marloth) N.E.Br. subsp. **claviferens** S.A.Hammer
Perennial. Succulent. Ht up to 0.8 m. Alt 730–910 m. NC

bilobum (Marloth) N.E.Br. subsp. **gracilistylum** (L.Bolus) S.A.Hammer
C. gracilistylum (L.Bolus) N.E.Br. (3)
Mesembryanthemum gracistylum L.Bolus (3)
Perennial. Succulent. Ht up to 0.06 m. Alt 320–750 m. WC

blandum L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 940–1140 m. NC

bolusiae Schwantes subsp. **bolusiae**
C. intrepidum L.Bolus (3)
Perennial. Succulent. Ht up to 0.15 m. Alt 500–750 m. NC

bolusiae Schwantes subsp. **primavernum** S.A.Hammer
Perennial. Succulent. Ht up to 0.08 m. Alt 350–580 m. NC

boreale L.Bolus = **C. lithopsoides** subsp. **boreale**

braunsii Tischer = **C. minutum** var. **minutum**

breve N.E.Br.
C. breve N.E.Br. var. *minor* L.Bolus (3)
C. doornense N.E.Br., confused name (6)
C. membranaceum L.Bolus (3)
C. paucipunctum Tischer (3)
C. pumilum N.E.Br. (3)
C. pygmaeum Schick & Tischer (3)
C. subtile N.E.Br. (3)
Perennial. Succulent. Ht up to 0.1 m. Alt 820–1200 m. NC

breve N.E.Br. var. *minor* L.Bolus = **C. breve**

breve N.E.Br. var. *minutiflorum* (Schwantes) Rawe = **C. pageae**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

breve N.E.Br. var. *vanzylii* (Lavis) Rawe, invalid combination = **C. calculus** subsp. **vanzylii**
brevilineatum Tischer = **C. minimum**
brevipes L.Bolus = **C. wettsteinii**
brevipetalum Lavis = **C. piluliforme** subsp. **piluliforme**
brevisectum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
brevitubum Lavis = **C. truncatum** subsp. **truncatum** var. **truncatum**
brownii Tischer = **C. ectypum** subsp. **brownii**
brunneum S.A.Hammer
Perennial. Succulent. Ht up to 0.04 m. Alt 450–590 m. WC
bruynsii S.A.Hammer
Perennial. Succulent. Ht up to 0.02 m. Alt 450–590 m. WC
burgeri L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 1050–1100 m. NC
buysianum A.R.Mitch. & S.A.Hammer = **C. reconditum** subsp. **buysianum**
calculus (A.Berger) N.E.Br. subsp. **calculus**
C. calculus (A.Berger) N.E.Br. var. *komkansicum* (L.Bolus) Rawe (3)
C. komkansicum L.Bolus (3)
Mesembryanthemum calculus A.Berger (3)
Perennial. Succulent. Ht up to 0.08 m with age. Alt 180–350 m. NC, WC
calculus (A.Berger) N.E.Br. subsp. **vanzylii** (Lavis) S.A.Hammer
C. breve N.E.Br. var. *vanzylii* (Lavis) Rawe, invalid combination (3)
C. namiesicum L.Bolus (3)
C. vanzylii Lavis (3)
Perennial. Succulent. Ht up to 0.04 m. Alt 1080–1150 m. NC, WC
calculus (A.Berger) N.E.Br. var. *komkansicum* (L.Bolus) Rawe = **C. calculus** subsp. **calculus**
calculus (A.Berger) N.E.Br. var. *protusum* L.Bolus = **C. pageae**
calitzdorpense L.Bolus = **C. truncatum** subsp. **truncatum** var. **truncatum**
calitzdorpense Tischer = **C. truncatum** subsp. **truncatum** var. **truncatum**
candidum L.Bolus = **C. meyeri**
caroli Lavis
C. singulare G.D.Rowley (3)
Ophthalmophyllum australe L.Bolus (3)
Ophthalmophyllum caroli (Lavis) Tischer (3)
Perennial. Succulent. Ht up to 0.02 m. Alt 940–1050 m. NC
carpianum L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 900–1160 m. NC
catervum (N.E.Br.) N.E.Br. = **C. truncatum** subsp. **viridicatum**
cauliferum N.E.Br. var. *cauliferum* = **C. bilobum** subsp. **bilobum** var. **bilobum**
cauliferum N.E.Br. var. *lekkersingense* L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
ceresianum L.Bolus = **C. obcordellum** subsp. **obcordellum** var. **ceresianum**
ceresianum L.Bolus var. *divergens* (L.Bolus) Rawe = **C. obcordellum** subsp. **obcordellum** var. **ceresianum**
chauviniae (Schwantes) S.A.Hammer
Mesembryanthemum augeiforme Schwantes (3)
Mesembryanthemum chauviniae Schwantes (3)
Perennial. Succulent. Ht up to 0.06 m. Alt 410–800 m. WC
chloratum Tischer = **C. ectypum** subsp. **ectypum**
chrisocruxum S.A.Hammer
Perennial. Succulent. Ht up to 0.02 m. Alt ± 900 m. NC
chrisolum S.A.Hammer
Perennial. Succulent. Ht up to 0.01 m. Alt ± 750 m. NC
christiansenianum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
cibdelum N.E.Br. = **C. truncatum** subsp. **truncatum** var. **truncatum**
circumpunctatum Schick & Tischer = **C. wettsteinii**
citrinum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
clarum N.E.Br. = **C. uviformе** subsp. **uviformе**
clavatum L.Bolus = **C. obscurum** subsp. **obscurum**
colorans Lavis = **C. uviformе** subsp. **uviformе**
complanatum L.Bolus = **C. truncatum** subsp. **viridicatum**
compressum N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

comptonii N.E.Br.
Perennial. Succulent. Ht up to 0.01 m. Alt 850–1010 m. WC
concavum L.Bolus
Perennial. Succulent. Ht up to 0.01 m. Alt 300–650 m. NC
concinnum Schwantes = **C. flavum** subsp. **flavum**
concordans G.D.Rowley
Ophthalmophyllum villetii L.Bolus (6)
Perennial. Succulent. Ht up to 0.02 m. Alt 900–1300 m. NC
connatum L.Bolus = **C. bilobum** subsp. **altum**
conradii L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
convexum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
corculum Schwantes = **C. meyeri**
cordatum Schick & Tischer var. *cordatum* = **C. bilobum** subsp. **bilobum** var. **bilobum**
cordatum Schick & Tischer var. *macrostigma* L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
coriaceum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
corniferum Schick & Tischer = **C. bilobum** subsp. **altum**
crassum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
craterulum Tischer = **C. velutinum** subsp. **velutinum**
cubicum Pavelka
Perennial. Succulent. Ht up to 0.01 m. Alt up to 930 m. NC
cuneatum Tischer = **C. halenbergense**
cupreatum Tischer = **C. pellucidum** subsp. **cupreatum**
cupreiflorum Tischer (insufficiently known)
Perennial. Succulent. Ht? Alt? NC
curtum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
cylindratum Schwantes = **C. roodiae** subsp. **cylindratum**
cylindratum Schwantes var. *primosii* (Lavis) Rawe = **C. roodiae** subsp. **cylindratum**
danielii Pavelka = **C. jarmilae**
declinatum L.Bolus = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
decoratum N.E.Br. = **C. uviforme** subsp. **decoratum**
dennisii N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
densipunctum L.Bolus = **C. quaesitum** subsp. **densipunctum**
depressum Lavis subsp. **depressum**
Perennial. Succulent. Ht up to 0.01 m. Alt 500–1450 m. NC
depressum Lavis subsp. **perdurans** S.A.Hammer
Perennial. Succulent. Ht up to 0.04 m. Alt 950–1075 m. NC
devium G.D.Rowley subsp. **devium**
Ophthalmophyllum littlewoodii L.Bolus (3)
Perennial. Succulent. Ht up to 0.02 m. Alt 650–1150 m. NC
devium G.D.Rowley subsp. **stiriiferum** S.A.Hammer & Barnhill
Perennial. Succulent. Ht up to 0.02 m. Alt up to 1200 m. NC
difforme L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
dilatatum Tischer = **C. bilobum** subsp. **bilobum** var. **bilobum**
discrepans G.D.Rowley forma *discrepans* = **C. maughanii** subsp. **latum**
discrepans G.D.Rowley forma *rubrum* (Tischer) G.D.Rowley = **C. maughanii** subsp. **latum**
dispar N.E.Br. = **C. truncatum** subsp. **viridicatum**
dissimile L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
distans L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
divaricatum N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
divergens L.Bolus = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
diversum N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
dolomiticum Tischer = **C. bilobum** subsp. **bilobum** var. **bilobum**
doornense N.E.Br., confused name = **C. breve**
ecarinatum L.Bolus var. *angustum* L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
ecarinatum L.Bolus var. *candidum* (L.Bolus) Rawe = **C. meyeri**
ecarinatum L.Bolus var. *ecarinatum* = **C. bilobum** subsp. **bilobum** var. **bilobum**
ecarinatum L.Bolus var. *mutabile* L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
ectypum N.E.Br. subsp. **brownii** (Tischer) S.A.Hammer
C. ectypum N.E.Br. subsp. *ectypum* var. *brownii* (Tischer) Tischer (8)
C. brownii Tischer (8)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.03 m. Alt 950–1000 m. NC

ectypum N.E.Br. subsp. **cruciatum** S.A.Hammer

Perennial. Succulent. Ht up to 0.012 m. Alt 650–850 m. NC

ectypum N.E.Br. subsp. **ectypum**

C. chloratum Tischer (3)

C. ectypum N.E.Br. var. *limbatum* (N.E.Br.) Tischer (3)

C. ectypum N.E.Br. var. *tischleri* (Schwantes) Tischer (3)

C. limbatum N.E.Br. (3)

C. tischleri Schwantes (3)

C. virens L.Bolus (6)

Perennial. Succulent. Ht up to 0.025 m. Alt 650–950 m. NC

ectypum N.E.Br. subsp. *ectypum* var. *brownii* (Tischer) Tischer = **C. ectypum** subsp. **brownii**

ectypum N.E.Br. subsp. **ignavum** S.A.Hammer

Perennial. Succulent. Ht up to 0.03 m. Alt 950–1100 m. NC

ectypum N.E.Br. subsp. **sulcatum** (L.Bolus) S.A.Hammer

C. sulcatum L.Bolus (3)

Perennial. Succulent. Ht up to 0.02 m. Alt 760–1080 m. NC

ectypum N.E.Br. var. *limbatum* (N.E.Br.) Tischer = **C. ectypum** subsp. **ectypum**

ectypum N.E.Br. var. *tischleri* (Schwantes) Tischer = **C. ectypum** subsp. **ectypum**

edithiae N.E.Br. = **C. subfenestratum**

edwardii Schwantes = **C. piluliforme** subsp. **edwardii**

edwardsiae Lavis = **C. luckhoffii**

edwardsiae Lavis var. *albiflorum* Rawe = **C. albiflorum**

eenkokerense L.Bolus = **C. tantillum** subsp. **eenkokerense**

elegans N.E.Br. = **C. pellucidum** subsp. **pellucidum**

elishae (N.E.Br.) N.E.Br. = **C. bilobum** subsp. **bilobum** var. **elishae**

ellipticum Tischer = **C. flavum** subsp. **novicium**

elongatum Schick & Tischer = **C. hians**

ernianum Loesch & Tischer = **C. taylorianum** subsp. **ernianum**

ernstii S.A.Hammer subsp. **cerebellum** S.A.Hammer

Perennial. Succulent. Ht up to 0.02 m. Alt 600–920 m. N

ernstii S.A.Hammer subsp. **ernstii**

Perennial. Succulent. Ht up to 0.02 m. Alt 200–1200 m. NC

etaylorii Schwantes = **C. piluliforme** subsp. **piluliforme**

excisum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**

exiguum N.E.Br. = **C. saxetanum**

exsertum N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**

extractum Tischer = **C. meyeri**

fenestratum Schwantes = **C. pellucidum** subsp. **pellucidum**

fibuliforme (Haw.) N.E.Br. (insufficiently known)

Mesembryanthemum fibuliforme Haw. (3)

Perennial. Succulent. Ht? Alt? 'SA'

ficiforme (Haw.) N.E.Br.

C. altile (N.E.Br.) N.E.Br. (3)

C. assimile (N.E.Br.) N.E.Br. (3)

C. ficiforme (Haw.) N.E.Br. var. *placitum* (N.E.Br.) Rawe (3)

C. fossulatum Tischer (3)

C. odoratum (N.E.Br.) N.E.Br. (3)

C. pallidum (N.E.Br.) N.E.Br. (3)

C. placitum (N.E.Br.) N.E.Br. var. *placitum* (3)

C. placitum (N.E.Br.) N.E.Br. var. *pubescens* Littlew. (3)

Mesembryanthemum altile N.E.Br. (3)

Mesembryanthemum assimile N.E.Br. (3)

Mesembryanthemum ficiforme Haw. (3)

Mesembryanthemum jugiferum N.E.Br. (3)

Mesembryanthemum odoratum N.E.Br. (3)

Mesembryanthemum pallidum N.E.Br. (3)

Mesembryanthemum placitum N.E.Br. (3)

Perennial. Succulent. Ht up to 0.05 m. Alt 300–550 m. WC

ficiforme (Haw.) N.E.Br. var. *placitum* (N.E.Br.) Rawe = **C. ficiforme**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

flavum N.E.Br. subsp. **flavum**
C. concinnum Schwantes (3)
C. flavum N.E.Br. var. *luteum* (N.E.Br.) Boom (3)
C. luteum N.E.Br. (3)
C. ornatum Lavis (3)
C. percrassum Schick & Tischer (3)
C. tetracarpum Lavis (3)
C. tinctum Lavis (3)
Perennial. Succulent. Ht up to 0.04 m. Alt 850–1100 m. NC
flavum N.E.Br. subsp. **novicium** (N.E.Br.) S.A.Hammer
C. ellipticum Tischer (3)
C. luteolum L.Bolus var. *luteolum* (3)
C. luteolum L.Bolus var. *macrostigma* L.Bolus (3)
C. novicium N.E.Br. (3)
C. rubristylosum Tischer (3)
Perennial. Succulent. Ht up to 0.04 m. Alt 800–1150 m. NC
flavum N.E.Br. var. *luteum* (N.E.Br.) Boom = **C. flavum** subsp. **flavum**
forresteri L.Bolus = **C. pageae**
fossulatum Tischer = **C. ficiforme**
fragile Tischer = **C. jucundum** subsp. **fragile**
framesii Lavis = **C. uviforme** subsp. **uviforme**
francisci L.Bolus = **C. uviforme** subsp. **uviforme**
francoiseae (S.A.Hammer) S.A.Hammer
C. wettsteinii (A.Berger) N.E.Br. subsp. *francoiseae* S.A.Hammer (8)
Perennial. Succulent. Ht up to 0.04 m. Alt 360–850 m. NC
fraternum (N.E.Br.) N.E.Br.
C. kubusanum N.E.Br. (3)
C. praecox N.E.Br. (3)
Mesembryanthemum fraternum N.E.Br. (3)
Perennial. Succulent. Ht up to 0.05 m. Alt 800–1200 m. NC
fraternum (N.E.Br.) N.E.Br. var. *leptanthum* (L.Bolus) L.Bolus = **C. jucundum** subsp. **marlothii**
friedrichiae (Dinter) Schwantes
C. renominatum G.D.Rowley (3)
C. schwantesii G.D.Rowley (3)
Mesembryanthemum friedrichiae Dinter (6)
Ophthalmophyllum dinteri Schwantes ex H.Jacobsen (6)
Ophthalmophyllum friedrichiae (Dinter) Dinter & Schwantes (6)
Ophthalmophyllum triebneri Schwantes (3)
Ophthalmophyllum vanheerdei L.Bolus (3)
Perennial. Succulent. Ht up to 0.01 m. Alt 900–1100 m. N, NC
frutescens Schwantes
C. notabile N.E.Br. (3)
C. salmonicolor L.Bolus (3)
C. teguliflorum Tischer (3)
Perennial. Succulent. Ht up to 0.25 m. Alt 300–540 m. NC
fulleri L.Bolus
C. wiesemannianum Schwantes (3)
Perennial. Succulent. Ht up to 0.02 m. Alt 980–1150 m. NC
geometricum Lavis = **C. violaciflorum**
germanum N.E.Br. = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
geyeri L.Bolus = **C. jucundum** subsp. **jucundum**
giftbergense Tischer = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
glabrum Tischer = **C. minutum** var. **minutum**
globosum (N.E.Br.) N.E.Br.
C. globosum (N.E.Br.) N.E.Br. var. *vanbredae* (L.Bolus) Rawe (3)
C. obovatum Lavis var. *obovatum* (3)
C. obovatum Lavis var. *obtusum* L.Bolus (3)
C. vanbredae L.Bolus (3)
Mesembryanthemum globosum N.E.Br. (6)
Perennial. Succulent. Ht up to 0.1 m. Alt 300–580 m. NC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

globosum (N.E.Br.) N.E.Br. var. *vanbredae* (L.Bolus) Rawe = **C. globosum**
globuliforme Schick & Tischer = **C. meyeri**
gonapense L.Bolus var. *gonapense* = **C. bilobum** subsp. **bilobum** var. **bilobum**
gonapense L.Bolus var. *numeesicum* L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
gracile N.E.Br. var. *gracile* = **C. bilobum** subsp. **altum**
gracile N.E.Br. var. *majusculum* L.Bolus = **C. bilobum** subsp. **altum**
graciliramosum L.Bolus = **C. bilobum** subsp. **altum**
gracilistylum (L.Bolus) N.E.Br. = **C. bilobum** subsp. **gracilistylum**
graessneri Tischer = **C. saxetanum**
grandiflorum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
gratum (N.E.Br.) N.E.Br. subsp. *gratum* = **C. jucundum** subsp. **jucundum**
gratum (N.E.Br.) N.E.Br. subsp. *marlothii* (N.E.Br.) S.A.Hammer = **C. jucundum** subsp. **marlothii**
halenbergense (Dinter & Schwantes) N.E.Br.
C. cuneatum Tischer (3)
Mesembryanthemum halenbergense Dinter & Schwantes (3)
Perennial. Succulent. Ht up to 0.08 m. Alt 530–670 m. N
hallii L.Bolus = **C. roodiae** subsp. **roodiae**
hammeri G.Will. & H.C.Kennedy
Perennial. Succulent. Ht up to 0.02 m. Alt 310–650 m. NC
hanae Pavelka = **C. tomasi**
haramoepense L.Bolus, as '*karamoepense*' = **C. marginatum** subsp. **haramoepense**
heleniae Rawe = **C. tantillum** subsp. **heleniae**
helmutii Lavis = **C. stephanii** subsp. **helmutii**
hermarium (S.A.Hammer) S.A.Hammer
C. smorenskaduense de Boer subsp. *hermarium* S.A.Hammer (8)
Perennial. Succulent. Ht up to 0.04 m. Alt 1000–1190 m. NC
herreanthus S.A.Hammer subsp. **herreanthus**
Herreanthus meyeri Schwantes (3)
Perennial. Succulent. Ht up to 0.1 m. Alt ± 780 m. NC
herreanthus S.A.Hammer subsp. **rex** S.A.Hammer
Perennial. Succulent. Ht up to 0.1 m. Alt 790–980 m. NC
herrei Schwantes = **C. minusculum** subsp. **minisculum**
hians N.E.Br.
C. elongatum Schick & Tischer (3)
C. hians N.E.Br. var. *acuminatum* L.Bolus (3)
C. hirtum Schwantes (3)
C. miserum N.E.Br. (3)
C. parvimarinum L.Bolus (3)
Perennial. Succulent. Ht up to 0.06 m. Alt 130–1000 m. NC
hians N.E.Br. var. *acuminatum* L.Bolus = **C. hians**
hillii L.Bolus = **C. uviforme** subsp. **uviforme**
hirtum Schwantes = **C. hians**
hirtum Schwantes var. *baradii* Rawe = **C. klinghardtense** subsp. **baradii**
impressum Tischer = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
inclusum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
incurvum N.E.Br. var. *incurvum* = **C. bilobum** subsp. **bilobum** var. **bilobum**
incurvum N.E.Br. var. *leucanthum* (Lavis) Tischer = **C. bilobum** subsp. **bilobum** var. **bilobum**
indefinitum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
indutum L.Bolus = **C. obscurum** subsp. **obscurum**
inornatum N.E.Br. (insufficiently known)
Perennial. Succulent. Ht? Alt? 'SA'
insigne L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
intermedium L.Bolus = **C. loeschianum**
intrepidum L.Bolus = **C. bolusiae** subsp. **bolusiae**
irmae S.A.Hammer & Barnhill
Perennial. Succulent. Ht up to 0.03 m. Alt ± 750 m. NC
jacobsenianum Tischer = **C. jucundum** subsp. **jucundum**
jarmilae Halda
C. danielii Pavelka (6)
Perennial. Succulent. Ht up to 0.03 m. Alt 1000–1150 m. NC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

johannis-winkleri (Dinter & Schwantes) N.E.Br. = **C. pageae**
joubertii Lavis
C. viride Tischer (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 390–580 m. WC
jucundum (N.E.Br.) N.E.Br. subsp. **fragile** (Tischer) S.A.Hammer
C. avenantii L.Bolus (8)
C. fragile Tischer (8)
C. middlemostii L.Bolus (8)
C. nordenstamii L.Bolus (8)
C. wettsteinii (A.Berger) N.E.Br. subsp. *fragile* (Tischer) S.A.Hammer (8)
Perennial. Succulent. Ht up to 0.04 m. Alt 700–930 m. NC
jucundum (N.E.Br.) N.E.Br. subsp. **jucundum**
C. admiraalii L.Bolus (3)
C. geyeri L.Bolus (3)
C. gratum (N.E.Br.) N.E.Br. subsp. *gratum* (6)
C. jacobsenianum Tischer (6)
C. longistylum N.E.Br. (3)
C. maximum Tischer (3)
C. orbicum N.E.Br. ex Tischer (3)
C. praegratum Tischer (3)
C. rarum N.E.Br. (3)
C. robustum Tischer (3)
Mesembryanthemum gratum N.E.Br. (6)
Mesembryanthemum jucundum N.E.Br. (3)
Perennial. Succulent. Ht up to 0.06 m. Alt 700–1100 m. N, NC
jucundum (N.E.Br.) N.E.Br. subsp. **marlothii** (N.E.Br.) S.A.Hammer
C. fraternum (N.E.Br.) N.E.Br. var. *leptanthum* (L.Bolus) L.Bolus (3)
C. gratum (N.E.Br.) N.E.Br. subsp. *marlothii* (N.E.Br.) S.A.Hammer (6)
C. leptanthum L.Bolus (3)
C. marlothii N.E.Br. (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 700–850 m. NC
jucundum (N.E.Br.) N.E.Br. subsp. **ruschii** (Schwantes) S.A.Hammer
C. ruschii Schwantes var. *obtusipetalum* L.Bolus (8)
C. ruschii Schwantes var. *ruschii* (8)
C. speciosum Tischer (8)
C. wettsteinii (A.Berger) N.E.Br. subsp. *ruschii* (Schwantes) S.A.Hammer (8)
C. wettsteinii (A.Berger) N.E.Br. var. *oculatum* L.Bolus, semi-naked name (8)
C. wettsteinii (A.Berger) N.E.Br. var. *speciosum* (Tischer) Tischer (8)
Perennial. Succulent. Ht up to 0.03 m. Alt 780–1200 m. NC
julii Schwantes ex H.Jacobsen = **C. uviforme** subsp. **uviforme**
kennedyi L.Bolus = **C. lithopsoides** subsp. **lithopsoides**
khamiesbergense (L.Bolus) Schwantes
Berrisfordia khamiesbergensis L.Bolus (3)
Perennial. Succulent. Ht up to 0.02 m. Alt 1200–1500 m. NC
klaverense N.E.Br. = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
klinghardtense Rawe subsp. **baradii** (Rawe) S.A.Hammer
C. hirtum Schwantes var. *baradii* Rawe (3)
Perennial. Succulent. Ht up to 0.04 m. Alt 290–1000 m. N
klinghardtense Rawe subsp. **klinghardtense**
Perennial. Succulent. Ht up to 0.03 m. Alt 700–1120 m. N
klipbokbergense L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
komkansicum L.Bolus = **C. calculus** subsp. **calculus**
koubergense L.Bolus = **C. lithopsoides** subsp. **koubergense**
koupense Tischer = **C. truncatum** subsp. **viridicatum**
kubusanum N.E.Br.
Perennial. Succulent. Ht up to 0.05 m. Alt 300–800 m. NC
labiatum Tischer = **C. pageae**
labyrintheum (N.E.Br.) N.E.Br. = **C. minimum**
lacteum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
laetum L.Bolus var. *extractum* (Tischer) Rawe = **C. meyeri**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

laetum L.Bolus var. *laetum* = **C. meyeri**
lambertense Schick & Tischer var. *conspicuum* Rawe = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
lambertense Schick & Tischer var. *lambertense* = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
lambertense Schick & Tischer var. *rolfii* (de Boer) Rawe = **C. obcordellum** subsp. **rolfii**
largum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
latum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
lavisianum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
lavranosii Rawe var. *cuneatum* Rawe = **C. taylorianum** subsp. **taylorianum**
lavranosii Rawe var. *lavranosii* = **C. taylorianum** subsp. **taylorianum**
laxipetalum N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
leightoniae L.Bolus = **C. piluliforme** subsp. **piluliforme**
leipoldtii N.E.Br. = **C. minusculum** subsp. **leipoldtii**
lekkersingense L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
leopardinum L.Bolus = **C. meyeri**
leptanthum L.Bolus = **C. jucundum** subsp. **marlothii**
leucanthum Lavis = **C. bilobum** subsp. **bilobum** var. **bilobum**
leucanthum Lavis var. *multipetalum* L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
leviculum (N.E.Br.) N.E.Br. = **C. minimum**
lilianum Littlew. = **C. pellucidum** subsp. **pellucidum** var. **lilianum**
limbatum N.E.Br. = **C. ectypum** subsp. **ectypum**
limpidum S.A.Hammer
Perennial. Succulent. Ht up to 0.02 m. Alt 900–1100 m. NC
lindenianum Lavis & S.A.Hammer = **C. tantillum** subsp. **lindenianum**
linearilucidum L.Bolus = **C. bilobum** subsp. **bilobum** var. **linearilucidum**
literatum N.E.Br., semi-naked name = **C. minimum**
lithopsoides L.Bolus subsp. *arthurolfago* S.A.Hammer = **C. arthurolfago**
lithopsoides L.Bolus subsp. **boreale** (L.Bolus) S.A.Hammer
C. boreale L.Bolus (3)
Perennial. Succulent. Ht up to 0.02 m. Alt 710–960 m. NC
lithopsoides L.Bolus subsp. **koubergense** (L.Bolus) S.A.Hammer
C. koubergense L.Bolus (3)
Perennial. Succulent. Ht up to 0.023 m. Alt 1000–1200 m. NC
lithopsoides L.Bolus subsp. **lithopsoides**
C. kennedyi L.Bolus (3)
Perennial. Succulent. Ht up to 0.02 m. Alt 870–1100 m. NC
litorale L.Bolus = **C. uviforme** subsp. **uviforme**
littlewoodii L.Bolus = **C. marginatum** subsp. **littlewoodii**
loeschianum Tischer
C. intermedium L.Bolus (3)
C. rubricarinatum Tischer (3)
C. saxetanum (N.E.Br.) N.E.Br. var. *loeschianum* (Tischer) Rawe (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 540–1200 m. N, NC
longibracteatum L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 300–780 m. NC
longifissum Tischer = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
longipetalum L.Bolus = **C. pageae**
longistylum N.E.Br. = **C. jucundum** subsp. **jucundum**
longitubum L.Bolus = **C. truncatum** subsp. **viridicatum**
longum N.E.Br.
C. rawei G.D.Rowley (3)
Ophthalmophyllum fulleri Lavis (6)
Ophthalmophyllum longitubum L.Bolus (3)
Ophthalmophyllum longum (N.E.Br.) Tischer (6)
Ophthalmophyllum schlechteri Schwantes (6)
Perennial. Succulent. Ht up to 0.02 m. Alt 860–1150 m. NC
lucipunctum N.E.Br. = **C. subfenestratum**
luckhoffii Lavis
C. edwardsiae Lavis (3)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.05 m. Alt 100–980 m. WC
luiseae Schwantes = **C. bilobum** subsp. **altum**
luiseae Schwantes var. *papillatum* L.Bolus, semi-naked name = **C. bilobum** subsp. **altum**
luteolum L.Bolus var. *luteolum* = **C. flavum** subsp. **novicium**
luteolum L.Bolus var. *macrostigma* L.Bolus = **C. flavum** subsp. **novicium**
luteum N.E.Br. = **C. flavum** subsp. **flavum**
lydiae (H.Jacobsen) G.D.Rowley
C. spathulatum (L.Bolus) G.D.Rowley (3)
Ophthalmophyllum lydiae H.Jacobsen (3)
Ophthalmophyllum spathulatum L.Bolus (3)
Perennial. Succulent. Ht up to 0.02 m. Alt 950–1140 m. NC
marginatum Lavis subsp. **haramoepense** (L.Bolus) S.A.Hammer
C. haramoepense L.Bolus, as '*karmoepense*'(8)
C. marginatum Lavis var. *haramoepense* (L.Bolus) Rawe, as '*karmoepense*' (8)
C. senarium L.Bolus (8)
C. triebneri Schwantes (8)
Ophthalmophyllum haramoepense L.Bolus (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 940–1200 m. NC
marginatum Lavis subsp. **littlewoodii** (L.Bolus) S.A.Hammer
C. littlewoodii L.Bolus (8)
C. marginatum Lavis var. *littlewoodii* (L.Bolus) Rawe (8)
Perennial. Succulent. Ht up to 0.03 m. Alt 750–1200 m. N, NC
marginatum Lavis subsp. **marginatum**
Perennial. Succulent. Ht up to 0.03 m. Alt 940–1200 m. NC
marginatum Lavis var. *eenkokerense* (L.Bolus) Rawe = **C. tantillum** subsp. **eenkokerense**
marginatum Lavis var. *haramoepense* (L.Bolus) Rawe = **C. marginatum** subsp. **haramoepense**
marginatum Lavis var. *littlewoodii* (L.Bolus) Rawe = **C. marginatum** subsp. **littlewoodii**
markoetterae Schwantes = **C. bilobum** subsp. **bilobum** var. **bilobum**
marlothii N.E.Br. = **C. jucundum** subsp. **marlothii**
maughanii N.E.Br. subsp. **armeniacum** S.A.Hammer
Perennial. Succulent. Ht up to 0.01 m. Alt 700–1000 m. NC
maughanii N.E.Br. subsp. **latum** (Tischer) S.A.Hammer
C. discrepans G.D.Rowley forma *discrepans* (3)
C. discrepans G.D.Rowley forma *rubrum* (Tischer) G.D.Rowley (3)
C. noctiflorum (L.Bolus) G.D.Rowley (3)
Ophthalmophyllum latum Tischer forma *latum* (3)
Ophthalmophyllum latum Tischer forma *rubrum* (Tischer) G.D.Rowley (3)
Ophthalmophyllum noctiflorum L.Bolus (3)
Perennial. Succulent. Ht up to 0.01 m. Alt 740–1200 m. NC
maughanii N.E.Br. subsp. **maughanii**
C. rufescens N.E.Br. (3)
Ophthalmophyllum maughanii (N.E.Br.) Schwantes (3)
Ophthalmophyllum rufescens (N.E.Br.) Tischer (6)
Ophthalmophyllum schuldtii Schwantes (6)
Perennial. Succulent. Ht up to 0.01 m. Alt 950–1200 m. NC
maximum Tischer = **C. jucundum** subsp. **jucundum**
meleagris L.Bolus = **C. uviforme** subsp. **uviforme**
membranaceum L.Bolus = **C. breve**
meridianum L.Bolus var. *meridianum* = **C. pellucidum** subsp. **cupreatum**
meridianum L.Bolus var. *pulverulentum* L.Bolus = **C. pellucidum** subsp. **cupreatum**
meyerae Schwantes forma *alatum* Tischer = **C. bilobum** subsp. **bilobum** var. **bilobum**
meyerae Schwantes forma *apiculatum* (N.E.Br.) Tischer, invalid combination = **C. bilobum** subsp. **bilobum** var. **bilobum**
meyerae Schwantes forma *asperulum* (L.Bolus) H.Jacobsen = **C. bilobum** subsp. **bilobum** var. **bilobum**
meyerae Schwantes forma *meyerae* = **C. bilobum** subsp. **bilobum** var. **bilobum**
meyerae Schwantes forma *pole-evansii* (N.E.Br.) Tischer, invalid combination = **C. bilobum** subsp. **bilobum** var. **bilobum**
meyeri N.E.Br.
C. candidum L.Bolus (3)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

C. corculum Schwantes (3)
C. ecarinatum L.Bolus var. *candidum* (L.Bolus) Rawe (3)
C. extractum Tischer (3)
C. globuliforme Schick & Tischer (3)
C. laetum L.Bolus var. *extractum* (Tischer) Rawe (3)
C. laetum L.Bolus var. *laetum* (3)
C. leopardinum L.Bolus (3)
C. meyeri N.E.Br. var. *globuliforme* (Schick & Tischer) Rawe (3)
C. meyeri N.E.Br. var. *meyeri* forma *semilunulum* (Tischer) Rawe (3)
C. meyeri N.E.Br. var. *quinarium* L.Bolus (3)
C. meyeri N.E.Br. var. *ramosum* (Lavis) Rawe (3)
C. microstoma L.Bolus (3)
C. nanum Tischer (3)
C. niveum L.Bolus (3)
C. ovigerum Schwantes (3)
C. papillatum L.Bolus (6)
C. puberulum Lavis (3)
C. ramosum Lavis (3)
C. retusum N.E.Br. (3)
C. semilunulum Tischer (3)
Perennial. Succulent. Ht up to 0.04 m. Alt 130–980 m. NC

meyeri N.E.Br. var. *globuliforme* (Schick & Tischer) Rawe = **C. meyeri**
meyeri N.E.Br. var. *meyeri* forma *semilunulum* (Tischer) Rawe = **C. meyeri**
meyeri N.E.Br. var. *quinarium* L.Bolus = **C. meyeri**
meyeri N.E.Br. var. *ramosum* (Lavis) Rawe = **C. meyeri**
microstoma L.Bolus = **C. meyeri**
middlemostii L.Bolus = **C. jucundum** subsp. **fragile**

minimum (Haw.) N.E.Br.
C. albifissum Tischer (3)
C. batesii N.E.Br. (3)
C. brevilineatum Tischer (3)
C. labyrintheum (N.E.Br.) N.E.Br. (3)
C. leviculum (N.E.Br.) N.E.Br. (3)
C. literatum N.E.Br., semi-naked name (3)
C. notatum N.E.Br. (3)
C. obmetale (N.E.Br.) N.E.Br. (3)
C. pauxillum (N.E.Br.) N.E.Br. (3)
C. perpusillum (Haw.) N.E.Br. (3)
C. petraeum N.E.Br. (3)
C. pictum (N.E.Br.) N.E.Br. (3)
C. polulum N.E.Br. (3)
C. praecinctum N.E.Br. (3)
C. pusillum (N.E.Br.) N.E.Br. (3)
C. radiatum Tischer (3)
C. scitulum (N.E.Br.) N.E.Br. (3)
C. signatum (N.E.Br.) N.E.Br. (3)
C. vagum N.E.Br. (3)
C. wittebergense de Boer (3)
Mesembryanthemum labyrintheum N.E.Br. (3)
Mesembryanthemum leviculum N.E.Br. (3)
Mesembryanthemum minimum Haw. (6)
Mesembryanthemum obmetale N.E.Br. (3)
Mesembryanthemum pauxillum N.E.Br. (3)
Mesembryanthemum perpusillum Haw. (3)
Mesembryanthemum pictum N.E.Br. (3)
Mesembryanthemum pusillum N.E.Br. (3)
Mesembryanthemum scitulum N.E.Br. (3)
Mesembryanthemum signatum N.E.Br. (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 800–1100 m. WC

minusculum (N.E.Br.) N.E.Br. subsp. **aestiflorens** S.A.Hammer & T.C.Smale

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.02 m. Alt 1400–2050 m. WC

minusculum (N.E.Br.) N.E.Br. subsp. **leipoldtii** (N.E.Br.) S.A.Hammer

C. leipoldtii N.E.Br. (3)

Perennial. Succulent. Ht up to 0.02 m. Alt 980–1300 m. WC

minusculum (N.E.Br.) N.E.Br. subsp. **minisculum**

C. herrei Schwantes (3)

C. minusculum (N.E.Br.) N.E.Br. var. *paucilineatum* Rawe (3)

C. minusculum (N.E.Br.) N.E.Br. var. *reticulatum* (L.Bolus) Rawe ex G.D.Rowley forma *reticulatum* (3)

C. *minusculum* (N.E.Br.) N.E.Br. var. *reticulatum* (L.Bolus) Rawe ex G.D.Rowley forma *roseum* (G.D.Rowley) G.D.Rowley (3)

C. minusculum (N.E.Br.) N.E.Br. var. *roseum* (G.D.Rowley) Tischer (3)

C. reticulatum L.Bolus (3)

C. reticulatum L.Bolus forma *roseum* G.D.Rowley (3)

Mesembryanthemum minisculum N.E.Br. (3)

Perennial. Succulent. Ht up to 0.02 m. Alt 800–1400 m. WC

minusculum (N.E.Br.) N.E.Br. var. *paucilineatum* Rawe = **C. minusculum** subsp. **minisculum**

minusculum (N.E.Br.) N.E.Br. var. *reticulatum* (L.Bolus) Rawe ex G.D.Rowley forma *reticulatum* = **C. minusculum** subsp. **minisculum**

minusculum (N.E.Br.) N.E.Br. var. *reticulatum* (L.Bolus) Rawe ex G.D.Rowley forma *roseum* (G.D.Rowley) G.D.Rowley = **C. minusculum** subsp. **minisculum**

minusculum (N.E.Br.) N.E.Br. var. *roseum* (G.D.Rowley) Tischer = **C. minusculum** subsp. **minisculum**

minutiflorum (Schwantes) N.E.Br. = **C. pageae**

minutum (Haw.) N.E.Br. var. **minutum**

C. braunsii Tischer (6)

C. glabrum Tischer (6)

C. minutum (Haw.) N.E.Br. forma *sellatum* (Tischer) Rawe (3)

C. minutum (Haw.) N.E.Br. var. *laxum* Lavis (3)

C. minutum (Haw.) N.E.Br. var. *sellatum* (Tischer) Boom (3)

C. sellatum Tischer (3)

C. tubatum Tischer (6)

Mesembryanthemum minutum Haw. (3)

Perennial. Succulent. Ht up to 0.03 m. Alt 30–580 m. NC, WC

minutum (Haw.) N.E.Br. var. *laxum* Lavis = **C. minutum** var. **minutum**

minutum (Haw.) N.E.Br. var. *sellatum* (Tischer) Boom = **C. minutum** var. **minutum**

minutum (Haw.) N.E.Br. var. **nudum** (Tischer) Boom

C. nudum Tischer (8)

Perennial. Succulent. Ht up to 0.05 m. Alt 120–350 m. WC

minutum (Haw.) N.E.Br. var. **pearsonii** (N.E.Br.) Boom

C. pearsonii N.E.Br. var. *latisectum* L.Bolus (8)

C. pearsonii N.E.Br. var. *minor* N.E.Br. (8)

C. pearsonii N.E.Br. var. *pearsonii* (8)

Perennial. Succulent. Ht up to 0.03 m. Alt 120–580 m. NC, WC

minutum (Haw.) N.E.Br. var. *sellatum* (Tischer) Boom = **C. minutum** var. **minutum**

mirabile A.R.Mitch. & S.A.Hammer

Perennial. Succulent. Ht up to 0.03 m. Alt 1100–1340 m. NC

misellum N.E.Br. = **C. saxetanum**

miserum N.E.Br. = **C. hians**

modestum L.Bolus = **C. quaesitum** subsp. **quaesitum** var. **quaesitum**

morganii Lavis = **C. truncatum** subsp. **truncatum** var. **truncatum**

muirii N.E.Br. = **C. truncatum** subsp. **viridicatum**

multicolor Tischer = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**

multipunctatum Tischer = **C. truncatum** subsp. **truncatum** var. **truncatum**

mundum N.E.Br. = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**

muscosipapillatum Lavis = **C. bilobum** subsp. **bilobum** var. **muscosipapillatum**

namibense N.E.Br. = **C. saxetanum**

namiesicum L.Bolus = **C. calculus** subsp. **vanzylii**

nanum Tischer = **C. meyeri**

nelianum Schwantes = **C. bilobum** subsp. **bilobum** var. **bilobum**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

nevillei (N.E.Br.) N.E.Br. = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
niveum L.Bolus = **C. meyeri**
noctiflorum (L.Bolus) G.D.Rowley = **C. maughanii** subsp. **latum**
noisabiense L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
nordenstamii L.Bolus = **C. jucundum** subsp. **fragile**
notabile N.E.Br. = **C. frutescens**
notatum N.E.Br. = **C. minimum**
novellum N.E.Br. = **C. truncatum** subsp. **viridicatum**
novicium N.E.Br. = **C. flavum** subsp. **novicium**
nudum Tischer = **C. minutum** var. **nudum**
nutaboiense Tischer = **C. bilobum** subsp. **bilobum** var. **bilobum**
obconellum (Haw.) Schwantes = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
obcordellum (Haw.) N.E.Br. subsp. **obcordellum** var. **ceresianum** (L.Bolus) S.A.Hammer
C. ceresianum L.Bolus (6)
C. ceresianum L.Bolus var. *divergens* (L.Bolus) Rawe (6)
Perennial. Succulent. Ht up to 0.05 m. Alt 650–900 m. WC
obcordellum (Haw.) N.E.Br. subsp. **obcordellum** var. **obcordellum**
C. declinatum L.Bolus (3)
C. divergens L.Bolus (6)
C. germanum N.E.Br. (3)
C. giftbergense Tischer (6)
C. impressum Tischer (3)
C. klaverense N.E.Br. (3)
C. lambertense Schick & Tischer var. *conspicuum* Rawe (3)
C. lambertense Schick & Tischer var. *lambertense* (3)
C. longifissum Tischer (6)
C. multicolor Tischer (3)
C. mundum N.E.Br. (3)
C. nevillei (N.E.Br.) N.E.Br. (3)
C. obconellum (Haw.) Schwantes (3)
C. obcordellum (Haw.) N.E.Br. var. *germanum* (N.E.Br.) Rawe (3)
C. obcordellum (Haw.) N.E.Br. var. *mundum* (N.E.Br.) Rawe forma *mundum* (3)
C. obcordellum (Haw.) N.E.Br. var. *mundum* (N.E.Br.) Rawe forma *picturatum* (N.E.Br.) Rawe (3)
C. obcordellum (Haw.) N.E.Br. var. *mundum* (N.E.Br.) Rawe forma *stayneri* (L.Bolus) Rawe (6)
C. obcordellum (Haw.) N.E.Br. var. *mundum* (N.E.Br.) Rawe forma *ursprungianum* (Tischer) Rawe (3)
C. obcordellum (Haw.) N.E.Br. var. *obcordellum* forma *declinatum* (L.Bolus) Tischer (3)
C. obcordellum (Haw.) N.E.Br. var. *obcordellum* forma *multicolor* (Tischer) Tischer (3)
C. obcordellum (Haw.) N.E.Br. var. *obcordellum* forma *picturatum* (N.E.Br.) Tischer (3)
C. obcordellum (Haw.) N.E.Br. var. *parvipetalum* (N.E.Br.) Tischer (3)
C. parviflorum N.E.Br. (3)
C. parviflorum N.E.Br. var. *impressum* (Tischer) Tischer (6)
C. parvipetalum (N.E.Br.) N.E.Br. (3)
C. picturatum N.E.Br. (3)
C. spectabile Lavis (3)
C. ursprungianum Tischer var. *stayneri* L.Bolus (6)
C. ursprungianum Tischer var. *ursprungianum* (3)
Mesembryanthemum nevillei N.E.Br. (3)
Mesembryanthemum obconellum Haw. (3)
Mesembryanthemum obcordellum Haw. (3)
Mesembryanthemum parvipetalum N.E.Br. (3)
Perennial. Succulent. Ht up to 0.04 m. Alt 600–1650 m. NC, WC
obcordellum (Haw.) N.E.Br. subsp. **rolfii** (de Boer) S.A.Hammer
C. lambertense Schick & Tischer var. *rolfii* (de Boer) Rawe (3)
C. rolfii de Boer (3)
Perennial. Succulent. Ht up to 0.01 m. Alt 20–180 m. WC
obcordellum (Haw.) N.E.Br. subsp. **stenandrum** (L.Bolus) S.A.Hammer
C. stenandrum L.Bolus (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 450–1150 m. NC, WC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

obcordellum (Haw.) N.E.Br. var. *germanum* (N.E.Br.) Rawe = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
obcordellum (Haw.) N.E.Br. var. *mundum* (N.E.Br.) Rawe forma *mundum* = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
obcordellum (Haw.) N.E.Br. var. *mundum* (N.E.Br.) Rawe forma *picturatum* (N.E.Br.) Rawe = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
obcordellum (Haw.) N.E.Br. var. *mundum* (N.E.Br.) Rawe forma *stayneri* (L.Bolus) Rawe = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
obcordellum (Haw.) N.E.Br. var. *mundum* (N.E.Br.) Rawe forma *ursprungianum* (Tischer) Rawe = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
obcordellum (Haw.) N.E.Br. var. *obcordellum* forma *declinatum* (L.Bolus) Tischer = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
obcordellum (Haw.) N.E.Br. var. *obcordellum* forma *multicolor* (Tischer) Tischer = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
obcordellum (Haw.) N.E.Br. var. *obcordellum* forma *picturatum* (N.E.Br.) Tischer = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
obcordellum (Haw.) N.E.Br. var. *parvipetalum* (N.E.Br.) Tischer = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
obmetale (N.E.Br.) N.E.Br. = **C. minimum**
obovatum Lavis var. *obovatum* = **C. globosum**
obovatum Lavis var. *obtusum* L.Bolus = **C. globosum**
obscurum N.E.Br. subsp. **barbatum** (L.Bolus) S.A.Hammer
C. barbatum L.Bolus (6)
Perennial. Succulent. Ht up to 0.03 m. Alt 750–980 m. NC
obscurum N.E.Br. subsp. **obscurum**
C. clavatum L.Bolus (3)
C. indutum L.Bolus (6)
C. pulchellum Tischer (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 750–1000 m. NC
obscurum N.E.Br. subsp. **sponsaliorum** (S.A.Hammer) S.A.Hammer
C. bachelorum S.A.Hammer subsp. *sponsaliorum* S.A.Hammer (8)
Perennial. Succulent. Ht up to 0.02 m. Alt ± 680 m. NC
obscurum N.E.Br. subsp. **vitreopapillum** (Rawe) S.A.Hammer
C. vitreopapillum Rawe (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 300–650 m. NC
obtusum N.E.Br. var. *amplum* (L.Bolus) Rawe = **C. bilobum** subsp. **bilobum** var. **bilobum**
obtusum N.E.Br. var. *obtusum* = **C. bilobum** subsp. **bilobum** var. **bilobum**
occultum L.Bolus = **C. uviforme** subsp. **decoratum**
odoratum (N.E.Br.) N.E.Br. = **C. ficiforme**
orbicum N.E.Br. ex Tischer = **C. jucundum** subsp. **jucundum**
orientale L.Bolus = **C. truncatum** subsp. **truncatum** var. **truncatum**
ornatum Lavis = **C. flavum** subsp. **flavum**
ovatum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
ovigerum Schwantes = **C. meyeri**
pageae (N.E.Br.) N.E.Br.
C. aequatum L.Bolus (3)
C. breve N.E.Br. var. *minutiflorum* (Schwantes) Rawe (3)
C. calculus (A.Berger) N.E.Br. var. *protusum* L.Bolus (3)
C. forresteri L.Bolus (3)
C. johannis-winkleri (Dinter & Schwantes) N.E.Br. (3)
C. labiatum Tischer (3)
C. longipetalum L.Bolus (3)
C. minutiflorum (Schwantes) N.E.Br. (3)
C. pageae (N.E.Br.) N.E.Br. var. *albiflorum* Rawe (3)
C. pauperae L.Bolus (3)
C. poellnitzianum Schwantes (3)
C. productum L.Bolus (3)
C. schickianum Tischer (3)
C. subrisum (N.E.Br.) N.E.Br. (3)
C. tenuisectum L.Bolus (3)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

C. thudichumii L.Bolus (3)
C. udabibense Loesch & Tischer (3)
Mesembryanthemum johannis-winkleri Dinter & Schwantes (3)
Mesembryanthemum pageae N.E.Br. (3)
Mesembryanthemum subrisum N.E.Br. (3)
Perennial. Succulent. Ht up to 0.05 m. Alt 350–700 m. NC, WC

pageae (N.E.Br.) N.E.Br. var. *albiflorum* Rawe = **C. pageae**

pageae (N.E.Br.) N.E.Br. var. *pygmaeum* (Schick & Tischer) Rawe in sense of Rawe = **C. stevens-jonesianum**

pallidum (N.E.Br.) N.E.Br. = **C. ficiforme**

papillatum L.Bolus = **C. meyeri**

pardicolor Tischer = **C. pellucidum** subsp. **pellucidum**

pardivisum Tischer = **C. uviforme** subsp. **uviforme**

parviflorum N.E.Br. = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**

parviflorum N.E.Br. var. *impressum* (Tischer) Tischer = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**

parvimarinum L.Bolus = **C. hians**

parvipetalum (N.E.Br.) N.E.Br. = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**

parvipunctum Tischer = **C. truncatum** subsp. **truncatum** var. **truncatum**

parvulum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**

paucipunctum Tischer = **C. breve**

pauperae L.Bolus = **C. pageae**

pauxillum (N.E.Br.) N.E.Br. = **C. minimum**

pearsonii N.E.Br. var. *latisectum* L.Bolus = **C. minutum** var. **pearsonii**

pearsonii N.E.Br. var. *minor* N.E.Br. = **C. minutum** var. **pearsonii**

pearsonii N.E.Br. var. *pearsonii* = **C. minutum** var. **pearsonii**

peersii Lavis var. *multipunctatum* (Tischer) Rawe = **C. truncatum** subsp. **truncatum** var. **truncatum**

peersii Lavis var. *peersii* = **C. truncatum** subsp. **truncatum** var. **truncatum**

pellucidum Schwantes subsp. **cupreatum** (Tischer) S.A.Hammer var. **cupreatum**
C. astylum L.Bolus (3)
C. cupreatum Tischer (3)
C. meridianum L.Bolus var. *meridianum* (3)
C. meridianum L.Bolus var. *pulverulentum* L.Bolus (3)
Perennial. Succulent. Ht up to 0.04 m. Alt 870–1050 m. NC

pellucidum Schwantes subsp. **cupreatum** (Tischer) S.A.Hammer var. **terrestre** (Tischer) S.A.Hammer
C. terrestre Tischer (8)
Perennial. Succulent. Ht up to 0.04 m. Alt 870–950 m. NC

pellucidum Schwantes subsp. **pellucidum** var. **lilianum** (Littlew.) S.A.Hammer
C. lilianum Littlew. (8)
Perennial. Succulent. Ht up to 0.04 m. Alt 420–600 m. NC

pellucidum Schwantes subsp. **pellucidum** var. **neohallii** S.A.Hammer
Perennial. Succulent. Ht up to 0.04 m. Alt 350–1050 m. NC

pellucidum Schwantes subsp. **pellucidum** var. **pellucidum**
C. areolatum Littlew. (3)
C. elegans N.E.Br. (3)
C. fenestratum Schwantes (3)
C. pardicolor Tischer (3)
Perennial. Succulent. Ht up to 0.04 m. Alt 350–1050 m. NC

pellucidum Schwantes subsp. **pellucidum** var. **terricolor** (Tischer) Littlewood ex S.A.Hammer
C. terricolor Tischer (3)
Perennial. Succulent. Ht up to 0.04 m. Alt 350–1150 m. NC

pellucidum Schwantes subsp. **saueri** S.A.Hammer & T.C.Smale
Perennial. Succulent. Ht up to 0.02 m. Alt 900–1150 m. NC

percrassum Schick & Tischer = **C. flavum** subsp. **flavum**

permaculatum Tischer = **C. truncatum** subsp. **truncatum** var. **truncatum**

perpusillum (Haw.) N.E.Br. = **C. minimum**

petraeum N.E.Br. = **C. minimum**

philippi L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**

phoeniceum S.A.Hammer

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.01 m. Alt 700–800 m. NC
pictum (N.E.Br.) N.E.Br. = **C. minimum**
picturatum N.E.Br. = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
pillansii Lavis = **C. subfenestratum**
piluliforme (N.E.Br.) N.E.Br. subsp. **edwardii** (Schwantes) S.A.Hammer
C. edwardii Schwantes (3)
C. rubrum L.Bolus (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 500–650 m. WC
piluliforme (N.E.Br.) N.E.Br. subsp. **piluliforme**
C. advenum N.E.Br. (3)
C. aggregatum (Haw. ex N.E.Br.) N.E.Br. (3)
C. archeri Lavis var. *archeri* (3)
C. brevipetalum Lavis (3)
C. etaylorii Schwantes (3)
C. leightoniae L.Bolus (3)
C. piluliforme (N.E.Br.) N.E.Br. var. *advenum* (N.E.Br.) Rawe (3)
C. piluliforme (N.E.Br.) N.E.Br. var. *brevipetalum* (Lavis) Rawe (3)
C. subconfusum Tischer (3)
Mesembryanthemum aggregatum Haw. ex N.E.Br. (3)
Mesembryanthemum piluliforme N.E.Br. (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 390–600 m. WC
piluliforme (N.E.Br.) N.E.Br. var. *advenum* (N.E.Br.) Rawe = **C. piluliforme** subsp. **piluliforme**
piluliforme (N.E.Br.) N.E.Br. var. *brevipetalum* (Lavis) Rawe = **C. piluliforme** subsp. **piluliforme**
piriforme L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
pisinnum N.E.Br. = **C. truncatum** subsp. **viridicatum**
placitum (N.E.Br.) N.E.Br. var. *placitum* = **C. ficiforme**
placitum (N.E.Br.) N.E.Br. var. *pubescens* Littlew. = **C. ficiforme**
plenum N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
pluriforme L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
poellnitzianum Schwantes = **C. pageae**
pole-evansii N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
polulum N.E.Br. = **C. minimum**
polyandrum Lavis = **C. velutinum** subsp. **polyandrum**
praecinctum N.E.Br. = **C. minimum**
praecox N.E.Br. = **C. fraternum**
praegratum Tischer = **C. jucundum** subsp. **jucundum**
praeparvum N.E.Br. var. *praeparvum* = **C. uviforme** subsp. **uviforme**
praeparvum N.E.Br. var. *roseum* Lavis = **C. uviforme** subsp. **uviforme**
praesectum N.E.Br.
Ophthalmophyllum praesectum (N.E.Br.) Schwantes (6)
Perennial. Succulent. Ht up to 0.03 m. Alt 1000–1150 m. NC
primosii Lavis = **C. roodiae**
productum L.Bolus = **C. pageae**
prolongatum L.Bolus = **C. uviforme** subsp. **uviforme**
proximum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
puberulum Lavis = **C. meyeri**
pubescens (Tischer) G.D.Rowley
Ophthalmophyllum pubescens Tischer (3)
Perennial. Succulent. Ht up to 0.02 m. Alt 1000–1100 m. NC
pubicalyx Lavis
Perennial. Succulent. Ht up to 0.02 m. Alt 600–1070 m. NC
pulchellum Tischer = **C. obscurum** subsp. **obscurum**
pumilum N.E.Br. = **C. breve**
purpusii (Schwantes) N.E.Br. = **C. truncatum** subsp. **truncatum** var. **truncatum**
pusillum (N.E.Br.) N.E.Br. = **C. minimum**
pygmaeum Schick & Tischer = **C. breve**
quaesitum (N.E.Br.) N.E.Br. subsp. **densipunctum** (L.Bolus) S.A.Hammer
C. densipunctum L.Bolus (3)
Perennial. Succulent. Ht up to 0.04 m. Alt 1050–1200 m. N
quaesitum (N.E.Br.) N.E.Br. subsp. **quaesitum** var. **quaesitum**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

C. modestum L.Bolus (6)
C. quartziticum Tischer (3)
Mesembryanthemum quaesitum N.E.Br. (3)
Perennial. Succulent. Ht up to 0.05 m. Alt 700–1200 m. NC
quaesitum (N.E.Br.) N.E.Br. subsp. **quaesitum** var. **rostratum** (Tischer) S.A.Hammer
C. rostratum Tischer (6)
Perennial. Succulent. Ht up to 0.05 m. Alt 700–1200 m. NC
quartziticum Tischer = **C. quaesitum** subsp. **quaesitum** var. **quaesitum**
radiatum Tischer = **C. minimum**
ramosum Lavis = **C. meyeri**
rarum N.E.Br. = **C. jucundum** subsp. **jucundum**
ratum S.A.Hammer
Perennial. Succulent. Ht up to 0.01 m. Alt 800–950 m. NC
rauhii Tischer = **C. uviforme** subsp. **rauhii**
rawei G.D.Rowley = **C. longum**
recisum N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
reconditum A.R.Mitch. subsp. **buysianum** (A.R.Mitch. & S.A.Hammer) S.A.Hammer
C. buysianum A.R.Mitch. & S.A.Hammer (3)
Perennial. Succulent. Ht up to 0.02 m. Alt 980–1100 m. NC
reconditum A.R.Mitch. subsp. **reconditum**
Perennial. Succulent. Ht up to 0.02 m. Alt 430–1150 m. NC
regale Lavis
Perennial. Succulent. Ht up to 0.04 m. Alt 950–1150 m. NC
renniei Lavis = **C. truncatum** subsp. **truncatum** var. **truncatum**
renominatum G.D.Rowley = **C. friedrichiae**
reticulatum L.Bolus = **C. minusculum** subsp. **minisculum**
reticulatum L.Bolus forma *roseum* G.D.Rowley = **C. minusculum** subsp. **minisculum**
retusum N.E.Br. = **C. meyeri**
ricardianum Loesch & Tischer subsp. **ricardianum**
Perennial. Succulent. Ht up to 0.04 m. Alt 690–970 m. N
ricardianum Loesch & Tischer subsp. **rubriflorum** Tischer
Perennial. Succulent. Ht up to 0.04 m. Alt 650–1050 m. N
robustum Tischer = **C. jucundum** subsp. **jucundum**
rolfii de Boer = **C. obcordellum** subsp. **rolfii**
roodiae N.E.Br. subsp. **corrugatum** T.C.Smale
Perennial. Succulent. Ht up to 0.03 m. Alt 780–1250 m. NC
roodiae N.E.Br. subsp. **cylindratum** (Schwantes) T.C.Smale
C. cylindratum Schwantes (8)
C. cylindratum Schwantes var. *primosii* (Lavis) Rawe (8)
Perennial. Succulent. Ht up to 0.04 m. Alt 650–1100 m. NC
roodiae N.E.Br. subsp. **roodiae**
C. hallii L.Bolus (3)
C. primosii Lavis (3)
C. rubroniveum L.Bolus (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 780–1250 m. NC
roodiae N.E.Br. subsp. **sanguineum** (S.A.Hammer) T.C.Smale
C. rugosum S.A.Hammer subsp. *sanguineum* S.A.Hammer (6)
Perennial. Succulent. Ht up to 0.03 m. Alt 780–1250 m. NC
rooipanense L.Bolus = **C. uviforme** subsp. **uviforme**
rostratum Tischer = **C. quaesitum** subsp. **quaesitum** var. **rostratum**
rubricarinatum Tischer = **C. loeschianum**
rubristylosum Tischer = **C. flavum** subsp. **novicium**
rubrolineatum Rawe = **C. swanepoelianum** subsp. **rubrolineatum**
rubroniveum L.Bolus = **C. roodiae** subsp. **roodiae**
rubrum L.Bolus = **C. piluliforme** subsp. **edwardii**
rufescens N.E.Br. = **C. maughanii** subsp. **maughanii**
rugosum S.A.Hammer
Perennial. Succulent. Ht up to 0.01 m. Alt 200–1200 m. NC, WC
rugosum S.A.Hammer subsp. *sanguineum* S.A.Hammer = **C. roodiae** subsp. **sanguineum**
ruschii Schwantes var. *obtusipetalum* L.Bolus = **C. jucundum** subsp. **ruschii**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

ruschii Schwantes var. *ruschii* = **C. jucundum** subsp. **ruschii**
salmonicolor L.Bolus = **C. frutescens**
saxetanum (N.E.Br.) N.E.Br.
C. exiguum N.E.Br. (3)
C. graessneri Tischer (3)
C. misellum N.E.Br. (3)
C. namibense N.E.Br. (6)
C. saxetanum (N.E.Br.) N.E.Br. forma *hallianum* G.D.Rowley (3)
C. saxetanum (N.E.Br.) N.E.Br. var. *misellum* (N.E.Br.) Rawe (3)
C. vescum N.E.Br. (3)
Mesembryanthemum saxetanum N.E.Br. (6)
Perennial. Succulent. Ht up to 0.04 m. Alt 20–1125 m. N, NC
saxetanum (N.E.Br.) N.E.Br. forma *hallianum* G.D.Rowley = **C. saxetanum**
saxetanum (N.E.Br.) N.E.Br. var. *loeschianum* (Tischer) Rawe = **C. loeschianum**
saxetanum (N.E.Br.) N.E.Br. var. *misellum* (N.E.Br.) Rawe = **C. saxetanum**
schickianum Tischer = **C. pageae**
schlechteri Schwantes
Perennial. Succulent. Ht up to 0.05 m. Alt 700–1050 m. NC
schwantesii G.D.Rowley = **C. friedrichiae**
scitulum (N.E.Br.) N.E.Br. = **C. minimum**
sellatum Tischer = **C. minutum** var. **minutum**
semilunulum Tischer = **C. meyeri**
semivestitum L.Bolus
Perennial. Succulent. Ht up to 0.02 m. Alt? NC
senarium L.Bolus = **C. marginatum** subsp. **haramoepense**
signatum (N.E.Br.) N.E.Br. = **C. minimum**
simile N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
simplum N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
singulare G.D.Rowley = **C. caroli**
sitzlerianum Schwantes = **C. bilobum** subsp. **bilobum** var. **bilobum**
smithersii L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
smorenskaduense de Boer
Perennial. Succulent. Ht up to 0.02 m. Alt 1000–1190 m. NC
smorenskaduense de Boer subsp. *hermarium* S.A.Hammer = **C. hermarium**
sororium N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
spathulatum (L.Bolus) G.D.Rowley = **C. lydiae**
speciosum Tischer = **C. jucundum** subsp. **ruschii**
spectabile Lavis = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
spirale N.E.Br. = **C. truncatum** subsp. **truncatum** var. **truncatum**
springbokense N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
stegmannianum L.Bolus = **C. truncatum** subsp. **truncatum** var. **truncatum**
stenandrum L.Bolus = **C. obcordellum** subsp. **stenandrum**
stephanii Schwantes subsp. *abductum* S.A.Hammer = **C. stephanii** subsp. **stephanii**
stephanii Schwantes subsp. **helmutii** (Lavis) S.A.Hammer
C. helmutii Lavis (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 700–1150 m. NC
stephanii Schwantes subsp. **stephanii**
C. stephanii Schwantes subsp. *abductum* S.A.Hammer (6)
Perennial. Succulent. Ht up to 0.03 m. Alt 600–1169 m. NC
stevens-jonesianum L.Bolus
C. pageae (N.E.Br.) N.E.Br. var. *pygmaeum* (Schick & Tischer) Rawe in sense of Rawe (3)
Perennial. Succulent. Ht up to 0.06 m. Alt 500–1110 m. NC
steytlervillense Tischer = **C. truncatum** subsp. **truncatum** var. **truncatum**
stipitatum L.Bolus = **C. uviforme** subsp. **uviforme**
strictum L.Bolus var. *inaequale* L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
strictum L.Bolus var. *strictum* = **C. bilobum** subsp. **bilobum** var. **bilobum**
stylosum (N.E.Br.) Tischer = **C. bilobum** subsp. **bilobum** var. **bilobum**
subacutum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
subconfusum Tischer = **C. piluliforme** subsp. **piluliforme**
subcylindricum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

subfenestratum Schwantes
C. edithiae N.E.Br. (3)
C. lucipunctum N.E.Br. (3)
C. pillansii Lavis (3)
Ophthalmophyllum subfenestratum (Schwantes) Tischer (6)
Perennial. Succulent. Ht up to 0.005 m. Alt 180–350 m. WC
subglobosum Tischer = **C. truncatum** subsp. **truncatum** var. **truncatum**
subincanum Tischer = **C. uviforme** subsp. **subincanum**
subrisum (N.E.Br.) N.E.Br. = **C. pageae**
subtenue L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
subterraneum T.C.Smale & T.Jacobs
Perennial. Succulent. Ht up to 0.02 m, when in flower. Alt 750–1100 m. NC
subtile N.E.Br. = **C. breve**
sulcatum L.Bolus = **C. ectypum** subsp. **sulcatum**
supremum L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
swanepoelianum Rawe subsp. **proliferans** S.A.Hammer
Perennial. Succulent. Ht up to 0.02 m. Alt 750–980 m. NC
swanepoelianum Rawe subsp. **rubrolineatum** (Rawe) S.A.Hammer
C. rubrolineatum Rawe (8)
Perennial. Succulent. Ht up to 0.03 m. Alt 600–850 m. NC
swanepoelianum Rawe subsp. **swanepoelianum**
Perennial. Succulent. Ht up to 0.02 m. Alt 800–1100 m. NC
tantillum N.E.Br. subsp. **amicorum** S.A.Hammer & Barnhill
Perennial. Succulent. Ht up to 0.02 m. Alt ± 850 m. NC
tantillum N.E.Br. subsp. **eenkokerense** (L.Bolus) S.A.Hammer
C. eenkokerense L.Bolus (8)
C. marginatum Lavis var. *eenkokerense* (L.Bolus) Rawe (8)
Perennial. Succulent. Ht up to 0.02 m. Alt 1050–1150 m. NC
tantillum N.E.Br. subsp. **heleniae** (Rawe) S.A.Hammer
C. heleniae Rawe (3)
Perennial. Succulent. Ht up to 0.02 m. Alt 1000–1150 m. NC
tantillum N.E.Br. subsp. **inexpectatum** S.A.Hammer
Perennial. Succulent. Ht up to 0.02 m. Alt 750–1000 m. NC
tantillum N.E.Br. subsp. **lindenianum** (Lavis & S.A.Hammer) S.A.Hammer
C. lindenianum Lavis & S.A.Hammer (3)
Perennial. Succulent. Ht up to 0.02 m. Alt 650–950 m. NC
tantillum N.E.Br. subsp. **tantillum**
Perennial. Succulent. Ht up to 0.02 m. Alt 1050–1150 m. NC
taylorianum (Dinter & Schwantes) N.E.Br. subsp. **ernianum** (Loesch & Tischer) de Boer ex S.A.Hammer
C. ernianum Loesch & Tischer (3)
Perennial. Succulent. Ht up to 0.04 m. Alt 600–1114 m. N
taylorianum (Dinter & Schwantes) N.E.Br. subsp. **rosynense** S.A.Hammer
Perennial. Succulent. Ht up to 0.04 m. Alt 600–1200 m. NC
taylorianum (Dinter & Schwantes) N.E.Br. subsp. **taylorianum**
C. lavranosii Rawe var. *cuneatum* Rawe (3)
C. lavranosii Rawe var. *lavranosii* (3)
Mesembryanthemum taylorianum Dinter & Schwantes (3)
Perennial. Succulent. Ht up to 0.04 m. Alt 650–1125 m. N
tectum N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
teguliflorum Tischer = **C. frutescens**
tenuisectum L.Bolus = **C. pageae**
terrestre Tischer = **C. pellucidum** subsp. **cupreatum**
terricolor Tischer = **C. pellucidum** subsp. **pellucidum** var. **terricolor**
tetracarpum Lavis = **C. flavum** subsp. **flavum**
thudichumi L.Bolus = **C. pageae**
tinctum Lavis = **C. flavum** subsp. **flavum**
tischeri Schick = **C. velutinum** subsp. **velutinum**
tischleri Schwantes = **C. ectypum** subsp. **ectypum**
tomasi Halda

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

C. hanae Pavelka (8)
Perennial. Succulent. Ht up to 0.04 m. Alt 1000–1300 m. NC
translucens N.E.Br. = **C. truncatum** subsp. **truncatum** var. **truncatum**
triebneri Schwantes = **C. marginatum** subsp. **haramoepense**
truncatum (Thunb.) N.E.Br. subsp. **truncatum** var. **truncatum**
C. albertense (N.E.Br.) N.E.Br. (3)
C. brevitubum Lavis (3)
C. calitzdorpense L.Bolus (6)
C. calitzdorpense Tischer (6)
C. cibdelum N.E.Br. (3)
C. morganii Lavis (3)
C. multipunctatum Tischer (3)
C. orientale L.Bolus (3)
C. parvipunctum Tischer (3)
C. peersii Lavis var. *multipunctatum* (Tischer) Rawe (3)
C. peersii Lavis var. *peersii* (3)
C. permaculatum Tischer (6)
C. purpusii (Schwantes) N.E.Br. (3)
C. renniei Lavis (3)
C. spirale N.E.Br. (3)
C. stegmannianum L.Bolus (6)
C. steytlervillense Tischer (3)
C. subglobosum Tischer (3)
C. translucens N.E.Br. (3)
C. truncatum (Thunb.) N.E.Br. var. *brevitubum* (Lavis) Tischer (3)
C. truncatum (Thunb.) N.E.Br. var. *truncatum* forma *parvipunctum* (Tischer) Tischer (3)
C. truncatum (Thunb.) N.E.Br. var. *truncatum* forma *rennei* (Lavis) Tischer (3)
C. wagneriorum Schwantes (3)
Mesembryanthemum purpusii Schwantes (3)
Perennial. Succulent. Ht up to 0.04 m. Alt 440–950 m. NC, WC, EC
truncatum (Thunb.) N.E.Br. subsp. **truncatum** var. **wiggettiae** (N.E.Br.) Rawe
C. wiggettiae N.E.Br. (8)
Perennial. Succulent. Ht up to 0.04 m. Alt 440–950 m. WC
truncatum (Thunb.) N.E.Br. subsp. **viridicatum** (N.E.Br.) S.A.Hammer
C. archeri Lavis var. *stayneri* L.Bolus (3)
C. catervum (N.E.Br.) N.E.Br. (3)
C. complanatum L.Bolus (3)
C. dispar N.E.Br. (3)
C. koupense Tischer (3)
C. longitubum L.Bolus (3)
C. muirii N.E.Br. (3)
C. novellum N.E.Br. (3)
C. pisinnum N.E.Br. (3)
C. viridicatum (N.E.Br.) N.E.Br. var. *pisinnum* (N.E.Br.) Rawe (6)
C. viridicatum (N.E.Br.) N.E.Br. var. *punctatum* N.E.Br. (3)
C. viridicatum (N.E.Br.) N.E.Br. var. *viridicatum* (3)
Mesembryanthemum catervum N.E.Br. (3)
Mesembryanthemum pisinnum N.E.Br. (3)
Perennial. Succulent. Ht up to 0.04 m. Alt 550–1250 m. WC
truncatum (Thunb.) N.E.Br. var. *brevitubum* (Lavis) Tischer = **C. truncatum** subsp. **truncatum** var. **truncatum**
truncatum (Thunb.) N.E.Br. var. *truncatum* forma *parvipunctum* (Tischer) Tischer = **C. truncatum** subsp. **truncatum** var. **truncatum**
truncatum (Thunb.) N.E.Br. var. *truncatum* forma *rennei* (Lavis) Tischer = **C. truncatum** subsp. **truncatum** var. **truncatum**
tubatum Tischer = **C. minutum** var. **minutum**
tumidum N.E.Br. = **C. bilobum** subsp. **bilobum** var. **bilobum**
tumidum N.E.Br. var. *asperulum* L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
turbiniforme Rawe = **C. auriflorum** subsp. **turbiniforme**
turrigerum (N.E.Br.) N.E.Br.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Mesembryanthemum turrigerum N.E.Br. (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 200–880 m. WC
udabibense Loesch & Tischer = **C. pageae**
umdausense L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
ursprungianum Tischer var. *stayneri* L.Bolus = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
ursprungianum Tischer var. *ursprungianum* = **C. obcordellum** subsp. **obcordellum** var. **obcordellum**
uviforme (Haw.) N.E.Br. forma *framesii* (Lavis) Tischer = **C. uviforme** subsp. **uviforme**
uviforme (Haw.) N.E.Br. forma *meleagris* (L.Bolus) Tischer = **C. uviforme** subsp. **uviforme**
uviforme (Haw.) N.E.Br. subsp. **decoratum** (N.E.Br.) S.A.Hammer
C. decoratum N.E.Br. (3)
C. occultum L.Bolus (3)
C. varians L.Bolus (6)
Perennial. Succulent. Ht up to 0.02 m. Alt 20–600 m. NC, WC
uviforme (Haw.) N.E.Br. subsp. **rauhii** (Tischer) S.A.Hammer
C. rauhii Tischer (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 600–820 m. NC
uviforme (Haw.) N.E.Br. subsp. **subincanum** (Tischer) S.A.Hammer
C. subincanum Tischer (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 200–250 m. WC
uviforme (Haw.) N.E.Br. subsp. **uviforme**
C. clarum N.E.Br. (3)
C. colorans Lavis (3)
C. framesii Lavis (3)
C. francisci L.Bolus (3)
C. hillii L.Bolus (3)
C. julii Schwantes ex H.Jacobsen (3)
C. litorale L.Bolus (3)
C. meleagris L.Bolus (3)
C. pardivisum Tischer (3)
C. praeparvum N.E.Br. var. *praeparvum* (3)
C. praeparvum N.E.Br. var. *roseum* Lavis (3)
C. prolongatum L.Bolus (3)
C. rooipanense L.Bolus (3)
C. stipitatum L.Bolus (3)
C. uviforme (Haw.) N.E.Br. forma *framesii* (Lavis) Tischer (3)
C. uviforme (Haw.) N.E.Br. forma *meleagris* (L.Bolus) Tischer (3)
C. uviforme (Haw.) N.E.Br. var. *clarum* (N.E.Br.) Rawe (3)
C. uviforme (Haw.) N.E.Br. var. *litorale* (L.Bolus) Rawe (3)
C. uviforme (Haw.) N.E.Br. var. *occultum* (L.Bolus) Rawe (3)
C. uviforme (Haw.) N.E.Br. var. *subincanum* (Tischer) Rawe (3)
C. vanrhynsdorpense Schwantes (3)
Mesembryanthemum uviforme (Haw.) N.E.Br. (3)
Perennial. Succulent. Ht up to 0.04 m. Alt 200–1200 m. NC
uviforme (Haw.) N.E.Br. var. *clarum* (N.E.Br.) Rawe = **C. uviforme** subsp. **uviforme**
uviforme (Haw.) N.E.Br. var. *litorale* (L.Bolus) Rawe = **C. uviforme** subsp. **uviforme**
uviforme (Haw.) N.E.Br. var. *occultum* (L.Bolus) Rawe = **C. uviforme** subsp. **uviforme**
uviforme (Haw.) N.E.Br. var. *subincanum* (Tischer) Rawe = **C. uviforme** subsp. **uviforme**
vagum N.E.Br. = **C. minimum**
vanbredae L.Bolus = **C. globosum**
vanheerdei Tischer
Perennial. Succulent. Ht up to 0.04 m. Alt 850–1200 m. NC
vanrhynsdorpense Schwantes = **C. uviforme** subsp. **uviforme**
vanzylii Lavis = **C. calculus** subsp. **vanzylii**
variabile L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
varians L.Bolus = **C. uviforme** subsp. **decoratum**
velutinum Schwantes subsp. **polyandrum** (Lavis) S.A.Hammer
C. polyandrum Lavis (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 300–540 m. NC
velutinum Schwantes subsp. **velutinum**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

C. craterulum Tischer (3)
C. tischeri Schick (3)
C. velutinum Schwantes var. *craterulum* (Tischer) Rawe (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 300–750 m. NC
velutinum Schwantes var. *craterulum* (Tischer) Rawe = **C. velutinum** subsp. **velutinum**
verrucosum (Lavis) G.D.Rowley
Ophthalmophyllum verrucosum Lavis (3)
Perennial. Succulent. Ht up to 0.01 m. Alt 750–880 m. NC
vescum N.E.Br. = **C. saxetanum**
violaciflorum Schick & Tischer
C. anjametae de Boer (3)
C. geometricum Lavis (3)
Perennial. Succulent. Ht up to 0.04 m. Alt 900–1320 m. NC
virens L.Bolus = **C. ectypum** subsp. **ectypum**
viride Tischer = **C. joubertii**
viridicatum (N.E.Br.) N.E.Br. var. *pisinnum* (N.E.Br.) Rawe = **C. truncatum** subsp. **viridicatum**
viridicatum (N.E.Br.) N.E.Br. var. *punctatum* N.E.Br. = **C. truncatum** subsp. **viridicatum**
viridicatum (N.E.Br.) N.E.Br. var. *viridicatum* = **C. truncatum** subsp. **viridicatum**
vitreopapillum Rawe = **C. obscurum** subsp. **vitreopapillum**
vlakmynense L.Bolus = **C. bilobum** subsp. **bilobum** var. **bilobum**
wagneriorum Schwantes = **C. truncatum** subsp. **truncatum** var. **truncatum**
wettsteinii (A.Berger) N.E.Br.
C. brevipes L.Bolus (3)
C. circumpunctatum Schick & Tischer (3)
Perennial. Succulent. Ht up to 0.05 m. Alt 910–1160 m. NC
wettsteinii (A.Berger) N.E.Br. subsp. *fragile* (Tischer) S.A.Hammer = C. **jucundum** subsp. **fragile**
wettsteinii (A.Berger) N.E.Br. subsp. *francoiseae* S.A.Hammer = **C. francoiseae**
wettsteinii (A.Berger) N.E.Br. subsp. *ruschii* (Schwantes) S.A.Hammer = C. **jucundum** subsp. **ruschii**
wettsteinii (A.Berger) N.E.Br. var. *oculatum* L.Bolus, semi-naked name = **C. jucundum** subsp. **ruschii**
wettsteinii (A.Berger) N.E.Br. var. *speciosum* (Tischer) Tischer = **C. jucundum** subsp. **ruschii**
wiesemannianum Schwantes = **C. fulleri**
wiggettiae N.E.Br. = **C. truncatum** subsp. **truncatum** var. **wiggettiae**
wittebergense de Boer = **C. minimum**

CORPUSCULARIA Schwantes 2405130
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 175–178.
angustifolia (L.Bolus) H.E.K.Hartmann
Delosperma angustifolium L.Bolus (1)
Perennial. Succulent. Ht 0.04–0.05 m. Alt 600–840 m. EC
angustipetala (Lavis) H.E.K.Hartmann
Delosperma angustipetalum Lavis (1)
Perennial. Succulent. Ht up to 0.12 m. Alt? EC
appressa (L.Bolus) H.E.K.Hartmann
Delosperma appressum L.Bolus (1)
Perennial. Succulent. Ht up to 0.09 m. Alt? EC
britteniae (L.Bolus) H.E.K.Hartmann
Delosperma britteniae L.Bolus (1)
Perennial. Succulent. Ht up to 0.05 m. Alt 100–340 m. EC
cymbiformis (Haw.) Schwantes
Mesembryanthemum cymbiforme Haw. (1)
Perennial. Succulent. Ht up to 0.3 m. Alt? 'SA'
dolomitica (Dinter) Schwantes = **Antimima dolomitica**
gracilis (L.Bolus) H.E.K.Hartmann
Delosperma gracillimum L.Bolus (1)
Perennial. Succulent. Ht 0.1–0.2 m. Alt 280–650 m. EC
lehmannii (Eckl. & Zeyh.) Schwantes
Delosperma lehmannii (Eckl. & Zeyh.) Schwantes (1)
Schonlandia lehmannii (Eckl. & Zeyh.) L.Bolus (1)
Perennial. Succulent. Ht up to 0.03 m. Alt 140–400 m. EC
quarzitica (Dinter) Schwantes = **Antimima quarzitica**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

taylori (N.E.Br.) Schwantes
Delosperma minimum Lavis (1)
Delosperma taylori (N.E.Br.) Schwantes (1)
Delosperma taylori (N.E.Br.) Schwantes var. *albanense* L.Bolus (1)
Mesembryanthemum taylori N.E.Br. (1)
Perennial. Succulent. Ht up to 0.12 m. Alt 100–700 m. EC

CROCANTHUS L.Bolus 2405142
thunbergii (Haw.) L.Bolus = **Malephora thunbergii**

CRYOPHYTUM N.E.Br. 2405164
suaveolens (L.Bolus) J.W.Ingram = **Phyllobolus lignescens**
suffruticosum L.Bolus = **Phyllobolus suffruticosus**

CYLINDROPHYLLUM Schwantes 2405031
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 179–181.
calamiforme (L.) Schwantes
C. dyeri L.Bolus (1)
Mesembryanthemum calamiforme L. (1)
Perennial. Succulent. Ht 0.02–0.03 m. Alt 750–1050 m. EC
comptonii L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 450–1290 m. WC
dichroum (Rolfe) Schwantes = **Ruschia dichroa**
dyeri L.Bolus = **C. calamiforme**
hallii L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 720–754 m. NC
obsubulatum (Haw.) Schwantes
Mesembryanthemum obsubulatum Haw. (1)
Perennial. Succulent. Ht? Alt? 'SA'
tugwelliae L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt 800–1100 m. WC

DACTYLOPSIS N.E.Br. 2405032
(1) Phillips. 1923. *The Flowering Plants of South Africa* 3: t. 102.
(2) Chesselet *et al.* 2000. In Leistner, *Strelitzia* 10: 385.
(3) Gerbaulet. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 208, 209.
digitata (Aiton) N.E.Br.
Mesembryanthemum digitatum Aiton (2)
Mesembryanthemum digitatum Thunb. (2)
Mesembryanthemum digitiforme Thunb. (2)
Phyllobolus digitatus (Aiton) Gerbaulet subsp. *digitatus* (2)
Perennial. Succulent. Ht 0.1–0.2 m. Alt 180–290 m. WC
littlewoodii L.Bolus
Phyllobolus digitatus (Aiton) Gerbaulet subsp. *littlewoodii* (L.Bolus) Gerbaulet (2)
Perennial. Succulent. Ht up to 0.1 m. Alt 180–290 m. WC

DEILANTHE N.E.Br. 2405165
(1) Hammer. 1995. *Cactus and Succulent Journal (U.S.)* 67: 173.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 182, 183.
hilmarii (L.Bolus) H.E.K.Hartmann
Aloinopsis hilmarii (L.Bolus) L.Bolus (2)
Perennial. Succulent. Ht 0.025–0.03 m. Alt 750–1330 m. WC
peersii (L.Bolus) N.E.Br.
Aloinopsis peersii (L.Bolus) L.Bolus (2)
Mesembryanthemum canum A.Berger (2)
Nananthus peersii L.Bolus (2)
Perennial. Succulent. Ht 0.02–0.035 m. Alt 850–1400 m. FS, WC, EC
thudichumii (L.Bolus) S.A.Hammer
Aloinopsis thudichumii L.Bolus (1)
Perennial. Succulent. Ht up to 0.03 m. Alt 800–1300 m. NC, WC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

DELOSPERMA N.E.Br. emend. Lavis 2405033

(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: tt. 259, 261, 278.
(2) Bolus. 1931. *The Flowering Plants of South Africa* 11: t. 419.
(3) Bolus. 1947. *The Flowering Plants of Africa* 26: t. 1023, 1024.
(4) Lavis. 1966. *Journal of South African Botany* 32: 209, 210.
(5) Hammer & Barnhill. 1997. *Bradleya* 15: 46.
(6) Van Jaarsveld & Van Wyk. 1999. *Aloe* 36: 71–74.
(7) Smith *et al.* 1999. *Flowering Plants of Africa* 56: 46–52, t. 2149.
(8) Hartmann. 2001. *Aloe* 38: 4–12.
(9) Hartmann 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 184–210.

aberdeenense (L.Bolus) L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.2 m. Alt ± 1067 m. EC

acocksii L.Bolus
D. acocksii L.Bolus var. *luxurians* L.Bolus (9)
Perennial. Dwarf shrub, succulent. Ht up to 0.16 m. Alt 1200–1600 m. NC

acocksii L.Bolus var. *luxurians* L.Bolus = **D. acocksii**

acuminatum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.2 m. Alt 250–830 m. EC

adelaidense Lavis
Perennial. Dwarf shrub, succulent. Ht? Alt 420–950 m. EC

aereum (L.Bolus) L.Bolus
D. aereum (L.Bolus) L.Bolus var. *album* (L.Bolus) L.Bolus (9)
Perennial. Succulent. Ht? Alt? 'CP'

aereum (L.Bolus) L.Bolus var. *album* (L.Bolus) L.Bolus = **D. aereum**

affine Lavis
Perennial. Succulent. Ht 0.12–0.3 m. Alt? 'SA'

algoense L.Bolus
Perennial. Dwarf shrub, succulent. Ht? Alt? EC

aliwalense L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.2 m. Alt 1400–1700 m. EC

alticola L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.08 m. Alt 3000–3300 m. KZN

angustifolium L.Bolus = **Corpuscularia angustifolia**

angustipetalum Lavis = **Corpuscularia angustipetala**

annulare L.Bolus
Perennial. Dwarf shrub, succulent. Ht 0.04–0.12 m. Alt 2000–2330 m. M

appressum L.Bolus = **Corpuscularia appressum**

ashtonii L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.08 m. Alt 1600–3400 m. FS, KZN, L

asperulum (Salm-Dyck) L.Bolus
Perennial. Dwarf shrub, succulent. Ht 0.3–0.8 m. Alt 91–300 m. WC

ausense L.Bolus = **D. klinghardtianum**

basuticum L.Bolus
Perennial. Succulent. Ht up to 0.055 m. Alt 3000–3400 m. L

brevipetalum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.08 m, when in flower. Alt 250–900 m. EC

brevisepalum L.Bolus
D. brevisepalum L.Bolus var. *majus* L.Bolus (9)
Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt ± 1220 m. EC

brevisepalum L.Bolus var. *majus* L.Bolus = **D. brevisepalum**

britteniae L.Bolus = **Corpuscularia britteniae**

brunnthaleri (A.Berger) Schwantes
Perennial. Dwarf shrub, succulent. Ht 0.3–0.4 m. Alt 120–580 m. EC

burtoniae L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.15 m. Alt 300–550 m. WC

caespitosum L.Bolus
D. caespitosum L.Bolus forma *roseum* (L.Bolus) L.Bolus (9)
Perennial. Dwarf shrub, succulent. Ht up to 0.3 m. Alt 20–610 m. KZN, EC

caespitosum L.Bolus forma *roseum* (L.Bolus) L.Bolus = **D. caespitosum**

calitzdorpense L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt 270–1200 m. WC

calycinum L.Bolus

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Dwarf shrub, succulent. Ht 0.1–0.12 m. Alt ± 305 m. EC

carolinense N.E.Br.

D. carolinense N.E.Br. var. *compacta* L.Bolus (9)

Perennial. Dwarf shrub, succulent. Ht 0.06–0.14 m. Alt ± 1700 m. M, FS

carolinense N.E.Br. var. *compacta* L.Bolus = **D. carolinense**

carterae L.Bolus

Perennial. Dwarf shrub, succulent. Ht up to 0.2 m. Alt 365–915 m. EC

clavipes Lavis

Perennial. Succulent. Ht up to 0.05 m. Alt 1600–3400 m. FS, L

cloeteae Lavis

Perennial. Dwarf shrub, succulent. Ht up to 0.15 m. Alt 520–980 m. EC

concavum L.Bolus

Perennial. Dwarf shrub, succulent. Ht 0.1–0.12 m. Alt 610–1520 m. KZN, L, EC

congestum L.Bolus

Perennial. Dwarf shrub, succulent. Ht up to 0.13 m. Alt up to 3400 m. FS, KZN, L

cooperi (Hook.f.) L.Bolus

D. cooperi (Hook.f.) L.Bolus forma *bicolor* (L.Bolus) G.D.Rowley (9)

Perennial. Dwarf shrub, succulent. Ht 0.2–0.4 m. Alt 1350–2745 m. FS, L

cooperi (Hook.f.) L.Bolus forma *bicolor* (L.Bolus) G.D.Rowley = **D. cooperi**

crassuloides (Haw.) L.Bolus

Perennial. Succulent. Ht up to 0.055 m. Alt 1450–3200 m. FS, KZN, L, EC

crassum L.Bolus

Drosanthemum robustum L.Bolus (9)

Perennial. Dwarf shrub, succulent. Ht up to 0.3 m. Alt 200–350 m. WC

cronemeyerianum (A.Berger) H.Jacobsen

Perennial. Dwarf shrub, succulent. Ht up to 0.2 m. Alt? 'SA'

davyi N.E.Br.

Perennial. Succulent. Ht up to 0.15 m. Alt ± 1730 m. G

deilanthoides S.A.Hammer

Perennial. Succulent. Ht up to 0.08 m, when in flower. Alt 2000–2250 m. M

deleeuwiae Lavis

Perennial. Succulent. Ht up to 0.03 m. Alt up to 2970 m. FS, KZN, L

denticulatum L.Bolus

Perennial. Dwarf shrub, succulent. Ht up to 0.15 m. Alt 990–1800 m. M

dolomitica Van Jaarsv.

Perennial. Dwarf shrub, succulent. Ht up to 0.3 m. Alt 1000–1500 m. M

dunense L.Bolus

Perennial. Dwarf shrub, succulent. Ht up to 0.3 m. Alt 50–350 m. EC

dyeri L.Bolus

D. dyeri L.Bolus var. *laxum* L.Bolus (9)

Perennial. Dwarf shrub, succulent. Ht? Alt 1300–1600 m. EC

dyeri L.Bolus var. *laxum* L.Bolus = **D. dyeri**

echinatum (Lam.) Schwantes

D. pruinosum (Thunb.) J.W.Ingram (9)

Trichodiadema echinatum L.Bolus (9)

Perennial. Dwarf shrub, succulent. Ht 0.1–0.2 m. Alt 150–860 m. EC

ecklonis (Salm-Dyck) Schwantes

D. ecklonis (Salm-Dyck) Schwantes var. *latifolia* L.Bolus (9)

Perennial. Succulent. Ht up to 0.25 m. Alt 50–850 m. EC?

ecklonis (Salm-Dyck) Schwantes var. *latifolia* L.Bolus = **D. ecklonis**

edwardsiae L.Bolus = **D. rogersii**

erectum L.Bolus

Perennial. Dwarf shrub, succulent. Ht up to 0.14 m. Alt? 'SA'

esterhuyseniae L.Bolus

Perennial. Succulent. Ht up to 0.03 m. Alt ± 700 m. WC

exspersum (N.E.Br.) L.Bolus var. *decumbens* L.Bolus = **Drosanthemum exspersum**

exspersum (N.E.Br.) L.Bolus var. *exspersum* = **Drosanthemum exspersum**

ficksburgense Lavis

Perennial. Dwarf shrub, succulent. Ht up to 0.15 m. Alt ± 700 m. FS

floribundum L.Bolus

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Dwarf shrub, succulent. Ht up to 0.25 m. Alt 800–1920 m. FS, KZN

framesii L.Bolus

Perennial. Succulent. Ht up to 0.05 m. Alt 1200–1740 m. G

fredericii Lavis

Perennial. Dwarf shrub, succulent. Ht up to 0.27 m. Alt 120–650 m. EC

frutescens L.Bolus

Perennial. Dwarf shrub, succulent. Ht up to 1.5 m. Alt 450–1100 m. EC

galpinii L.Bolus

D. galpinii L.Bolus var. *minus* L.Bolus (9)

Perennial. Succulent. Ht 0.05–0.12 m. Alt ± 2440 m. FS, KZN, L

galpinii L.Bolus var. *minus* L.Bolus = **D. galpinii**

gautengense H.E.K.Hartmann

Perennial. Dwarf shrub, succulent. Ht up to 0.15 m. Alt 1250–1600 m. G

gerstneri L.Bolus

Perennial. Dwarf shrub, succulent. Ht up to 0.15 m. Alt ± 1600 m. L

giffenii Lavis

Perennial. Dwarf shrub, succulent. Ht up to 0.45 m. Alt 550–1250 m. EC

gracile L.Bolus

Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt ± 1525 m. KZN

gracillimum L.Bolus = **Corpuscularia gracilis**

gramineum L.Bolus

Perennial. Succulent. Ht up to 0.2 m. Alt ± 1465 m. EC

grandiflorum L.Bolus = **Drosanthemum longipes**

grantiae L.Bolus

Perennial. Succulent. Ht up to 0.1 m. Alt 320–890 m. EC

gratiae L.Bolus

D. longii L.Bolus (9)

Perennial. Dwarf shrub, succulent. Ht up to 0.6 m. Alt ± 305 m. EC

guthriei Lavis

Perennial. Succulent. Ht up to 0.25 m. Alt 20–200 m. WC

hallii L.Bolus = **Hartmanthus halii**

herbeum (N.E.Br.) N.E.Br.

Perennial. Succulent. Ht 0.09–0.15 m. Alt 1000–2200 m. B, NW, G, M, FS

hirtum (N.E.Br.) Schwantes

D. hirtum (N.E.Br.) Schwantes var. *bicolor* L.Bolus (9)

Perennial. Succulent. Ht 0.08–0.12 m. Alt 900–3400 m. M, FS, KZN, L

hirtum (N.E.Br.) Schwantes var. *bicolor* L.Bolus = **D. hirtum**

hollandii L.Bolus

Perennial. Dwarf shrub, succulent. Ht up to 0.3 m. Alt 170–550 m. EC

imbricatum L.Bolus

Perennial. Dwarf shrub, succulent. Ht up to 0.15 m. Alt 610–1980 m. EC

inaequale L.Bolus

Perennial. Dwarf shrub, succulent. Ht up to 0.2 m. Alt 150–330 m. WC

incomptum (Haw.) L.Bolus

D. incomptum (Haw.) L.Bolus var. *gracile* L.Bolus (9)

Perennial. Dwarf shrub, succulent. Ht up to 0.6 m. Alt 1000–1100 m. NC

incomptum (Haw.) L.Bolus var. *ecklonis* (Salm-Dyck) H.Jacobsen = **D. invalidum**

incomptum (Haw.) L.Bolus var. *gracile* L.Bolus = **D. incomptum**

inconspicuum L.Bolus

Perennial. Dwarf shrub, succulent. Ht ± 0.25 m. Alt 20–200 m. WC

intonsum L.Bolus

Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt 1200–1540 m. NC

invalidum (N.E.Br.) H.E.K.Hartmann

D. incomptum (Haw.) L.Bolus var. *ecklonis* (Salm-Dyck) H.Jacobsen (9)

Perennial. Dwarf shrub, succulent. Ht? Alt? 'SA'

jansei N.E.Br.

Perennial. Succulent. Ht up to 0.15 m. Alt 1000–1800 m. M, KZN

karrooicum L.Bolus

Perennial. Dwarf shrub, succulent. Ht up to 0.15 m. Alt 1000–1800 m. EC

katbergense L.Bolus

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

D. katbergense L.Bolus var. *amatolense* L.Bolus (9)
D. katbergense L.Bolus var. *angustifolium* L.Bolus (9)
Perennial. Succulent. Ht up to 0.2 m. Alt 1200–1700 m. EC
katbergense L.Bolus var. *amatolense* L.Bolus = **D. katbergense**
katbergense L.Bolus var. *angustifolium* L.Bolus = **D. katbergense**
klinghardtianum (Dinter) Schwantes
D. ausense L.Bolus (9)
Perennial. Dwarf shrub, succulent. Ht 0.1–0.3 m. Alt 120–800 m. N, NC
knox-daviesii Lavis
Perennial. Dwarf shrub, succulent. Ht up to 0.09 m. Alt ± 1500 m. G
kofleri Lavis
Perennial. Dwarf shrub, succulent. Ht up to 0.13 m. Alt up to 3400 m. FS, L
lavisiae L.Bolus
D. lavisiae L.Bolus var. *parisepalum* L.Bolus (9)
Perennial. Dwarf shrub, succulent. Ht up to 0.09 m. Alt 730–3415 m. FS, KZN, L
lavisiae L.Bolus var. *parisepalum* L.Bolus = **D. lavisiae**
laxipetalum L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 550–1100 m. EC
lebomboense (L.Bolus) Lavis
Perennial. Succulent. Ht up to 0.15 m. Alt 340–650 m. M, S, KZN
leendertziae N.E.Br.
Perennial. Succulent. Ht up to 0.15 m. Alt ± 1600 m. G
lehmannii (Eckl. & Zeyh.) Schwantes = **Corpuscularia lehmannii**
leightoniae Lavis
Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt 450–1200 m. EC
liebenbergii L.Bolus
Perennial. Dwarf shrub, succulent. Ht 0.1–0.15 m. Alt 1500–1900 m. EC
lineare L.Bolus
D. lineare L.Bolus var. *tenuifolium* L.Bolus (9)
Perennial. Dwarf shrub, succulent. Ht up to 0.18 m. Alt up to 3400 m. KZN, L
lineare L.Bolus var. *tenuifolium* L.Bolus = **D. lineare**
litorale (Kensit) L.Bolus
Perennial. Dwarf shrub, succulent. Ht 0.03–0.15 m. Alt 5–305 m. WC
longii L.Bolus = **D. gratiae**
longipes L.Bolus = **Drosanthemum longipes**
lootsbergense Lavis
Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt 1200–1900 m. EC
luckhoffii L.Bolus
Perennial. Dwarf shrub, succulent. Ht 0.03–0.05 m. Alt? 'SA'
luteum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.2 m. Alt 450–1000 m. EC
lydenburgense L.Bolus
D. lydenburgense L.Bolus var. *acutipetalum* L.Bolus (9)
Perennial. Succulent. Ht up to 0.15 m. Alt 750–2000 m. M
lydenburgense L.Bolus var. *acutipetalum* L.Bolus = **D. lydenburgense**
macellum (N.E.Br.) N.E.Br.
Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt up to 2000 m. B, NW, G, FS
macrostigma L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.05 m. Alt 175–350 m. WC
mahonii (N.E.Br.) N.E.Br.
Perennial. Dwarf shrub, succulent. Ht 0.15–0.2 m. Alt 1100–1800 m. B, NP, NW, G
mariae L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.3 m. Alt 50–300 m. WC
maxwellii L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt 730–1200 m. EC
minimum Lavis = **Corpuscularia taylori**
monanthemum Lavis
Perennial. Dwarf shrub, succulent. Ht up to 0.2 m. Alt? 'SA'
muirii L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt 50–350 m. EC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

multiflorum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.25 m. Alt 220–590 m. EC
neethlingiae (L.Bolus) Schwantes
Trichodiadema tenue L.Bolus (9)
Perennial. Dwarf shrub, succulent. Ht up to 0.14 m. Alt 50–650 m. WC
nelii L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.08 m. Alt up to 3400 m. L
nubigenum (Schltr.) L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.15 m. Alt up to 3400 m. FS, L
obtusum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.05 m. Alt 1600–1700 m. FS
ornatulum N.E.Br.
Perennial. Dwarf shrub, succulent. Ht up to 0.38 m. Alt 400–1405 m. FS, EC
pachyrhizum L.Bolus
D. pachyrhizum L.Bolus var. *pubescens* L.Bolus (9)
Perennial. Dwarf shrub, succulent. Ht 0.14–0.2 m. Alt 120–1220 m. FS, KZN
pachyrhizum L.Bolus var. *pubescens* L.Bolus = **D. pachyrhizum**
pageanum (L.Bolus) L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.26 m. Alt ± 400 m. WC
pallidum L.Bolus
Perennial. Succulent. Ht up to 0.1 m. Alt? 'SA'
papillatum (L.Bolus) L.Bolus = **Drosanthemum papillatum**
parviflorum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.06 m. Alt up to 305 m. EC
patersoniae (L.Bolus) L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.2 m. Alt 5–100 m. EC
peersii Lavis
Perennial. Dwarf shrub, succulent. Ht up to 0.24 m. Alt 750–1300 m. EC
peglerae L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt 550–1500 m. EC
pergamentaceum L.Bolus var. *pergamentaceum* = **Hartmanthus pergamentaceus**
pergamentaceum L.Bolus var. *roseum* Lavis = **Hartmanthus pergamentaceus**
pilosulum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.05 m. Alt up to 3400 m. L
platysepalum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.3 m. Alt 550–1000 m. EC
pondoense L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.17 m. Alt 20–100 m. KZN
pontii L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.2 m. Alt ± 1400 m. FS
pottsii (L.Bolus) L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt 1400–1600 m. FS
prasinum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.12 m. Alt ± 185 m. EC
pruinosum (Thunb.) J.W.Ingram = **D. echinatum**
pubipetalum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.3 m. Alt 1000–1600 m. WC
purpureum H.E.K.Hartmann
Perennial. Dwarf shrub, succulent. Ht up to 0.09 m. Alt 1200–1500 m. G
repens L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.03 m. Alt 1500–1900 m. FS, EC
reynoldsii Lavis
Perennial. Dwarf shrub, succulent. Ht 0.1–0.17 m. Alt up to 3300 m. FS, KZN, L
rileyi L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.2 m. Alt 1200–1800 m. NP, M
robustum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.25 m. Alt up to 610 m. EC
rogersii (Schönland & A.Berger) L.Bolus
D. edwardsiae L.Bolus (9)
D. rogersii (Schönland & A.Berger) L.Bolus var. *glabrescens* L.Bolus (9)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Dwarf shrub, succulent. Ht up to 0.15 m. Alt 20–140 m. EC
rogersii (Schönland & A.Berger) L.Bolus var. *glabrescens* L.Bolus = **D. rogersii**
roseopurpureum Lavis
Perennial. Dwarf shrub, succulent. Ht up to 0.2 m. Alt 1220–3400 m. FS, L
saturatum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.16 m. Alt 1065–1300 m. KZN
saxicola Lavis
Perennial. Dwarf shrub, succulent. Ht up to 0.04 m. Alt 5–80 m. EC
scabripes L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.01 m. Alt 1675–3300 m. KZN, L, EC
smytheae L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.03 m. Alt 1100–1300 m. KZN
sphalmanthoides S.A.Hammer
Perennial. Dwarf shrub, succulent. Ht up to 0.01 m. Alt ± 1500 m. NC
stenandrum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.15 m. Alt 890–1250 m. EC
subclavatum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt 600–850 m. EC
subincanum (Haw.) Schwantes
Perennial. Dwarf shrub, succulent. Ht up to 0.6 m. Alt 85–1465 m. EC
subpetiolatum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.03 m. Alt 20–80 m. KZN
sulcatum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt 50–200 m. EC
sutherlandii (Hook.f.) N.E.Br.
Perennial. Dwarf shrub, succulent. Ht 0.05–0.2 m, when in flower. Alt up to 2210 m. G, M, KZN
suttoniae Lavis
Perennial. Succulent. Ht up to 0.02–0.04 m. Alt ± 1300 m. KZN
taylori (N.E.Br.) Schwantes = **Corpuscularia taylori**
taylori (N.E.Br.) Schwantes var. *albanense* L.Bolus = **Corpuscularia taylori**
testaceum (Haw.) Schwantes
Perennial. Shrub, dwarf shrub, succulent. Ht 0.6–0.9 m. Alt? 'CP'
tradescantioides (A.Berger) L.Bolus
Perennial. Succulent. Ht 0.01–0.25 m. Alt 400–1440 m. M, S, KZN, EC
truteri Lavis
Perennial. Dwarf shrub, succulent. Ht up to 0.15 m. Alt 1400–1800 m. EC
uitenhagense L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.15 m. Alt 20–450 m. EC
uncinatum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt 20–450 m. EC
uniflorum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.2 m. Alt 500–1500 m. EC
vandermerwei L.Bolus
Perennial. Succulent. Ht 0.02–0.05 m. Alt 1300–1700 m. NP
velutinum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.05 m. Alt 1470–1530 m. KZN
verecundum L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.25 m. Alt 20–765 m. EC
vernicolor L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt 100–300 m. EC
versicolor L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.08 m. Alt 850–1400 m. EC
vinaceum (L.Bolus) L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.03 m. Alt? 'CP'
virens L.Bolus
Perennial. Shrub, succulent. Ht 0.2–0.45 m. Alt 600–1400 m. WC
vogtsii L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.15 m. Alt 1200–1700 m. G
waterbergense L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt 1500–1800 m. NP

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

wethamae L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt 1700–3400 m. FS, L
wilmaniae Lavis
Perennial. Dwarf shrub, succulent. Ht up to 0.15 m. Alt 1000–1140 m. NC
wiumii Lavis as '*wiunii*'
Perennial. Dwarf shrub, succulent. Ht up to 0.08 m. Alt ± 3100 m. FS
zeederbergii L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.17 m. Alt ± 1500 m. M
zoeae L.Bolus
Perennial. Herb, succulent. Ht 0.15–0.25 m. Alt 1000–1400 m. NC
zoutpansbergense L.Bolus
Perennial. Dwarf shrub, succulent. Ht up to 0.1 m. Alt 1500–1730 m. NP

DICROCAULON N.E.Br. 2405034
(1) Ihlenfeldt *et al.* 1978. *Mitteilungen aus dem Institut für Allgemeine Botanik, Hamburg* 16: 171–181.
(2) Ihlenfeldt. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 211–214.
brevifolium N.E.Br.
Perennial. Succulent. Ht up to 0.15 m. Alt 175–350 m. WC
grandiflorum Ihlenf.
Monilaria brevifolia L.Bolus (1)
Perennial. Succulent. Ht up to 0.5 m. Alt 170–300 m. WC
humile N.E.Br.
Perennial. Succulent. Ht up to 0.05 m. Alt 250–350 m. WC
microstigma (L.Bolus) Ihlenf.
Meyerophytum microstigma (L.Bolus) L.Bolus (1)
Meyerophytum primosii (L.Bolus) L.Bolus (1)
Monilaria microstigma L.Bolus (1)
Perennial. Succulent. Ht up to 0.1 m. Alt 170–350 m. WC
nodosum (A.Berger) N.E.Br.
D. pearsonii N.E.Br. (2)
Perennial. Succulent. Ht up to 0.4 m. Alt 250–350 m. WC
pearsonii N.E.Br. = **D. nodosum**
ramulosum (L.Bolus) Ihlenf.
Perennial. Succulent. Ht up to 0.2 m. Alt 20–540 m. NC
spissum N.E.Br.
Perennial. Succulent. Ht up to 0.3 m. Alt up to 400 m. NC
trichotomum (Thunb.) N.E.Br. = **Phyllobolus trichotomus**

DIDYMAOTUS N.E.Br. 2405035
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 215.
lapidiformis (Marloth) N.E.Br.
Perennial. Succulent. Ht up to 0.06 m. Alt 630–910 m. WC

DINTERANTHUS Schwantes 2405036
(1) Sauer. 1975. *Aloe* 13: 9–24.
(2) Sauer. 1978. *The Flowering Plants of Africa* 45: tt. 1778A–1779B, 1780A, 1780B.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 215–217.
inexpectatus Dinter ex H.Jacobsen
D. wilmotianus L.Bolus subsp. *impunctatus* N.Sauer (3)
Perennial. Succulent. Ht up to 0.03 m. Alt 910–1030 m. N
microspermus (Dinter & Derenb.) Schwantes subsp. **impunctatus** N.Sauer
Perennial. Succulent. Ht? Alt? N
microspermus (Dinter & Derenb.) Schwantes subsp. **microspermus**
D. microspermus (Dinter & Derenb.) Schwantes var. *acutipetalus* L.Bolus (3)
Perennial. Succulent. Ht? Alt? N
microspermus (Dinter & Derenb.) Schwantes subsp. *puberulus* (N.E.Br.) N.Sauer = **D. puberulus**
microspermus (Dinter & Derenb.) Schwantes var. *acutipetalus* L.Bolus = **D. microspermus** subsp. **microspermus**
pole-evansii (N.E.Br.) Schwantes
Perennial. Succulent. Ht up to 0.03 m. Alt 910–1100 m. NC
puberulus N.E.Br.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

D. microspermus (Dinter & Derenb.) Schwantes subsp. *puberulus* (N.E.Br.) N.Sauer (3)
D. punctatus L.Bolus (3)
Perennial. Succulent. Ht up to 0.07 m. Alt 870–930 m. NC
punctatus L.Bolus = **D. puberulus**
vanzylii (L.Bolus) Schwantes
D. vanzylii (L.Bolus) Schwantes var. *lineatus* H.Jacobsen (2)
Lithops vanzylii L.Bolus (1)
Perennial. Succulent. Ht up to 0.02 m. Alt 870–930 m. NC
vanzylii (L.Bolus) Schwantes var. *lineatus* H.Jacobsen = **D. vanzylii**
wilmotianus L.Bolus
Perennial. Succulent. Ht up to 0.05 m. Alt 800–960 m. NC
wilmotianus L.Bolus subsp. *impunctatus* N.Sauer = **D. inexpectatus**

DIPLOSOMA Schwantes 2405037
(1) Ihlenfeldt 1988. *Beiträge zur Biologie der Pflanzen* 63: 375–401.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 218, 219.
leipoldtii L.Bolus = **D. retroversum**
luckhoffii (L.Bolus) Schwantes ex Ihlenf.
Maughaniella luckhoffii (L.Bolus) L.Bolus (2)
Perennial. Succulent. Ht up to 0.03 m. Alt 100–270 m. WC
retroversum (Kensit) Schwantes
D. leipoldtii L.Bolus (1)
Perennial. Succulent. Ht up to 0.02 m. Alt 300–450 m. WC

DISPHYMA N.E.Br. 2405038
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 276.
(2) Hartmann. 1999. *Bradleya* 17: 38–74.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 220, 221.
crassifolium (L.) L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 5–50 m. WC, EC
dunsdonii L.Bolus
Perennial. Succulent. Ht up to 0.05 m. Alt 30–160 m. WC

DOROTHEANTHUS Schwantes 2405039
(1) Bolus. 1962. *The Flowering Plants of Africa* 35: t. 1365.
(2) Ihlenfeldt & Struck. 1986. *Beiträge zur Biologie der Pflanzen* 61: 411–453.
(3) Brusse. 1996. *Bradleya* 14: 89.
(4) Struck. 1998. *Feddes Repertorium* 109: 5, 6.
(5) Struck & Hartmann. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 222–225.
acuminatus L.Bolus = **D. bellidiformis** subsp. **bellidiformis**
apetalus (L.f.) N.E.Br.
D. gramineus (Haw.) Schwantes (4)
Annual. Succulent. Ht up to 0.04 m. Alt 40–320 m. WC
bellidiformis (Burm.f.) N.E.Br. subsp. **bellidiformis**
D. acuminatus L.Bolus (2)
D. bidouwensis L.Bolus (2)
D. flos-solis (A.Berger) L.Bolus (2)
D. hallii L.Bolus (2)
D. littlewoodii L.Bolus (2)
D. lutens N.E.Br. (2)
D. muiri L.Bolus, as '*muirii*' (2)
D. oculatus N.E.Br. var. *oculatus* (2)
D. oculatus N.E.Br. var. *saldhanensis* L.Bolus (2)
D. stayneri L.Bolus (2)
Drosanthemum martinii L.Bolus (2)
Annual. Succulent. Ht up to 0.1 m. Alt up to 450 m. NC, WC
bellidiformis (Burm.f.) N.E.Br. subsp. **hestermalensis** Ihlenf. & Struck
Annual. Succulent. Ht up to 0.01 m. Alt up to 1200 m. NC
bidouwensis L.Bolus = **D. bellidiformis** subsp. **bellidiformis**
booysenii L.Bolus
Annual. Succulent. Ht up to 0.03 m. Alt 800–1800 m. NC
clavatus (Haw.) Struck

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

D. gramineus (Haw.) Schwantes forma *albus* (Haw.) G.D.Rowley (5)
D. gramineus (Haw.) Schwantes forma *roseus* (Haw.) G.D.Rowley (5)
D. tricolor (Willd.) L.Bolus (5)
Annual. Succulent. Ht up to 0.04 m. Alt 100–930 m. WC
flos-solis (A.Berger) L.Bolus = **D. bellidiformis** subsp. **bellidiformis**
gramineus (Haw.) Schwantes = **D. apetalus**
gramineus (Haw.) Schwantes forma *albus* (Haw.) G.D.Rowley = **D. clavatus**
gramineus (Haw.) Schwantes forma *roseus* (Haw.) G.D.Rowley = **D. clavatus**
hallii L.Bolus = **D. bellidiformis** subsp. **bellidiformis**
littlewoodii L.Bolus = **D. bellidiformis** subsp. **bellidiformis**
lutens N.E.Br. = **D. bellidiformis** subsp. **bellidiformis**
maughanii (N.E.Br.) Ihlenf. & Struck
Pherolobus maughanii N.E.Br. var. *maughanii* (2)
Pherolobus maughanii N.E.Br. var. *stayneri* L.Bolus (2)
Annual. Succulent. Ht up to 0.04 m. Alt 900–1600 m. NC
muiri L.Bolus, as '*muirii*' = **D. bellidiformis** subsp. **bellidiformis**
oculatus N.E.Br. var. *oculatus* = **D. bellidiformis** subsp. **bellidiformis**
oculatus N.E.Br. var. *saldhanensis* L.Bolus = **D. bellidiformis** subsp. **bellidiformis**
rourkei L.Bolus
Sineoperculum rourkei (L.Bolus) Van Jaarsv. (4)
Annual. Succulent. Ht up to 0.06 m, when in flower. Alt 100–320 m. NC, WC
stayneri L.Bolus = **D. bellidiformis** subsp. **bellidiformis**
tricolor (Willd.) L.Bolus = **D. clavatus**
ulularis Brusse
Annual. Succulent. Ht up to 0.12 m. Alt 50–100 m. WC

DRACOPHILUS (Schwantes) Dinter & Schwantes 2405040
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 273.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 225, 226.
dealbatus (N.E.Br.) Walgate
D. montis-draconis (Dinter) Dinter & Schwantes (2)
D. proximus (L.Bolus) Walgate (2)
Juttadinteria proxima L.Bolus (2)
Perennial. Succulent. Ht up to 0.8 m. Alt 50–350 m. N, NC
delaetianus (Dinter) Dinter & Schwantes
Perennial. Succulent. Ht up to 0.12 m. Alt 50–1000 m. N
montis-draconis (Dinter) Dinter & Schwantes = **D. dealbatus**
proximus (L.Bolus) Walgate = **D. dealbatus**

DROSANTHEMOPSIS Rauschert 2405167
salaria (L.Bolus) Rauschert = **Jacobsenia vaginata**
vaginata (L.Bolus) Rauschert = **Jacobsenia vaginata**

DROSANTHEMUM Schwantes 2405041
(1) Bolus. 1951. *The Flowering Plants of Africa* 28: tt. 1106, 1107.
(2) Bolus. 1953. *The Flowering Plants of Africa* 29: t. 1152.
(3) Niesler. 1997. *Bradleya* 15: 13–27.
(4) Hartmann. 1999. *Bradleya* 17: 38–74.
(5) Hartmann & Bruckmann. 2000. *Bradleya* 18: 75–112.
(6) Hartmann *et al.* 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 227–250.
(7) Hartmann. 2002. *Bradleya* 20: 121–147.
acuminatum L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 550–890 m. WC
acutifolium (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.07 m. Alt 180–750 m. WC
albens L.Bolus
D. littlewoodii L.Bolus (6)
Perennial. Succulent. Ht up to 0.09 m. Alt up to 1200 m. N, NC
albiflorum (L.Bolus) Schwantes
Perennial. Succulent. Ht up to 0.15 m. Alt 150–280 m. WC
ambiguum L.Bolus
Perennial. Succulent. Ht up to 0.5 m. Alt 50–360 m. WC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

anomalum L.Bolus
Perennial. Succulent. Ht up to 0.02 m. Alt 200–650 m. WC
archeri L.Bolus
Perennial. Succulent. Ht up to 0.1 m. Alt 800–1100 m. WC
attenuatum (Haw.) Schwantes
Mesembryanthemum attenuatum Haw. (6)
Perennial. Succulent. Ht ± 0.25 m. Alt 300–600 m. WC
aureopurpureum L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 170–450 m. WC
austricola L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 20–220 m. WC
autumnale L.Bolus
Perennial. Succulent. Ht up to 0.45 m. Alt 10–75 m. WC
barkerae L.Bolus
Perennial. Succulent. Ht 0.3–0.6 m. Alt 400–750 m. WC
barwickii L.Bolus = **D. subcompressum**
bellum L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 300–580 m. WC
bicolor L.Bolus
Perennial. Succulent. Ht up to 0.9 m. Alt 490–850 m. WC
breve L.Bolus
Perennial. Succulent. Ht up to 0.08 m. Alt up to 1200 m. NC
brevifolium (Aiton) Schwantes
Mesembryanthemum brevifolium Aiton (6)
Perennial. Succulent. Ht up to 0.25 m. Alt 180–300 m. WC
calycinum (Haw.) Schwantes
Mesembryanthemum calycinum Haw. (6)
Perennial. Succulent. Ht up to 0.25 m. Alt 300–550 m. WC
candens (Haw.) Schwantes
Mesembryanthemum candens Haw. (6)
Perennial. Succulent. Ht up to 0.2 m. Alt 30–330 m. EC
capillare (Thunb.) Schwantes
D. subglobosum (Haw.) Schwantes (6)
Perennial. Succulent. Ht? Alt 100–290 m. WC, EC
cereale L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 500–750 m. WC
chrysum L.Bolus
Perennial. Succulent. Ht? Alt 750–1100 m. WC
collinum (Sond.) Schwantes
Mesembryanthemum collinum Sond. (6)
Perennial. Succulent. Ht up to 0.3 m. Alt 300–550 m. WC
comptonii L.Bolus
Perennial. Succulent. Ht up to 0.17 m. Alt 900–1100 m. WC
concavum L.Bolus
Perennial. Succulent. Ht up to 0.05 m. Alt 1000–1600 m. NC
crassum L.Bolus
Perennial. Succulent. Ht up to 0.26 m. Alt 800–1100 m. WC
croceum L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 700–1600 m. WC
curtophyllum L.Bolus
Perennial. Succulent. Ht 0.1–0.3 m. Alt 30–450 m. NC
cymiferum L.Bolus
Perennial. Succulent. Ht up to 0.1 m. Alt 500–1000 m. NC, WC
deciduum H.E.K.Hartmann & Bruckmann
Perennial. Succulent. Ht up to 0.3 m. Alt 250–320 m. WC
dejagerae L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 800–1200 m. WC
delicatulum (L.Bolus) Schwantes
Perennial. Succulent. Ht up to 0.1 m. Alt 250–550 m. WC
dipageae H.E.K.Hartmann

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.6 m. Alt? EC

diversifolium L.Bolus

D. subalbum L.Bolus (7)

Perennial. Succulent. Ht up to 0.12 m. Alt up to 1200 m. WC

duplessiae L.Bolus

Perennial. Succulent. Ht up to 0.2 m. Alt 400–900 m. WC

eburneum L.Bolus

Perennial. Succulent. Ht up to 0.05 m. Alt 1000–1700 m. NC

edwardsiae L.Bolus

Perennial. Succulent. Ht up to 0.15 m. Alt 50–350 m. WC

erigeriflorum (Jacq.) Stearn

Perennial. Succulent. Ht up to 0.6 m. Alt? 'SA'

exspersum (N.E.Br.) Schwantes

Delosperma exspersum (N.E.Br.) L.Bolus var. *decumbens* L.Bolus (6)

Delosperma exspersum (N.E.Br.) L.Bolus var. *exspersum* (6)

Perennial. Succulent. Ht 0.16–0.33 m. Alt 950–1500 m. NC

filiforme L.Bolus

Perennial. Succulent. Ht up to 0.1 m. Alt up to 1200 m. NC

flammeum L.Bolus

Perennial. Succulent. Ht up to 0.25 m. Alt 350–730 m. WC

flavum (Haw.) Schwantes

Perennial. Succulent. Ht up to 0.15 m. Alt? 'CP'

floribundum (Haw.) Schwantes

D. torquatum (Haw.) Schwantes (6)

Mesembryanthemum floribundum Haw. (6)

Perennial. Succulent. Ht up to 0.3 m. Alt 20–100 m. WC

fourcadei (L.Bolus) Schwantes

Perennial. Succulent. Ht up to 0.22 m. Alt 220–860 m. EC

framesii L.Bolus

Perennial. Succulent. Ht 0.07–0.08 m. Alt 500–850 m. WC

fulleri L.Bolus

Perennial. Succulent. Ht up to 0.2 m. Alt 1000–1150 m. NC

giffenii (L.Bolus) Schwantes

D. giffenii (L.Bolus) Schwantes var. *intertextum* (L.Bolus) Schwantes (6)

Perennial. Succulent. Ht up to 0.1 m. Alt 500–850 m. WC

giffenii (L.Bolus) Schwantes var. *intertextum* (L.Bolus) Schwantes = **D. giffenii**

glabrescens L.Bolus

Perennial. Succulent. Ht up to 0.2 m. Alt 900–1500 m. NC

globosum L.Bolus

Perennial. Succulent. Ht up to 0.45 m. Alt 500–750 m. WC

godmaniae L.Bolus

Perennial. Succulent. Ht up to 0.15 m. Alt up to 1200 m. NC

gracillimum L.Bolus

Perennial. Succulent. Ht up to 0.2 m. Alt 890–1250 m. WC

hallii L.Bolus

Perennial. Succulent. Ht up to 0.25 m. Alt 300–580 m. WC

hirtellum (Haw.) Schwantes

Mesembryanthemum hirtellum Haw. (6)

Perennial. Succulent. Ht up to 0.3 m. Alt? 'SA'

hispidum (L.) Schwantes

D. hispidum (L.) Schwantes var. *platypetalum* (Haw.) Schwantes (6)

Mesembryanthemum hispidum L. (6)

Perennial. Succulent. Ht 0.3–0.6 m. Alt up to 1600 m. N, FS, NC, WC, EC

hispidum (L.) Schwantes var. *platypetalum* (Haw.) Schwantes = **D. hispidum**

hispifolium (Haw.) Schwantes

D. striatum (Haw.) Schwantes var. *hispifolium* (Haw.) G.D.Rowley (6)

Perennial. Succulent. Ht up to 0.3 m. Alt 200–350 m. WC

inornatum (L.Bolus) L.Bolus

Trichodiadema inornatum L.Bolus (8)

Perennial. Succulent. Ht up to 0.3 m. Alt 450–1000 m. N, NC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

insolitum L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt ± 650 m. WC
intermedium (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.05 m. Alt 20–100 m. WC
jamesii L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt 990–1500 m. EC
karrooense L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 800–1100 m. WC
latipetalum L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 250–1200 m. WC
lavisii L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 50–390 m. WC
laxum L.Bolus
Perennial. Succulent. Ht up to 0.1 m. Alt 215–300 m. WC
leipoldtii L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 300–980 m. WC
leptum L.Bolus
Perennial. Succulent. Ht 0.22–0.35 m. Alt 215–300 m. WC
lignosum L.Bolus
Perennial. Succulent. Ht up to 0.1 m. Alt 500–800 m. WC
lique (N.E.Br.) Schwantes
Perennial. Succulent. Ht up to 0.6 m. Alt 760–1900 m. EC
littlewoodii L.Bolus = **D. albens**
longipes (L.Bolus) H.E.K.Hartmann
Delosperma grandiflorum L.Bolus (6)
Delosperma longipes L.Bolus (6)
Perennial. Succulent. Ht 0.2–0.6 m. Alt 240–1100 m. WC
luederitzii (Engl.) Schwantes
D. paxianum (Schltr. & Diels) Schwantes (6)
Mesembryanthemum luederitzii Engl. (6)
Mesembryanthemum paxianum Schltr. & Diels (6)
Perennial. Succulent. Ht 0.1–0.15 m. Alt 5–50 m. N, NC, WC
macrocalyx L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 500–1100 m. WC
maculatum (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.6 m. Alt? 'CP'
marinum L.Bolus
Perennial. Succulent. Ht up to 0.09 m. Alt 5–100 m. WC
martinii L.Bolus = **Dorotheanthus bellidiformis** subsp. **bellidiformis**
mathewsii L.Bolus
Perennial. Succulent. Ht up to 0.08 m. Alt 170–220 m. WC
micans (L.) Schwantes
Mesembryanthemum micans L. (6)
Perennial. Succulent. Ht up to 0.3 m. Alt 150–300 m. WC
montaguense L.Bolus = **D. praecultum**
muiri L.Bolus, as '*muirii*'
Perennial. Succulent. Ht up to 0.4 m. Alt 150–280 m. WC
nitidum (Haw.) Schwantes = **Phyllobolus nitidus**
nordenstamii L.Bolus
Perennial. Succulent. Ht up to 0.1 m. Alt 20–450 m. N
oculatum L.Bolus
Perennial. Succulent. Ht up to 0.09 m. Alt 173–428 m. WC
opacum L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 250–300 m. WC
otzenianum (Dinter) Friedrich = **Lampranthus otzenianus**
pallens (Haw.) Schwantes
D. striatum (Haw.) Schwantes var. *pallens* (Haw.) G.D.Rowley (6)
Perennial. Succulent. Ht up to 0.3 m. Alt 300–550 m. WC
papillatum L.Bolus
Delosperma papillatum (L.Bolus) L.Bolus (6)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.2 m. Alt ± 300 m. WC
parvifolium (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.15 m. Alt 560–640 m. WC
pauper (Dinter) Dinter & Schwantes
Perennial. Succulent. Ht up to 0.3 m. Alt 250–800 m. N
paxianum (Schltr. & Diels) Schwantes = **D. luederitzii**
pickhardii L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 500–800 m. WC
praecultum (N.E.Br.) Schwantes
D. montaguense L.Bolus (6)
Perennial. Succulent. Ht up to 0.17 m. Alt 200–550 m. WC
prostratum L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 300–700 m. WC
pulchellum L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 300–700 m. WC
pulchrum L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt 300–500 m. WC
pulverulentum (Haw.) Schwantes
D. roseatum (N.E.Br.) L.Bolus (6)
Mesembryanthemum pulverulentum Haw. (6)
Ruschia comptonii L.Bolus (6)
Perennial. Succulent. Ht up to 0.15 m. Alt? WC
ramosissimum (Schltr.) L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 200–330 m. WC
robustum L.Bolus = **Delosperma crassum**
roridum L.Bolus = **D. subcompressum**
roseatum (N.E.Br.) L.Bolus = **D. pulverulentum**
salicola L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt 300–980 m. WC
schoenlandianum (Schltr.) L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 200–330 m. WC
semiglobosum L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 850–950 m. WC
sessile (Thunb.) Schwantes = **Ruschia sessilis**
speciosum (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.6 m. Alt 85–500 m. WC
splendens L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 500–750 m. WC
stokoei L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 30–400 m. WC
striatum (Haw.) Schwantes
Mesembryanthemum striatum Haw. (6)
Perennial. Succulent. Ht up to 0.3 m. Alt 300–500 m. WC
striatum (Haw.) Schwantes var. *hispifolium* (Haw.) G.D.Rowley = **D. hispifolium**
striatum (Haw.) Schwantes var. *pallens* (Haw.) G.D.Rowley = **D. pallens**
strictifolium L.Bolus
Perennial. Succulent. Ht 0.2–0.3 m. Alt? WC?
subalbum L.Bolus = **D. diversifolium**
subclausum L.Bolus
Perennial. Succulent. Ht 0.13–0.16 m. Alt 470–700 m. NC
subcompressum (Haw.) Schwantes
D. barwickii L.Bolus (6)
D. roridum L.Bolus (6)
Mesembryanthemum subcompressum Haw. (6)
Perennial. Succulent. Ht up to 0.7 m. Alt 500–750 m. WC
subglobosum (Haw.) Schwantes = **D. capillare**
subplanum L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 800–1600 m. WC
subspinosum (O.Kuntze) H.E.K.Hartmann
Perennial. Succulent. Ht? Alt 990–1800 m. EC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

tardum L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt 190–350 m. NC
thudichumii L.Bolus
D. thudichumii L.Bolus var. *gracilius* L.Bolus forma *aurantiaca* L.Bolus (6)
D. thudichumii L.Bolus var. *gracilius* L.Bolus forma *aurea* L.Bolus (6)
D. thudichumii L.Bolus var. *gracilius* L.Bolus forma *gracilius* (6)
Perennial. Succulent. Ht up to 0.9 m. Alt 300–600 m. WC
thudichumii L.Bolus var. *gracilius* L.Bolus forma *aurantiaca* L.Bolus = **D. thudichumii**
thudichumii L.Bolus var. *gracilius* L.Bolus forma *aurea* L.Bolus = **D. thudichumii**
thudichumii L.Bolus var. *gracilius* L.Bolus forma *gracilius* = **D. thudichumii**
torquatum (Haw.) Schwantes = **D. floribundum**
tuberculiferum L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt 300–600 m. WC
uniflorum (L.Bolus) Friedrich ex H.Jacobsen = **Lampranthus uniflorus**
vaginatum L.Bolus = **Jacobsenia vaginata**
vandermerwei L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt 190–350 m. WC
vespertinum L.Bolus
D. vespertinum L.Bolus var. *suffusum* L.Bolus (6)
Perennial. Succulent. Ht up to 0.3 m. Alt 500–980 m. WC
vespertinum L.Bolus var. *suffusum* L.Bolus = **D. vespertinum**
wittebergense L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt ± 1100 m. WC
worcesterense L.Bolus
Perennial. Succulent. Ht 0.2–0.28 m. Alt 300–600 m. WC
zygophylloides (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.14 m. Alt 300–590 m. WC

EBERLANZIA Schwantes 2405042
(1) Hartmann & Stüber. 1993. *Contributions from the Bolus Herbarium* 15: 1–75.
(2) Hartmann. 1998. *Bothalia* 28: 67–82.
(3) Hartmann. 1998. *Bradleya* 16: 44–91.
(4) Hartmann. 1999. *Bradleya* 17: 38–74.
(5) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 250–254.
aculeata (N.E.Br.) Schwantes = **Ruschia spinosa**
albertensis (L.Bolus) L.Bolus = **Ruschia spinosa**
armata (L.Bolus) L.Bolus = **Arenifera stylosa**
clausa (Dinter) Schwantes
Mesembryanthemum clausum Dinter (3)
Perennial. Succulent. Ht up to 0.5 m. Alt up to 1000 m. N
cradockensis (Kuntze) Schwantes = **Ruschia cradockensis** subsp. **cradockensis**
cyathiformis (L.Bolus) H.E.K.Hartmann
Ruschia cyathiformis L.Bolus (3)
Perennial. Succulent. Ht up to 0.4 m. Alt 50–850 m. N, NC
dichotoma (L.Bolus) H.E.K.Hartmann
Ruschia dichotoma L.Bolus (3)
Ruschia milleflora L.Bolus (3)
Perennial. Succulent. Ht up to 0.35 m. Alt 350–1000 m. NC
disarticulata (L.Bolus) L.Bolus = **Antimima hantamensis**
divaricata (L.Bolus) L.Bolus = **Ruschia divaricata**
ebracteata (L.Bolus) H.E.K.Hartmann
Ruschia ebracteata L.Bolus (3)
Ruschia namaquana L.Bolus var. *quinqueflora* L.Bolus (3)
Perennial. Succulent. Ht up to 0.25 m. Alt 250–1000 m. N, NC
ferox (L.Bolus) L.Bolus = **Ruschia intricata**
globularis (L.Bolus) L.Bolus = **Ruschia spinosa**
gravida (L.Bolus) H.E.K.Hartmann
Ruschia gravida L.Bolus (3)
Perennial. Succulent. Ht up to 0.35 m. Alt 500–950 m. NC
horrescens (L.Bolus) L.Bolus = **Ruschia cradockensis** subsp. **cradockensis**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

horrescens (L.Bolus) L.Bolus var. *densa* (L.Bolus) H.Jacobsen, invalid name = **Ruschia cradockensis** subsp. **cradockensis**
horrida (L.Bolus) L.Bolus = **Ruschia cradockensis** subsp. **cradockensis**
hospitalis (Dinter) Schwantes = **Ruschia spinosa**
intricata (N.E.Br.) Schwantes = **Ruschia intricata**
macroura (L.Bolus) L.Bolus = **Ruschia spinosa**
micrantha (Pax) Schwantes = **Ruschia spinosa**
mucronifera (Haw.) Schwantes = **Ruschia spinosa**
munita (L.Bolus) Schwantes = **Ruschia intricata**
parvibracteata (L.Bolus) H.E.K.Hartmann
Mesembryanthemum parvibracteatum (L.Bolus) N.E.Br. (3)
Ruschia parvibracteata L.Bolus (3)
Perennial. Succulent. Ht up to 0.3 m. Alt 200–1000 m. NC
persistens (L.Bolus) L.Bolus = **Ruschia intricata**
puniens (L.Bolus) L.Bolus = **Ruschia intricata**
schneideriana (A.Berger) H.E.K.Hartmann
Mesembryanthemum floriferum N.E.Br. (3)
Mesembryanthemum lacunatum N.E.Br. (3)
Mesembryanthemum rugulosum A.Berger ex Range, naked name (3)
Mesembryanthemum schneiderianum A.Berger (3)
Ruschia hallowayana L.Bolus (3)
Ruschia hollowayana L.Bolus (4)
Ruschia pillansii L.Bolus (3)
Ruschia schneideriana (A.Berger) L.Bolus (3)
Ruschia spathulata L.Bolus (3)
Ruschia sphaerophylla Dinter, naked name (3)
Ruschia velutina L.Bolus (3)
Perennial. Succulent. Ht up to 0.5 m. Alt 190–850 m. N, NC
sedoides (Dinter & A.Berger) Schwantes
Mesembryanthemum cleistum (L.Bolus) N.E.Br. (3)
Mesembryanthemum crassulifolium (L.Bolus) N.E.Br. (3)
Mesembryanthemum sedoides Dinter & A.Berger (1)
Ruschia cleista L.Bolus (3)
Ruschia crassuloides L.Bolus (3)
Ruschia sedoides (Dinter & A.Berger) Friedrich (1)
Perennial. Succulent. Ht up to 0.3 m. Alt 20–350 m. N, NC
spinosa (L.) Schwantes = **Ruschia spinosa**
stellata L.Bolus, naked name = **Antimima hantamensis**
stylosa (L.Bolus) L.Bolus = **Arenifera stylosa**
tatasbergensis L.Bolus = **Ruschia divaricata**
triticiformis (L.Bolus) L.Bolus = **Ruschia cradockensis** subsp. **triticiformis**
triticiformis (L.Bolus) L.Bolus var. *subglobosa* L.Bolus = **Ruschia cradockensis** subsp. **triticiformis**
vanheerdei L.Bolus = **Leipoldtia alborosea**
vulnerans (L.Bolus) L.Bolus = **Ruschia divaricata**

EBRACTEOLA Dinter & Schwantes 2405043
(1) Glen. 1986. *Bothalia* 16: 203–226.
(2) Hartmann. 1999. *Bradleya* 17: 38–74.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 254–257.
candida L.Bolus = **E. derenbergiana**
derenbergiana (Dinter) Dinter & Schwantes
E. candida L.Bolus (3)
Mesembryanthemum derenbergiana Dinter (3)
Ruschia derenbergiana (Dinter) C.Weber (3)
Perennial. Succulent. Ht up to 0.06 m. Alt 250–1200 m. N, NC
fulleri (L.Bolus) Glen
Ruschia fulleri L.Bolus (3)
Perennial. Succulent. Ht up to 0.05 m. Alt 940–1100 m. N, NC
montis-moltkei (Dinter) Dinter & Schwantes
Mesembryanthemum montis-moltkei Dinter (3)
Perennial. Succulent. Ht up to 0.06 m. Alt 1600–2100 m. N

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

wilmaniae (L.Bolus) Glen
Ruschia wilmaniae (L.Bolus) L.Bolus var. *angustifolia* L.Bolus (1)
Ruschia wilmaniae (L.Bolus) L.Bolus var. *vermeuleniae* (L.Bolus) L.Bolus (1)
Ruschia wilmaniae (L.Bolus) L.Bolus var. *wilmaniae* (1)
Perennial. Succulent. Ht up to 0.1 m. Alt 700–1600 m. NW, FS, NC

ECHINUS L.Bolus 2405143
apiculatus (Kensit) L.Bolus = **Braunsia apiculata**
edentulus (Haw.) N.E.Br. = **Ruschia edentula**

ECTOTROPIS N.E.Br. 2405044
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 257.
alpina N.E.Br.
Perennial. Succulent. Ht up to 0.03 m. Alt ± 2000 m. EC

ENARGANTHE N.E.Br. 2405045
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 271.
(2) Hartmann. 1999. *Bradleya* 17: 38–74.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 258.
octonaria (L.Bolus) N.E.Br.
Mesembryanthemum octonarium L.Bolus (3)
Ruschia octonaria (L.Bolus) G.D.Rowley (3)
Perennial. Succulent. Ht up to 0.45 m. Alt 420–700 m. NC

EREPSIA N.E.Br. 2405046
(1) Phillips. 1923. *The Flowering Plants of South Africa* 3: t. 110.
(2) Phillips. 1927. *The Flowering Plants of South Africa* 7: tt. 254, 270.
(3) Bolus. 1949. *The Flowering Plants of Africa* 27: t. 1065.
(4) Bolus. 1959. *The Flowering Plants of Africa* 33: t. 1286.
(5) Liede. 1989. *Beiträge zur Biologie der Pflanzen* 65: 1–98.
(6) Bruyns. 1997. *South African Journal of Botany* 63: 241.
(7) Hartmann. 1998. *Bradleya* 16: 44–91.
(8) Hartmann. 1999. *Bradleya* 17: 38–74.
(9) Klak. 2000. *Bothalia* 30: 35–42.
(10) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 258–266.
anceps (Haw.) Schwantes
E. laxa L.Bolus (10)
Perennial. Succulent. Ht up to 0.3 m. Alt 30–450 m. WC
aperta L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 300–600 m. WC
aristata (L.Bolus) Liede & H.E.K.Hartmann
Ruschia aristata L.Bolus (8)
Perennial. Succulent. Ht up to 0.6 m. Alt 50–550 m. WC, EC
aspera (Haw.) L.Bolus
E. nudicaulis (A.Berger) H.Jacobsen (5)
E. restiophila L.Bolus (5)
E. tuberculata N.E.Br. (5)
Perennial. Succulent. Ht up to 0.4 m. Alt 0–2000 m. WC
babiloniae Liede
Perennial. Succulent. Ht up to 0.2 m. Alt 300–650 m. WC
bracteata (Aiton) Schwantes
E. racemosa (N.E.Br.) Schwantes (10)
E. radiata (Haw.) Schwantes (10)
Perennial. Succulent. Ht up to 0.5 m. Alt 50–550 m. WC
bracteata (Aiton) Schwantes × **E. anceps** (Haw.) Schwantes
E. caledonica L.Bolus (10)
E. compressa (Haw.) Schwantes (10)
Perennial. Succulent. Ht? Alt? WC
bracteata (Aiton) Schwantes × **E. ramosa** L.Bolus
Perennial. Succulent. Ht? Alt? 'SA'
brevipetala L.Bolus
Perennial. Succulent. Ht up to 0.7 m. Alt 30–265 m. WC
caledonica L.Bolus = **E. bracteata** × **E. anceps**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

carterae L.Bolus var. *carterae* = **E. gracilis**
carterae L.Bolus var. *lepta* L.Bolus = **E. gracilis**
compressa (Haw.) Schwantes = **E. bracteata × E. anceps**
distans L.Bolus
Perennial. Succulent. Ht up to 0.7 m. Alt 500–850 m. WC
dubia Liede
Perennial. Succulent. Ht up to 0.4 m. Alt 190–250 m. WC
dunensis (Sond.) Klak
Perennial. Succulent. Ht up to 0.06 m. Alt 20–380 m. WC
esterhuyseniae L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 1600–2080 m. WC
forficata (L.) Schwantes
E. mutabilis (Haw.) Schwantes (10)
Ruschia filamentosa (L.) L.Bolus (8)
Ruschia forficata (L.) L.Bolus (6)
Perennial. Succulent. Ht up to 0.3 m. Alt 300–900 m. WC
gracilis (Haw.) L.Bolus
E. carterae L.Bolus var. *carterae* (10)
E. carterae L.Bolus var. *lepta* L.Bolus (10)
E. levis L.Bolus (10)
E. tenuicaulis (A.Berger) H.Jacobsen (10)
Perennial. Succulent. Ht up to 0.3 m. Alt 300–2000 m. WC
hallii L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 350–750 m. WC
heteropetala (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.2 m. Alt 400–1300 m. WC
inclaudens (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.4 m. Alt 300–1300 m. WC
insignis (Schltr.) Schwantes
Perennial. Succulent. Ht up to 0.15 m. Alt 1200–1700 m. WC
lacera (Haw.) Liede
Mesembryanthemum lacerum Haw. (5)
Semnanthe lacera (Haw.) N.E.Br. var. *densipetala* L.Bolus (5)
Semnanthe lacera (Haw.) N.E.Br. var. *lacera* (5)
Perennial. Succulent. Ht up to 0.8 m. Alt 300–700 m. WC
laxa L.Bolus = **E. anceps**
levis L.Bolus = **E. gracilis**
marlothii N.E.Br. = **E. saturata**
mutabilis (Haw.) Schwantes = **E. forficata**
nudicaulis (A.Berger) H.Jacobsen = **E. aspera**
oxysepala (Schltr.) L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 200–1400 m. WC
pageae L.Bolus = **E. patula**
patula (Haw.) Schwantes
E. pageae L.Bolus (10)
Perennial. Succulent. Ht up to 0.3 m. Alt 200–500 m. WC
pentagona (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.4 m. Alt 500–1000 m. WC
pillansii (Kensit) Liede
Kensitia pillansii (Kensit) Fedde (5)
Mesembryanthemum pillansii Kensit (5)
Perennial. Succulent. Ht up to 0.8 m. Alt 500–1000 m. WC
polita (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt ± 350 m. WC
polypetala (A.Berger & Schltr.) L.Bolus
Perennial. Succulent. Ht up to 0.4 m. Alt 160–450 m. WC
promontorii L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 50–300 m. WC
purpureostyla (L.Bolus) Schwantes = **Acrodon purpureostylus**
racemosa (N.E.Br.) Schwantes = **E. bracteata**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

radiata (Haw.) Schwantes = **E. bracteata**
ramosa L.Bolus
E. roseo-alba L.Bolus (10)
Perennial. Succulent. Ht up to 0.4 m. Alt 10–750 m. WC
restiophila L.Bolus = **E. aspera**
roseo-alba L.Bolus = **E. ramosa**
saturata L.Bolus
E. marlothii N.E.Br. (10)
Perennial. Succulent. Ht up to 0.4 m. Alt 700–1000 m. WC
serrata (L.) L.Bolus = **Circandra serrata**
steytlerae L.Bolus
Perennial. Succulent. Ht up to 0.4 m. Alt 300–650 m. WC
tenuicaulis (A.Berger) H.Jacobsen = **E. gracilis**
tuberculata N.E.Br. = **E. aspera**
urbaniana (Schltr.) Schwantes
Perennial. Succulent. Ht up to 0.2 m. Alt 20–150 m. WC
villiersii L.Bolus
Perennial. Succulent. Ht up to 0.7 m. Alt 300–600 m. WC
viridis L.Bolus = **Smicrostigma viride**

ESTERHUYSENIA L.Bolus 2405047
(1) Hartmann. 1991. *Contributions from the Bolus Herbarium* 13: 75–157.
(2) Hartmann. 1998. *Bradleya* 16: 44–91.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, A–E*: 267, 268.
alpina L.Bolus
Lampranthus alpinus (L.Bolus) G.D.Rowley (1)
Perennial. Succulent. Ht up to 0.15 m. Alt 1700–2080 m. WC
drepanophylla (Schltr. & A.Berger) H.E.K.Hartmann
Lampranthus drepanophyllus (Schltr. & A.Berger) N.E.Br. (2)
Mesembryanthemum drepanophyllum Schltr. & A.Berger (2)
Mesembryanthemum mallesoniae L.Bolus (2)
Ruschia drepanophylla (Schltr. & A.Berger) L.Bolus (2)
Ruschia drepanophylla (Schltr. & A.Berger) L.Bolus var. *sneeubergensis* L.Bolus (2)
Ruschia mallesoniae (L.Bolus) L.Bolus (2)
Perennial. Succulent. Ht up to 0.15 m. Alt 600–1500 m. WC
inclaudens (L.Bolus) H.E.K.Hartmann
Ruschia inclaudens L.Bolus (2)
Perennial. Succulent. Ht up to 0.25 m. Alt 550–1000 m. WC
stokoei (L.Bolus) H.E.K.Hartmann
Mesembryanthemum stokoei L.Bolus (2)
Ruschia thomae L.Bolus var. *microstigma* L.Bolus (2)
Ruschia thomae L.Bolus var. *thomae* (2)
Perennial. Succulent. Ht up to 0.2 m. Alt 300–800 m. WC

EURYSTIGMA L.Bolus 2405048
clavatum (L.Bolus) L.Bolus = **Mesembryanthemum eurystigmatum**

FAUCARIA Schwantes 2405049
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 267.
(2) Groen & Van der Maesen. 1999. *Bothalia* 29: 35–85.
(3) Groen & Hartmann. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 23–26.
acutipetala L.Bolus = **F. felina**
albidens N.E.Br. = **F. bosscheana**
bosscheana (A.Berger) Schwantes
F. albidens N.E.Br. (2)
F. bosscheana (A.Berger) Schwantes var. *haagei* (Tischer) H.Jacobsen (2)
F. haagei Tischer (2)
F. kendrewensis L.Bolus (2)
F. paucidens N.E.Br. (2)
F. peersii L.Bolus (2)
Mesembryanthemum bosscheanum A.Berger (2)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.03 m. Alt up to 980 m. WC, EC

bosscheana (A.Berger) Schwantes var. *haagei* (Tischer) H.Jacobsen = **F. bosscheana**

britteniae L.Bolus

F. coronata L.Bolus (3)

F. felina (Weston) Schwantes subsp. *britteniae* (L.Bolus) L.E.Groen (3)

F. grandis L.Bolus (3)

F. smithii L. Bolus (3)

F. speciosa L.Bolus (3)

Perennial. Succulent. Ht up to 0.1 m. Alt 450–910 m. EC

candida L.Bolus = **F. felina**

coronata L.Bolus = **F. britteniae**

cradockensis L.Bolus = **F. felina**

crassisepala L.Bolus = **F. felina**

duncanii L.Bolus = **F. felina**

felina (L.) Schwantes

F. acutipetala L.Bolus (2)

F. candida L.Bolus (2)

F. cradockensis L.Bolus (2)

F. crassisepala L.Bolus (2)

F. duncanii L.Bolus (2)

F. felina (L.) Schwantes var. *jamesii* L.Bolus (2)

F. jamesii L.Bolus ex Tischer, naked name (2)

F. kingiae L.Bolus (2)

F. latipetala L.Bolus (2)

F. laxipetala L.Bolus (2)

F. longidens L.Bolus (2)

F. longifolia L.Bolus (2)

F. lupina (Haw.) Schwantes (2)

F. militaris Tischer (2)

F. montana L.Bolus (2)

F. multidens L.Bolus (2)

F. multidens L.Bolus var. *paardeportensis* L.Bolus (2)

F. plana L.Bolus (2)

F. ryneveldiae L.Bolus (2)

F. uniondalensis L.Bolus (2)

Mesembryanthemum felinum (L.) Weston (2)

Mesembryanthemum lupinum Haw. (2)

Mesembryanthemum ringens L. var. ß *felinum* L. (2)

Perennial. Succulent. Ht up to 0.08 m. Alt 450–930 m. WC, EC

felina (L.) Schwantes subsp. *tuberculosa* (Rolfe) L.E.Groen = **F. tuberculosa**

felina (L.) Schwantes var. *jamesii* L.Bolus = **F. felina**

felina (Weston) Schwantes subsp. *britteniae* (L.Bolus) L.E.Groen = **F. britteniae**

grandis L.Bolus = **F. britteniae**

gratiae L.Bolus

F. hooleae L.Bolus (2)

Perennial. Succulent. Ht up to 0.04 m. Alt 450–850 m. EC

haagei Tischer = **F. bosscheana**

hooleae L.Bolus = **F. gratiae**

jamesii L.Bolus ex Tischer, naked name = **F. felina**

kendrewensis L.Bolus = **F. bosscheana**

kingiae L.Bolus = **F. felina**

latipetala L.Bolus = **F. felina**

laxipetala L.Bolus = **F. felina**

longidens L.Bolus = **F. felina**

longifolia L.Bolus = **F. felina**

lupina (Haw.) Schwantes = **F. felina**

militaris Tischer = **F. felina**

montana L.Bolus = **F. felina**

multidens L.Bolus = **F. felina**

multidens L.Bolus var. *paardeportensis* L.Bolus = **F. felina**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

nemorosa L.Bolus ex L.E.Groen
Perennial. Succulent. Ht up to 0.05 m. Alt 450–900 m. EC
paucidens N.E.Br. = **F. bosscheana**
peersii L.Bolus = **F. bosscheana**
plana L.Bolus = **F. felina**
ryneveldiae L.Bolus = **F. felina**
smithii L.Bolus = **F. britteniae**
speciosa L.Bolus = **F. britteniae**
subindurata L.Bolus = **F. subintegra**
subintegra L.Bolus
F. subindurata L.Bolus (2)
Perennial. Succulent. Ht up to 0.04 m. Alt 340–580 m. EC
tigrina (Haw.) Schwantes
F. tigrina (Haw.) Schwantes forma *splendens* H.Jacobsen & G.D.Rowley (2)
Mesembryanthemum tigrinum Haw. (2)
Perennial. Succulent. Ht up to 0.08 m. Alt 550–920 m. EC
tigrina (Haw.) Schwantes forma *splendens* H.Jacobsen & G.D.Rowley = **F. tigrina**
tuberculosa (Rolfe) Schwantes
F. felina (L.) Schwantes subsp. *tuberculosa* (Rolfe) L.E.Groen
Perennial. Succulent. Ht up to 0.07 m. Alt 520–980 m. EC
uniondalensis L.Bolus = **F. felina**

FENESTRARIA N.E.Br. 2405050
(1) Hartmann. 1982. *Botanische Jahrbücher* 103: 145–183.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 26, 27.
rhopalophylla (Schltr. & Diels) N.E.Br. subsp. **aurantiaca** (N.E.Br.) H.E.K.Hartmann
Perennial. Succulent. Ht up to 0.04 m, when in flower. Alt 20–250 m. N, NC
rhopalophylla (Schltr. & Diels) N.E.Br. subsp. **rhopalophylla**
Perennial. Succulent. Ht up to 0.04 m, when in flower. Alt 20–250 m. N

FRITHIA N.E.Br. 2405051
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 275.
(2) Burgoyne *et al.* 2000. *Bothalia* 30: 1–7.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 27, 28.
humilis Burgoyne
F. pulchra N.E.Br. var. *minor* de Boer, illegitimate name (2)
Perennial. Succulent. Ht up to 0.02 m. Alt 1400–1600 m. G, M
pulchra N.E.Br.
Perennial. Succulent. Ht up to 0.04 m. Alt 1500–1770 m. G, NW
pulchra N.E.Br. var. *minor* de Boer = **F. humilis**

GIBBAEUM N.E.Br. 2405052
(1) Bolus. 1953. *The Flowering Plants of Africa* 29: t. 1153.
(2) Nel. 1953. *The* Gibbaeum *Handbook.*
(3) Glen. 1983. *The Flowering Plants of Africa* 47: t. 1865A.
(4) Van Jaarsveld & Hammer. 1996. *Bradleya* 14: 14–16.
(5) Frandsen. 1998. *Aloe* 35: 14–17.
(6) Klak. 2000. In Goldblatt & Manning, *Strelitzia* 9: 243, 244.
(7) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 35–41.
album N.E.Br.
G. album N.E.Br. forma *roseum* (N.E.Br.) G.D.Rowley (6)
Perennial. Succulent. Ht up to 0.06 m. Alt 330–630 m. WC
album N.E.Br. forma *roseum* (N.E.Br.) G.D.Rowley = **G. album**
angulipes (L.Bolus) N.E.Br.
Perennial. Succulent. Ht up to 0.1 m. Alt 200–590 m. WC
blackburniae L.Bolus = **G. heathii**
comptonii (L.Bolus) L.Bolus = **G. heathii**
cryptopodium (Kensit) L.Bolus = **G. nuciforme**
dispar N.E.Br.
Perennial. Succulent. Ht up to 0.06 m. Alt 490–730 m. WC
esterhuyseniae L.Bolus
Perennial. Succulent. Ht up to 0.08 m. Alt 300–450 m. WC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

geminum N.E.Br.
Perennial. Succulent. Ht up to 0.06 m. Alt 540–730 m. WC
gibbosum (Haw.) N.E.Br.
G. luteoviride (Haw.) N.E.Br. (2)
G. marlothii N.E.Br. (2)
G. muirii N.E.Br. (2)
G. perviride (Haw.) N.E.Br. (2)
Perennial. Succulent. Ht up to 0.1 m. Alt 420–880 m. WC
haagei Schwantes var. *haagei* = **G. haaglenii**
haagei Schwantes var. *parviflorum* L.Bolus = **G. haaglenii**
haaglenii H.E.K.Hartmann
G. haagei Schwantes var. *haagei* (7)
G. haagei Schwantes var. *parviflorum* L.Bolus (7)
Perennial. Succulent. Ht up to 0.1 m. Alt 175–250 m. WC
heathii (N.E.Br.) L.Bolus
G. blackburniae L.Bolus (2)
G. comptonii (L.Bolus) L.Bolus (2)
G. heathii (N.E.Br.) L.Bolus var. *elevatum* (L.Bolus) L.Bolus (7)
G. heathii (N.E.Br.) L.Bolus var. *majus* (L.Bolus) L.Bolus (7)
G. luckhoffii (L.Bolus) L.Bolus (6)
Perennial. Succulent. Ht up to 0.06 m. Alt 430–700 m. WC
heathii (N.E.Br.) L.Bolus var. *elevatum* (L.Bolus) L.Bolus = **G. heathii**
heathii (N.E.Br.) L.Bolus var. *majus* (L.Bolus) L.Bolus = **G. heathii**
helmiae L.Bolus = **G. nuciforme**
hortenseae (N.E.Br.) Thiede & Klak = **Muiria hortenseae**
johnstonii Van Jaarsv. & S.A.Hammer = **G. nebrownii**
luckhoffii (L.Bolus) L.Bolus = **G. heathii**
luteoviride (Haw.) N.E.Br. = **G. gibbosum**
marlothii N.E.Br. = **G. gibbosum**
molle N.E.Br. = **G. nuciforme**
muirii N.E.Br. = **G. gibbosum**
nebrownii Tischer
G. johnstonii Van Jaarsv. & S.A.Hammer (6)
Imitaria muirii N.E.Br. (7)
Perennial. Succulent. Ht up to 0.03 m. Alt 730–880 m. WC
nuciforme (Haw.) Glen & H.E.K.Hartmann
G. cryptopodium (Kensit) L.Bolus (7)
G. helmiae L.Bolus (7)
G. molle N.E.Br. (7)
Perennial. Succulent. Ht up to 0.04 m. Alt 530–850 m. WC
pachypodium (Kensit) L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 400–490 m. WC
perviride (Haw.) N.E.Br. = **G. gibbosum**
petrense (N.E.Br.) Tischer
G. tischleri H.Wulff (7)
Perennial. Succulent. Ht up to 0.05 m. Alt 400–630 m. WC
pilosulum (N.E.Br.) N.E.Br.
Perennial. Succulent. Ht up to 0.03 m. Alt 400–580 m. WC
pubescens (Haw.) N.E.Br.
Perennial. Succulent. Ht up to 0.3 m. Alt 730–880 m. WC
schwantesii Tischer = **G. velutinum**
shandii N.E.Br.
Perennial. Succulent. Ht up to 0.3 m. Alt 700–850 m. WC
tischleri H.Wulff = **G. petrense**
velutinum (L.Bolus) Schwantes
G. schwantesii Tischer (6)
Perennial. Succulent. Ht up to 0.15 m. Alt 650–800 m. WC

GLOTTIPHYLLUM N.E.Br. 2405053

(1) Hartmann & Gölling. 1993. *Bradleya* 11: 1–49.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 42–47.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

album L.Bolus, naked name
angustum (Haw.) N.E.Br. = **G. cruciatum**
apiculatum N.E.Br. = **G. cruciatum**
armoedense Schwantes = **G. cruciatum**
arrectum N.E.Br. = **G. surrectum**
barrydalense Schwantes = **G. depressum**
buffelsvleyense Schwantes = **G. depressum**
carnosum N.E.Br.
G. jordaanianum Schwantes (1)
Perennial. Succulent. Ht up to 0.04 m. Alt 400–650 m. WC
cilliersiae Schwantes = **G. linguiforme**
compressum L.Bolus = **G. regium**
concavum N.E.Br. = **G. surrectum**
cruciatum (Haw.) N.E.Br.
G. angustum (Haw.) N.E.Br. (1)
G. apiculatum N.E.Br. (1)
G. armoedense Schwantes (1)
G. longipes N.E.Br. (1)
G. praepingue (Haw.) N.E.Br. (1)
G. rosaliae L.Bolus (1)
Mesembryanthemum angustum Haw. (1)
Mesembryanthemum cruciatum Haw. (1)
Mesembryanthemum praepingue Haw. (1)
Perennial. Succulent. Ht up to 0.12 m. Alt 400–650 m. WC
cultratum (Salm-Dyck) N.E.Br. = **G. longum**
davisii L.Bolus = **G. longum**
depressum (Haw.) N.E.Br.
G. barrydalense Schwantes (1)
G. buffelsvleyense Schwantes (1)
G. fragrans (Salm-Dyck) Schwantes (1)
G. framesii L.Bolus (1)
G. haagei Tischer (1)
G. jacobsenianum Schwantes (1)
G. marlothii Schwantes (1)
G. muirii N.E.Br. (1)
G. nysiae Schwantes (1)
G. platycarpum L.Bolus (1)
G. proclive N.E.Br. (1)
G. rufescens (Haw.) Tischer (1)
G. starkeae L.Bolus (1)
G. taurinum (Haw.) N.E.Br. (1)
G. uniondalense L.Bolus (1)
Mesembryanthemum angustum Haw. var. *heterophyllum* in sense of Salm-Dyck, not of Haw. (1)
Mesembryanthemum depressum Haw. (1)
Mesembryanthemum depressum Haw. var. *lividum* Haw. (1)
Mesembryanthemum fragrans Salm-Dyck (1)
Mesembryanthemum linguaeforme Haw. (1)
Mesembryanthemum linguaeforme Haw. var. *rufescens* Haw., invalid name (1)
Mesembryanthemum linguiforme L. var. *angustum* (Haw.) A.Berger, invalid name (1)
Mesembryanthemum linguiforme L. var. *fragrans* (Salm-Dyck) A.Berger (1)
Mesembryanthemum longum Haw. var. *declive* Haw. (1)
Mesembryanthemum longum Haw. var. *flaccidum* Haw. (1)
Mesembryanthemum rufescens Haw. (1)
Mesembryanthemum taurinum Haw. (1)
Perennial. Succulent. Ht up to 0.04 m. Alt 500–980 m. WC
difforme (L.) N.E.Br.
G. semicylindricum (Haw.) N.E.Br. (1)
G. subditum N.E.Br. (1)
Mesembryanthemum bidentatum Haw. (1)
Mesembryanthemum bigibberatum Haw. (1)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Mesembryanthemum difforme L. (1)
Mesembryanthemum semicylindricum Haw. (1)
Perennial. Succulent. Ht up to 0.1 m. Alt 450–1300 m. NC, EC
erectum N.E.Br. = **G. longum**
fergusoniae L.Bolus
Perennial. Succulent. Ht up to 0.05 m. Alt 170–350 m. WC
fragrans (Salm-Dyck) Schwantes = **G. depressum**
framesii L.Bolus = **G. depressum**
grandiflorum (Haw.) N.E.Br.
G. lombergii N.E.Br. on herbarium label, naked name (1)
Mesembryanthemum grandiflorum Haw. (1)
Mesembryanthemum linguiforme L. var. *grandiflorum* (Haw.) A.Berger (1)
Perennial. Succulent. Ht up to 0.2 m. Alt 200–890 m. EC
haagei Tischer = **G. depressum**
herrei L.Bolus = **G. suave**
jacobsenianum Schwantes = **G. depressum**
jordaanianum Schwantes = **G. carnosum**
latifolium N.E.Br. = **G. linguiforme**
latum N.E.Br. = **G. longum**
latum N.E.Br. var. *cultratum* (Salm-Dyck) N.E.Br. = **G. longum**
linguiforme (L.) N.E.Br.
G. cilliersiae Schwantes (1)
G. latifolium N.E.Br. (1)
G. ryderae Schwantes (1)
Mesembryanthemum linguiforme L. (1)
Mesembryanthemum linguiforme (L.) N.E.Br. var. *scalpratum* (Haw.) A.Berger (1)
Mesembryanthemum scalpratum Haw., illegitimate name (1)
Perennial. Succulent. Ht up to 0.05 m. Alt 270–650 m. WC
lombergii N.E.Br. on herbarium label, naked name = **G. grandiflorum**
longipes N.E.Br. = **G. cruciatum**
longum (Haw.) N.E.Br.
G. cultratum (Salm-Dyck) N.E.Br. (1)
G. davisii L.Bolus (1)
G. erectum N.E.Br. (1)
G. latum N.E.Br. (1)
G. latum N.E.Br. var. *cultratum* (Salm-Dyck) N.E.Br. (1)
G. longum (Haw.) N.E.Br. var. *hamatum* N.E.Br. (1)
G. longum (Haw.) N.E.Br. var. *heterophyllum* (Haw.) G.D.Rowley (1)
G. obliquum (Willd.) N.E.Br. (1)
G. propinquum N.E.Br. (1)
G. pustulatum (Haw.) N.E.Br. (1)
G. uncatum (Salm-Dyck) N.E.Br. (1)
Mesembryanthemum adscendens Haw. (1)
Mesembryanthemum angustum Haw. var. *heterophyllum* Haw. (1)
Mesembryanthemum cultratum Salm-Dyck (1)
Mesembryanthemum latum Haw. (1)
Mesembryanthemum linguiforme in sense of Haw., not of L. (1)
Mesembryanthemum linguiforme L. var. *adscendens* (Haw.) A.Berger (1)
Mesembryanthemum linguiforme L. var. *cultratum* (Salm-Dyck) A.Berger (1)
Mesembryanthemum linguiforme L. var. *depressum* (Haw.) A.Berger, invalid name (1)
Mesembryanthemum linguiforme L. var. *longum* (Haw.) A.Berger (1)
Mesembryanthemum linguiforme L. var. *obliquum* (Willd.) A.Berger (1)
Mesembryanthemum linguiforme L. var. *pustulatum* (Haw.) A.Berger (1)
Mesembryanthemum linguiforme L. var. *uncatum* (Haw.) A.Berger (1)
Mesembryanthemum longum Haw. (1)
Mesembryanthemum longum Haw. var. *uncatum* Haw. (1)
Mesembryanthemum lucidum Haw. (1)
Mesembryanthemum medium Haw. (1)
Mesembryanthemum obliquum Willd. (1)
Mesembryanthemum pustulatum Haw. (1)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Mesembryanthemum pustulatum Haw. var. *lividum* Salm-Dyck (1)
Mesembryanthemum uncatum Salm-Dyck (1)
Perennial. Succulent. Ht up to 0.15 m. Alt 30–650 m. WC, EC
longum (Haw.) N.E.Br. var. *hamatum* N.E.Br. = **G. longum**
longum (Haw.) N.E.Br. var. *heterophyllum* (Haw.) G.D.Rowley = **G. longum**
marlothii Schwantes = **G. depressum**
muirii N.E.Br. = **G. depressum**
neilii N.E.Br.
Perennial. Succulent. Ht up to 0.04 m. Alt 550–980 m. WC
nelii Schwantes
G. pallens L.Bolus (1)
G. pygmaeum L.Bolus (1)
Perennial. Succulent. Ht up to 0.06 m. Alt 780–1100 m. WC, EC
nysiae Schwantes = **G. depressum**
obliquum (Willd.) N.E.Br. = **G. longum**
ochraceum (A.Berger) N.E.Br. = **Malephora ochracea**
oligocarpum L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 370–1020 m. EC
pallens L.Bolus = **G. nelii**
parvifolium L.Bolus = **G. surrectum**
peersii L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 730–950 m. WC, EC
platycarpum L.Bolus = **G. depressum**
praepingue (Haw.) N.E.Br. = **G. cruciatum**
proclive N.E.Br. = **G. depressum**
propinquum N.E.Br. = **G. longum**
pustulatum (Haw.) N.E.Br. = **G. longum**
pygmaeum L.Bolus = **G. nelii**
regium N.E.Br.
G. compressum L.Bolus (1)
Perennial. Succulent. Ht up to 0.2 m. Alt 400–650 m. WC
rosaliae L.Bolus = **G. cruciatum**
rubrostigma L.Bolus = **G. surrectum**
rufescens (Haw.) Tischer = **G. depressum**
ryderae Schwantes = **G. linguiforme**
salmii (Haw.) N.E.Br.
Mesembryanthemum salmii Haw. (1)
Perennial. Succulent. Ht up to 0.12 m. Alt 950–1150 m. WC, EC
semicylindricum (Haw.) N.E.Br. = **G. difforme**
starkeae L.Bolus = **G. depressum**
suave N.E.Br.
G. herrei L.Bolus (1)
Perennial. Succulent. Ht up to 0.05 m. Alt 800–1100 m. WC
subditum N.E.Br. = **G. difforme**
surrectum (Haw.) L.Bolus
G. arrectum N.E.Br. (1)
G. concavum N.E.Br. (1)
G. parvifolium L.Bolus (1)
G. rubrostigma L.Bolus (1)
Mesembryanthemum surrectum Haw. (1)
Perennial. Succulent. Ht up to 0.15 m. Alt 800–1100 m. WC
taurinum (Haw.) N.E.Br. = **G. depressum**
uncatum (Salm-Dyck) N.E.Br. = **G. longum**
uniondalense L.Bolus = **G. depressum**

HALLIANTHUS H.E.K.Hartmann 2405150
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 260.
(2) Hartmann. 1983. *Botanische Jahrbücher* 104: 143–169.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 53.
(4) Hammer. 2002. *Cactus and Succulent Journal (US)* 74: 228–232.
griseus S.A.Hammer & U.Schmiedel

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.06 m. Alt up to 250 m. WC
planus (L.Bolus) H.E.K.Hartmann
Leipoldtia compressa L.Bolus var. *compressa* (2)
Leipoldtia compressa L.Bolus var. *lekkersingensis* L.Bolus (2)
Leipoldtia plana L.Bolus (2)
Perennial. Succulent. Ht up to 0.15 m. Alt up to 1200 m. NC, WC

HAMMERIA Burgoyne 2405190
(1) Burgoyne *et al.* 1998. *Cactus and Succulent Journal (US)* 70: 203–208.
(2) Klak. 2000. *Bothalia* 30: 35–42.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 53, 54.
gracilis Burgoyne
Perennial. Succulent. Ht up to 0.15 m. Alt 1400–1600 m. NC
meleagris (L.Bolus) Klak
H. salteri (L.Bolus) Burgoyne (2)
Perennial. Succulent. Ht up to 0.06 m. Alt 600–700 m. NC, WC
salteri (L.Bolus) Burgoyne = **H. meleagris**

HARTMANTHUS S.A.Hammer 2405189
(1) Hammer. 1995. *Haseltonia* 3: 77–82.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 55.
hallii (L.Bolus) S.A.Hammer
Perennial. Succulent. Ht up to 0.2 m. Alt 190–850 m. N
pergamentaceus (L.Bolus) S.A.Hammer
Delosperma pergamentaceum L.Bolus var. *pergamentaceum* (2)
Delosperma pergamentaceum L.Bolus var. *roseum* Lavis (2)
Perennial. Succulent. Ht up to 0.3 m. Alt 190–1100 m. N, NC

HEREROA (Schwantes) Dinter & Schwantes 2405055
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 56–62.
acuminata L.Bolus
Perennial. Succulent. Ht up to 0.05 m, when in flower. Alt 800–1100 m. WC
albanensis L.Bolus = **Rhombophyllum albanense**
aspera L.Bolus
Perennial. Succulent. Ht up to 0.08 m. Alt 190–550 m. WC
brevifolia L.Bolus
Perennial. Succulent. Ht up to 0.07 m. Alt 950–1200 m. WC
calycina L.Bolus
Perennial. Succulent. Ht up to 0.06 m. Alt 1200–1900 m. EC
cana in sense of L.Bolus, misapplied name = **Bijlia dilatata**
carinans (Haw.) Dinter & Schwantes ex H.Jacobsen
Perennial. Succulent. Ht up to 0.04 m. Alt? 'SA'
concava L.Bolus
Perennial. Succulent. Ht up to 0.07 m. Alt 850–1950 m. WC
crassa L.Bolus
Perennial. Succulent. Ht up to 0.12 m. Alt 800–1100 m. WC
dolabriformis (L.) L.Bolus = **Rhombophyllum dolabriforme**
dyeri L.Bolus = **Rhombophyllum dyeri**
fimbriata L.Bolus
Perennial. Succulent. Ht up to 0.35 m. Alt 850–1000 m. WC
glenensis (N.E.Br.) L.Bolus
Bergeranthus glenensis N.E.Br. (1)
Perennial. Succulent. Ht up to 0.05 m. Alt 1100–1750 m. G, FS, NC
gracilis L.Bolus
H. gracilis L.Bolus var. *compressa* L.Bolus (1)
Perennial. Succulent. Ht up to 0.15 m. Alt 900–1300 m. WC
gracilis L.Bolus var. *compressa* L.Bolus = **H. gracilis**
granulata (N.E.Br.) Dinter & Schwantes
Mesembryanthemum granulatum N.E.Br. (1)
Perennial. Succulent. Ht 0.03–0.04 m. Alt 30–240 m. EC
herrei Schwantes

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.6 m. Alt 630–1100 m. EC
hesperantha (Dinter & A.Berger) Dinter & Schwantes
Mesembryanthemum bergerianum Dinter (1)
Mesembryanthemum hesperanthum Dinter & A.Berger (1)
Perennial. Succulent. Ht 0.15–0.3 m. Alt 450–900 m. N, NC
incurva L.Bolus
Perennial. Succulent. Ht up to 0.07 m, when in flower. Alt 990–1200 m. EC
joubertii L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 880–1100 m. WC
latipetala L.Bolus
Perennial. Succulent. Ht up to 0.09 m. Alt 550–1000 m. WC
muirii L.Bolus
Perennial. Succulent. Ht up to 0.1 m. Alt 190–380 m. WC
nelii Schwantes
Perennial. Succulent. Ht up to 0.1 m. Alt 500–880 m. WC
odorata (L.Bolus) L.Bolus
Aridaria odorata (L.Bolus) Schwantes ex H.Jacobsen (1)
Mesembryanthemum odoratum L.Bolus (1)
Nycteranthus odoratus (L.Bolus) Schwantes, illegitimate name (1)
Perennial. Succulent. Ht up to 0.1 m. Alt 190–950 m. WC
pallens L.Bolus
Perennial. Succulent. Ht up to 0.1 m. Alt 800–1000 m. NC
puttkameriana (Dinter & A.Berger) Dinter & Schwantes
Mesembryanthemum puttkamerianum Dinter & A.Berger (1)
Perennial. Succulent. Ht up to 0.1 m. Alt 250–1250 m. N
rehneltiana (A.Berger) Dinter & Schwantes
Perennial. Succulent. Ht? Alt 960–1500 m. WC
stanfordiae L.Bolus
Perennial. Succulent. Ht up to 0.06 m. Alt 980–1200 m. NC
stanleyi (L.Bolus) L.Bolus = **Chasmatophyllum stanleyi**
stenophylla L.Bolus
Perennial. Succulent. Ht? Alt? 'SA'
tenuifolia L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt 190–650 m. WC
teretifolia L.Bolus
Perennial. Succulent. Ht? Alt 300–650 m. NC, WC
tugwelliae in sense of L.Bolus (1927, 1928), not of L.Bolus (1930), misapplied name = **Bijlia dilatata**
tugwelliae (L.Bolus) L.Bolus = **Bijlia tugwelliae**
uncipetala (N.E.Br.) L.Bolus = **H. wilmaniae**
willowmorensis L.Bolus
Perennial. Succulent. Ht up to 0.6 m, when in flower. Alt 700–950 m. WC, EC
wilmaniae L.Bolus
H. uncipetala (N.E.Br.) L.Bolus (1)
H. wilmaniae L.Bolus var. *langebergensis* L.Bolus (1)
Prepodesma uncipetala N.E.Br. (1)
Perennial. Succulent. Ht up to 0.1 m. Alt 1200–1600 m. NC
wilmaniae L.Bolus var. *langebergensis* L.Bolus = **H. wilmaniae**

HERREA Schwantes 2405056
acocksii L.Bolus = **Conicosia elongata**
affinis (N.E.Br.) L.Bolus = **Conicosia elongata**
alba L.Bolus = **Conicosia elongata**
albolutea L.Bolus = **Conicosia elongata**
blanda L.Bolus = **Conicosia elongata**
brevisepala L.Bolus = **Conicosia elongata**
caledonica L.Bolus = **Conicosia pugioniformis** subsp. **pugioniformis**
elongata (Haw.) L.Bolus var. *elongata* = **Conicosia elongata**
elongata (Haw.) L.Bolus var. *minor* (Haw.) L.Bolus = **Conicosia elongata**
excavata L.Bolus = **Conicosia elongata**
fusiformis (Haw.) L.Bolus = **Conicosia elongata**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

grandis L.Bolus = **Conicosia elongata**
gydouwensis L.Bolus = **Conicosia elongata**
inaequalis L.Bolus = **Conicosia elongata**
klaverensis L.Bolus = **Conicosia elongata**
laticalyx L.Bolus = **Conicosia elongata**
macrocalyx L.Bolus = **Conicosia elongata**
nelii Schwantes = **Conicosia elongata**
obtusa L.Bolus = **Conicosia elongata**
plana L.Bolus = **Conicosia elongata**
porcina L.Bolus = **Conicosia elongata**
robusta (N.E.Br.) L.Bolus = **Conicosia elongata**
ronaldii L.Bolus = **Conicosia elongata**
roodiae (N.E.Br.) L.Bolus = **Conicosia elongata**
stipitata L.Bolus = **Conicosia elongata**

HERREANTHUS Schwantes 2405057
meyeri Schwantes = **Conophytum herreanthus** subsp. **herreanthus**

HYMENOGYNE Haw. 2405059
(1) Ihlenfeldt & Gerbaulet. 1990. *Botanische Jahrbücher* 111: 457–498.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 63, 64.
conica L.Bolus
Annual. Succulent. Ht up to 0.18 m, when in flower. Alt 420–850 m. WC
glabra (Aiton) Haw.
Annual. Succulent. Ht up to 0.15 m. Alt 30–550 m. WC

IHLENFELDTIA H.E.K.Hartmann 2405161
(1) Hartmann & Dehn. 1987. *Botanische Jahrbücher* 108: 567–663.
(2) Hartmann. 1992. *Botanische Jahrbücher* 114: 29–50.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 64, 65.
excavata (L.Bolus) H.E.K.Hartmann
Cheiridopsis albirosea L.Bolus (1)
Cheiridopsis dilatata L.Bolus (1)
Cheiridopsis excavata L.Bolus (1)
Cheiridopsis vanbredai L.Bolus (1)
Perennial. Succulent. Ht up to 0.04 m. Alt 770–1050 m. NC
vanzylii (L.Bolus) H.E.K.Hartmann
Cheiridopsis papillata L.Bolus (1)
Cheiridopsis richardiana L.Bolus (2)
Cheiridopsis vanzijlii L.Bolus (1)
Perennial. Succulent. Ht up to 0.04 m. Alt 1070–1150 m. NC

IMITARIA N.E.Br. 2405060
muirii N.E.Br. = **Gibbaeum nebrownii**

JACOBSENIA L.Bolus & Schwantes emend. Ihlenf. 2405061
(1) Ihlenfeldt. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 65–67.
hallii L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 170–230 m. NC, WC
kolbei (L.Bolus) L.Bolus & Schwantes
Perennial. Succulent. Ht up to 0. 5 m. Alt 190–370 m. WC
vaginata (L.Bolus) Ihlenf.
Anisocalyx salarius L.Bolus (1)
Anisocalyx vaginatus (L.Bolus) L.Bolus (1)
Anysocalyx vaginatus (L.Bolus) L.Bolus (1)
Drosanthemopsis salaria (L.Bolus) Rauschert (1)
Drosanthemopsis vaginata (L.Bolus) Rauschert (1)
Drosanthemum vaginatum L.Bolus (1)
Perennial. Succulent. Ht 0.08–0.2 m. Alt 50–550 m. WC

JENSENOBOTRYA A.G.J.Herre 2405062
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 67.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

lossowiana A.G.J.Herre
Perennial. Succulent. Ht up to 0.25 m. Alt 20–100 m. N
vanheerdei L.Bolus = **Stoeberia carpii**

JORDAANIELLA H.E.K.Hartmann 2405145
(1) Bolus. 1962. *The Flowering Plants of Africa* 35: tt. 1397, 1398.
(2) Hartmann. 1983. *Bibliographia Botanica* 136: 1–67.
(3) Hartmann. 1984. *Botanische Jahrbücher* 104: 321–360.
(4) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 67–69.
clavifolia (L.Bolus) H.E.K.Hartmann
Cephalophyllum clavifolium (L.Bolus) L.Bolus (2)
Perennial. Succulent. Ht up to 0.05 m. Alt 10–220 m. NC
cuprea (L.Bolus) H.E.K.Hartmann
Cephalophyllum cupreum L.Bolus (3)
Cephalophyllum luxurians Dinter, naked name (3)
Perennial. Succulent. Ht up to 0.12 m. Alt 10–100 m. N, NC
dubia (Haw.) H.E.K.Hartmann
Cephalophyllum albertiniense (L.Bolus) Schwantes (3)
Cephalophyllum anemoniflorum (L.Bolus) N.E.Br. (3)
Cephalophyllum dubium (Haw.) N.E.Br. (3)
Cephalophyllum maritimum (L.Bolus) Schwantes (3)
Cephalophyllum pittenii L.Bolus (3)
Cephalophyllum procumbens (Haw.) Schwantes (3)
Cephalophyllum vanputtenii L.Bolus (3)
Cephalophyllum watermeyeri L.Bolus (3)
Perennial. Succulent. Ht up to 0.08 m. Alt 10–200 m. WC
spongiosa (L.Bolus) H.E.K.Hartmann
Cephalophyllum spongiosum (L.Bolus) L.Bolus (4)
Perennial. Succulent. Ht up to 0.3 m. Alt 20–150 m. NC
uniflora (L.Bolus) H.E.K.Hartmann
Cephalophyllum uniflorum L.Bolus (3)
Perennial. Succulent. Ht up to 0.08 m. Alt 10–100 m. NC

JUTTADINTERIA Schwantes 2405063
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 273.
(2) Bolus. 1958. *The Flowering Plants of Africa* 32: t. 1273.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 70–72.
albata (L.Bolus) L.Bolus
Mesembryanthemum albatum L.Bolus (3)
Perennial. Succulent. Ht up to 0.2 m. Alt 50–590 m. N, NC
attenuata Walgate
Perennial. Succulent. Ht up to 0.1 m. Alt? N, NC
ausensis (L.Bolus) Schwantes
J. suavissima (Dinter) Schwantes (3)
Perennial. Succulent. Ht up to 0.15 m. Alt up to 1700 m. N
decumbens Schick & Tischer = **J. deserticola**
deserticola (Marloth) Schwantes
J. decumbens Schick & Tischer (3)
J. elizae (Dinter & A.Berger) L.Bolus (3)
J. insolita (L.Bolus) L.Bolus (3)
J. tetrasepala L.Bolus (3)
Perennial. Succulent. Ht up to 0.25 m. Alt 50–750 m. N, NC
elizae (Dinter & A.Berger) L.Bolus = **J. deserticola**
insolita (L.Bolus) L.Bolus = **J. deserticola**
kovisimontana (Dinter) Schwantes = **J. simpsonii**
longipetala L.Bolus = **Namibia cinerea**
proxima L.Bolus = **Dracophilus dealbatus**
simpsonii (Dinter) Schwantes
J. kovisimontana (Dinter) Schwantes (3)
Perennial. Succulent. Ht up to 0.25 m. Alt 530–590 m. N
suavissima (Dinter) Schwantes = **J. ausensis**
tetrasepala L.Bolus = **J. deserticola**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

KENSITIA Fedde 2405064
pillansii (Kensit) Fedde = **Erepsia pillansii**

KHADIA N.E.Br. 2405065
(1) Bolus. 1958. *The Flowering Plants of Africa* 32: t. 1263.
(2) Chesselet & Hartmann. 1995. *Aloe* 32: 46–49.
(3) Chesselet *et al.* 1998. *Bothalia* 28: 25–33.
(4) Winter & Hahn. 1999. *Aloe* 36: 16–19.
(5) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 72–74.
acutipetala (N.E.Br.) N.E.Br.
K. nationae (N.E.Br.) N.E.Br. (2)
Perennial. Succulent. Ht up to 0.05 m. Alt 1200–1779 m. NW, G
alticola Chesselet & H.E.K.Hartmann
Perennial. Succulent. Ht up to 0.1 m. Alt up to 2331 m. M, KZN
beswickii (L.Bolus) N.E.Br.
K. nelsoniae N.E.Br. (2)
Perennial. Succulent. Ht up to 0.08 m. Alt 1600–1700 m. G
borealis L.Bolus
Perennial. Succulent. Ht up to 0.05 m. Alt 1500–1730 m. NP
carolinensis (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.8 m. Alt 1690–2015 m. M
media P.Winter & N.Hahn
Perennial. Succulent. Ht up to 0.1 m. Alt 1500–1870 m. NP
nationae (N.E.Br.) N.E.Br. = **K. acutipetala**
nelsoniae N.E.Br. = **K. beswickii**

LAMPRANTHUS N.E.Br. 2405066
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: tt. 253, 263.
(2) Bolus. 1931. *The Flowering Plants of South Africa* 11: t. 413.
(3) Bolus. 1947. *The Flowering Plants of Africa* 26: t. 1012.
(4) Bolus. 1949. *The Flowering Plants of Africa* 27: t. 1064.
(5) Hartmann. 1998. *Bradleya* 16: 44–91.
(6) Hartmann. 1999. *Bradleya* 17: 38–74.
(7) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 75–108.
(8) Klak. 2001. *Phylogeny and character evolution in the* Lampranthus *group (Aizoaceae–Ruschioideae).* Unpublished Ph.D. thesis, University of Cape Town.
(9) Hartmann. 2001. *Bradleya* 19: 83–90.
acrosepalus (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.18–0.25 m. Alt 600–800 m. WC
acutifolius (L.Bolus) N.E.Br.
Perennial. Succulent. Ht ± 0.4 m. Alt 330–750 m. WC
aduncus (Haw.) N.E.Br.
Perennial. Succulent. Ht? Alt? 'CP'
aestivus (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.2–0.3 m. Alt 500–1010 m. WC
affinis L.Bolus
Perennial. Succulent. Ht 0.4–0.6 m. Alt 300–1050 m. WC
albus (L.Bolus) L.Bolus = **Oscularia alba**
algoensis L.Bolus
Perennial. Succulent. Ht? Alt 20–100 m. EC
alpinus (L.Bolus) G.D.Rowley = **Esterhuysenia alpina**
altistylus N.E.Br.
Perennial. Succulent. Ht up to 0.15 m. Alt 200–880 m. WC
amabilis L.Bolus
Perennial. Succulent. Ht? Alt 30–360 m. WC
amoenus (Salm-Dyck ex DC.) N.E.Br.
Perennial. Succulent. Ht up to 0.15 m. Alt 200–880 m. WC
amphibolius (G.D.Rowley) H.E.K.Hartmann
Amphibolia hallii (L.Bolus) L.Bolus ex Toelken & Jessop (5)
Ruschia amphibolia G.D.Rowley (5)
Stoeberia hallii L.Bolus (5)
Perennial. Succulent. Ht? Alt? 'CP'

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

antemeridianus (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.5 m. Alt 50–450 m. WC
antonii L.Bolus
Perennial. Succulent. Ht? Alt 500–850 m. WC
arbuthnotiae (L.Bolus) L.Bolus
Perennial. Succulent, creeping. Ht 0.1–0.15 m. Alt? WC
arenarius H.E.K.Hartmann
Ruschia arenosa L.Bolus (5)
Perennial. Succulent. Ht 0.2–0.3 m. Alt 850–1500 m. NC
arenicola L.Bolus
Perennial. Succulent. Ht? Alt? WC
arenosus (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.2–0.3 m. Alt 300–650 m. WC
argenteus (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.23–0.4 m. Alt 300–800 m. WC
argillosus L.Bolus
Perennial. Succulent. Ht ± 0.2 m. Alt? WC
aurantiacus (DC.) Schwantes = **L. glaucoides**
aureus (L.) N.E.Br.
Perennial. Succulent. Ht 0.2–0.25 m. Alt 20–200 m. WC
austricola (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.2–0.3 m. Alt 500–1010 m. WC
baylissii L.Bolus
Perennial. Succulent. Ht up to 0.5 m. Alt 50–450 m. WC
berghiae (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.5 m. Alt 600–1070 m. WC
bicolor (L.) N.E.Br.
Perennial. Succulent. Ht up to 0.5 m. Alt 50–450 m. WC
bicolorus (L.) N.E.Br.
Perennial. Succulent. Ht up to 0.5 m. Alt 50–450 m. WC
bicolorus (L.) N.E.Br. var. *inaequale* (Haw.) Schwantes = **L. inaequalis**
blandus (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.6 m. Alt 50–1000 m. WC, EC
bolusiae Schwantes ex H.Jacobsen = **L. dilutus**
borealis L.Bolus
Perennial. Succulent. Ht 0.18–0.25 m. Alt 20–470 m. N, NC
brachyandrus (L.Bolus) N.E.Br.
Perennial. Succulent. Ht up to 0.7 m. Alt 250–1000 m. N, NC
brevistaminus (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.14 m. Alt 1100–2000 m. WC
brownii (Hook.f.) N.E.Br.
Perennial. Succulent. Ht 0.15–0.3 m. Alt 20–120 m. WC
caespitosus (L.Bolus) N.E.Br.
L. caespitosus (L.Bolus) N.E.Br. var. *luxurians* (L.Bolus) H.Jacobsen (7)
Perennial. Succulent, creeping. Ht 0.1–0.15 m. Alt? WC
caespitosus (L.Bolus) N.E.Br. var. *luxurians* (L.Bolus) H.Jacobsen = **L. caespitosus**
calcaratus (Wolley-Dod) N.E.Br.
Perennial. Succulent. Ht up to 0.26 m. Alt 20–80 m. WC
candidus L.Bolus
Perennial. Succulent. Ht 0.25–0.3 m. Alt 300–980 m. WC
capillaceus (L.Bolus) N.E.Br.
Perennial. Succulent. Ht up to 0.3 m. Alt? WC
capornii (L.Bolus) L.Bolus = **Ruschia capornii**
caudatus L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 20–190 m. WC
cedarbergensis (L.Bolus) L.Bolus = **Oscularia cedarbergensis**
ceriseus (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 100–320 m. WC
citrinus (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.15–0.25 m. Alt 20–550 m. WC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

coccineus (Haw.) N.E.Br.
Perennial. Succulent. Ht 0.15–0.3 m. Alt 20–120 m. WC
compressus L.Bolus = **Oscularia compressa**
comptonii (L.Bolus) N.E.Br. forma *roseus* (L.Bolus) G.D.Rowley = **Oscularia comptonii**
comptonii (L.Bolus) N.E.Br. var. *angustifolius* (L.Bolus) L.Bolus forma *angustifolius* = **Oscularia comptonii**
comptonii (L.Bolus) N.E.Br. var. *angustifolius* (L.Bolus) L.Bolus forma *roseus* (L.Bolus) G.D.Rowley = **Oscularia comptonii**
comptonii (L.Bolus) N.E.Br. var. *comptonii* = **Oscularia comptonii**
comptonii (L.Bolus) N.E.Br. var. *roseus* (L.Bolus) L.Bolus ex H.Jacobsen = **Oscularia comptonii**
conspicuus (Haw.) N.E.Br.
Perennial. Succulent. Ht 0.4–0.6 m. Alt? WC
convexus (L.Bolus) L.Bolus
Perennial. Succulent. Ht? Alt 300–800 m. WC
coralliflorus (Salm-Dyck) N.E.Br.
Perennial. Succulent. Ht 0.4–0.6 m. Alt? EC
creber L.Bolus
Perennial. Succulent. Ht 0.15–0.3 m. Alt 110–300 m. WC
curviflorus (Haw.) H.E.K.Hartmann
Perennial. Succulent. Ht up to 0.6 m. Alt 50–1000 m. WC, EC
curvifolius (Haw.) N.E.Br.
Perennial. Succulent. Ht? Alt? 'CP'
curvifolius (Haw.) N.E.Br. var. *minor* (Salm-Dyck) G.D.Rowley = **L. flexifolius**
cyathiformis (L.Bolus) N.E.Br.
Perennial. Succulent. Ht ± 0.2 m. Alt? 'CP'
debilis (Haw.) N.E.Br.
Perennial. Succulent, creeping. Ht 0.1–0.15 m. Alt? WC
deflexus (Aiton) N.E.Br.
Perennial. Succulent. Ht? Alt? WC
deltoides (L.) Glen = **Oscularia deltoides**
deltoides (L.) Glen var. *caulescens* (Mill.) G.D.Rowley = **Oscularia caulescens**
densifolius (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.15–0.3 m. Alt 150–320 m. WC
densipetalus (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.26 m. Alt up to 1200 m. NC
dependens (L.Bolus) L.Bolus
Perennial. Succulent. Ht? Alt 50–650 m. WC
diffusus (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.3–0.4 m. Alt 500–850 m. WC
dilutus N.E.Br.
L. bolusiae Schwantes ex H.Jacobsen (8)
Mesembryanthemum pallidum L.Bolus (7)
Perennial. Succulent. Ht 0.15–0.3 m. Alt 110–300 m. WC
disgregus (N.E.Br.) N.E.Br.
Perennial. Succulent. Ht 0.3–0.6 m. Alt 120–1010 m. NC, WC
dissimilis (G.D.Rowley) H.E.K.Hartmann
Amphibolia staynerii L.Bolus ex Toelken & Jessop (5)
Amphibolia stayneri L.Bolus, illegitimate name (5)
Ruschia dissimilis G.D.Rowley (5)
Perennial. Succulent. Ht up to 0.05 m. Alt 500–900 m. WC
diutinus (L.Bolus) N.E.Br.
Perennial. Succulent. Ht up to 0.2 m. Alt 100–320 m. WC
dregeanus (Sond.) N.E.Br.
Perennial. Succulent. Ht 0.4–0.6 m. Alt 300–600 m. WC
drepanophyllus (Schltr. & A.Berger) N.E.Br. = **Esterhuysenia drepanophylla**
dubitans (L.Bolus) L.Bolus
Ruschia dubitans (L.Bolus) L.Bolus (7)
Perennial. Succulent. Ht ± 0.16 m. Alt? WC
dulcis (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.2–0.4 m. Alt 300–980 m. WC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

dyckii (A.Berger) N.E.Br.
Perennial. Succulent. Ht 0.3–0.6 m. Alt 120–1010 m. NC, WC
ebracteatus L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt? WC
edwardsiae (L.Bolus) L.Bolus
Perennial. Succulent. Ht? Alt 300–600 m. WC
egregius (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.4–0.6 m. Alt 300–1050 m. WC
elegans (Jacq.) Schwantes
Perennial. Succulent. Ht up to 0.35 m. Alt 20–650 m. WC
emarginatoides (Haw.) N.E.Br.
Perennial. Succulent. Ht up to 0.2 m. Alt 20–150 m. WC
emarginatus (L.) N.E.Br.
L. emarginatus (L.) N.E.Br. var. *puniceus* (Jacq.) Schwantes (7)
Perennial. Succulent. Ht up to 0.2 m. Alt 20–150 m. WC
emarginatus (L.) N.E.Br. var. *puniceus* (Jacq.) Schwantes = **L. emarginatus**
ernestii (L.Bolus) L.Bolus
Perennial. Succulent, creeping. Ht 0.1–0.15 m. Alt? WC
erratus N.E.Br.
Perennial. Succulent. Ht? Alt? WC, EC
esterhuyseniae L.Bolus
Perennial. Succulent. Ht 0.2–0.4 m. Alt 300–980 m. NC
excedens (L.Bolus) L.Bolus = **Oscularia excedens**
eximius L.Bolus
Perennial. Succulent. Ht 0.15–0.3 m. Alt 150–320 m. WC
explanatus (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.03–0.08 m. Alt 10–100 m. WC
falcatus (L.) N.E.Br.
L. falcatus (L.) N.E.Br. var. *galpinii* (L.Bolus) L.Bolus (7)
Perennial. Succulent. Ht up to 0.3 m. Alt? WC
falcatus (L.) N.E.Br. var. *galpinii* (L.Bolus) L.Bolus = **L. falcatus**
falciformis (Haw.) N.E.Br.
L. falciformis (Haw.) N.E.Br. var. *maritimus* (L.Bolus) L.Bolus (8)
Mesembryanthemum falciforme Haw. (8)
Mesembryanthemum maritimum L.Bolus, illegitimate name (8)
Oscularia falciformis (Haw.) H.E.K.Hartmann (8)
Perennial. Succulent. Ht 0.19–0.3 m. Alt 300–980 m. WC
falciformis (Haw.) N.E.Br. var. *maritimus* (L.Bolus) L.Bolus = **L. falciformis**
fergusoniae (L.Bolus) L.Bolus
L. fergusoniae (L.Bolus) L.Bolus var. *crassistigma* L.Bolus (7)
Perennial. Succulent. Ht? Alt? WC
fergusoniae (L.Bolus) L.Bolus var. *crassistigma* L.Bolus = **L. fergusoniae**
filicaulis (Haw.) N.E.Br.
Perennial. Succulent. Ht up to 0.03 m. Alt 20–80 m. WC
flexifolius (Haw.) N.E.Br.
L. curvifolius (Haw.) N.E.Br. var. *minor* (Salm-Dyck) G.D.Rowley (7)
Perennial. Succulent. Ht? Alt? 'CP'
flexilis (Haw.) N.E.Br.
Perennial. Succulent. Ht up to 0.35 m. Alt 20–650 m. WC
foliosus L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 100–320 m. WC
formosus (Haw.) N.E.Br.
Perennial. Succulent, creeping. Ht up to 0.1 m. Alt? EC
framesii (L.Bolus) N.E.Br.
Perennial. Succulent. Ht up to 0.3 m. Alt? WC
francesiae H.E.K.Hartmann
Ruschia leightoniae L.Bolus (5)
Perennial. Succulent. Ht up to 0.12 m. Alt 300–850 m. WC
franciscii L.Bolus
Perennial. Succulent. Ht up to 0.6 m. Alt 500–950 m. WC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

fugitans L.Bolus
Perennial. Succulent, creeping. Ht up to 0.1 m. Alt? EC
furvus (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.2–0.3 m. Alt 500–1010 m. WC
galpiniae (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.15–0.2 m. Alt 20–220 m. WC
glaucoides (Haw.) N.E.Br.
L. aurantiacus (DC.) Schwantes (7)
Perennial. Succulent. Ht 0.2–0.25 m. Alt 20–100 m. WC
glaucus (L.) N.E.Br.
L. glaucus (L.) N.E.Br. var. *tortuosus* (Salm-Dyck) Schwantes (8)
Perennial. Succulent. Ht 0.15–0.25 m. Alt 20–550 m. WC
glaucus (L.) N.E.Br. var. *tortuosus* (Salm-Dyck) Schwantes = **L. glaucus**
globosus (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.2–0.4 m. Alt 300–980 m. WC
glomeratus (L.) N.E.Br.
Perennial. Succulent. Ht 0.2–0.3 m. Alt 500–1010 m. WC
godmaniae (L.Bolus) L.Bolus
L. godmaniae (L.Bolus) L.Bolus var. *grandiflorus* (L.Bolus) L.Bolus (7)
Perennial. Succulent. Ht 0.5–0.7 m. Alt up to 1200 m. NC
godmaniae (L.Bolus) L.Bolus var. *grandiflorus* (L.Bolus) L.Bolus = **L. godmaniae**
gracilipes (L.Bolus) N.E.Br.
L. gracilipes (L.Bolus) N.E.Br. forma *luxurians* L.Bolus (8)
Perennial. Succulent. Ht 0.2–0.4 m. Alt 300–980 m. NC, WC
gracilipes (L.Bolus) N.E.Br. forma *luxurians* L.Bolus = **L. gracilipes**
guthrieae (L.Bolus) N.E.Br. = **Oscularia guthriae**
gydouwensis L.Bolus
Amphibolia gydouwensis (L.Bolus) L.Bolus ex Toelken & Jessop (7)
Ruschia gydouwensis (L.Bolus) G.D.Rowley (7)
Perennial. Shrub, succulent. Ht up to 0.45 m. Alt 300–550 m. WC
hallii L.Bolus
Perennial. Succulent. Ht up to 0.36 m. Alt 150–380 m. WC
haworthii (Haw.) N.E.Br.
Perennial. Succulent. Ht 0.4–0.6 m. Alt 300–1050 m. WC
henricii (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.2–0.35 m. Alt 300–1000 m. WC
hiemalis (L.Bolus) L.Bolus
Perennial. Succulent. Ht? Alt 300–1000 m. WC
hoerleinianus (Dinter) Friedrich
Perennial. Succulent. Ht up to 0.7 m. Alt 250–1000 m. N, NC
holensis L.Bolus
Perennial. Succulent. Ht 0.2–0.4 m. Alt 120–270 m. NC
hollandii (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 10–350 m. EC
hurlingii (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.3–0.45 m. Alt 300–450 m. WC
imbricans (Haw.) N.E.Br.
Perennial. Succulent. Ht up to 0.2 m. Alt 20–150 m. WC
immelmaniae (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.15–0.3 m. Alt 150–320 m. WC
inaequalis (Haw.) N.E.Br.
L. bicolorus (L.) N.E.Br. var. *inaequale* (Haw.) Schwantes (7)
Perennial. Succulent. Ht up to 0.3 m. Alt 50–450 m. WC
inconspicuus (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.25 m. Alt 100–340 m. WC
incurvus (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.6 m. Alt 50–1000 m. WC, EC
intervallaris L.Bolus
Perennial. Succulent. Ht up to 0.16 m. Alt 800–1150 m. WC
laetus (L.Bolus) L.Bolus

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.35 m. Alt 20–650 m. WC
lavisii (L.Bolus) L.Bolus
L. lavisii (L.Bolus) L.Bolus var. *concinnus* L.Bolus (8)
Perennial. Succulent. Ht 0.25–0.35 m. Alt 100–400 m. EC
lavisii (L.Bolus) L.Bolus var. *concinnus* L.Bolus = **L. lavisii**
laxifolius (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.15–0.25 m. Alt? WC
leightoniae (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.5 m. Alt 600–1070 m. WC
leipoldtii (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.4 m. Alt 300–600 m. WC
leptaleon (Haw.) N.E.Br.
Perennial. Succulent. Ht up to 0.15. Alt 200–880 m. WC
leptosepalus (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.4 m. Alt 300–850 m. WC
lerouxiae (L.Bolus) N.E.Br. = **Ruschia lerouxii**
lewisiae (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.075 m. Alt 800–900 m. WC
liberalis (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.35 m. Alt 20–650 m. WC
littlewoodii L.Bolus
Perennial. Succulent. Ht 0.2–0.4 m. Alt 300–980 m. NC, WC
longistamineus (L.Bolus) N.E.Br.
Perennial. Succulent. Ht up to 0.2 m. Alt 300–850 m. WC
lunatus (Willd.) N.E.Br. = **Oscularia lunata**
lunulatus (A.Berger) L.Bolus
Perennial. Succulent. Ht? Alt 300–850 m. WC
macrocarpus (A.Berger) N.E.Br.
Perennial. Succulent, creeping. Ht up to 0.1 m. Alt? EC
macrosepalus (L.Bolus) L.Bolus
Perennial. Succulent, creeping. Ht up to 0.1 m. Alt? EC
macrostigma L.Bolus
Perennial. Succulent. Ht 0.13–0.22 m. Alt 300–950 m. WC
magnificus (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.1–0.15 m. Alt 30–1000 m. WC
marcidulus N.E.Br.
Perennial. Succulent. Ht 0.2–0.25 m. Alt 20–100 m. WC
marginatus (L.Bolus) H.E.K.Hartmann
Ruschia marginata L.Bolus (5)
Perennial. Succulent. Ht? Alt 300–980 m. WC
mariae (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.2–0.35 m. Alt 300–1000 m. WC
martleyi (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.5 m. Alt 600–1070 m. WC
maturus N.E.Br.
Perennial. Succulent. Ht up to 0.15. Alt 200–880 m. WC
matutinus (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.2–0.25 m. Alt 20–100 m. WC
microsepalus L.Bolus
Perennial. Succulent. Ht up to 0.15. Alt 200–880 m. WC
microstigma (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.3–0.4 m. Alt 500–850 m. WC
middlemostii (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.15–0.2 m. Alt ± 700 m. WC
montaguensis (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.23–0.4 m. Alt 300–800 m. WC
monticola (L.Bolus) L.Bolus = **L. stenus**
mucronatus L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 700–1400 m. WC
multiradiatus (Jacq.) N.E.Br.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.6 m. Alt 50–1000 m. WC, EC
multiseriatus (L.Bolus) N.E.Br.
Perennial. Succulent. Ht up to 0.2 m. Alt 100–320 m. WC
mutans (L.Bolus) N.E.Br.
Perennial. Succulent. Ht? Alt 100–350 m. EC
mutatus (G.D.Rowley) H.E.K.Hartmann
Amphibolia littlewoodii (L.Bolus) L.Bolus ex Toelken & Jessop (5)
Ruschia mutata G.D.Rowley (5)
Stoeberia littlewoodii L.Bolus (5)
Perennial. Succulent. Ht? Alt 300–1000 m. WC
nardouwensis (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.23–0.4 m. Alt 300–800 m. WC
nelii L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt 100–340 m. WC
neostayneri L.Bolus
Perennial. Succulent. Ht 0.15–0.3 m. Alt 110–300 m. WC
obconicus (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.2–0.3 m. Alt 820–1500 m. NC, WC
occultans L.Bolus
Perennial. Succulent. Ht 0.3–0.4 m. Alt 500–850 m. WC
ornatus L.Bolus = **Oscularia ornata**
otzenianus (Dinter) Friedrich
Drosanthemum otzenianum (Dinter) Friedrich (7)
L. uniflorus (L.Bolus) L.Bolus var. *spathulatus* L.Bolus ex H.Jacobsen (7)
Psilocaulon otzenianum (Dinter) L.Bolus (7)
Perennial. Succulent. Ht 0.2–0.45 m. Alt up to 1200 m. N, NC, WC
paardebergensis (L.Bolus) L.Bolus = **Oscularia paardebergensis**
paarlensis L.Bolus
Perennial. Succulent. Ht 0.2–0.3 m. Alt 180–300 m. WC
pakhuisensis (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.5 m. Alt 600–1070 m. WC
pakpassensis H.E.K.Hartmann
Ruschia pakhuisensis L.Bolus (5)
Perennial. Succulent. Ht up to 0.3 m. Alt 450–950 m. WC
palustris (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.15–0.25 m. Alt 20–550 m. WC
parcus N.E.Br.
Perennial. Succulent. Ht up to 0.15. Alt 200–880 m. WC
pauciflorus (L.Bolus) N.E.Br.
Perennial. Succulent. Ht up to 0.3 m. Alt 900–1500 m. WC, EC
paucifolius (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.2–0.3 m. Alt 820–1500 m. NC, WC
peacockiae (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.02–0.04 m. Alt 240–360 m. WC
peersii (L.Bolus) N.E.Br.
Perennial. Succulent. Ht up to 0.35 m. Alt 250–440 m. WC
perreptans L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 100–320 m. WC
persistens (L.Bolus) L.Bolus
Perennial. Succulent. Ht? Alt 1200–1780 m. WC
piquetbergensis (L.Bolus) L.Bolus = **Oscularia piquetbergensis**
plautus N.E.Br.
Perennial. Succulent. Ht ± 0.26 m. Alt up to 1200 m. NC
pleniflorus L.Bolus
Perennial. Succulent. Ht? Alt 300–650 m. WC
plenus (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.5 m. Alt 600–1070 m. WC
pocockiae (L.Bolus) N.E.Br.
Perennial. Succulent. Ht up to 0.14 m. Alt 1100–2000 m. WC
polyanthon (Haw.) N.E.Br.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.35 m. Alt 20–650 m. WC
praecipitatus (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.35 m. Alt 190–450 m. EC
prasinus L.Bolus = **Oscularia prasina**
productus (Haw.) N.E.Br.
L. productus (Haw.) N.E.Br. var. *lepidus* (Haw.) Schwantes (7)
L. productus (Haw.) N.E.Br. var. *purpureus* (L.Bolus) L.Bolus (7)
Perennial. Succulent. Ht up to 0.35 m. Alt 190–450 m. WC, EC
productus (Haw.) N.E.Br. var. *lepidus* (Haw.) Schwantes = **L. productus**
productus (Haw.) N.E.Br. var. *purpureus* (L.Bolus) L.Bolus = **L. productus**
profundus (L.Bolus) H.E.K.Hartmann
Ruschia profunda L.Bolus (5)
Perennial. Succulent. Ht up to 0.35 m. Alt 300–980 m. WC
prominulus (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.35 m. Alt 20–650 m. WC
promontorii (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.2–0.25 m. Alt 50–310 m. WC
proximus L.Bolus
Perennial. Succulent. Ht 0.15–0.3 m. Alt 110–300 m. WC
punctulatus (L.Bolus) L.Bolus = **Ruschia punctulata**
purpureus L.Bolus
Perennial. Succulent. Ht up to 0.4 m. Alt 300–600 m. WC
rabiesbergensis (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.3–0.4 m. Alt 500–850 m. WC
recurvus (L.Bolus) Schwantes
Perennial. Succulent. Ht 0.15–0.3 m. Alt 110–300 m. WC
reptans (Aiton) N.E.Br.
Perennial. Succulent, creeping. Ht 0.04–0.08 m. Alt 30–300 m. WC
roseus (Willd.) Schwantes
Perennial. Succulent. Ht up to 0.6 m. Alt 50–1000 m. WC, EC
ruber (L.Bolus) L.Bolus = **Astridia rubra**
rubroluteus (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.18–0.25 m. Alt 600–800 m. WC
rupestris (L.Bolus) N.E.Br.
Perennial. Succulent. Ht up to 0.15 m. Alt 100–330 m. WC
rustii (A.Berger) N.E.Br.
Perennial. Succulent. Ht up to 0.35 m. Alt 20–650 m. WC
salicola (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.2–0.3 m. Alt 300–650 m. WC
salteri (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 100–320 m. WC
saturatus (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.3–0.6 m. Alt 120–1010 m. NC, WC
sauerae (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.15–0.3 m. Alt 20–120 m. WC
scaber (L.) N.E.Br.
Perennial. Succulent. Ht 0.2–0.3 m. Alt 180–300 m. WC
schlechteri (Zahlbr.) L.Bolus
Perennial. Succulent. Ht 0.2–0.3 m. Alt ± 160 m. WC
serpens (L.Bolus) L.Bolus
Perennial. Succulent, creeping. Ht 0.04–0.08 m. Alt 30–300 m. WC
simulans L.Bolus
Perennial. Succulent. Ht 0.2–0.3 m. Alt 40–300 m. WC
sociorum (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.04–0.05 m. Alt 140–320 m. WC
sparsiflorus L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 900–1500 m. WC, EC
spectabilis (Haw.) N.E.Br.
Perennial. Succulent, creeping. Ht up to 0.1 m. Alt? EC
spiniformis (Haw.) N.E.Br.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.25 m. Alt 100–340 m. WC
staminodiosus (L.Bolus) Schwantes
Perennial. Succulent. Ht 0.13–0.22 m. Alt 300–950 m. WC
stanfordiae L.Bolus
Perennial. Succulent. Ht 0.2–0.25 m. Alt 20–100 m. WC
stayneri (L.Bolus) N.E.Br.
Perennial. Succulent. Ht up to 0.35 m. Alt 190–450 m. EC
steenbergensis (L.Bolus) L.Bolus = **Oscularia steenbergensis**
stenopetalus (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.12–0.25 m. Alt 170–350 m. WC
stenus (Haw.) N.E.Br.
L. monticola (L.Bolus) L.Bolus (7)
Perennial. Succulent. Ht up to 0.3 m. Alt 30–900 m. WC
stephanii (Schwantes) Schwantes
Perennial. Succulent. Ht? Alt? WC
sternens L.Bolus
Perennial. Succulent. Ht 0.03–0.08 m. Alt 10–100 m. WC
stipulaceus (L.) N.E.Br.
Mesembryanthemum stipulaceum L. (9)
Perennial. Succulent. Ht up to 0.4 m. Alt 50–320 m. WC
suavissimus (L.Bolus) L.Bolus
L. suavissimus (L.Bolus) L.Bolus var. *oculatus* (L.Bolus) L.Bolus (7)
L. suavissimus (L.Bolus) L.Bolus var. *suavissimus* forma *fera* (L.Bolus) L.Bolus (7)
Perennial. Succulent. Ht up to 0.7 m. Alt 250–1000 m. N, NC
suavissimus (L.Bolus) L.Bolus var. *oculatus* (L.Bolus) L.Bolus = **L. suavissimus**
suavissimus (L.Bolus) L.Bolus var. *suavissimus* forma *fera* (L.Bolus) L.Bolus = **L. suavissimus**
subaequalis (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.28 m. Alt 950–1150 m. WC
sublaxus (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.16 m. Alt 800–1150 m. WC
subrotundus L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 20–150 m. WC
subtruncatus L.Bolus
L. subtruncatus L.Bolus var. *wupperthalensis* L.Bolus (7)
Perennial. Succulent. Ht up to 0.5 m. Alt 600–1070 m. WC
subtruncatus L.Bolus var. *wupperthalensis* L.Bolus = **L. subtruncatus**
superans (L.Bolus) L.Bolus = **Oscularia superans**
swartbergensis (L.Bolus) N.E.Br.
Perennial. Succulent. Ht? Alt 1100–2130 m. WC
swartkopensis Strohschneider
Perennial. Succulent. Ht? Alt? 'SA'
tegens (F.Muell.) N.E.Br.
Perennial. Succulent, creeping. Ht 0.1–0.15 m. Alt? WC
tenuifolius (L.) N.E.Br.
Perennial. Succulent. Ht 0.1–0.15 m. Alt 30–1000 m. WC
tenuis L.Bolus
Perennial. Succulent. Ht up to 0.26 m. Alt 20–80 m. WC
thermarum (L.Bolus) L.Bolus = **Oscularia thermarum**
tulbaghensis (A.Berger) N.E.Br.
Perennial. Succulent. Ht up to 0.3 m. Alt? WC
turbinatus (Jacq.) N.E.Br.
Perennial. Succulent, creeping. Ht up to 0.1 m. Alt? EC
uncus (L.Bolus) Schwantes
Ruschia unca (L.Bolus) L.Bolus (7)
Perennial. Succulent. Ht up to 0.25 m. Alt 2000–2200 m. WC
uniflorus (L.Bolus) L.Bolus
Drosanthemum uniflorum (L.Bolus) Friedrich ex H.Jacobsen (7)
Perennial. Shrub, succulent. Ht 0.2–0.45 m. Alt 600–1400 m. NC, WC
uniflorus (L.Bolus) L.Bolus var. *spathulatus* L.Bolus ex H.Jacobsen = **L. otzenianus**
vallis-gratiae (Schltr. & A.Berger) N.E.Br.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht 0.15–0.2 m. Alt ± 700 m. WC
vanheerdei L.Bolus
Perennial. Succulent. Ht 0.2–0.4 m. Alt 300–980 m. NC
vanputtenii (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.3–0.6 m. Alt 120–1010 m. WC
vanzijliae (L.Bolus) N.E.Br.
Perennial. Succulent, creeping. Ht 0.05–0.12 m. Alt 300–550 m. WC
variabilis (Haw.) N.E.Br.
Perennial. Succulent. Ht 0.15–0.3 m. Alt 20–120 m. WC
verecundus (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.15–0.2 m. Alt ± 700 m. WC
vernalis (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.2–0.3 m. Alt 300–650 m. WC
vernicolor (L.Bolus) L.Bolus = **Oscularia vernicolor**
verruculatus (L.) L.Bolus = **Scopelogena verruculata**
viatorum (L.Bolus) N.E.Br.
Perennial. Succulent. Ht? Alt 500–1100 m. NC
villiersii (L.Bolus) L.Bolus
Perennial. Succulent. Ht 0.12–0.25 m. Alt 170–350 m. WC
violaceus (DC.) Schwantes in H.Jacobsen
Perennial. Succulent. Ht up to 0.2 m. Alt 20–150 m. WC
virgatus L.Bolus
Perennial. Succulent. Ht 0.2–0.3 m. Alt 180–300 m. WC
vredenburgensis L.Bolus = **Oscularia vredenburgensis**
walgateae L.Bolus
Perennial. Succulent. Ht up to 0.4 m. Alt 300–850 m. WC
watermeyeri (L.Bolus) N.E.Br.
Perennial. Succulent. Ht 0.3–0.6 m. Alt 120–1010 m. NC
woodburniae (L.Bolus) N.E.Br.
Perennial. Succulent, creeping. Ht 0.04–0.08 m. Alt 30–300 m. WC
wordsworthiae (L.Bolus) N.E.Br.
Perennial. Succulent. Ht up to 0.03 m. Alt? WC
zeyheri (Salm-Dyck) N.E.Br.
Perennial. Succulent. Ht up to 0.35 m. Alt 190–450 m. EC

LAPIDARIA (Dinter & Schwantes) N.E.Br. 2405067
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 109.
margaretae (Schwantes) Dinter & Schwantes
Perennial. Succulent. Ht up to 0.08 m. Alt 660–1100 m. N, NC

LEIPOLDTIA L.Bolus 2405068
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: tt. 256, 260.
(2) Hartmann. 1983. *Bibliographia Botanica* 136: 1–67.
(3) Hartmann. 1988. *Mitteilungen aus dem Institut für Allgemeine Botanik, Hamburg* 22: 93–187.
(4) Hartmann & Stüber. 1993. *Contributions from the Bolus Herbarium* 15: 1–75.
(5) Hartmann & Rust. 1994. *Verhandelungen des Naturwissenschaftlichen Vereins Hamburg* 34: 275–351.
(6) Hartmann. 1999. *Bradleya* 17: 38–74.
(7) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 109–114.
alborosea (L.Bolus) H.E.K.Hartmann & Stüber
Eberlanzia vanheerdei L.Bolus (4)
Mesembryanthemum alboroseum L.Bolus (7)
Perennial. Succulent. Ht up to 0.3 m. Alt 200–1200 m. N, NC
amplexicaulis (L.Bolus) L.Bolus forma *amplexicaulis* = **L. schultzei**
amplexicaulis (L.Bolus) L.Bolus forma *fera* L.Bolus = **L. schultzei**
aprica (A.Berger) L.Bolus = **L. schultzei**
brevifolia L.Bolus = **L. schultzei**
britteniae (L.Bolus) L.Bolus = **L. schultzei**
calandra (L.Bolus) L.Bolus
Mesembryanthemum calandrum L.Bolus (5)
Perennial. Succulent. Ht up to 0.11 m. Alt up to 1200 m. NC
compacta L.Bolus
Ruschia gibbosa L.Bolus (6)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.08 m. Alt 900–1200 m. NC
compressa L.Bolus var. *compressa* = **Hallianthus planus**
compressa L.Bolus var. *lekkersingensis* L.Bolus = **Hallianthus planus**
constricta (L.Bolus) L.Bolus = **L. schultzei**
framesii L.Bolus = **L. laxa**
frutescens (L.Bolus) H.E.K.Hartmann
Cephalophyllum frutescens L.Bolus (2)
Cephalophyllum frutescens L.Bolus var. *decumbens* L.Bolus (3)
Perennial. Succulent. Ht up to 0.6 m. Alt 30–180 m. NC, WC
herrei (Schwantes) Schwantes = **L. schultzei**
jacobseniana Schwantes = **L. schultzei**
klaverensis L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 120–350 m. NC, WC
laxa L.Bolus
L. framesii L.Bolus (5)
Perennial. Succulent. Ht up to 0.35 m. Alt 190–650 m. NC, WC
lunata H.E.K.Hartmann & Rust
Perennial. Succulent. Ht up to 0.4 m. Alt 190–1220 m. NC
nelii L.Bolus = **L. schultzei**
pauciflora L.Bolus = **L. schultzei**
plana L.Bolus = **Hallianthus planus**
rosea L.Bolus
Cephalophyllum calvinianum L.Bolus (5)
Cephalophyllum roseum (L.Bolus) L.Bolus (3)
Perennial. Succulent. Ht up to 0.1 m. Alt 180–320 m. NC, WC
schultzei (Schltr. & Diels) Friedrich
L. amplexicaulis (L.Bolus) L.Bolus forma *amplexicaulis* (5)
L. amplexicaulis (L.Bolus) L.Bolus forma *fera* L.Bolus (5)
L. aprica (A.Berger) L.Bolus (5)
L. brevifolia L.Bolus (5)
L. britteniae (L.Bolus) L.Bolus (5)
L. constricta (L.Bolus) L.Bolus (5)
L. herrei (Schwantes) Schwantes (5)
L. jacobseniana Schwantes (5)
L. nelii L.Bolus (5)
L. pauciflora L.Bolus (5)
Mesembryanthemum amplexicaulis L.Bolus (5)
Mesembryanthemum apricum A.Berger (5)
Mesembryanthemum britteniae L.Bolus (5)
Mesembryanthemum constrictum L.Bolus (5)
Mesembryanthemum schultzei Schltr. & Diels (5)
Rhopalocyclus herrei Schwantes (5)
Rhopalocyclus nelii Schwantes (5)
Perennial. Succulent. Ht 0.1–0.7 m. Alt 230–1200 m. NC, WC, EC
uniflora L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt up to 1200 m. NC
weigangiana (Dinter) Dinter & Schwantes subsp. **grandiflora** (L.Bolus) H.E.K.Hartmann & Rust
Perennial. Succulent. Ht up to 0.35 m. Alt? N, NC
weigangiana (Dinter) Dinter & Schwantes subsp. **littlewoodii** (L.Bolus) H.E.K.Hartmann & Rust
Perennial. Succulent. Ht up to 0.3 m. Alt? N, NC
weigangiana (Dinter) Dinter & Schwantes subsp. **weigangiana**
Cephalophyllum weigangianum (Dinter) Dinter & Schwantes (5)
Mesembryanthemum weigangianum Dinter (5)
Rhopalocyclus weigangianus (Dinter) Dinter & Schwantes (5)
Perennial. Succulent. Ht up to 0.35 m. Alt? N, NC

LITHOPS N.E.Br. 2405069
(1) Cole & Glen. 1984. *The Flowering Plants of Africa* 48: tt. 1895A, 1895B.
(2) Cole. 1988. *Lithops: flowering stones*: 1–254.
(3) Cole. 1990. *The Flowering Plants of Africa* 51: tt. 2005A, 2005B.
(4) Hammer & Uijs. 1994. *Aloe* 31: 36–38

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

(5) Hammer. 1999. *Lithops–treasures of the veld*: 1–148.
(6) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 114–135.

alpina Dinter = **L. pseudotruncatella** subsp. **pseudotruncatella** var. **pseudotruncatella**
annae de Boer = **L. gesineae** var. **annae**
archerae de Boer = **L. pseudotruncatella** subsp. **archerae**
aucampiae L.Bolus subsp. **aucampiae**
L. aucampiae L.Bolus subsp. *aucampiae* var. *koelemanii* (de Boer) D.T.Cole (6)
L. koelemanii de Boer (6)
Perennial. Succulent. Ht up to 0.02 m. Alt 1100–1640 m. NW, NC
aucampiae L.Bolus subsp. *aucampiae* var. *koelemanii* (de Boer) D.T.Cole = **L. aucampiae** subsp. **aucampiae**
aucampiae L.Bolus subsp. **euniceae** (de Boer) D.T.Cole
L. aucampiae L.Bolus subsp. *euniceae* (de Boer) D.T.Cole var. *fluminalis* D.T.Cole (6)
L. aucampiae L.Bolus var. *euniceae* de Boer (2)
L. aucampiae L.Bolus var. *fluminalis* D.T.Cole (6)
Perennial. Succulent. Ht up to 0.02 m. Alt 1100–1250 m. NC
aucampiae L.Bolus subsp. *euniceae* (de Boer) D.T.Cole var. *fluminalis* D.T.Cole = **L. aucampiae** subsp. **euniceae**
aucampiae L.Bolus var. *euniceae* de Boer = **L. aucampiae** subsp. **euniceae**
aucampiae L.Bolus var. *fluminalis* D.T.Cole = **L. aucampiae** subsp. **euniceae**
aurantiaca L.Bolus = **L. hookeri**
bella N.E.Br. var. *bella* = **L. karasmontana** subsp. **bella**
bella N.E.Br. var. *eberlanzii* (Dinter & Schwantes) de Boer & Boom = **L. karasmontana** subsp. **eberlanzii**
bella N.E.Br. var. *lericheana* (Dinter & Schwantes) de Boer & Boom = **L. karasmontana** subsp. **karasmontana**
brevis L.Bolus = **L. dinteri** subsp. **dinteri**
bromfieldii L.Bolus
L. bromfieldii L.Bolus var. *glaudinae* (de Boer) D.T.Cole (6)
L. bromfieldii L.Bolus var. *insularis* (L.Bolus) B.Fearn (6)
L. bromfieldii L.Bolus var. *insularis* (L.Bolus) B.Fearn forma *sulphurea* Y.Shimada (2)
L. bromfieldii L.Bolus var. *mennellii* (L.Bolus) B.Fearn (6)
L. glaudinae de Boer (2)
L. insularis L.Bolus (6)
L. mennellii L.Bolus (6)
Perennial. Succulent. Ht up to 0.03 m. Alt 980–1300 m. NC
bromfieldii L.Bolus var. *glaudinae* (de Boer) D.T.Cole = **L. bromfieldii**
bromfieldii L.Bolus var. *insularis* (L.Bolus) B.Fearn = **L. bromfieldii**
bromfieldii L.Bolus var. *insularis* (L.Bolus) B.Fearn forma *sulphurea* Y.Shimada = **L. bromfieldii**
bromfieldii L.Bolus var. *mennellii* (L.Bolus) B.Fearn = **L. bromfieldii**
christinae de Boer = **L. schwantesii** subsp. **schwantesii**
chrysocephala Nel = **L. julii** subsp. **julii**
coleorum S.A.Hammer & Uijs
Perennial. Succulent. Ht up to 0.02 m. Alt 920–1150 m. NP
comptonii L.Bolus
L. comptonii L.Bolus var. *weberi* (Nel) D.T.Cole (6)
L. otzeniana Nel var. *weberi* (Nel) B.Fearn (6)
L. weberi Nel (6)
Perennial. Succulent. Ht up to 0.03 m. Alt 800–1550 m. NC, WC
comptonii L.Bolus var. *divergens* (L.Bolus) B.Fearn = **L. divergens**
comptonii L.Bolus var. *divergens* (L.Bolus) B.Fearn forma *amethystina* (de Boer) B.Fearn = **L. divergens**
comptonii L.Bolus var. *viridis* (H.A.Lückh.) B.Fearn = **L. viridis**
comptonii L.Bolus var. *weberi* (Nel) D.T.Cole = **L. comptonii**
dabneri L.Bolus = **L. hookeri**
damarana (N.E.Br.) N.E.Br. = **L. karasmontana** subsp. **karasmontana**
deboeri Schwantes = **L. villetii** subsp. **deboeri**
dendritica Nel = **L. pseudotruncatella** subsp. **dendritica**
dinteri Schwantes subsp. **dinteri**
L. brevis L.Bolus (2)
L. dinteri Schwantes subsp. *dinteri* var. *brevis* (L.Bolus) B.Fearn (6)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.02 m. Alt 910–1070 m. N

dinteri Schwantes subsp. *dinteri* var. *brevis* (L.Bolus) B.Fearn = **L. dinteri** subsp. **dinteri**

dinteri Schwantes subsp. **frederici** (D.T.Cole) D.T.Cole

L. dinteri Schwantes var. *frederici* D.T.Cole (2)

Perennial. Succulent. Ht up to 0.02 m. Alt 890–1200 m. NC

dinteri Schwantes subsp. **multipunctata** (de Boer) D.T.Cole

L. dinteri Schwantes var. *multipunctata* de Boer (2)

Perennial. Succulent. Ht up to 0.01 m. Alt 860–1080 m. N

dinteri Schwantes var. *frederici* D.T.Cole = **L. dinteri** subsp. **frederici**

dinteri Schwantes var. *marthae* (Loesch & Tischer) B.Fearn = **L. schwantesii** subsp. **schwantesii**

dinteri Schwantes var. *multipunctata* de Boer = **L. dinteri** subsp. **multipunctata**

diutina L.Bolus = **L. marmorata**

divergens L.Bolus

L. comptonii L.Bolus var. *divergens* (L.Bolus) B.Fearn (2)

L. comptonii L.Bolus var. *divergens* (L.Bolus) B.Fearn forma *amethystina* (de Boer) B.Fearn (2)

L. divergens L.Bolus var. *amethystina* de Boer (6)

Perennial. Succulent. Ht up to 0.02 m. Alt 380–1100 m. NC, WC

divergens L.Bolus var. *amethystina* de Boer = **L. divergens**

dorotheae Nel

L. eksteeniae L.Bolus (6)

Perennial. Succulent. Ht up to 0.02 m. Alt 1050–1160 m. NC

eberlanzii (Dinter & Schwantes) N.E.Br. = **L. karasmontana** subsp. **eberlanzii**

edithiae in sense of H.Jacobsen, misapplied name = **L. pseudotruncatella** subsp. **pseudotruncatella**

edithiae in sense of Schwantes, misapplied name = **L. pseudotruncatella** subsp. **pseudotruncatella**

edithiae N.E.Br. = **L. karasmontana** subsp. **eberlanzii;**

eksteeniae L.Bolus = **L. dorotheae**

elevata L.Bolus = **L. optica**

elisabethiae Dinter = **L. pseudotruncatella** subsp. **pseudotruncatella**

elisae de Boer = **L. marmorata**

erniana Tischer ex H.Jacobsen = **L. karasmontana** subsp. **eberlanzii**

erniana Tischer ex H.Jacobsen var. *aiaisensis* de Boer = **L. karasmontana** subsp. **karasmontana**

erniana Tischer ex H.Jacobsen var. *witputzensis* de Boer = **L. karasmontana** subsp. **eberlanzii**

framesii L.Bolus = **L. marmorata**

francisci (Dinter & Schwantes) N.E.Br.

L. halenbergensis Tischer (2)

Mesembryanthemum francisci Dinter & Schwantes (6)

Perennial. Succulent. Ht up to 0.02 m. Alt 530–670 m. N

francisci (Dinter & Schwantes) N.E.Br. var. *annae* (de Boer) B.Fearn = **L. gesineae**

francisci (Dinter & Schwantes) N.E.Br. var. *gesinae* (de Boer) B.Fearn = **L. gesineae**

fulleri N.E.Br. var. *brunnea* de Boer = **L. julii** subsp. **fulleri**

fulleri N.E.Br. var. *chrysocephala* (Nel) de Boer = **L. julii** subsp. **julii**

fulleri N.E.Br. var. *fulleri* = **L. julii** subsp. **fulleri**

fulleri N.E.Br. var. *kennedyi* de Boer = **L. villetii** subsp. **kennedyi**

fulleri N.E.Br. var. *ochracea* de Boer = **L. hallii**

fulleri N.E.Br. var. *rouxii* (de Boer) D.T.Cole = **L. julii** subsp. **fulleri**

fulleri N.E.Br. var. *tapscottii* L.Bolus = **L. julii** subsp. **fulleri**

fulviceps (N.E.Br.) N.E.Br.

L. fulviceps (N.E.Br.) N.E.Br. var. *lactinea* D.T.Cole (6)

Mesembryanthemum fulviceps N.E.Br. (6)

Perennial. Succulent. Ht up to 0.03 m. Alt 700–1150 m. N, NC

fulviceps (N.E.Br.) N.E.Br. var. *lactinea* D.T.Cole = **L. fulviceps**

gesineae de Boer

L. annae de Boer (2)

L. francisci (Dinter & Schwantes) N.E.Br. var. *annae* (de Boer) B.Fearn (2)

L. francisci (Dinter & Schwantes) N.E.Br. var. *gesinae* (de Boer) B.Fearn (2)

L. gesineae de Boer var. *annae* (de Boer) D.T.Cole (2)

Perennial. Succulent. Ht up to 0.02 m. Alt 1200–1620 m. N

gesineae de Boer var. *annae* (de Boer) D.T.Cole = **L. gesineae**

geyeri Nel

L. herrei L.Bolus var. *geyeri* (Nel) de Boer & Boom (2)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

L. hillii L.Bolus (6)
Perennial. Succulent. Ht up to 0.02 m. Alt 620–790 m. NC

glaudinae de Boer = **L. bromfieldii**

gracilidelineata Dinter subsp. **brandbergensis** (de Boer) D.T.Cole
L. pseudotruncatella (A.Berger) N.E.Br. var. *brandbergensis* de Boer (2)
Perennial. Succulent. Ht up to 0.02 m. Alt 1900–2574 m. N

gracilidelineata Dinter subsp. **gracilidelineata**
L. gracilidelineata Dinter subsp. *gracilidelineata* var. *waldroniae* de Boer (6)
L. pseudotruncatella (A.Berger) N.E.Br. var. *gracilidelineata* (Dinter) B.Fearn (2)
L. pseudotruncatella (A.Berger) N.E.Br. var. *gracilidelineata* (Dinter) B.Fearn forma *waldronae* (de Boer) B.Fearn (2)
L. streyi Schwantes (2)
Perennial. Succulent. Ht up to 0.02 m. Alt 180–1430 m. N

gracilidelineata Dinter subsp. *gracilidelineata* var. *waldroniae* de Boer = **L. gracilidelineata** subsp. **gracilidelineata**

gulielmi L.Bolus = **L. schwantesii** subsp. **schwantesii**

halenbergensis Tischer (insufficiently known)

hallii de Boer
L. fulleri N.E.Br. var. *ochracea* de Boer (2)
L. hallii de Boer var. *ochracea* (de Boer) D.T.Cole (6)
Perennial. Succulent. Ht up to 0.02 m. Alt 830–1500 m. NC

hallii de Boer var. *ochracea* (de Boer) D.T.Cole = **L. hallii**

helmutii L.Bolus
Perennial. Succulent. Ht up to 0.03 m, when in flower. Alt 1080–1160 m. NC

hermetica D.T.Cole
Perennial. Succulent. Ht up to 0.025 m. Alt 20–180 m. N

herrei L.Bolus
L. herrei L.Bolus var. *plena* L.Bolus (2)
L. translucens L.Bolus (2)
Perennial. Succulent. Ht up to 0.03 m. Alt 100–640 m. N, NC

herrei L.Bolus forma *albiflora* H.Jacobsen = **L. marmorata**

herrei L.Bolus var. *geyeri* (Nel) de Boer & Boom = **L. geyeri**

herrei L.Bolus var. *plena* L.Bolus = **L. herrei**

hillii L.Bolus = **L. geyeri**

hookeri (A.Berger) Schwantes
L. aurantiaca L.Bolus (2)
L. dabneri L.Bolus (2)
L. hookeri (A.Berger) Schwantes var. *dabneri* (L.Bolus) D.T.Cole (6)
L. hookeri (A.Berger) Schwantes var. *elephina* (D.T.Cole) D.T.Cole (6)
L. hookeri (A.Berger) Schwantes var. *lutea* (de Boer) D.T.Cole (6)
L. hookeri (A.Berger) Schwantes var. *marginata* (Nel) D.T.Cole (6)
L. hookeri (A.Berger) Schwantes var. *subfenestrata* (de Boer) D.T.Cole (6)
L. hookeri (A.Berger) Schwantes var. *susannae* (D.T.Cole) D.T.Cole (6)
L. marginata Nel (2)
L. turbiniformis in sense of N.E.Br., not of Haw., misapplied name (2)
L. turbiniformis in sense of N.E.Br. var. *brunneo-violacea* de Boer, misapplied name (2)
L. turbiniformis in sense of N.E.Br. var. *dabneri* (L.Bolus) D.T.Cole, misapplied name (2)
L. turbiniformis in sense of N.E.Br. var. *elephina* D.T.Cole, misapplied name (2)
L. turbiniformis in sense of N.E.Br. var. *lutea* de Boer, misapplied name (2)
L. turbiniformis in sense of N.E.Br. var. *marginata* (Nel) D.T.Cole, misapplied name (2)
L. turbiniformis in sense of N.E.Br. var. *subfenestrata* de Boer, misapplied name (2)
L. turbiniformis in sense of N.E.Br. var. *susannae* D.T.Cole, misapplied name (2)
Mesembryanthemum hookeri A.Berger (6)
Mesembryanthemum truncatellum Hook.f., not of Haw. (2)
Mesembryanthemum turbiniforme in sense of N.E.Br., not of Haw., misapplied name (2)
Perennial. Succulent. Ht up to 0.02 m. Alt 890–1460 m. NC

hookeri (A.Berger) Schwantes var. *dabneri* (L.Bolus) D.T.Cole = **L. hookeri**

hookeri (A.Berger) Schwantes var. *elephina* (D.T.Cole) D.T.Cole = **L. hookeri**

hookeri (A.Berger) Schwantes var. *lutea* (de Boer) D.T.Cole = **L. hookeri**

hookeri (A.Berger) Schwantes var. *marginata* (Nel) D.T.Cole = **L. hookeri**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

hookeri (A.Berger) Schwantes var. *subfenestrata* (de Boer) D.T.Cole = **L. hookeri**
hookeri (A.Berger) Schwantes var. *susannae* (D.T.Cole) D.T.Cole = **L. hookeri**
inae Nel = **L. verruculosa**
insularis L.Bolus = **L. bromfieldii**
julii (Dinter & Schwantes) N.E.Br. subsp. **fulleri** (N.E.Br.) B.Fearn
L. fulleri N.E.Br. var. *brunnea* de Boer (2)
L. fulleri N.E.Br. var. *fulleri* (2)
L. fulleri N.E.Br. var. *rouxii* (de Boer) D.T.Cole (2)
L. fulleri N.E.Br. var. *tapscottii* L.Bolus (2)
L. julii (Dinter & Schwantes) N.E.Br. subsp. *fulleri* (N.E.Br.) B.Fearn var. *brunnea* de Boer (6)
L. julii (Dinter & Schwantes) N.E.Br. subsp. *fulleri* (N.E.Br.) B.Fearn var. *rouxii* (de Boer) D.T.Cole (6)
L. julii (Dinter & Schwantes) N.E.Br. var. *rouxii* de Boer (2)
L. maughanii N.E.Br. (2)
Perennial. Succulent. Ht up to 0.02 m. Alt 870–1150 m. NC
julii (Dinter & Schwantes) N.E.Br. subsp. *fulleri* (N.E.Br.) B.Fearn var. *brunnea* de Boer = **L. julii** subsp. **fulleri**
julii (Dinter & Schwantes) N.E.Br. subsp. *fulleri* (N.E.Br.) B.Fearn var. *rouxii* (de Boer) D.T.Cole = **L. julii** subsp. **fulleri**
julii (Dinter & Schwantes) N.E.Br. subsp. **julii**
L. chrysocephala Nel (2)
L. fulleri N.E.Br. var. *chrysocephala* (Nel) de Boer (2)
L. julii (Dinter & Schwantes) N.E.Br. var. *littlewoodii* de Boer (2)
L. julii (Dinter & Schwantes) N.E.Br. var. *reticulata* Tischer ex de Boer (2)
L. lactea Schick & Tischer (2)
Mesembryanthemum julii Dinter & Schwantes (6)
Perennial. Succulent. Ht up to 0.02 m. Alt 550–1069 m. N
julii (Dinter & Schwantes) N.E.Br. var. *littlewoodii* de Boer = **L. julii** subsp. **julii**
julii (Dinter & Schwantes) N.E.Br. var. *reticulata* Tischer ex de Boer = **L. julii** subsp. **julii**
julii (Dinter & Schwantes) N.E.Br. var. *rouxii* de Boer = **L. julii** subsp. **fulleri**
karasmontana (Dinter & Schwantes) N.E.Br. subsp. **bella** (N.E.Br.) D.T.Cole
L. bella N.E.Br. var. *bella* (2)
Mesembryanthemum bellum (N.E.Br.) Dinter (2)
Perennial. Succulent. Ht up to 0.02 m. Alt 1200–1300 m. N
karasmontana (Dinter & Schwantes) N.E.Br. subsp. **eberlanzii** (Dinter & Schwantes) D.T.Cole
L. bella N.E.Br. var. *eberlanzii* (Dinter & Schwantes) de Boer & Boom (2)
L. eberlanzii (Dinter & Schwantes) N.E.Br. (2)
L. edithiae N.E.Br. (2)
L. erniana Tischer ex H.Jacobsen (2)
L. erniana Tischer ex H.Jacobsen var. *witputzensis* de Boer (2)
Mesembryanthemum eberlanzii Dinter & Schwantes (2)
Perennial. Succulent. Ht up to 0.02 m. Alt 1000–1550 m. N
karasmontana (Dinter & Schwantes) N.E.Br. subsp. **karasmontana**
L. bella N.E.Br. var. *lericheana* (Dinter & Schwantes) de Boer & Boom (2)
L. damarana (N.E.Br.) N.E.Br. (2)
L. erniana Tischer ex H.Jacobsen var. *aiaisensis* de Boer (2)
L. karasmontana (Dinter & Schwantes) N.E.Br. subsp. *karasmontana* var. *aiaisensis* (de Boer) D.T.Cole (6)
L. karasmontana (Dinter & Schwantes) N.E.Br. subsp. *karasmontana* var. *lericheana* (Dinter & Schwantes) D.T.Cole (6)
L. karasmontana (Dinter & Schwantes) N.E.Br. subsp. *karasmontana* var. *tischeri* D.T.Cole (6)
L. karasmontana (Dinter & Schwantes) N.E.Br. var. *mickbergensis* (Dinter) de Boer & Boom (2)
L. karasmontana (Dinter & Schwantes) N.E.Br. var. *opalina* (Dinter) de Boer & Boom (2)
L. karasmontana (Dinter & Schwantes) N.E.Br. var. *summitatum* (Dinter) de Boer & Boom (2)
L. lateritia Dinter (2)
L. lericheana Dinter & Schwantes (2)
L. lericheana (Dinter & Schwantes) Dinter & Schwantes (2)
L. lericheana (Dinter & Schwantes) N.E.Br. (2)
L. mickbergensis Dinter (2)
L. opalina Dinter (2)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

L. summitatum Dinter (2)
Mesembryanthemum damaranum N.E.Br. (2)
Mesembryanthemum karasmontanum Dinter & Schwantes (6)
Mesembryanthemum lericheanum Dinter & Schwantes (2)
Perennial. Succulent. Ht up to 0.02 m. Alt 1200–2200 m. N

karasmontana (Dinter & Schwantes) N.E.Br. subsp. *karasmontana* var. *aiaisensis* (de Boer) D.T.Cole = **L. karasmontana** subsp. **karasmontana**

karasmontana (Dinter & Schwantes) N.E.Br. subsp. *karasmontana* var. *lericheana* (Dinter & Schwantes) D.T.Cole = **L. karasmontana** subsp. **karasmontana**

karasmontana (Dinter & Schwantes) N.E.Br. subsp. *karasmontana* var. *tischeri* D.T.Cole = **L. karasmontana** subsp. **karasmontana**

karasmontana (Dinter & Schwantes) N.E.Br. var. *mickbergensis* (Dinter) de Boer & Boom = **L. karasmontana** subsp. **karasmontana**

karasmontana (Dinter & Schwantes) N.E.Br. var. *opalina* (Dinter) de Boer & Boom = **L. karasmontana** subsp. **karasmontana**

karasmontana (Dinter & Schwantes) N.E.Br. var. *summitatum* (Dinter) de Boer & Boom = **L. karasmontana** subsp. **karasmontana**

koelemanii de Boer = **L. aucampiae** subsp. **aucampiae**

kuibisensis Dinter ex H.Jacobsen = **L. schwantesii** subsp. **schwantesii**

kunjasensis Dinter = **L. schwantesii** subsp. **schwantesii**

lactea Schick & Tischer = **L. julii** subsp. **julii**

lateritia Dinter = **L. karasmontana** subsp. **karasmontana**

lericheana Dinter & Schwantes = **L. karasmontana** subsp. **karasmontana**

lericheana (Dinter & Schwantes) Dinter & Schwantes = **L. karasmontana** subsp. **karasmontana**

lericheana (Dinter & Schwantes) N.E.Br. = **L. karasmontana** subsp. **karasmontana**

lesliei (N.E.Br.) N.E.Br. forma *minor* (de Boer) B.Fearn = **L. lesliei** subsp. **lesliei**

lesliei (N.E.Br.) N.E.Br. subsp. **burchellii** D.T.Cole
Perennial. Succulent. Ht up to 0.01 m. Alt 1030–1350 m. NC

lesliei (N.E.Br.) N.E.Br. subsp. **lesliei**
L. lesliei (N.E.Br.) N.E.Br. forma *minor* (de Boer) B.Fearn (2)
L. lesliei (N.E.Br.) N.E.Br. subsp. *lesliei* var. *hornii* de Boer (6)
L. lesliei (N.E.Br.) N.E.Br. subsp. *lesliei* var. *mariae* D.T.Cole (6)
L. lesliei (N.E.Br.) N.E.Br. subsp. *lesliei* var. *minor* de Boer (6)
L. lesliei (N.E.Br.) N.E.Br. subsp. *lesliei* var. *rubrobrunnea* de Boer (2)
L. lesliei (N.E.Br.) N.E.Br. subsp. *lesliei* var. *venteri* (Nel) de Boer & Boom (6)
L. lesliei (N.E.Br.) N.E.Br. var. *lesliei* 'Albiflora' D.T.Cole (2)
L. lesliei (N.E.Br.) N.E.Br. var. *lesliei* 'Albinica' D.T.Cole (2)
L. lesliei (N.E.Br.) N.E.Br. var. *luteoviridis* de Boer (2)
L. lesliei (N.E.Br.) N.E.Br. var. *maraisii* de Boer (2)
L. venteri Nel (2)
Mesembryanthemum ferrugineum Schwantes (2)
Mesembryanthemum lesliei N.E.Br. (6)
Perennial. Succulent. Ht up to 0.01 m. Alt 900–1950 m. B, NP, NW, G, FS, NC

lesliei (N.E.Br.) N.E.Br. subsp. *lesliei* var. *hornii* de Boer = **L. lesliei** subsp. **lesliei**

lesliei (N.E.Br.) N.E.Br. subsp. *lesliei* var. *mariae* D.T.Cole = **L. lesliei** subsp. **lesliei**

lesliei (N.E.Br.) N.E.Br. subsp. *lesliei* var. *minor* de Boer = **L. lesliei** subsp. **lesliei**

lesliei (N.E.Br.) N.E.Br. subsp. *lesliei* var. *rubrobrunnea* de Boer = **L. lesliei** subsp. **lesliei**

lesliei (N.E.Br.) N.E.Br. subsp. *lesliei* var. *venteri* (Nel) de Boer & Boom = **L. lesliei** subsp. **lesliei**

lesliei (N.E.Br.) N.E.Br. var. *lesliei* 'Albiflora' D.T.Cole = **L. lesliei** subsp. **lesliei**

lesliei (N.E.Br.) N.E.Br. var. *lesliei* 'Albinica' D.T.Cole = **L. lesliei** subsp. **lesliei**

lesliei (N.E.Br.) N.E.Br. var. *luteoviridis* de Boer = **L. lesliei** subsp. **lesliei**

lesliei (N.E.Br.) N.E.Br. var. *maraisii* de Boer = **L. lesliei** subsp. **lesliei**

lineata Nel = **L. ruschiorum**

localis (N.E.Br.) Schwantes
L. localis in sense of de Boer, misapplied name (2)
L. localis in sense of de Boer & Boom, misapplied name (2)
L. localis in sense of de Boer & Boom var. *peersii* (L.Bolus) de Boer & Boom, misapplied name (2)
L. localis in sense of de Boer & Boom var. *terricolor* (N.E.Br.) de Boer & Boom, misapplied name (2)
L. peersii L.Bolus (6)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

L. terricolor N.E.Br. (6)
Perennial. Succulent. Ht up to 0.02 m. Alt 800–1150 m. NC, EC
localis in sense of de Boer, misapplied name = **L. localis**
localis in sense of de Boer & Boom, misapplied name = **L. localis**
localis in sense of de Boer & Boom var. *peersii* (L.Bolus) de Boer & Boom, misapplied name = **L. localis**
localis in sense of de Boer & Boom var. *terricolor* (N.E.Br.) de Boer & Boom, misapplied name = **L. localis**
marginata Nel = **L. hookeri**
marmorata (N.E.Br.) N.E.Br.
L. diutina L.Bolus (6)
L. elisae de Boer (6)
L. framesii L.Bolus (6)
L. herrei L.Bolus forma *albiflora* H.Jacobsen (2)
L. marmorata (N.E.Br.) N.E.Br. var. *elisae* (de Boer) D.T.Cole (6)
L. umdausensis L.Bolus (6)
Mesembryanthemum marmoratum N.E.Br. (6)
Perennial. Succulent. Ht up to 0.01 m. Alt up to 1320 m. NC
marmorata (N.E.Br.) N.E.Br. var. *elisae* (de Boer) D.T.Cole = **L. marmorata**
marthae Loesch & Tischer = **L. schwantesii** subsp. **schwantesii**
maughanii N.E.Br. = **L. julii** subsp. **fulleri**
mennellii L.Bolus = **L. bromfieldii**
meyeri L.Bolus
Perennial. Succulent. Ht up to 0.02 m. Alt 825–1000 m. NC
mickbergensis Dinter = **L. karasmontana** subsp. **karasmontana**
mundtii Tischer = **L. pseudotruncatella** subsp. **pseudotruncatella**
naureeniae D.T.Cole
Perennial. Succulent. Ht up to 0.01 m. Alt 1000–1200 m. NC
nelii Schwantes = **L. ruschiorum**
olivacea L.Bolus
L. olivacea L.Bolus var. *nebrownii* D.T.Cole (6)
Perennial. Succulent. Ht up to 0.02 m. Alt 1030–1150 m. NC
olivacea L.Bolus var. *nebrownii* D.T.Cole = **L. olivacea**
opalina Dinter = **L. karasmontana** subsp. **karasmontana**
optica (Marloth) N.E.Br.
L. elevata L.Bolus (6)
L. optica (Marloth) N.E.Br. cv. '*rubra*' (Tischer) H.Jacobsen (6)
Mesembryanthemum opticum Marloth (6)
Perennial. Succulent. Ht up to 0.02 m. Alt 50–450 m. N
optica (Marloth) N.E.Br. cv. '*rubra*' (Tischer) H.Jacobsen = **L. optica**
otzeniana Nel
Perennial. Succulent. Ht up to 0.02 m. Alt 825–1000 m. NC
otzeniana Nel var. *weberi* (Nel) B.Fearn = **L. comptonii**
peersii L.Bolus = **L. localis**
pillansii L.Bolus = **L. ruschiorum**
pseudotruncatella (A.Berger) N.E.Br. forma *mundtii* (Tischer) H.Jacobsen = **L. pseudotruncatella** subsp. **pseudotruncatella**
pseudotruncatella (A.Berger) N.E.Br. subsp. **archerae** (de Boer) D.T.Cole
L. archerae de Boer (2)
L. pseudotruncatella (A.Berger) N.E.Br. var. *archerae* (de Boer) D.T.Cole (2)
Perennial. Succulent. Ht up to 0.015 m. Alt 1500–1770 m. N
pseudotruncatella (A.Berger) N.E.Br. subsp. **dendritica** (Nel) D.T.Cole
L. dendritica Nel (2)
L. pseudotruncatella (A.Berger) N.E.Br. var. *dendritica* (Nel) de Boer & Boom (2)
Perennial. Succulent. Ht up to 0.015 m. Alt 1500–1870 m. N
pseudotruncatella (A.Berger) N.E.Br. subsp. **groendrayensis** (H.Jacobsen) D.T.Cole
L. pseudotruncatella (A.Berger) N.E.Br. var. *groendrayensis* H.Jacobsen (2)
L. vallis-mariae (Dinter & Schwantes) N.E.Br. var. *groendraaiensis* (H.Jacobsen) de Boer (2)
Perennial. Succulent. Ht up to 0.015 m. Alt 1490–1520 m. N
pseudotruncatella (A.Berger) N.E.Br. subsp. **pseudotruncatella**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

L. alpina Dinter (2)
L. edithiae in sense of H.Jacobsen, misapplied name (2)
L. edithiae in sense of Schwantes, misapplied name (2)
L. elisabethiae Dinter (2)
L. mundtii Tischer (2)
L. pseudotruncatella (A.Berger) N.E.Br. forma *mundtii* (Tischer) H.Jacobsen (2)
L. pseudotruncatella (A.Berger) N.E.Br. subsp. *pseudotruncatella* var. *elisabethae* (Dinter) de Boer & Boom (6)
L. pseudotruncatella (A.Berger) N.E.Br. subsp. *pseudotruncatella* var. *riehmerae* D.T.Cole (6)
L. pseudotruncatella (A.Berger) N.E.Br. var. *alpina* (Dinter) Boom (2)
L. pseudotruncatella (A.Berger) N.E.Br. var. *alta* Tischer (2)
L. pseudotruncatella (A.Berger) N.E.Br. var. *edithiae* (N.E.Br.) de Boer & Boom (2)
L. pseudotruncatella (A.Berger) N.E.Br. var. *mundtii* (Tischer) H.Jacobsen (2)
Mesembryanthemum pseudotruncatellum A.Berger (6)
Mesembryanthemum truncatellum in sense of Dinter, not of Haw. (2)
Perennial. Succulent. Ht up to 0.015 m. Alt 1800–2080 m. N

pseudotruncatella (A.Berger) N.E.Br. subsp. *pseudotruncatella* var. *elisabethae* (Dinter) de Boer & Boom = **L. pseudotruncatella** subsp. **pseudotruncatella**

pseudotruncatella (A.Berger) N.E.Br. subsp. *pseudotruncatella* var. *riehmerae* D.T.Cole = **L. pseudotruncatella** subsp. **pseudotruncatella**

pseudotruncatella (A.Berger) N.E.Br. subsp. **volkii** (Schwantes ex de Boer & Boom) D.T.Cole
L. pseudotruncatella (A.Berger) N.E.Br. var. *volkii* Schwantes ex de Boer & Boom (2)
Perennial. Succulent. Ht up to 0.015 m. Alt 2000–2260 m. N

pseudotruncatella (A.Berger) N.E.Br. var. *alpina* (Dinter) Boom = **L. pseudotruncatella** subsp. **pseudotruncatella**

pseudotruncatella (A.Berger) N.E.Br. var. *alta* Tischer = **L. pseudotruncatella** subsp. **pseudotruncatella**

pseudotruncatella (A.Berger) N.E.Br. var. *archerae* (de Boer) D.T.Cole = **L. pseudotruncatella** subsp. **archerae**

pseudotruncatella (A.Berger) N.E.Br. var. *brandbergensis* de Boer = **L. gracilidelineata** subsp. **brandbergensis**

pseudotruncatella (A.Berger) N.E.Br. var. *dendritica* (Nel) de Boer & Boom = **L. pseudotruncatella** subsp. **dendritica**

pseudotruncatella (A.Berger) N.E.Br. var. *edithiae* (N.E.Br.) de Boer & Boom = **L. pseudotruncatella** subsp. **pseudotruncatella**

pseudotruncatella (A.Berger) N.E.Br. var. *gracilidelineata* (Dinter) B.Fearn = **L. gracilidelineata** subsp. **gracilidelineata**

pseudotruncatella (A.Berger) N.E.Br. var. *gracilidelineata* (Dinter) B.Fearn forma *waldronae* (de Boer) B.Fearn = **L. gracilidelineata** subsp. **gracilidelineata**

pseudotruncatella (A.Berger) N.E.Br. var. *groendrayensis* H.Jacobsen = **L. pseudotruncatella** subsp. **groendrayensis**

pseudotruncatella (A.Berger) N.E.Br. var. *mundtii* (Tischer) H.Jacobsen = **L. pseudotruncatella** subsp. **pseudotruncatella**

pseudotruncatella (A.Berger) N.E.Br. var. *volkii* Schwantes ex de Boer & Boom = **L. pseudotruncatella** subsp. **volkii**

rugosa Dinter = **L. schwantesii** subsp. **schwantesii**

ruschiorum (Dinter & Schwantes) N.E.Br.
L. lineata Nel (2)
L. nelii Schwantes (2)
L. pillansii L.Bolus (2)
L. ruschiorum (Dinter & Schwantes) N.E.Br. var. *lineata* (Nel) D.T.Cole (6)
L. ruschiorum (Dinter & Schwantes) N.E.Br. var. *nelii* (Schwantes) de Boer & Boom (2)
Mesembryanthemum ruschiorum Dinter & Schwantes (6)
Perennial. Succulent. Ht up to 0.02 m. Alt 100–550 m. N

ruschiorum (Dinter & Schwantes) N.E.Br. var. *lineata* (Nel) D.T.Cole = **L. ruschiorum**

ruschiorum (Dinter & Schwantes) N.E.Br. var. *nelii* (Schwantes) de Boer & Boom = **L. ruschiorum**

salicola L.Bolus
Perennial. Succulent. Ht up to 0.02 m. Alt 1000–1350 m. FS, NC

schwantesii Dinter subsp. **gebseri** (de Boer) D.T.Cole
L. schwantesii Dinter var. *gebseri* de Boer (2)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.02 m. Alt 1200–1650 m. N

schwantesii Dinter subsp. **schwantesii**

L. christinae de Boer (2)

L. dinteri Schwantes var. *marthae* (Loesch & Tischer) B.Fearn (2)

L. gulielmi L.Bolus (6)

L. kuibisensis Dinter ex H.Jacobsen (6)

L. kunjasensis Dinter (2)

L. marthae Loesch & Tischer (2)

L. rugosa Dinter (2)

L. schwantesii Dinter subsp. *schwantesii* var. *marthae* (Loesch & Tischer) D.T.Cole (6)

L. schwantesii Dinter subsp. *schwantesii* var. *rugosa* (Dinter) de Boer & Boom (6)

L. schwantesii Dinter subsp. *schwantesii* var. *urikosensis* (Dinter) de Boer & Boom (6)

L. schwantesii Dinter var. *christinae* (de Boer) B.Fearn (6)

L. schwantesii Dinter var. *kunjasensis* (Dinter) de Boer & Boom (2)

L. schwantesii Dinter var. *nutupsdriftensis* de Boer (2)

L. schwantesii Dinter var. *triebneri* (L.Bolus) de Boer & Boom (2)

L. triebneri L.Bolus (2)

L. urikosensis Dinter (2)

Perennial. Succulent. Ht up to 0.02 m. Alt 1100–1500 m. N

schwantesii Dinter subsp. *schwantesii* var. *marthae* (Loesch & Tischer) D.T.Cole = **L. schwantesii** subsp. **schwantesii**

schwantesii Dinter subsp. *schwantesii* var. *rugosa* (Dinter) de Boer & Boom = **L. schwantesii** subsp. **schwantesii**

schwantesii Dinter subsp. *schwantesii* var. *urikosensis* (Dinter) de Boer & Boom = **L. schwantesii** subsp. **schwantesii**

schwantesii Dinter var. *christinae* (de Boer) B.Fearn = **L. schwantesii** subsp. **schwantesii**

schwantesii Dinter var. *gebseri* de Boer = **L. schwantesii** subsp. **gebseri**

schwantesii Dinter var. *kunjasensis* (Dinter) de Boer & Boom = **L. schwantesii** subsp. **schwantesii**

schwantesii Dinter var. *nutupsdriftensis* de Boer = **L. schwantesii** subsp. **schwantesii**

schwantesii Dinter var. *triebneri* (L.Bolus) de Boer & Boom = **L. schwantesii** subsp. **schwantesii**

streyi Schwantes = **L. gracilidelineata** subsp. **gracilidelineata**

summitatum Dinter = **L. karasmontana** subsp. **karasmontana**

terricolor N.E.Br. = **L. localis**

translucens L.Bolus = **L. herrei**

triebneri L.Bolus = **L. schwantesii** subsp. **schwantesii**

turbiniformis in sense of N.E.Br., misapplied name = **L. hookeri**

turbiniformis in sense of N.E.Br. var. *brunneo-violacea* de Boer, misapplied name = **L. hookeri**

turbiniformis in sense of N.E.Br. var. *dabneri* (L.Bolus) D.T.Cole, misapplied name = **L. hookeri**

turbiniformis in sense of N.E.Br. var. *elephina* D.T.Cole, misapplied name = **L. hookeri**

turbiniformis in sense of N.E.Br. var. *lutea* de Boer, misapplied name = **L. hookeri**

turbiniformis in sense of N.E.Br. var. *marginata* (Nel) D.T.Cole, misapplied name = **L. hookeri**

turbiniformis in sense of N.E.Br. var. *subfenestrata* de Boer, misapplied name = **L. hookeri**

turbiniformis in sense of N.E.Br. var. *susannae* D.T.Cole, misapplied name = **L. hookeri**

umdausensis L.Bolus = **L. marmorata**

urikosensis Dinter = **L. schwantesii** subsp. **schwantesii**

vallis-mariae (Dinter & Schwantes) N.E.Br.

L. vallis-mariae (Dinter & Schwantes) N.E.Br. var. *margarethae* de Boer (6)

Mesembryanthemum vallis-mariae Dinter & Schwantes (6)

Perennial. Succulent. Ht up to 0.02 m. Alt 1100–1300 m. N

vallis-mariae (Dinter & Schwantes) N.E.Br. var. *groendraaiensis* (H.Jacobsen) de Boer = **L. pseudotruncatella** subsp. **groendrayensis**

vallis-mariae (Dinter & Schwantes) N.E.Br. var. *margarethae* de Boer = **L. vallis-mariae**

vanzylii L.Bolus = **Dinteranthus vanzylii**

venteri Nel = **L. lesliei** subsp. **lesliei**

verruculosa Nel

L. inae Nel (2)

L. verruculosa Nel var. *glabra* de Boer (6)

L. verruculosa Nel var. *inae* (Nel) de Boer & Boom (2)

Perennial. Succulent. Ht up to 0.02 m. Alt 950–1250 m. NC

verruculosa Nel var. *glabra* de Boer = **L. verruculosa**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

verruculosa Nel var. *inae* (Nel) de Boer & Boom = **L. verruculosa**
villetii L.Bolus subsp. **deboeri** (Schwantes) D.T.Cole
L. deboeri Schwantes (2)
L. villetii L.Bolus var. *deboeri* (Schwantes) D.T.Cole (2)
Perennial. Succulent. Ht up to 0.02 m. Alt up to 1150 m. NC
villetii L.Bolus subsp. **kennedyi** (de Boer) D.T.Cole
L. fulleri N.E.Br. var. *kennedyi* de Boer (2)
L. villetii L.Bolus var. *kennedyi* (de Boer) D.T.Cole (2)
Perennial. Succulent. Ht up to 0.02 m. Alt 900–1200 m. NC
villetii L.Bolus subsp. **villetii**
Perennial. Succulent. Ht up to 0.02 m. Alt 920–1075 m. NC
villetii L.Bolus var. *deboeri* (Schwantes) D.T.Cole = **L. villetii** subsp. **deboeri**
villetii L.Bolus var. *kennedyi* (de Boer) D.T.Cole = **L. villetii** subsp. **kennedyi**
viridis H.A.Lückh.
L. comptonii L.Bolus var. *viridis* (H.A.Lückh.) B.Fearn (2)
Perennial. Succulent. Ht up to 0.02 m. Alt 690–930 m. NC
weberi Nel = **L. comptonii**
werneri Schwantes & H.Jacobsen
Perennial. Succulent. Ht up to 0.02 m. Alt 1750–2300 m. N

MACHAIROPHYLLUM Schwantes 2405070
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 136, 137.
(2) Kurzweil & Chesselet. 2003. *Bothalia* 33: 19–39.
acuminatum L.Bolus = **M. bijliae**
albidum (L.) Schwantes
M. cookii (L.Bolus) Schwantes (2)
Perennial. Succulent. Ht up to 0.17 m. Alt 330–600 m. WC
baxteri L.Bolus = **M. bijliae**
bijliae (N.E.Br.) L.Bolus
M. acuminatum L.Bolus (2)
M. baxteri L.Bolus (2)
M. stenopetalum L.Bolus (2)
M. vanbredai L.Bolus (2)
Perennial. Succulent. Ht up to 0.14 m. Alt 570–1560 m. WC, EC
brevifolium L.Bolus
M. latifolium L.Bolus (2)
Perennial. Succulent. Ht 0.03–0.05 m. Alt 500–600 m. WC
cookii (L.Bolus) Schwantes = **M. albidum**
latifolium L.Bolus = **M. brevifolium**
stayneri L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt? EC
stenopetalum L.Bolus = **M. bijliae**
vanbredai L.Bolus = **M. bijliae**

MALEPHORA N.E.Br. 2405071
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 255.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 138–141.
crassa (L.Bolus) H.Jacobsen & Schwantes
Perennial. Succulent. Ht up to 0.3 m. Alt 470–600 m. NC, WC
crocea (Jacq.) Schwantes
Perennial. Succulent. Ht up to 0.3 m. Alt 1100–1600 m. NC
crocea (Jacq.) Schwantes var. *purpureo-crocea* (Haw.) H.Jacobsen = **M. purpureo-crocea**
engleriana (Dinter & A.Berger) Schwantes
Perennial. Succulent. Ht up to 0.3 m. Alt 1300–1700 m. N
flavo-crocea (Haw.) H.Jacobsen & Schwantes
Perennial. Succulent. Ht up to 0.4 m. Alt 1100–1600 m. NC
framesii (L.Bolus) H.Jacobsen & Schwantes
Perennial. Succulent. Ht up to 0.2 m. Alt 50–190 m. WC
herrei (Schwantes) Schwantes
Perennial. Succulent. Ht up to 0.3 m. Alt ± 1500 m. FS
latipetala (L.Bolus) H.Jacobsen & Schwantes

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.2 m. Alt 400–950 m. WC
lutea (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.3 m. Alt 500–800 m. WC
luteola (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.3 m. Alt 500–800 m. WC
mollis (Aiton) N.E.Br.
Perennial. Succulent. Ht up to 0.5 m. Alt 50–850 m. WC, EC
ochracea (A.Berger) H.E.K.Hartmann
Glottiphyllum ochraceum (A.Berger) N.E.Br. (2)
Perennial. Succulent. Ht? Alt? 'SA'
purpureo-crocea (Haw.) Schwantes
M. crocea (Jacq.) Schwantes var. *purpureo-crocea* (Haw.) H.Jacobsen (2)
Perennial. Succulent. Ht up to 0.3 m. Alt 175–1100 m. NC, WC
smithii (L.Bolus) H.E.K.Hartmann
Perennial. Succulent. Ht 0.035–0.04 m. Alt 1400–1500 m. FS
thunbergii (Haw.) Schwantes
Crocanthus thunbergii (Haw.) L.Bolus (2)
Perennial. Succulent. Ht up to 0.2 m. Alt 250–1100 m. EC
uitenhagensis (L.Bolus) H.Jacobsen & Schwantes
Perennial. Succulent. Ht up to 0.3 m. Alt 550–1200 m. WC
verruculoides (Sond.) Schwantes
Perennial. Succulent. Ht up to 0.08 m. Alt 1100–1500 m. NC

MARLOTHISTELLA Schwantes 2405175
(1) Schwantes. 1928. *Gartenwelt* 32: 599.
(2) Hammer. 1995. *Bradleya* 13: 82–87.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 142.
stenophylla (L.Bolus) S.A.Hammer
Mesembryanthemum stenophyllum L.Bolus (2)
Ruschia stenophylla (L.Bolus) L.Bolus (2)
Perennial. Succulent. Ht up to 0.07 m. Alt 680–1400 m. EC
uniondalensis Schwantes
Perennial. Succulent. Ht up to 0.05 m. Alt 850–1250 m. WC

MAUGHANIELLA L.Bolus 2405072
luckhoffii (L.Bolus) L.Bolus = **Diplosoma luckhoffii**

MESEMBRYANTHEMUM L. 2405073
(1) Phillips. 1922. *The Flowering Plants of South Africa* 2: tt. 54, 73.
(2) Phillips. 1923. *The Flowering Plants of South Africa* 3: tt. 102, 110.
(3) Phillips. 1927. *The Flowering Plants of South Africa* 7: tt. 251, 256, 263, 271, 272, 279.
(4) Phillips. 1930. *The Flowering Plants of South Africa* 10: tt. 393, 397.
(5) Bolus. 1931. *The Flowering Plants of South Africa* 11: t. 413.
(6) Koutnik & O'Connor-Fenton. 1984. *Journal of South African Botany* 50: 365–371.
(7) Gerbaulet. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 143–153.
abruptum A.Berger = **Octopoma abruptum**
acinaciforme Gouan = **Carpobrotus acinaciformis**
acinaciforme L. = **Carpobrotus acinaciformis**
acinaciforme L. var. *ß flavum* L. = **Carpobrotus edulis** subsp. **edulis**
acinaciforme L. var. *purpureum* L. = **Carpobrotus acinaciformis**
aculeatum N.E.Br. = **Ruschia spinosa**
acuminatum Haw. = **Phyllobolus splendens** subsp. **splendens**
acutangulum Haw. = **Ruschia acutangula**
acutisepalum A.Berger = **Psilocaulon junceum**
adscendens Haw. = **Glottiphyllum longum**
aggregatum Haw. ex N.E.Br. = **Conophytum piluliforme** subsp. **piluliforme**
aitonis Jacq.
M. louiseae L.Bolus (7)
M. paulum (N.E.Br.) L.Bolus (7)
Micropterum puberulum (Haw.) Schwantes (7)
Micropterum sessiliflorum (Aiton) Schwantes var. *album* (Haw.) H.Jacobsen (7)
Annual, biennial. Succulent. Ht up to 0.2 m. Alt 20–1200 m. NC, WC, EC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

alatum (L.Bolus) L.Bolus = **M. guerichianum**
albatum L.Bolus = **Juttadinteria albata**
albicaule Haw. = **Phyllobolus splendens** subsp. **splendens**
albicaule Salm-Dyck = **Phyllobolus splendens** subsp. **splendens**
albicute N.E.Br. = **Ruschia bolusiae**
alboroseum L.Bolus = **Leipoldtia alborosea**
album L.Bolus = **Oscularia alba**
aloides Haw. = **Nananthus aloides**
altigenum L.Bolus = **Ruschia altigena**
altile N.E.Br. = **Conophytum ficiforme**
amicorum L.Bolus = **Ruschia amicorum**
amplexicaule L.Bolus = **Leipoldtia schultzei**
amplexum N.E.Br. = **Ruschia inclusa**
ampliatum (L.Bolus) N.E.Br. = **Ruschia ampliata**
anatomicum Haw. var. *anatomicum* = **Sceletium emarcidum**
anatomicum Haw. var. *emarcidum* (Thunb.) DC. = **Sceletium emarcidum**
anatomicum Haw. var. *fragile* Haw. = **Sceletium emarcidum**
androsaceum Marloth, naked name = **Antimima androsacea**
androsaceum (Schwantes) N.E.Br. = **Antimima androsacea**
angelicae (Dinter & Schwantes) N.E.Br. = **Conophytum angelicae** subsp. **angelicae**
angustum Haw. = **Glottiphyllum cruciatum**
angustum Haw. var. *heterophyllum* Haw. = **Glottiphyllum longum**
angustum Haw. var. *heterophyllum* in sense of Salm-Dyck, not of Haw. = **Glottiphyllum depressum**
annuum L.Bolus = **M. stenandrum**
apiatum N.E.Br. = **Conophytum bilobum** subsp. **bilobum**
approximatum L.Bolus = **Ruschia approximata**
apricum A.Berger = **Leipoldtia schultzei**
arenosum Schinz = **Brownanthus arenosus**
aridum Moench, illegitimate name = **Sceletium tortuosum**
aristulatum Sond. = **Antimima aristulata**
articulatum Thunb. = **Psilocaulon articulatum**
assimile N.E.Br. = **Conophytum ficiforme**
atratum (L.Bolus) N.E.Br. = **Ruschia atrata**
atrocinctum N.E.Br. = **Antimima saturata**
attenuatum Haw. = **Drosanthemum attenuatum**
augeiforme Schwantes = **Conophytum chauviniae**
auratum Sond. = **Phyllobolus nitidus**
aureum Thunb., illegitimate name = **Phyllobolus nitidus**
ausanum Dinter & A.Berger = **Prenia tetragona**
axthelmianum Dinter = **Ruschia axthelmiana**
barklyi N.E.Br.
M. macrophyllum L.Bolus (7)
Biennial. Succulent. Ht up to 1.5 m, when in flower. Alt 30–1250 m. N, NC
barnardii (L.Bolus) N.E.Br. = **Ruschia barnardii**
beetzii Dinter = **Stoeberia beetzii**
bellidiflorum L. var. *subulatum* (Mill.) Haw. = **Acrodon subulatus**
bellum (N.E.Br.) Dinter = **Lithops karasmontana** subsp. **bella**
bergerianum Dinter = **Hereroa hesperantha**
bicorne Sond. = **Psilocaulon bicorne**
bidentatum Haw. = **Glottiphyllum difforme**
biforme N.E.Br. = **Antimima biformis**
bigibberatum Haw. = **Glottiphyllum difforme**
bijliae (L.Bolus) N.E.Br. = **Ruschia bijliae**
bilobum Marloth = **Conophytum bilobum** subsp. **bilobum**
bolusii Hook.f. = **Pleiospilos bolusii**
bosscheanum A.Berger = **Faucaria bosscheana**
brakdamense L.Bolus = **Ruschia brakdamensis**
breve L.Bolus = **M. crystallinum**
brevicolle N.E.Br. = **Antimima brevicollis**
brevifolium Aiton = **Drosanthemum brevifolium**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

britteniae L.Bolus = **Leipoldtia schultzei**
calamiforme L. = **Cylindrophyllum calamiforme**
calandrum L.Bolus = **Leipoldtia calandra**
calcicola L.Bolus = **Ruschia calcicola**
calculus A.Berger = **Conophytum calculus** subsp. **calculus**
calycinum Haw. = **Drosanthemum calycinum**
campestre Burch. = **Ruschia campestris**
canaliculatum Haw. = **Phyllobolus canaliculatus**
candens Haw. = **Drosanthemum candens**
canonotatum L.Bolus = **Ruschia canonotata**
canum A.Berger = **Deilanthe peersii**
canum Haw. = **Pleiospilos compactus** subsp. **canus**
capornii L.Bolus = **Ruschia capornii**
capornii L.Bolus forma *ferum* L.Bolus = **Ruschia capornii**
capornii L.Bolus var. *longifolium* L.Bolus = **Ruschia capornii**
carneum Haw. = **Phyllobolus spinuliferus**
caroli L.Bolus = **Ruschia caroli**
catervum N.E.Br. = **Conophytum truncatum** subsp. **viridicatum**
caudatum L.Bolus = **Phyllobolus caudatus**
caulescens Mill. = **Oscularia caulescens**
cedarbergense L.Bolus = **Oscularia cedarbergensis**
chauviniae Schwantes = **Conophytum chauviniae**
chrysum L.Bolus = **M. excavatum**
ciliatum Aiton = **Brownanthus ciliatus** subsp. **ciliatus**
ciliolatum N.E.Br. = **Antimima dasyphylla**
cinctum L.Bolus = **Ruschia cincta**
clausum Dinter = **Eberlanzia clausa**
clavulatum A.Berger = **Psilocaulon subnodosum**
cleistum (L.Bolus) N.E.Br. = **Eberlanzia sedoides**
collinum Sond. = **Drosanthemum collinum**
commutatum A.Berger = **Phyllobolus grossus**
compactum Aiton = **Pleiospilos compactus** subsp. **compactus**
comptonii L.Bolus = **Oscularia comptonii**
comptonii L.Bolus var. *roseum* L.Bolus = **Oscularia comptonii**
comptum N.E.Br. = **Antimima concinna**
concavum Haw. = **Sceletium tortuosum**
condensum N.E.Br. = **Antimima condensa**
congestum Salm-Dyck = **Ruschia congesta**
connatum N.E.Br. = **Octopoma connatum**
constrictum L.Bolus = **Leipoldtia schultzei**
corallinum Thunb. = **Brownanthus corallinus**
coriarium Burch. ex N.E.Br. = **Psilocaulon coriarium**
cradockense Kuntze = **Ruschia cradockensis** subsp. **cradockensis**
crassicaule Haw. = **Sceletium crassicaule**
crassipes Marloth = **Aloinopsis spathulata**
crassulifolium (L.Bolus) N.E.Br. = **Eberlanzia sedoides**
crassum L.Bolus = **Ruschia crassa**
cruciatum Haw. = **Glottiphyllum cruciatum**
cryocalyx L.Bolus = **M. longistylum**
cryptanthum Hook.f.
Aizoon theurkauffii Maire (7)
Annual. Succulent. Ht up to 0.25 m. Alt? N, NC, WC
crystallino-papillosum Bolus ex Fedde & J.Schust. = **Phyllobolus oculatus**
crystallinum L.
M. breve L.Bolus (7)
Annual. Succulent. Ht up to 0.5 m, when in flower. Alt 20–1300 m. N, NC, WC, EC
cultratum Salm-Dyck = **Glottiphyllum longum**
cupreum L.Bolus = **Cephalophyllum caespitosum**
cupulatum L.Bolus = **Ruschia cupulata**
curtum Haw. = **Ruschia curta**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

cylindricum Haw. = **Calamophyllum cylindricum**
cylindricum Haw. var. *teretifolium* Haw. = **Calamophyllum teretifolium**
cymbifolium Haw. = **Ruschia cymbifolia**
cymbiforme Haw. = **Corpuscularia cymbiformis**
damaranum N.E.Br. = **Lithops karasmontana** subsp. **karasmontana**
dasyphyllum Schltr. = **Antimima dasyphylla**
deceptum N.E.Br., illegitimate name = **Ruschia cymbifolia**
decurrens (L.Bolus) N.E.Br. = **Ruschia decurrens**
deflectum N.E.Br. = **Ruschia decumbens**
defoliatum Haw. = **Aridaria noctiflora** subsp. **defoliata**
dejagerae (L.Bolus) N.E.Br. = **Ruschia dejagerae**
dekenahi N.E.Br. = **Antimima dekenahi**
deliciosum L.Bolus = **Carpobrotus deliciosus**
deltoides L. var. *muricatum* A.Berger = **Oscularia deltoides**
deltoides L. var. *pedunculatum* N.E.Br. = **Oscularia pedunculata**
deltoides L. var. *simplex* DC. = **Oscularia caulescens**
delum L.Bolus = **Phyllobolus delus**
depressum Haw. = **Glottiphyllum depressum**
depressum Haw. var. *lividum* Haw. = **Glottiphyllum depressum**
derenbergiana Dinter = **Ebracteola derenbergiana**
dichroum Rolfe = **Ruschia dichroa**
difforme L. = **Glottiphyllum difforme**
difforme Thunb. = **Cheiridopsis namaquensis**
digitatum Aiton = **Dactylopsis digitata**
digitatum Thunb. = **Dactylopsis digitata**
digitiforme Thunb. = **Dactylopsis digitata**
dilatatum Haw. = **Ruschia haworthii**
dimidiatum Haw. = **Carpobrotus dimidiatus**
dinterae Dinter = **Chasmatophyllum musculinum**
dinteri Engl. = **Psilocaulon dinteri**
diplosum N.E.Br. = **Ruschia patens**
dissitum N.E.Br. = **Mitrophyllum dissitum**
distans L.Bolus = **Antimima distans**
dolabriforme L. = **Rhombophyllum dolabriforme**
dolomiticum Dinter = **Antimima dolomitica**
drepanophyllum Schltr. & A.Berger = **Esterhuysenia drepanophylla**
duale N.E.Br. = **Antimima dualis**
duthiae L.Bolus = **Ruschia duthiae**
dyeri (L.Bolus) N.E.Br. = **Rhombophyllum albanense**
eberlanzii Dinter & Schwantes = **Lithops karasmontana** subsp. **eberlanzii**
edentulum Haw. = **Ruschia edentula**
edule L. = **Carpobrotus edulis** subsp. **edulis**
eendornense Dinter = **Antimima eendornensis**
elineatum (L.Bolus) N.E.Br. = **Ruschia elineata**
elishae N.E.Br. = **Conophytum bilobum** subsp. **bilobum**
emarcidum Thunb. = **Sceletium emarcidum**
englishiae L.Bolus = **Prenia englishiae**
enorme N.E.Br. = **Antimima tuberculosa**
erectum L.Bolus = **Ruschia erecta**
eurystigmatum Gerbaulet
Eurystigma clavatum (L.Bolus) L.Bolus (7)
Annual. Succulent. Ht up to 0.2 m. Alt 600–1050 m. NC, WC
evolutum N.E.Br. = **Antimima evoluta**
exacutum N.E.Br. = **Ruschia acuminata**
excavatum L.Bolus
M. chrysum L.Bolus (7)
Annual. Succulent. Ht up to 0.04 m. Alt 500–1100 m. WC
excedens L.Bolus = **Oscularia excedens**
exile N.E.Br. = **Ruschia gracilis**
expansum L. = **Sceletium expansum**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

falciforme Haw. = **Lampranthus falciformis**
fastigiatum Haw., illegitimate name = **Phyllobolus splendens** subsp. **splendens**
fastigiatum Haw. var. *reflexum* (Haw.) Haw. = **Phyllobolus splendens** subsp. **splendens**
fastigiatum Salm-Dyck = **Phyllobolus splendens** subsp. **splendens**
fastigiatum Thunb.
M. pachypus L.Bolus (7)
Opophytum fastigiatum (Thunb.) N.E.Br. (7)
Annual. Succulent. Ht up to 0.1 m. Alt 170–350 m. WC
felinum (L.) Weston = **Faucaria felina**
fergusoniae (L.Bolus) N.E.Br. = **Antimima fergusoniae**
ferrugineum Schwantes = **Lithops lesliei** subsp. **lesliei**
festivum N.E.Br. = **Ruschia festiva**
fibuliforme Haw. = **Conophytum fibuliforme**
ficiforme Haw. = **Conophytum ficiforme**
filipetalum (L.Bolus) N.E.Br. = **Ruschia filipetala**
firmum N.E.Br. = **Ruschia brevipes**
flexuosum Haw. = **Phyllobolus splendens** subsp. **splendens**
flexuosum Salm-Dyck = **Phyllobolus splendens** subsp. **splendens**
floribundum Haw. = **Drosanthemum floribundum**
floriferum N.E.Br. = **Eberlanzia schneideriana**
formosulum N.E.Br. = **Antimima peersii**
fourcadei in sense of (L.Bolus) N.E.Br., not of L.Bolus, illegitimate name = **Ruschia fourcadei**
fragrans Salm-Dyck = **Glottiphyllum depressum**
framesii (L.Bolus) N.E.Br., illegitimate name= **Ruschia framesii**
francisci Dinter & Schwantes = **Lithops francisci**
fraternum N.E.Br. = **Conophytum fraternum**
fredericii L.Bolus = **Ruschia fredericii**
friedrichiae Dinter = **Conophytum friedrichiae**
frutescens L.Bolus = **Stoeberia frutescens**
fulviceps N.E.Br. = **Lithops fulviceps**
fulvum Haw. = **Aridaria noctiflora** subsp. **straminea**
gariusanum Dinter
M. violense L.Bolus (7)
Annual. Succulent. Ht up to 0.15 m. Alt 220–1200 m. N, NC
geminatum Jacq. = **Ruschia geminiflora**
geminatum Salm-Dyck = **Ruschia geminiflora**
geminiflorum Haw. = **Ruschia geminiflora**
geminum N.E.Br. = **Cerochlamys gemina**
gessertianum Dinter & A.Berger = **Psilocaulon gessertianum**
gigas Dinter = **Stoeberia gigas**
glareosum A.Berger = **Psilocaulon salicornioides**
globosum N.E.Br. = **Conophytum globosum**
goodiae (L.Bolus) N.E.Br. = **Ruschia goodiae**
gracistylum L.Bolus = **Conophytum bilobum** subsp. **gracilistylum**
grandiflorum Haw. = **Glottiphyllum grandiflorum**
graniticum L.Bolus = **Antimima granitica**
granulatum N.E.Br. = **Hereroa granulata**
granulicaule Haw. = **Psilocaulon granulicaule**
gratum N.E.Br. = **Conophytum jucundum** subsp. **jucundum**
griquense L.Bolus = **Ruschia griquensis**
griseum L.Bolus = **Ruschia grisea**
grossum Aiton = **Phyllobolus grossus**
guerichianum Pax
Amoebophyllum guerichianum (Pax) N.E.Br. (7)
M. alatum (L.Bolus) L.Bolus (7)
M. horridum Koutnik & Lavis (7)
M. intransparens L.Bolus var. *intransparens* (7)
M. intransparens L.Bolus var. *laxum* (L.Bolus) L.Bolus (7)
M. karrooense L.Bolus (7)
M. latisepalum (L.Bolus) L.Bolus (7)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

M. macrostigma L.Bolus (7)
M. neilsoniae (L.Bolus) L.Bolus (7)
M. parvipapillatum L.Bolus (7)
M. perlatum Dinter (7)
M. purpureoroseum L.Bolus (7)
M. quinangulatum L.Bolus (7)
M. rhodanthum L.Bolus (7)
M. rubroroseum L.Bolus (7)
M. sedentiflorum (L.Bolus) L.Bolus (7)
M. setosum (L.Bolus) L.Bolus (7)
M. squamulosum (L.Bolus) L.Bolus (7)
M. subrigidum L.Bolus (7)
M. subtereticaule L.Bolus (7)
Annual, biennial. Succulent. Ht up to 0.6 m. Alt? N, NC, WC, EC

guthriae L.Bolus = **Oscularia guthriae**
halenbergense Dinter & Schwantes = **Conophytum halenbergense**
hamatile (L.Bolus) N.E.Br. = **Antimima hamatilis**
hamatum L.Bolus = **Ruschia hamata**
hantamense Engl. = **Antimima hantamensis**
hebes N.E.Br. = **Ruschia obtusa**
herrei (Schwantes) N.E.Br. = **Antimima herrei**
hesperanthum Dinter & A.Berger = **Hereroa hesperantha**
hexamerum (L.Bolus) N.E.Br. = **Ruschia hexamera**
hirtellum Haw. = **Drosanthemum hirtellum**
hispidum L. = **Drosanthemum hispidum**
hookeri A.Berger = **Lithops hookeri**
horizontale Haw. = **Aridaria noctiflora** subsp. **defoliata**
horridum Koutnik & Lavis = **M. guerichianum**
hospitale Dinter = **Ruschia spinosa**
hutchinsonii (L.Bolus) N.E.Br. = **Amphibolia laevis**

hypertrophicum Dinter
Opophytum ampliatum L.Bolus (7)
Opophytum aquosum (L.Bolus) N.E.Br. (7)
Opophytum australe L.Bolus (7)
Annual. Succulent. Ht up to 0.25 m. Alt 50–1000 m. N, NC

imbricatum Haw. = **Ruschia imbricata**
imbricatum Haw. var. *rubrum* Haw. = **Ruschia imbricata**
impressum (L.Bolus) J.W.Ingram = **Ruschia impressa**

inachabense Engl.
M. longipapillosum Dinter (7)
Annual. Succulent. Ht up to 0.2 m. Alt 700–1100 m. N, NC

inclusum L.Bolus = **Octopoma inclusum**
incurvatum (L.Bolus) N.E.Br. = **Ruschia incurvata**
indecorum L.Bolus = **Ruschia indecora**
induratum L.Bolus = **Ruschia indurata**
inornatum L.Bolus = **M. nodiflorum**
insidens (L.Bolus) N.E.Br. = **Antimima insidens**
intransparens L.Bolus var. *intransparens* = **M. guerichianum**
intransparens L.Bolus var. *laxum* (L.Bolus) L.Bolus = **M. guerichianum**
intricatum N.E.Br. = **Ruschia intricata**
intrusum Kensit = **Brianhuntleya intrusa**
iteratum N.E.Br. = **Ruschia britteniae**
ivori N.E.Br. = **Antimima ivori**
johannis-winkleri Dinter & Schwantes = **Conophytum pageae**
jucundum N.E.Br. = **Conophytum jucundum** subsp. **jucundum**
jugiferum N.E.Br. = **Conophytum ficiforme**
julii Dinter & Schwantes = **Lithops julii** subsp. **julii**
junceum Haw. = **Psilocaulon junceum**
junceum Haw. var. *pauciflorum* Sond. = **Psilocaulon junceum**
juritzii L.Bolus = **Carpobrotus dimidiatus**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

karasmontanum Dinter & Schwantes = **Lithops karasmontana** subsp. **karasmontana**
karrooense L.Bolus = **M. guerichianum**
karrooicum L.Bolus = **Ruschia karrooica**
klaverensis L.Bolus = **Antimima klaverensis**
knysnanum L.Bolus = **Ruschia knysnana**
kuntzei Schinz = **Brownanthus kuntzei**
labyrintheum N.E.Br. = **Conophytum minimum**
lacerum Haw. = **Erepsia lacera**
lacunatum N.E.Br. = **Eberlanzia schneideriana**
laeve Aiton = **Amphibolia laevis**
laevigatum Haw. = **Carpobrotus acinaciformis**
lanceum Thunb. = **Prenia pallens** subsp. **lancea**
latens N.E.Br. = **Ruschia inconspicua**
latisepalum (L.Bolus) L.Bolus = **M. guerichianum**
latum Haw. = **Glottiphyllum longum**
lawsonii L.Bolus = **Antimima lawsonii**
laxipetalum (L.Bolus) N.E.Br. = **Ruschia laxipetala**
leipoldtii (L.Bolus) N.E.Br. = **Antimima leipoldtii**
lene N.E.Br. = **Ruschia mollis**
leptarthron A.Berger = **Psilocaulon leptarthron**
lericheanum Dinter & Schwantes = **Lithops karasmontana** subsp. **karasmontana**
lerouxiae L.Bolus = **Ruschia lerouxii**
lesliei N.E.Br. = **Lithops lesliei** subsp. **lesliei**
leucantherum L.Bolus = **Antimima leucanthera**
leviculum N.E.Br. = **Conophytum minimum**
levynsiae L.Bolus = **Antimima pumila**
liebendalense L.Bolus = **M. stenandrum**
limbatum N.E.Br. = **Antimima limbata**
lindequistii Engl. = **Aridaria noctiflora** subsp. **noctiflora**
linearifolium L.Bolus = **M. longistylum**
lineolatum Haw. = **Ruschia lineolata**
linguaeforme Haw. = **Glottiphyllum depressum**
linguaeforme Haw. var. *rufescens* Haw., invalid name= **Glottiphyllum depressum**
linguiforme in sense of Haw., not of L. = **Glottiphyllum longum**
linguiforme L. = **Glottiphyllum linguiforme**
linguiforme (L.) N.E.Br. var. *scalpratum* (Haw.) A.Berger = **Glottiphyllum linguiforme**
linguiforme L. var. *adscendens* (Haw.) A.Berger = **Glottiphyllum longum**
linguiforme L. var. *angustum* (Haw.) A.Berger, invalid name = **Glottiphyllum depressum**
linguiforme L. var. *cultratum* (Salm-Dyck) A.Berger = **Glottiphyllum longum**
linguiforme L. var. *depressum* (Haw.) A.Berger, invalid name = **Glottiphyllum longum**
linguiforme L. var. *fragrans* (Salm-Dyck) A.Berger = **Glottiphyllum depressum**
linguiforme L. var. *grandiflorum* (Haw.) A.Berger = **Glottiphyllum grandiflorum**
linguiforme L. var. *longum* (Haw.) A.Berger = **Glottiphyllum longum**
linguiforme L. var. *obliquum* (Willd.) A.Berger = **Glottiphyllum longum**
linguiforme L. var. *pustulatum* (Haw.) A.Berger = **Glottiphyllum longum**
linguiforme L. var. *uncatum* (Haw.) A.Berger = **Glottiphyllum longum**
longifolium L.Bolus = **Astridia longifolia**
longipapillosum Dinter = **M. inachabense**
longipes (L.Bolus) N.E.Br. = **Antimima longipes**
longispinulum Haw. = **Phyllobolus grossus**
longispinulum Salm-Dyck = **Phyllobolus grossus**
longistylum DC.
M. cryocalyx L.Bolus (7)
M. linearifolium L.Bolus (7)
Annual, biennial. Succulent. Ht 0.1–0.4 m. Alt 120–1100 m. NC, WC
longum Haw. = **Glottiphyllum longum**
longum Haw. var. *declive* Haw. = **Glottiphyllum depressum**
longum Haw. var. *flaccidum* Haw. = **Glottiphyllum depressum**
longum Haw. var. *uncatum* Haw. = **Glottiphyllum longum**
loratum Haw. = **Prenia pallens** subsp. **pallens**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

louiseae L.Bolus = **M. aitonis**
lucidum Haw. = **Glottiphyllum longum**
luederitzii Engl. = **Drosanthemum luederitzii**
lunatum Willd. = **Oscularia lunata**
lupinum Haw. = **Faucaria felina**
macowanii L.Bolus = **Ruschia macowanii**
macrophyllum L.Bolus = **M. barklyi**
macrostigma L.Bolus = **M. guerichianum**
magnipunctatum Haw. = **Pleiospilos compactus** subsp. **canus**
maleolens (L.Bolus) N.E.Br. = **Antimima maleolens**
mallesoniae L.Bolus = **Esterhuysenia drepanophylla**
marianae L.Bolus = **Ruschia marianae**
maritimum L.Bolus, illegitimate name = **Lampranthus falciformis**
marlothii Pax = **Brownanthus marlothii**
marmoratum N.E.Br. = **Lithops marmorata**
maximum Haw. = **Ruschia maxima**
maxwellii (L.Bolus) N.E.Br. = **Antimima maxwellii**
medium Haw. = **Glottiphyllum longum**
melanospermum Dinter, illegitimate name = **Phyllobolus melanospermus**
mellei L.Bolus = **Carpobrotus mellei**
mentiens A.Berger = **Psilocaulon coriarium**
micans L. = **Drosanthemum micans**
micranthon Haw., illegitimate name = **Psilocaulon parviflorum**
microphyllum Haw. = **Antimima microphylla**
minimum Haw. = **Conophytum minimum**
minisculum N.E.Br. = **Conophytum minusculum** subsp. **minisculum**
minutum Haw. = **Conophytum minutum**
miserum L.Bolus = **Ruschia misera**
molle in sense of A.Berger, not of Aiton, illegitimate name = **Ruschia mollis**
montis-moltkei Dinter = **Ebracteola montis-moltkei**
mucronatum Haw. = **Antimima mucronata**
mucroniferum Haw. = **Ruschia spinosa**
mucronulatum Dinter = **Psilocaulon articulatum**
muelleri L.Bolus = **Ruschia muelleri**
muirianum L.Bolus = **Ruschia muiriana**
muirii L.Bolus = **Carpobrotus muirii**
multiflorum Haw. = **Ruschia multiflora**
multiflorum Haw. var. *rubrum* (Haw.) Haw. = **Ruschia imbricata**
munitum L.Bolus = **Ruschia intricata**
muricatum Haw. = **Oscularia deltoides**
musculinum Haw. = **Chasmatophyllum musculinum**
muticum (L.Bolus) N.E.Br. = **Antimima mutica**
namaquanum (L.Bolus) N.E.Br. = **Amphibolia rupis-arcuatae**
namibense Marloth = **Brownanthus namibensis**
neilsoniae (L.Bolus) L.Bolus = **M. guerichianum**
nevillei N.E.Br. = **Conophytum obcordellum** subsp. **obcordellum** var. **obcordellum**
nitidum Haw. = **Phyllobolus nitidus**
nobile Haw. = **Pleiospilos compactus** subsp. **canus**
noctiflorum L. var. *elatum* Haw. = **Aridaria noctiflora** subsp. **noctiflora**
noctiflorum L. var. *fulvum* (Haw.) Salm-Dyck = **Aridaria noctiflora** subsp. **straminea**
noctiflorum L. var. *noctiflorum* = **Aridaria noctiflora** subsp. **noctiflora**
noctiflorum L. var. *phoeniceum* Haw., illegitimate name = **Aridaria noctiflora** subsp. **noctiflora**
noctiflorum L. var. *stramineum* (Haw.) Haw. = **Aridaria noctiflora** subsp. **straminea**
nodiflorum L.
M. inornatum L.Bolus (7)
M. paucandrum L.Bolus (7)
Annual. Succulent. Ht up to 0.15 m. Alt 20–1150 m. N, NC, WC
nothum N.E.Br. = **Phyllobolus splendens** subsp. **splendens**
obconellum Haw. = **Conophytum obcordellum** subsp. **obcordellum** var. **obcordellum**
obcordellum Haw. = **Conophytum obcordellum** subsp. **obcordellum** var. **obcordellum**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

obliquum Willd. = **Glottiphyllum longum**
obmetale N.E.Br. = **Conophytum minimum**
obsubulatum Haw. = **Cylindrophyllum obsubulatum**
octojuge L.Bolus = **Octopoma octojuge**
octonarium L.Bolus = **Enarganthe octonaria**
oculatum N.E.Br. = **Phyllobolus oculatus**
odontocalyx Schltr. & Diels = **Ruschia odontocalyx**
odoratum L.Bolus = **Hereroa odorata**
odoratum N.E.Br. = **Conophytum ficiforme**
olivaceum Schltr. = **Phyllobolus tenuiflorus**
optatum N.E.Br. = **Pleiospilos compactus** subsp. **compactus**
opticum Marloth = **Lithops optica**
paardebergense L.Bolus = **Oscularia paardebergensis**
pachyphyllum L.Bolus = **Cerochlamys pachyphylla**
pachypus L.Bolus = **M. fastigiatum**
pageae N.E.Br. = **Conophytum pageae**
pageanum in sense of L.Bolus (1929), not of L.Bolus (1927), illegitimate name = **Oscularia ornata**
pallens Aiton = **Prenia pallens** subsp. **pallens**
pallescens Haw. = **Prenia pallens** subsp. **pallens**
pallidum L.Bolus = **Lampranthus dilutus**
pallidum N.E.Br. = **Conophytum ficiforme**
pansifolium N.E.Br. = **Amphibolia laevis**
papulosum L.f. = **Cleretum papulosum** subsp. **papulosum**
paripetalum L.Bolus = **Ruschia paripetala**
parvibracteatum (L.Bolus) N.E.Br. = **Eberlanzia parvibracteata**
parviflorum in sense of Haw., not of Jacq. = **Ruschia parviflora**
parviflorum Jacq. = **Psilocaulon parviflorum**
parvipapillatum L.Bolus = **M. guerichianum**
parvipetalum N.E.Br. = **Conophytum obcordellum** subsp. **obcordellum** var. **obcordellum**
parvulum Schltr. = **Cephalophyllum parvulum**
parvum N.E.Br. = **Antimima pusilla**
paucandrum L.Bolus = **M. nodiflorum**
paulum (N.E.Br.) L.Bolus = **M. aitonis**
pauxillum N.E.Br. = **Conophytum minimum**
paxianum Schltr. & Diels = **Drosanthemum luederitzii**
pellanum N.E.Br. = **Ruschia muricata**
pellitum Friedrich
Annual, biennial. Succulent. Ht up to 0.5 m. Alt 30–350 m. N, NC
perfoliatum Mill. = **Ruschia perfoliata**
perforatum (L.Bolus) N.E.Br. = **Antimima perforata**
perlatum Dinter = **M. guerichianum**
perpusillum Haw. = **Conophytum minimum**
pfeilii Engl. = **Prenia tetragona**
phylicoides (L.Bolus) N.E.Br. = **Ruschia phylicoides**
pictum N.E.Br. = **Conophytum minimum**
pillansii Kensit = **Erepsia pillansii**
piluliforme N.E.Br. = **Conophytum piluliforme** subsp. **piluliforme**
piquetbergense L.Bolus = **Oscularia piquetbergensis**
pisinnum N.E.Br. = **Conophytum truncatum** subsp. **viridicatum**
placitum N.E.Br. = **Conophytum ficiforme**
plenifolium N.E.Br. = **Phyllobolus splendens** subsp. **splendens**
pomeridianum L.Bolus = **M. stenandrum**
praepingue Haw. = **Glottiphyllum cruciatum**
prismaticum Marloth ex Schwantes = **Tanquana prismatica**
propinquum N.E.Br. = **Antimima propinqua**
prostratum (L.Bolus) N.E.Br. = **Antimima prostrata**
pseudoausanum Dinter, naked name = **Prenia tetragona**
pseudorupicolum Dinter, naked name = **Ruschia barnardii**
pseudotruncatellum A.Berger = **Lithops pseudotruncatella** subsp. **pseudotruncatella**
pulchellum Haw., insufficiently known

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

pulverulentum Haw. = **Drosanthemum pulverulentum**
pumilum L.Bolus = **Antimima pumila**
pumilum (L.Bolus) N.E.Br., illegitimate name = **Antimima pumila**
punctulatum L.Bolus = **Ruschia punctulata**
pungens A.Berger = **Ruschia pungens**
purpureoroseum L.Bolus = **M. guerichianum**
purpureostylum L.Bolus = **Acrodon purpureostylus**
purpusii Schwantes = **Conophytum truncatum** subsp. **truncatum** var. **truncatum**
pusillum N.E.Br. = **Conophytum minimum**
pustulatum Haw. = **Glottiphyllum longum**
pustulatum Haw. var. *lividum* Salm-Dyck = **Glottiphyllum longum**
puttkamerianum Dinter & A.Berger = **Hereroa puttkameriana**
pygmaeum Haw. = **Antimima pygmaea**
quaesitum N.E.Br. = **Conophytum quaesitum** subsp. **quaesitum** var. **quaesitum**
quarziticum Dinter = **Antimima quarzitica**
quinangulatum L.Bolus = **M. guerichianum**
recurvum Moench = **Ruschia recurva**
reductum N.E.Br. in part N.E.Br. = **Octopoma subglobosum**
reductum N.E.Br. in part N.E.Br., illegitimate name = **Ruschia nana**
reflexum Haw. = **Phyllobolus splendens** subsp. **splendens**
relaxatum Willd. = **Prenia pallens** subsp. **pallens**
resurgens Kensit = **Phyllobolus resurgens**
rhodanthum L.Bolus = **M. guerichianum**
rhomboideum Salm-Dyck = **Rhombophyllum rhomboideum**
rigidum Haw. = **Ruschia rigida**
ringens L. var. ß *felinum* L. = **Faucaria felina**
roodiae N.E.Br. = **Tanquana prismatica**
roseolum N.E.Br. = **Antimima roseola**
rostellum Haw. = **Ruschia rostella**
rubrocinctum Haw. = **Carpobrotus acinaciformis**
rubroroseum L.Bolus = **M. guerichianum**
rubrum L.Bolus = **Astridia rubra**
rufescens Haw. = **Glottiphyllum depressum**
rugulosum A.Berger ex Range, naked name = **Eberlanzia schneideriana**
rupis-arcuatae Dinter = **Amphibolia rupis-arcuatae**
ruschiorum Dinter & Schwantes = **Lithops ruschiorum**
salicornioides Pax = **Psilocaulon salicornioides**
salmii Haw. = **Glottiphyllum salmii**
salmoneum Haw. = **Phyllobolus canaliculatus**
salmoneum Salm-Dyck = **Phyllobolus canaliculatus**
saxetanum N.E.Br. = **Conophytum saxetanum**
saxicolum (L.Bolus) N.E.Br. = **Antimima saxicola**
scalpratum Haw., illegitimate name = **Glottiphyllum linguiforme**
schenckii Schinz = **Brownanthus ciliatus** subsp. **schenckii**
schlechteri (Schwantes) N.E.Br. = **Antimima schlechteri**
schlichtianum Sond. = **Brownanthus arenosus**
schneiderianum A.Berger = **Eberlanzia schneideriana**
schultzei Schltr. & Diels = **Leipoldtia schultzei**
scintillans Dinter = **Phyllobolus oculatus**
scitulum N.E.Br. = **Conophytum minimum**
secundum Thunb., naked name = **Psilocaulon articulatum**
sedentiflorum (L.Bolus) L.Bolus = **M. guerichianum**
sedoides Dinter & A.Berger = **Eberlanzia sedoides**
semicylindricum Haw. = **Glottiphyllum difforme**
separatum N.E.Br. = **Zeuktophyllum calycinum**
serratum L. = **Circandra serrata**
sessile Thunb. = **Ruschia sessilis**
sessiliflorum Aiton = **Cleretum papulosum** subsp. **papulosum**
setosum (L.Bolus) L.Bolus = **M. guerichianum**
signatum N.E.Br. = **Conophytum minimum**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

simile Sond. = **Psilocaulon junceum**
simile Sond. var. *namaquense* Sond. = **Psilocaulon junceum**
simulans Marloth = **Pleiospilos simulans**
sinuosum L.Bolus = **Phyllobolus sinuosus**
sinus-redfordiani Dinter, naked name = **Psilocaulon salicornioides**
sladenianum L.Bolus = **Prenia sladeniana**
sobrinum N.E.Br. = **Antimima sobrina**
socium N.E.Br. = **Argyroderma fissum**
solidum L.Bolus = **Antimima solida**
sororium N.E.Br. = **Pleiospilos compactus** subsp. **sororius**
spinescens Pax, naked name = **Ruschia divaricata**
spinosum L. = **Ruschia spinosa**
spinosum L. var. *cradockense* (Kuntze) A.Berger ex Range, naked name= **Ruschia cradockensis** subsp. **cradockensis**
spinosum L. var. *micranthum* Pax = **Ruschia spinosa**
spinuliferum Haw. = **Phyllobolus spinuliferus**
spinuliforme Harv. & Sond. = **Phyllobolus spinuliferus**
splendens L. = **Phyllobolus splendens** subsp. **splendens**
squamulosum (L.Bolus) L.Bolus = **M. guerichianum**
steenbergense L.Bolus = **Oscularia steenbergensis**
stellans (L.Bolus) N.E.Br. = **Antimima hantamensis**
stenandrum (L.Bolus) L.Bolus
M. annuum L.Bolus (7)
M. liebendalense L.Bolus (7)
M. pomeridianum L.Bolus (7)
Psilocaulon pomeridianum L.Bolus (7)
Annual, occ. perennial. Succulent. Ht up to 0.2 m. Alt 250–1450 m. FS, NC, WC
stenophyllum L.Bolus = **Marlothistella stenophylla**
stipulaceum L. = **Lampranthus stipulaceus**
stokoei L.Bolus = **Esterhuysenia stokoei**
stramineum Haw. = **Aridaria noctiflora** subsp. **straminea**
striatum Haw. = **Drosanthemum striatum**
stylosum N.E.Br. = **Conophytum bilobum** subsp. **bilobum**
suaveolens L.Bolus, illegitimate name = **Phyllobolus lignescens**
subalatum Haw. = **Carpobrotus acinaciformis**
subcompressum Haw. = **Drosanthemum subcompressum**
subnodosum A.Berger = **Psilocaulon subnodosum**
subrigidum L.Bolus = **M. guerichianum**
subrisum N.E.Br. = **Conophytum pageae**
subtereticaule L.Bolus = **M. guerichianum**
subtruncatum L.Bolus
Annual. Succulent. Ht up to 0.02 m. Alt 300–700 m. WC
succulentum (L.Bolus) N.E.Br. = **Amphibolia succulenta**
sulcatum Haw. = **Phyllobolus splendens** subsp. **splendens**
superans L.Bolus = **Oscularia superans**
suppositum L.Bolus = **Zeuktophyllum suppositum**
surrectum Haw. = **Glottiphyllum surrectum**
taurinum Haw. = **Glottiphyllum depressum**
taylori N.E.Br. = **Corpuscularia taylori**
taylorianum Dinter & Schwantes = **Conophytum taylorianum** subsp. **taylorianum**
tenellum Haw. = **Ruschia tenella**
tenue Haw. = **Psilocaulon parviflorum**
tenuiflorum Jacq. = **Phyllobolus tenuiflorus**
teretifolium Haw. = **Calamophyllum teretifolium**
tetragonum Thunb. = **Prenia tetragona**
thermarum L.Bolus = **Oscularia thermarum**
tigrinum Haw. = **Faucaria tigrina**
tinctum L.Bolus = **Meyerophytum meyeri**
tortuosum L. = **Sceletium tortuosum**
trichosanthum A.Berger = **Phyllobolus viridiflorus**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

trichotomum Thunb. = **Phyllobolus trichotomus**
triquetrum (L.Bolus) N.E.Br. = **Antimima triquetra**
triticiforme L.Bolus = **Ruschia cradockensis** subsp. **triticiformis**
trothai Engl. = **Psilocaulon salicornioides**
truncatellum Hook.f., not of Haw. = **Lithops hookeri**
truncatellum in sense of Dinter, not of Haw. = **Lithops pseudotruncatella** subsp. **pseudotruncatella**
tuitum N.E.Br. on herbarium label, naked name = **Ruschia intricata**
tumidulum Haw. = **Ruschia tumidula**
turbiniforme in sense of N.E.Br., not of Haw., misapplied name = **Lithops hookeri**
turrigerum N.E.Br. = **Conophytum turrigerum**
umbellatum L. = **Ruschia umbellata**
umbelliflorum Jacq. = **Phyllobolus splendens** subsp. **splendens**
uncatum Salm-Dyck = **Glottiphyllum longum**
utile L.Bolus = **Stoeberia utilis**
uviforme (Haw.) N.E.Br. = **Conophytum uviforme** subsp. **uviforme**
vaginatum Haw. = **Ruschia vaginata**
vaginatum Haw. var. *acutangulum* A.Berger = **Ruschia acutangula**
vaginatum Haw. var. *curtum* (Haw.) A.Berger = **Ruschia curta**
valens N.E.Br. = **Ruschia glauca**
vallis-mariae Dinter & Schwantes = **Lithops vallis-mariae**
varians Haw. = **Sceletium varians**
variifolium N.E.Br. = **Ruschia diversifolia**
velutinum Dinter = **Astridia velutina**
ventricosum L.Bolus = **Antimima ventricosa**
vernicolor L.Bolus = **Oscularia vernicolor**
verruculatum L. = **Scopelogena verruculata**
verruculosum (L.Bolus) N.E.Br. = **Antimima verruculosa**
violense L.Bolus = **M. gariusanum**
virgatum Haw. = **Ruschia virgata**
viridiflorum Aiton = **Phyllobolus viridiflorus**
weigangianum Dinter = **Leipoldtia weigangiana** subsp. **weigangiana**
wittebergense L.Bolus = **Antimima wittebergensis**

MESTOKLEMA N.E.Br. ex Glen 2405074
(1) Glen. 1981. *Bothalia* 13: 454.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 168, 169.
albanicum N.E.Br. ex Glen
Perennial. Succulent. Ht 0.25–0.4 m. Alt 450–860 m. EC
arboriforme (Burch.) N.E.Br. ex Glen
Perennial. Succulent. Ht 0.25–0.5 m. Alt 1100–1450 m. FS, NC
copiosum N.E.Br. ex Glen
Perennial. Succulent. Ht up to 0.5 m. Alt 800–1300 m. NC
elatum N.E.Br. ex Glen
Perennial. Succulent. Ht up to 1.2 m. Alt 260–540 m. EC
illepidum N.E.Br. ex Glen
Perennial. Succulent. Ht 0.23–0.25 m. Alt 400–880 m. EC
tuberosum (L.) N.E.Br. ex Glen
M. tuberosum (L.) N.E.Br. ex Glen var. *macrorhizum* (Haw.) N.E.Br. ex Glen (1)
Perennial. Succulent. Ht up to 0.6 m. Alt 100–800 m. EC
tuberosum (L.) N.E.Br. ex Glen var. *macrorhizum* (Haw.) N.E.Br. ex Glen = **M. tuberosum**

MEYEROPHYTUM Schwantes 2405075
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 279.
(2) Ihlenfeldt. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 170, 171.
globosum (L.Bolus) Ihlenf.
Conophyllum globosum L.Bolus (2)
Monilaria globosa (L.Bolus) L.Bolus (2)
Perennial. Succulent. Ht up to 0.1 m, 0.13 m when in flower. Alt 300–650 m. NC
meyeri (Schwantes) Schwantes
Mesembryanthemum tinctum L.Bolus (2)
M. meyeri (Schwantes) Schwantes var. *holgatense* L.Bolus (2)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

M. tinctum (L.Bolus) Schwantes (2)
Perennial. Succulent. Ht up to 0.2 m. Alt 100–370 m. NC
meyeri (Schwantes) Schwantes var. *holgatense* L.Bolus = **M. meyeri**
microstigma (L.Bolus) L.Bolus = **Dicrocaulon microstigma**
primosii (L.Bolus) L.Bolus = **Dicrocaulon microstigma**
tinctum (L.Bolus) Schwantes = **M. meyeri**

MICROPTERUM Schwantes 2405076
papulosum (L.f.) Schwantes = **Cleretum papulosum** subsp. **papulosum**
papulosum (L.f.) Schwantes subsp. *multiflorum* Schwantes, naked name = **Cleretum papulosum** subsp. **multiflorum**
puberulum (Haw.) Schwantes = **Mesembryanthemum aitonis**
sessiliflorum (Aiton) Schwantes = **Cleretum papulosum** subsp. **papulosum**
sessiliflorum (Aiton) Schwantes var. *album* (Haw.) H.Jacobsen = **Mesembryanthemum aitonis**

MITROPHYLLUM Schwantes 2405078
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: tt. 272, 274.
(2) Poppendieck. 1976. *Botanische Jahrbücher* 97: 339–413.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 172–175.
abbreviatum L.Bolus
Perennial. Succulent. Ht up to 0.4 m. Alt 400–950 m. NC
clivorum (N.E.Br.) Schwantes
Perennial. Succulent. Ht up to 0.6 m. Alt up to 1200 m. NC
crassifolium (L.Bolus) G.D.Rowley = **M. grande**
cuspidatum (L.Bolus) de Boer = **M. grande**
dissitum (N.E.Br.) Schwantes
Mesembryanthemum dissitum N.E.Br. (3)
M. parvifolium (L.Bolus) G.D.Rowley (3)
Perennial. Succulent. Ht 0.4–0.6 m. Alt 350–1200 m. NC
grande N.E.Br.
M. crassifolium (L.Bolus) G.D.Rowley (3)
M. cuspidatum (L.Bolus) de Boer (3)
Perennial. Succulent. Ht up to 0.4 m, when in flower. Alt 360–710 m. NC
mitratum (Marloth) Schwantes
Perennial. Succulent. Ht up to 0.6 m. Alt 350–700 m. NC
parvifolium (L.Bolus) G.D.Rowley = **M. dissitum**
roseum L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 540–700 m. NC

MONILARIA (Schwantes) Schwantes 2405079
(1) Ihlenfeldt *et al.* 1978. *Mitteilungen aus dem Institut für Allgemeine Botanik, Hamburg* 16: 171–182.
(2) Ihlenfeldt. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 176–178.
brevifolia L.Bolus = **Dicrocaulon grandiflorum**
chrysoleuca (Schltr.) Schwantes
M. chrysoleuca (Schltr.) Schwantes var. *polita* (L.Bolus) Ihlenf. & Jörg. (3)
Perennial. Succulent. Ht up to 0.2 m. Alt 220–350 m. WC
chrysoleuca (Schltr.) Schwantes var. *polita* (L.Bolus) Ihlenf. & Jörg. = **M. chrysoleuca**
globosa (L.Bolus) L.Bolus = **Meyerophytum globosum**
microstigma L.Bolus = **Dicrocaulon microstigma**
moniliformis (Thunb.) Ihlenf. & Jörg.
Perennial. Succulent. Ht up to 0.2 m. Alt 175–340 m. WC
obconica Ihlenf. & Jörg.
Perennial. Succulent. Ht up to 0.2 m. Alt 1000–1200 m. NC
pisiformis (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.12 m. Alt 220–350 m. WC
scutata (L.Bolus) Schwantes subsp. **obovata** Ihlenf. & Jörg.
Perennial. Succulent. Ht? Alt? NC
scutata (L.Bolus) Schwantes subsp. **scutata**
Perennial. Succulent. Ht? Alt? NC

MOSSIA N.E.Br. 2405080

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

(1) Smith & Hartzer. 1997. *Taxon* 46: 349, 350.
(2) Smith *et al.* 1997. *Curtis's Botanical Magazine* 14: 16–22.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 178, 179.
intervallaris (L.Bolus) N.E.Br.
Perennial. Succulent. Ht up to 0.02 m. Alt 1100–3000 m. G, M, FS, L, EC

MUIRIA N.E.Br. 2405081
(1) Klak. 2000. In Goldblatt & Manning, *Strelitzia* 9: 243, 244.
(2) Chesselet, Burgoyne & Hammer. Personal communication.
hortenseae N.E.Br.
Gibbaeum hortenseae (N.E.Br.) Thiede & Klak (2)
Perennial. Succulent. Ht up to 0.05 m. Alt 550–630 m. WC

NAMAQUANTHUS L.Bolus 2405082
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 180.
vanheerdei L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 700–900 m. NC

NAMIBIA (Schwantes) Schwantes 2405083
(1) Walgate. 1939. In Bolus, *Notes on* Mesembryanthemum *and allied genera*, part 3: 171–188.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 180, 181.
cinerea (Marloth) Dinter & Schwantes
Juttadinteria longipetala L.Bolus (2)
Perennial. Succulent. Ht up to 0.15 m. Alt? N
pomonae (Dinter) Dinter & Schwantes ex Walgate
Perennial. Succulent. Ht up to 0.15 m. Alt? N

NANANTHUS N.E.Br. 2405084
(1) Phillips. 1922. *The Flowering Plants of South Africa* 2: t. 54.
(2) Bolus. 1947. *The Flowering Plants of Africa* 26: tt. 1036, 1037.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 181–184.
aloides (Haw.) Schwantes
Mesembryanthemum aloides Haw. (3)
N. aloides (Haw.) Schwantes var. *latus* L.Bolus (3)
N. wilmaniae (L.Bolus) L.Bolus (3)
Perennial. Succulent. Ht up to 0.02 m. Alt up to 1400 m. B, NW, NC
aloides (Haw.) Schwantes var. *latus* L.Bolus = **N. aloides**
aloides (Haw.) Schwantes var. *striatus* (L.Bolus) L.Bolus = **N. vittatus**
broomii (L.Bolus) L.Bolus = **N. vittatus**
gerstneri (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.02 m. Alt 1400–1800 m. FS, EC
margaritiferus L.Bolus
Perennial. Succulent. Ht up to 0.01 m. Alt 900–1300 m. N, B, NC
pallens (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 950–1250 m. NC
peersii L.Bolus = **Deilanthe peersii**
pole-evansii N.E.Br.
Perennial. Succulent. Ht up to 0.03 m. Alt 1100–1750 m. FS, EC
transvaalensis (Rolfe) L.Bolus var. *latus* L.Bolus = **N. vittatus**
transvaalensis (Rolfe) L.Bolus var. *transvaalensis* = **N. vittatus**
vittatus (N.E.Br.) Schwantes
N. aloides (Haw.) Schwantes var. *striatus* (L.Bolus) L.Bolus (3)
N. broomii (L.Bolus) L.Bolus (3)
N. transvaalensis (Rolfe) L.Bolus var. *latus* L.Bolus (3)
N. transvaalensis (Rolfe) L.Bolus var. *transvaalensis* (3)
Perennial. Succulent. Ht up to 0.01 m. Alt? NW, FS, NC
wilmaniae (L.Bolus) L.Bolus = **N. aloides**

NELIA Schwantes 2405085
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 184, 185.
meyeri Schwantes = **N. pillansii**
pillansii (N.E.Br.) Schwantes
N. meyeri Schwantes (1)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

N. robusta Schwantes (1)
Perennial. Succulent. Ht up to 0.08 m. Alt 100–350 m. NC
robusta Schwantes = **N. pillansii**
schlechteri Schwantes
Perennial. Succulent. Ht up to 0.12 m. Alt 190–680 m. NC

NEOHENRICIA L.Bolus 2405086
(1) Hammer. 1994. *Cactus and Succulent Journal (US)* 66: 84–86.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 186.
sibbettii (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.01 m. Alt 1120–1380 m. FS, NC, EC
spiculata S.A.Hammer
Perennial. Succulent. Ht up to 0.01 m. Alt 1400–1900 m. EC

NYCTERANTHUS Neck. 2405151
abbreviatus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus abbreviatus**
acuminatus (Haw.) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
albertensis (L.Bolus) Schwantes, illegitimate name = **Phyllobolus pumilus**
albicaulis (Haw.) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
anguineus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus oculatus**
arcuatus (L.Bolus) Schwantes, illegitimate name = **Aridaria noctiflora** subsp. **noctiflora**
arenicolus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus oculatus**
aureus (Thunb.) Schwantes, illegitimate name = **Phyllobolus nitidus**
ausanus (Dinter & A.Berger) Schwantes, illegitimate name = **Prenia tetragona**
bijliae (N.E.Br.) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
blandus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
brevicarpus (L.Bolus) Schwantes, illegitimate name = **Aridaria brevicarpa**
brevifolius (L.Bolus) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
calycinus (L.Bolus) Schwantes, illegitimate name = **Aridaria noctiflora** subsp. **noctiflora**
canaliculatus (Haw.) Schwantes, illegitimate name = **Phyllobolus canaliculatus**
carneus (Haw.) Schwantes, illegitimate name = **Phyllobolus spinuliferus**
caudatus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus caudatus**
celans (L.Bolus) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
commutatus (A.Berger) Schwantes, illegitimate name = **Phyllobolus grossus**
compactus (L.Bolus) Schwantes, illegitimate name = **Aridaria serotina**
congestus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus congestus**
constrictus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
debilis (L.Bolus) Schwantes, illegitimate name = **Aridaria noctiflora** subsp. **noctiflora**
deciduus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus deciduus**
decurvatus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus decurvatus**
defoliatus (Haw.) Schwantes, illegitimate name = **Aridaria noctiflora** subsp. **defoliata**
dejagerae (L.Bolus) Schwantes, illegitimate name = **Aridaria noctiflora** subsp. **straminea**
delus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus delus**
dinteri (L.Bolus) Schwantes, illegitimate name = **Phyllobolus melanospermus**
dyeri (L.Bolus) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
ebracteatus (N.E.Br.) Schwantes var. *brevipetalus* (L.Bolus) Schwantes, illegitimate name = **Phyllobolus trichotomus**
ebracteatus (N.E.Br.) Schwantes var. *ebracteatus*, illegitimate name = **Phyllobolus trichotomus**
elongatus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus prasinus**
englishiae (L.Bolus) Schwantes, illegitimate name = **Prenia englishiae**
esterhuyseniae (L.Bolus) Schwantes, illegitimate name = **Aridaria noctiflora** subsp. **straminea**
flexuosus (Haw.) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
floribundus (L.Bolus) Schwantes, illegitimate name = **Aridaria noctiflora** subsp. **noctiflora**
fourcadei (L.Bolus) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
fragilis (N.E.Br.) Schwantes, illegitimate name = **Phyllobolus oculatus**
framesii (L.Bolus) Schwantes, illegitimate name = **Phyllobolus spinuliferus**
fulvus (Haw.) Schwantes, illegitimate name = **Aridaria noctiflora** subsp. **straminea**
glanduliferus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus sinuosus**
globosus (L.Bolus) Schwantes, illegitimate name = **Aridaria serotina**
godmaniae (L.Bolus) Schwantes, illegitimate name = **Phyllobolus sinuosus**
gracilis (L.Bolus) Schwantes, illegitimate name = **Aridaria serotina**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

gratiae (L.Bolus) Schwantes, illegitimate name = **Phyllobolus grossus**
grossus (Aiton) Schwantes, illegitimate name = **Phyllobolus grossus**
herbertii (N.E.Br.) Schwantes, illegitimate name = **Phyllobolus herbertii**
horizontalis (Haw.) Schwantes, illegitimate name = **Aridaria noctiflora** subsp. **defoliata**
inaequalis (L.Bolus) Schwantes, illegitimate name = **Phyllobolus nitidus**
intricatus (L.Bolus) Schwantes, illegitimate name = **Aridaria brevicarpa**
latipetalus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus latipetalus**
laxipetalus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus grossus**
laxus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus decurvatus**
leptopetalus (L.Bolus) Friedrich = **Phyllobolus splendens** subsp. **splendens**
ligneus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus melanospermus**
longisepalus (L.Bolus) Schwantes, illegitimate name = **Aridaria noctiflora** subsp. **defoliata**
longispinulus (Haw.) Schwantes, illegitimate name = **Phyllobolus grossus**
longitubus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus tenuiflorus**
luteoalbus (L.Bolus) Schwantes, illegitimate name = **Prenia tetragona**
macrosiphon (L.Bolus) Schwantes, illegitimate name = **Phyllobolus tenuiflorus**
meridianus (L.Bolus) Schwantes, illegitimate name = **Aridaria noctiflora** subsp. **defoliata**
meyeri (L.Bolus) Schwantes, illegitimate name = **Aridaria brevicarpa**
muirii (L.Bolus) Schwantes, illegitimate name = **Aridaria noctiflora** subsp. **defoliata**
multiseriatus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus prasinus**
mutans (L.Bolus) Schwantes, illegitimate name = **Prenia tetragona**
noctiflorus (L.) Rothm., illegitimate name = **Aridaria noctiflora** subsp. **noctiflora**
nothus (N.E.Br.) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
obtusus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus decurvatus**
oculatus (N.E.Br.) Schwantes, illegitimate name = **Phyllobolus oculatus**
odoratus (L.Bolus) Schwantes, illegitimate name = **Hereroa odorata**
oubergensis (L.Bolus) Schwantes, illegitimate name = **Phyllobolus pumilus**
ovalis (L.Bolus) Schwantes, illegitimate name = **Aridaria serotina**
parvisepalus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus spinuliferus**
paucandrus L.Bolus var. *gracillima* (L.Bolus) Schwantes, illegitimate name = **Aridaria serotina**
paucandrus (L.Bolus) Schwantes var. *paucandrus*, illegitimate name = **Aridaria serotina**
peersii (L.Bolus) Schwantes, illegitimate name = **Phyllobolus tenuiflorus**
pentagonus (L.Bolus) Schwantes var. *occidentalis* (L.Bolus) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **pentagonus**
pentagonus (L.Bolus) Schwantes var. *pentagonus*, illegitimate name = **Phyllobolus splendens** subsp. **pentagonus**
platysepalus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus grossus**
plenifolius (N.E.Br.) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
pomonae (L.Bolus) Schwantes, illegitimate name = **Phyllobolus oculatus**
prasinus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus prasinus**
primulinus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
pumilus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus pumilus**
quartziticus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus quartziticus**
quaternus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus spinuliferus**
rabiei (L.Bolus) Schwantes, illegitimate name = **Phyllobolus rabiei**
rabiesbergensis (L.Bolus) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
radicans (L.Bolus) Schwantes, illegitimate name = **Prenia radicans**
recurvus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus sinuosus**
rhodandrus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus nitidus**
roseus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
salmoneus (Haw.) Schwantes, illegitimate name = **Phyllobolus canaliculatus**
saturatus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus saturatus**
scintillans (Dinter) Schwantes, illegitimate name = **Phyllobolus oculatus**
serotinus (L.Bolus) Schwantes, illegitimate name = **Aridaria serotina**
sinuosus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus sinuosus**
spinuliferus (Haw.) Schwantes, illegitimate name = **Phyllobolus spinuliferus**
splendens (L.) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
stramineus (Haw.) Schwantes, illegitimate name = **Aridaria noctiflora** subsp. **straminea**
straminicolor (L.Bolus) Schwantes, illegitimate name = **Phyllobolus sinuosus**
striatus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

strictus (L.Bolus) Schwantes, illegitimate name = **Phyllobolus spinuliferus**
subaequans (L.Bolus) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **pentagonus**
subpatens (L.Bolus) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **pentagonus**
subtruncatus (L.Bolus) Schwantes, illegitimate name = **Aridaria noctiflora** subsp. **straminea**
suffusus (L.Bolus) Schwantes, illegitimate name = **Prenia tetragona**
sulcatus (Haw.) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
tenuiflorus (Jacq.) Schwantes, illegitimate name = **Phyllobolus tenuiflorus**
tenuifolius (L.Bolus) Schwantes var. *speciosa* L.Bolus, illegitimate name = **Aridaria serotina**
tenuifolius (L.Bolus) Schwantes var. *tenuifolius*, illegitimate name = **Aridaria serotina**
tetragonus (Thunb.) Schwantes, illegitimate name = **Prenia tetragona**
tetramerus (L.Bolus) Schwantes var. *parviflorus* (L.Bolus) Schwantes, illegitimate name = **Phyllobolus trichotomus**
tetramerus (L.Bolus) Schwantes var. *tetramerus*, illegitimate name = **Phyllobolus trichotomus**
trichotomus (Thunb.) Schwantes, illegitimate name = **Phyllobolus trichotomus**
umbelliflorus (Jacq.) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
varians (L.Bolus) Schwantes, illegitimate name = **Phyllobolus oculatus**
vernalis (L.Bolus) Schwantes, illegitimate name = **Phyllobolus splendens** subsp. **splendens**
vespertinus (L.Bolus) Schwantes, illegitimate name = **Aridaria vespertina**
viridiflorus (Aiton) Schwantes, illegitimate name = **Phyllobolus viridiflorus**
watermeyeri (L.Bolus) Schwantes, illegitimate name = **Phyllobolus spinuliferus**
willowmorensis (L.Bolus) Schwantes, illegitimate name = **Phyllobolus grossus**

OCTOPOMA N.E.Br. 2405087
(1) Hartmann. 1998. *Bradleya* 16: 44–91.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 188–190.
abruptum (A.Berger) N.E.Br.
Mesembryanthemum abruptum A.Berger (1)
Ruschia abrupta (A.Berger) G.D.Rowley (1)
Perennial. Succulent. Ht up to 0.25 m. Alt 300–800 m. WC
calycinum (L.Bolus) L.Bolus = **Zeuktophyllum calycinum**
conjunctum (L.Bolus) L.Bolus = **O. connatum**
connatum (L.Bolus) L.Bolus
Mesembryanthemum connatum N.E.Br. (1)
O. conjunctum (L.Bolus) L.Bolus (1)
Ruschia conjuncta L.Bolus (1)
Ruschia connata L.Bolus (1)
Perennial. Succulent. Ht up to 0.3 m. Alt 180–650 m. NC, WC
inclusum (L.Bolus) N.E.Br.
Mesembryanthemum inclusum L.Bolus (1)
Ruschia restituta G.D.Rowley (1)
Perennial. Succulent. Ht up to 0.25 m. Alt up to 1200 m. NC
octojuge (L.Bolus) N.E.Br.
Mesembryanthemum octojuge L.Bolus (1)
Ruschia octojugis (L.Bolus) L.Bolus (1)
Perennial. Succulent. Ht up to 0.08 m. Alt 190–560 m. WC
quadrisepalum (L.Bolus) H.E.K.Hartmann
Ruschia quadrisepala L.Bolus (1)
Perennial. Succulent. Ht up to 0.1 m. Alt 190–560 m. WC
rupigenum (L.Bolus) L.Bolus
Ruschia rupicola L.Bolus, illegitimate name (1)
Ruschia rupigena L.Bolus (1)
Perennial. Succulent. Ht up to 0.2 m. Alt 300–850 m. WC
subglobosum (L.Bolus) L.Bolus
Mesembryanthemum reductum N.E.Br. in part (1)
Ruschia subglobosa L.Bolus (1)
Perennial. Succulent. Ht up to 0.2 m. Alt 650–1200 m. NC
tetrasepalum (L.Bolus) H.E.K.Hartmann
Ruschia tetrasepala L.Bolus (1)
Perennial. Succulent. Ht up to 0.2 m. Alt 200–270 m. WC

ODONTOPHORUS N.E.Br. 2405088

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

(1) Hartmann. 1976. *Botanische Jahrbücher* 97: 161–225.
(2) Hammer. 1993. *Bradleya* 11: 75–85.
(3) Hammer. 1995. *Piante Grasse* 15,4 Suppl.: 59–87.
(4) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 191, 192.

albus L.Bolus = **O. nanus**

angustifolius L.Bolus subsp. **angustifolius**
Perennial. Succulent. Ht up to 0.08 m. Alt up to 1200 m. NC

angustifolius L.Bolus subsp. **protoparcoides** S.A.Hammer
Perennial. Succulent. Ht up to 0.01 m. Alt 700–1200 m. NC

herrei L.Bolus = **O. nanus**

marlothii N.E.Br.
Perennial. Succulent. Ht up to 0.4 m. Alt 450–1200 m. NC

nanus L.Bolus
O. albus L.Bolus (1)
O. herrei L.Bolus (1)
O. prumulinus L.Bolus (1)
Perennial. Succulent. Ht up to 0.05 m. Alt 850–1200 m. NC

prumulinus L.Bolus = **O. nanus**

pusillus S.A.Hammer
Perennial. Succulent. Ht up to 0.08 m. Alt 1000–1200 m. NC

OOPHYTUM N.E.Br. 2405089
(1) Ihlenfeldt. 1978. *Botanische Jahrbücher* 99: 303–328.
(2) Ihlenfeldt. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 192, 193.

nanum (Schltr.) L.Bolus
Perennial. Succulent. Ht up to 0.015 m. Alt 200–350 m. WC

nordenstamii L.Bolus = **O. oviforme**

oviforme (N.E.Br.) N.E.Br.
O. nordenstamii L.Bolus (1)
Perennial. Succulent. Ht up to 0.015 m. Alt 200–350 m. WC

OPHTHALMOPHYLLUM Dinter & Schwantes 2405090

australe L.Bolus = **Conophytum caroli**

caroli (Lavis) Tischer = **Conophytum caroli**

dinteri Schwantes ex H.Jacobsen = **Conophytum friedrichiae**

friedrichiae (Dinter) Dinter & Schwantes = **Conophytum friedrichiae**

fulleri Lavis = **Conophytum longum**

haramoepense L.Bolus= **Conophytum marginatum** subsp. **haramoepense**

latum Tischer forma *latum* = **Conophytum maughanii** subsp. **latum**

latum Tischer forma *rubrum* (Tischer) G.D.Rowley = **Conophytum maughanii** subsp. **latum**

littlewoodii L.Bolus = **Conophytum devium** subsp. **devium**

longitubum L.Bolus = **Conophytum longum**

longum (N.E.Br.) Tischer = **Conophytum longum**

lydiae H.Jacobsen = **Conophytum lydiae**

maughanii (N.E.Br.) Schwantes = **Conophytum maughanii** subsp. **maughanii**

noctiflorum L.Bolus = **Conophytum maughanii** subsp. **latum**

praesectum (N.E.Br.) Schwantes = **Conophytum praesectum**

pubescens Tischer = **Conophytum pubescens**

rufescens (N.E.Br.) Tischer = **Conophytum maughanii** subsp. **maughanii**

schlechteri Schwantes = **Conophytum longum**

schuldtii Schwantes = **Conophytum maughanii** subsp. **maughanii**

spathulatum L.Bolus = **Conophytum lydiae**

subfenestratum (Schwantes) Tischer = **Conophytum subfenestratum**

triebneri Schwantes = **Conophytum friedrichiae**

vanheerdei L.Bolus = **Conophytum friedrichiae**

verrucosum Lavis = **Conophytum verrucosum**

villetii L.Bolus = **Conophytum concordans**

OPOPHYTUM N.E.Br. 2405091

ampliatum L.Bolus = **Mesembryanthemum hypertrophicum**

aquosum (L.Bolus) N.E.Br. = **Mesembryanthemum hypertrophicum**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

australe L.Bolus = **Mesembryanthemum hypertrophicum**
fastigiatum (Thunb.) N.E.Br. = **Mesembryanthemum fastigiatum**

ORTHOPTERUM L.Bolus 2405092
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 195.
coegana L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 100–145 m. EC
waltoniae L.Bolus
Perennial. Succulent. Ht up to 0.05 m. Alt 300–830 m. EC

OSCULARIA Schwantes 2405093
(1) Hartmann. 1998. *Bradleya* 16: 44–91.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 195–200.
(3) Klak. 2001. *Phylogeny and character evolution in the* Lampranthus *group (Aizoaceae–Ruschioideae).* Unpublished Ph.D. thesis, University of Cape Town.
alba (L.Bolus) H.E.K.Hartmann
Lampranthus albus (L.Bolus) L.Bolus (1)
Mesembryanthemum album L.Bolus (1)
Perennial. Succulent. Ht up to 0.2 m. Alt 300–1000 m. WC
caulescens (Mill.) Schwantes
Lampranthus deltoides (L.) Glen var. *caulescens* (Mill.) G.D.Rowley (1)
Mesembryanthemum caulescens Mill. (1)
Mesembryanthemum deltoides L. var. *simplex* DC. (1)
Perennial. Succulent. Ht up to 0.3 m. Alt 300–1200 m. WC
cedarbergensis (L.Bolus) H.E.K.Hartmann
Lampranthus cedarbergensis (L.Bolus) L.Bolus (1)
Mesembryanthemum cedarbergense L.Bolus (1)
Perennial. Succulent. Ht up to 0.15 m. Alt up to 2000 m. WC
compressa (L.Bolus) H.E.K.Hartmann
Lampranthus compressus L.Bolus (1)
Perennial. Succulent. Ht up to 0.18 m. Alt 300–2000 m. WC
comptonii (L.Bolus) H.E.K.Hartmann
Lampranthus comptonii (L.Bolus) N.E.Br. forma *roseus* (L.Bolus) G.D.Rowley (1)
Lampranthus comptonii (L.Bolus) N.E.Br. var. *angustifolius* (L.Bolus) L.Bolus forma *angustifolius* (3)
Lampranthus comptonii (L.Bolus) N.E.Br. var. *angustifolius* forma *roseus* (L.Bolus) G.D.Rowley (1)
Lampranthus comptonii (L.Bolus) N.E.Br. var. *comptonii* (1)
Lampranthus comptonii (L.Bolus) N.E.Br. var. *roseus* (L.Bolus) L.Bolus ex H.Jacobsen (1)
Mesembryanthemum comptonii L.Bolus (1)
Mesembryanthemum comptonii L.Bolus var. *roseum* L.Bolus (1)
Perennial. Succulent. Ht 0.15–0.23 m. Alt 400–1000 m. WC
copiosa (L.Bolus) H.E.K.Hartmann
Perennial. Succulent. Ht? Alt? 'SA'
deltata (Mill.) Schwantes, illegitimate name = **O. deltoides**
deltoides (L.) Schwantes
Lampranthus deltoides (L.) Glen (1)
Mesembryanthemum deltoides L. var. *muricatum* A.Berger (1)
Mesembryanthemum muricatum Haw. (1)
O. deltata (Mill.) Schwantes, illegitimate name (1)
O. deltoides (L.) Schwantes var. *muricata* (A.Berger) Schwantes (1)
O. muricata (Haw.) Schwantes ex H.Jacobsen, illegitimate name (1)
Perennial. Succulent. Ht up to 0.5 m. Alt 450–1250 m. WC
deltoides (L.) Schwantes var. *muricata* (A.Berger) Schwantes = **O. deltoides**
deltoides (L.) Schwantes var. *pedunculata* (N.E.Br.) Schwantes = **O. pedunculata**
excedens (L.Bolus) H.E.K.Hartmann
Lampranthus excedens (L.Bolus) L.Bolus (1)
Mesembryanthemum excedens L.Bolus (1)
Perennial. Succulent. Ht up to 0.16 m. Alt 300–980 m. WC
falciforme Haw. = **Lampranthus falciformis**
falciformis (Haw.) H.E.K.Hartmann = **Lampranthus falciformis**
guthriae (L.Bolus) H.E.K.Hartmann

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Lampranthus guthrieae (L.Bolus) N.E.Br. (1)
Mesembryanthemum guthriae L.Bolus (1)
Perennial. Succulent. Ht up to 0.12 m. Alt? WC
lunata (Willd.) H.E.K.Hartmann
Lampranthus lunatus (Willd.) N.E.Br. (1)
Mesembryanthemum lunatum Willd. (1)
Perennial. Succulent. Ht up to 0.4 m. Alt 50–450 m. WC
major (Weston) Schwantes
Perennial. Succulent. Ht? Alt? 'SA'
muricata (Haw.) Schwantes ex H.Jacobsen, illegitimate name = **O. deltoides**
ornata (L.Bolus) H.E.K.Hartmann
Lampranthus ornatus L.Bolus (1)
Mesembryanthemum pageanum in sense of L.Bolus (1929), not of L.Bolus (1927), illegitimate name (1)
Perennial. Succulent. Ht up to 0.25 m. Alt 300–850 m. WC
paardebergensis (L.Bolus) H.E.K.Hartmann
Lampranthus paardebergensis (L.Bolus) L.Bolus (1)
Mesembryanthemum paardebergense L.Bolus (1)
Perennial. Succulent. Ht up to 0.2 m. Alt 180–340 m. WC
pedunculata (N.E.Br.) Schwantes
Mesembryanthemum deltoides L. var. *pedunculatum* N.E.Br. (1)
O. deltoides (L.) Schwantes var. *pedunculata* (N.E.Br.) Schwantes (1)
Perennial. Succulent. Ht? Alt? WC
piquetbergensis (L.Bolus) H.E.K.Hartmann
Lampranthus piquetbergensis (L.Bolus) L.Bolus (1)
Mesembryanthemum piquetbergense L.Bolus (1)
Perennial. Succulent. Ht up to 0.1 m. Alt 300–980 m. WC
prasina (L.Bolus) H.E.K.Hartmann
Lampranthus prasinus L.Bolus (1)
Perennial. Succulent. Ht up to 0.12 m. Alt 350–550 m. WC
primiverna (L.Bolus) H.E.K.Hartmann
Perennial. Succulent. Ht up to 0.3 m. Alt 300–960 m. WC
steenbergensis (L.Bolus) H.E.K.Hartmann
Lampranthus steenbergensis (L.Bolus) L.Bolus (1)
Mesembryanthemum steenbergense L.Bolus (1)
Perennial. Succulent. Ht up to 0.25 m. Alt 30–350 m. WC
superans (L.Bolus) H.E.K.Hartmann
Lampranthus superans (L.Bolus) L.Bolus (1)
Mesembryanthemum superans L.Bolus (1)
Perennial. Succulent. Ht up to 0.25 m. Alt 200–1016 m. WC
thermarum (L.Bolus) H.E.K.Hartmann
Lampranthus thermarum (L.Bolus) L.Bolus (1)
Mesembryanthemum thermarum L.Bolus (1)
Perennial. Succulent. Ht 0.1–0.2 m. Alt 100–420 m. WC
vernicolor (L.Bolus) H.E.K.Hartmann
Lampranthus vernicolor (L.Bolus) L.Bolus (1)
Mesembryanthemum vernicolor L.Bolus (1)
Perennial. Succulent. Ht up to 0.1 m. Alt 300–900 m. WC
vredenburgensis (L.Bolus) H.E.K.Hartmann
Lampranthus vredenburgensis L.Bolus (1)
Perennial. Succulent. Ht 0.15–0.24 m. Alt 20–260 m. WC

OTTOSONDERIA L.Bolus 2405094
(1) Hartmann. 1999. *Bradleya* 17: 38–74.
(2) Chesselet *et al.* 2000. *Aloe* 37: 88–90.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 200.
monticola (Sond.) L.Bolus
Ruschia monticola (Sond.) G.D.Rowley (1)
Ruschia ottosonderi G.D.Rowley (1)
Perennial. Succulent. Ht up to 0.22 m. Alt 300–550 m. NC, WC
obtusa L.Bolus

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.3 m. Alt 200–450 m. NC, WC

PEERSIA L.Bolus 2405153
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 201.
frithii (L.Bolus) L.Bolus
Rhinephyllum frithii (L.Bolus) L.Bolus (1)
Perennial. Succulent. Ht up to 0.2 m. Alt 600–950 m. WC, EC
macradenia (L.Bolus) L.Bolus
Rhinephyllum macradenium (L.Bolus) L.Bolus (1)
Perennial. Succulent. Ht up to 0.25 m. Alt 600–1200 m. WC
vanheerdei (L.Bolus) H.E.K.Hartmann
Rhinephyllum vanheerdei L.Bolus (1)
Perennial. Succulent. Ht up to 0.7 m. Alt 1020–1170 m. NC, WC

PENTACOILANTHUS Rappa & Camarrone 2405187
crassicaulis (Haw.) Rappa & Camarrone, invalid name = **Sceletium crassicaule**
expansus (L.) Rappa & Camarrone, invalid name = **Sceletium expansum**
splendens (L.) Rappa & Camarrone, invalid name = **Phyllobolus splendens** subsp. **splendens**
tortuosus (L.) Rappa & Camarrone, invalid name = **Sceletium tortuosum**

PERAPENTACOILANTHUS Rappa & Camarrone 2405186
acuminatus (Haw.) Rappa & Camarrone, invalid name = **Phyllobolus splendens** subsp. **splendens**
brevifolius (L.Bolus) Rappa & Camarrone, invalid name = **Phyllobolus splendens** subsp. **splendens**
delus (L.Bolus) Rappa & Camarrone, invalid name = **Phyllobolus delus**
granulicaulis (Haw.) Rappa & Camarrone, invalid name = **Psilocaulon granulicaule**
grossus (Aiton) Rappa & Camarrone, invalid name = **Phyllobolus grossus**
longispinulus (Haw.) Rappa & Camarrone, invalid name = **Phyllobolus grossus**
scintillans (Dinter) Rappa & Camarrone, invalid name = **Phyllobolus oculatus**
spinuliferus (Haw.) Rappa & Camarrone, invalid name = **Phyllobolus spinuliferus**
splendens (L.) Rappa & Camarrone, invalid name = **Phyllobolus splendens** subsp. **splendens**
sulcatus (Haw.) Rappa & Camarrone, invalid name = **Phyllobolus splendens** subsp. **splendens**
vanrensburgii (L.Bolus) Rappa & Camarrone = **Prenia vanrensburgii**
viridiflorus (Aiton) Rappa & Camarrone, invalid name = **Phyllobolus viridiflorus**

PERATETRACOILANTHUS Rappa & Camarrone 2405188
defoliatus (Haw.) Rappa & Camarrone, invalid name = **Aridaria noctiflora** subsp. **defoliata**
noctiflorus (L.) Rappa & Camarrone, invalid name = **Aridaria noctiflora** subsp. **noctiflora**
tetragonus (Thunb.) Rappa & Camarrone = **Prenia tetragona**
junceus (Haw.) Rappa & Camarrone = **Psilocaulon junceum**
parviflorus (Jacq.) Rappa & Camarrone = **Psilocaulon parviflorum**

PHEROLOBUS N.E.Br. 2405095
maughanii N.E.Br. var. *maughanii* = **Dorotheanthus maughanii**
maughanii N.E.Br. var. *stayneri* L.Bolus = **Dorotheanthus maughanii**

PHYLLOBOLUS N.E.Br. 2405152
(1) Gerbaulet. 1997. *Botanische Jahrbücher* 119: 145–211.
(2) Gerbaulet. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 203–217.
abbreviatus (L.Bolus) Gerbaulet
Aridaria abbreviata L.Bolus (1)
Nycteranthus abbreviatus (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus abbreviatus (L.Bolus) L.Bolus, invalid name (1)
Perennial. Succulent, geophyte. Ht up to 0.03 m. Alt 180–350 m. WC
amabilis Gerbaulet & Struck
Perennial. Succulent, geophyte. Ht up to 0.1 m. Alt 1200–1600 m. NC
canaliculatus (Haw.) Bittrich
Aridaria canaliculata (Haw.) Friedrich (1)
Mesembryanthemum canaliculatum Haw. (1)
Mesembryanthemum salmoneum Haw. (1)
Mesembryanthemum salmoneum Salm-Dyck (1)
Nycteranthus canaliculatus (Haw.) Schwantes, illegitimate name (1)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Nycteranthus salmoneus (Haw.) Schwantes, illegitimate name (1)
Sphalmanthus calycinus L.Bolus (1)
Sphalmanthus canaliculatus (Haw.) N.E.Br. (1)
Sphalmanthus salmoneus (Haw.) N.E.Br. (1)
Perennial. Succulent, geophyte. Ht up to 0.05 m. Alt 40–370 m. WC, EC

caudatus (L.Bolus) Gerbaulet
Aridaria caudata (L.Bolus) L.Bolus (1)
Mesembryanthemum caudatum L.Bolus (1)
Nycteranthus caudatus (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus caudatus (L.Bolus) N.E.Br. (1)
Perennial. Succulent, geophyte. Ht up to 0.08 m. Alt 500–980 m. WC

chrysophthalmus Gerbaulet & Struck
Perennial. Succulent. Ht up to 0.15 m. Alt 180–350 m. WC

congestus (L.Bolus) Gerbaulet
Aridaria congesta L.Bolus (1)
Nycteranthus congestus (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus congestus (L.Bolus) L.Bolus, invalid name (1)
Perennial. Succulent. Ht up to 0.05 m. Alt 200–350 m. WC

deciduus (L.Bolus) Gerbaulet
Aridaria decidua L.Bolus (1)
Nycteranthus deciduus (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus deciduus (L.Bolus) L.Bolus (1)
Perennial. Succulent. Ht up to 0.7 m. Alt 800–1200 m. WC

decurvatus (L.Bolus) Gerbaulet
Aridaria decurvata L.Bolus (1)
Aridaria laxa L.Bolus (1)
Aridaria obtusa L.Bolus (1)
Nycteranthus decurvatus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus laxus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus obtusus (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus decurvatus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus laxus (L.Bolus) N.E.Br. (1)
Sphalmanthus obtusus (L.Bolus) L.Bolus, invalid name (1)
Perennial. Succulent. Ht up to 0.4 m. Alt up to 1200 m. NC

delus (L.Bolus) Gerbaulet
Aridaria dela (L.Bolus) L.Bolus (1)
Mesembryanthemum delum L.Bolus (1)
Nycteranthus delus (L.Bolus) Schwantes, illegitimate name (1)
Perapentacoilanthus delus (L.Bolus) Rappa & Camarrone, invalid name (1)
Sphalmanthus delus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus hallii L.Bolus (1)
Sphalmanthus stayneri L.Bolus (1)
Perennial. Succulent. Ht up to 0.2 m. Alt 200–1300 m. NC, WC

digitatus (Aiton) Gerbaulet subsp. *digitatus* = **Dactylopsis digitata**

digitatus (Aiton) Gerbaulet subsp. *littlewoodii* (L.Bolus) Gerbaulet = **Dactylopsis littlewoodii**

gariepensis Gerbaulet & Struck
Perennial. Succulent. Ht 0.2–0.3 m. Alt 190–1100 m. NC

grossus (Aiton) Gerbaulet
Aridaria gratiae L.Bolus (1)
Aridaria grossa (Aiton) Friedrich (1)
Aridaria laxipetala L.Bolus (1)
Aridaria longispinula (Haw.) L.Bolus (1)
Aridaria platysepala L.Bolus (1)
Aridaria subpetiolata L.Bolus (1)
Aridaria willowmorensis L.Bolus (1)
Mesembryanthemum commutatum A.Berger (1)
Mesembryanthemum grossum Aiton (1)
Mesembryanthemum longispinulum Haw. (1)
Mesembryanthemum longispinulum Salm-Dyck (1)
Nycteranthus commutatus (A.Berger) Schwantes, illegitimate name (1)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Nycteranthus gratiae (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus grossus (Aiton) Schwantes, illegitimate name (1)
Nycteranthus laxipetalus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus longispinulus (Haw.) Schwantes, illegitimate name (1)
Nycteranthus platysepalus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus willowmorensis (L.Bolus) Schwantes, illegitimate name (1)
Perapentacoilanthus grossus (Aiton) Rappa & Camarrone, invalid name (1)
Perapentacoilanthus longispinulus (Haw.) Rappa & Camarrone, invalid name (1)
Sphalmanthus commutatus (A.Berger) N.E.Br. (1)
Sphalmanthus gratiae (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus grossus (Aiton) N.E.Br. (1)
Sphalmanthus gydouwensis L.Bolus (1)
Sphalmanthus laxipetalus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus leipoldtii L.Bolus (1)
Sphalmanthus longispinulus (Haw.) N.E.Br. (1)
Sphalmanthus platysepalus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus subpetiolatus (L.Bolus) L.Bolus (1)
Sphalmanthus willowmorensis (L.Bolus) L.Bolus, invalid name (1)
Perennial. Succulent, geophyte. Ht up to 0.15 m. Alt 300–1100 m. WC, EC

herbertii (N.E.Br.) Gerbaulet
Aridaria herbertii (N.E.Br.) Friedrich (1)
Nycteranthus herbertii (N.E.Br.) Schwantes, illegitimate name (1)
Sphalmanthus herbertii N.E.Br. (1)
Sphalmanthus humilis L.Bolus (1)
Perennial. Succulent, geophyte. Ht up to 0.03 m. Alt 200–350 m. WC

latipetalus (L.Bolus) Gerbaulet
Aridaria latipetala L.Bolus (1)
Nycteranthus latipetalus (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus latipetalus (L.Bolus) L.Bolus, invalid name (1)
Perennial. Succulent. Ht up to 0.05 m. Alt 920–1150 m. NC

lesliei N.E.Br. = **P. resurgens**

lignescens (L.Bolus) Gerbaulet
Cryophytum suaveolens (L.Bolus) J.W.Ingram (1)
Mesembryanthemum suaveolens L.Bolus, illegitimate name (1)
Sphalmanthus lignescens L.Bolus (1)
Sphalmanthus suaveolens (L.Bolus) H.Jacobsen (2)
Perennial. Succulent. Ht up to 0.5 m. Alt 950–1650 m. N, NC

melanospermus (Dinter & Schwantes) Gerbaulet
Aridaria dinteri L.Bolus, illegitimate name (1)
Aridaria lignea L.Bolus (1)
Mesembryanthemum melanospermum Dinter, illegitimate name (1)
Nycteranthus dinteri (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus ligneus (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus dinteri (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus ligneus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus melanospermus Dinter & Schwantes (1)
Perennial. Succulent. Ht up to 0.25 m. Alt 10–1150 m. N, NC

nitidus (Haw.) Gerbaulet
Aridaria aurea (Thunb.) L.Bolus (1)
Aridaria inaequalis L.Bolus (1)
Aridaria nitida (Haw.) N.E.Br. (1)
Aridaria rhodandra L.Bolus (1)
Drosanthemum nitidum (Haw.) Schwantes (1)
Mesembryanthemum auratum Sond. (1)
Mesembryanthemum aureum Thunb., illegitimate name (1)
Mesembryanthemum nitidum Haw. (1)
Nycteranthus aureus (Thunb.) Schwantes, illegitimate name (1)
Nycteranthus inaequalis (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus rhodandrus (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus auratus (Sond.) L.Bolus, invalid name (1)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Sphalmanthus littlewoodii L.Bolus (1)
Sphalmanthus nitidus (Haw.) L.Bolus, invalid name (1)
Sphalmanthus rhodandrus (L.Bolus) L.Bolus, invalid name (1)
Perennial. Succulent. Ht up to 0.3 m. Alt 300–1600 m. NC, WC

noctiflorus (L.) Bittrich = **Aridaria noctiflora** subsp. **noctiflora**

oculatus (N.E.Br.) Gerbaulet
Amoebophyllum rangei N.E.Br. (1)
Aridaria anguinea L.Bolus (1)
Aridaria arenicola L.Bolus (1)
Aridaria fragilis (N.E.Br.) Friedrich (1)
Aridaria oculata (N.E.Br.) L.Bolus (1)
Aridaria pomonae L.Bolus (1)
Aridaria rangei (N.E.Br.) Friedrich (1)
Aridaria scintillans (Dinter) Friedrich (1)
Aridaria varians L.Bolus (1)
Mesembryanthemum crystallino-papillosum Bolus ex Fedde & J.Schust. (1)
Mesembryanthemum oculatum N.E.Br. (1)
Mesembryanthemum scintillans Dinter (1)
Nycteranthus anguineus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus arenicolus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus fragilis (N.E.Br.) Schwantes, illegitimate name (1)
Nycteranthus oculatus (N.E.Br.) Schwantes, illegitimate name (1)
Nycteranthus pomonae (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus scintillans (Dinter) Schwantes, illegitimate name (1)
Nycteranthus varians (L.Bolus) Schwantes, illegitimate name (1)
Perapentacoilanthus scintillans (Dinter) Rappa & Camarrone, invalid name (1)
Sphalmanthus anguineus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus arenicolus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus fragilis N.E.Br. (1)
Sphalmanthus longipapillatus L.Bolus (1)
Sphalmanthus oculatus (N.E.Br.) N.E.Br. (1)
Sphalmanthus pomonae (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus scintillans (Dinter) Dinter & Schwantes (1)
Sphalmanthus varians (L.Bolus) L.Bolus (2)
Perennial. Succulent, geophyte. Ht up to 0.08 m. Alt 10–1200 m. N, NC

pallens (Aiton) Bittrich = **Prenia pallens** subsp. **pallens**

pearsonii N.E.Br., invalid name = **P. resurgens**

prasinus (L.Bolus) Gerbaulet
Aridaria elongata L.Bolus (1)
Aridaria multiseriata L.Bolus (1)
Aridaria prasina L.Bolus (1)
Nycteranthus elongatus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus multiseriatus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus prasinus (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus crassus L.Bolus (1)
Sphalmanthus herrei L.Bolus (1)
Sphalmanthus prasinus (L.Bolus) L.Bolus, invalid name (1)
Perennial. Succulent, geophyte. Ht up to 0.05 m. Alt up to 1200 m. NC

pubicalyx N.E.Br. = **P. resurgens**

pumilus (L.Bolus) Gerbaulet
Aridaria albertensis L.Bolus (1)
Aridaria oubergensis L.Bolus (1)
Aridaria pumila L.Bolus (1)
Nycteranthus albertensis (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus oubergensis (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus pumilus (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus albertensis (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus oubergensis (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus pumilus (L.Bolus) L.Bolus, invalid name (1)
Perennial. Succulent, geophyte. Ht up to 0.03 m. Alt 300–1000 m. NC, WC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

quartziticus (L.Bolus) Gerbaulet
Aridaria quartzitica L.Bolus (1)
Nycteranthus quartziticus (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus quarziticus (L.Bolus) L.Bolus, invalid name (1)
Perennial. Succulent. Ht up to 0.3 m. Alt 100–350 m. NC, WC
rabiei (L.Bolus) Gerbaulet
Aridaria rabiei L.Bolus (1)
Nycteranthus rabiei (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus rabiei (L.Bolus) N.E.Br. (1)
Perennial. Succulent. Ht up to 0.05 m. Alt 1100–1450 m. FS
resurgens (Kensit) Schwantes
Aridaria resurgens (Kensit) L.Bolus (1)
Mesembryanthemum resurgens Kensit (1)
P. lesliei N.E.Br. (1)
P. pearsonii N.E.Br., invalid name (1)
P. publicalyx N.E.Br. (1)
Sphalmanthus micans L.Bolus (1)
Sphalmanthus resurgens (Kensit) L.Bolus (1)
Perennial. Succulent, geophyte. Ht up to 0.03 m. Alt 500–1200 m. NC, WC
roseus (L.Bolus) Gerbaulet
Amoebophyllum angustum N.E.Br., illegitimate name (1)
Amoebophyllum roseum L.Bolus (1)
Sphalmanthus vanheerdei L.Bolus (1)
Perennial. Succulent. Ht up to 1 m. Alt up to 1200 m. NC
saturatus (L.Bolus) Gerbaulet
Aridaria saturata L.Bolus (1)
Nycteranthus saturatus (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus acocksii L.Bolus (1)
Sphalmanthus baylissii L.Bolus (1)
Sphalmanthus saturatus (L.Bolus) L.Bolus, invalid name (1)
Perennial. Succulent. Ht up to 0.2 m. Alt 30–1000 m. NC, WC
sinuosus (L.Bolus) Gerbaulet
Aridaria glandulifera L.Bolus (1)
Aridaria godmaniae L.Bolus (1)
Aridaria recurva L.Bolus (1)
Aridaria straminea L.Bolus (1)
Aridaria straminicolor L.Bolus (1)
Mesembryanthemum sinuosum L.Bolus (1)
Nycteranthus glanduliferus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus godmaniae (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus recurvus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus sinuosus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus straminicolor (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus glanduliferus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus godmaniae (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus praecox L.Bolus (1)
Sphalmanthus recurvus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus sinuosus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus straminicolor (L.Bolus) L.Bolus, invalid name (1)
Perennial. Succulent, geophyte. Ht up to 0.2 m. Alt up to 1200 m. NC
spinuliferus (Haw.) Gerbaulet
Aridaria brevisepala L.Bolus (1)
Aridaria framesii L.Bolus (1)
Aridaria gibbosa L.Bolus, illegitimate name (1)
Aridaria parvisepala L.Bolus (1)
Aridaria quaterna L.Bolus (1)
Aridaria spinulifera (Haw.) N.E.Br. (1)
Aridaria stricta L.Bolus (1)
Aridaria watermeyeri L.Bolus (1)
Mesembryanthemum carneum Haw. (1)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Mesembryanthemum spinuliferum Haw. (1)
Mesembryanthemum spinuliforme Harv. & Sond. (1)
Nycteranthus carneus (Haw.) Schwantes, illegitimate name (1)
Nycteranthus framesii (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus parvisepalus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus quaternus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus spinuliferus (Haw.) Schwantes, illegitimate name (1)
Nycteranthus strictus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus watermeyeri (L.Bolus) Schwantes, illegitimate name (1)
Perapentacoilanthus spinuliferus (Haw.) Rappa & Camarrone, invalid name (1)
Sphalmanthus brevisepalus (L.Bolus) L.Bolus var. *brevisepalus*, invalid name (1)
Sphalmanthus carneus (Haw.) N.E.Br. (1)
Sphalmanthus framesii (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus quarternus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus rejuvenalis L.Bolus (1)
Sphalmanthus spinuliferus (Haw.) L.Bolus (1)
Sphalmanthus strictus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus watermeyeri (L.Bolus) L.Bolus, invalid name (1)
Perennial. Succulent. Ht up to 0.3 m. Alt 10–650 m. NC, WC

splendens (L.) Gerbaulet subsp. **pentagonus** (L.Bolus) Gerbaulet
Aridaria pentagona L.Bolus (1)
Aridaria pentagona L.Bolus var. *occidentalis* L.Bolus (1)
Aridaria subaequans L.Bolus (1)
Aridaria subpatens L.Bolus (1)
Nycteranthus pentagonus (L.Bolus) Schwantes var. *occidentalis* (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus pentagonus (L.Bolus) Schwantes var. *pentagonus*, illegitimate name (1)
Nycteranthus subaequans (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus subpatens (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus pentagonus (L.Bolus) L.Bolus var. *occidentalis* (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus pentagonus (L.Bolus) L.Bolus var. *pentagonus*, invalid name (1)
Sphalmanthus subaequans (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus subpatens (L.Bolus) L.Bolus, invalid name (1)
Perennial. Succulent. Ht up to 0.3 m. Alt 980–1500 m. FS, NC, WC, EC

splendens (L.) Gerbaulet subsp. **splendens**
Aridaria acuminata (Haw.) Schwantes (1)
Aridaria albicaulis (Haw.) N.E.Br. (1)
Aridaria bijliae N.E.Br. (1)
Aridaria blanda L.Bolus (1)
Aridaria brevifolia L.Bolus (1)
Aridaria celans L.Bolus (1)
Aridaria constricta L.Bolus (1)
Aridaria dyeri L.Bolus (1)
Aridaria fastigiata (Haw.) Schwantes, illegitimate name (1)
Aridaria flexuosa (Haw.) Schwantes (1)
Aridaria fourcadei L.Bolus (1)
Aridaria leptopetala L.Bolus (1)
Aridaria nocta (N.E.Br.) N.E.Br. (1)
Aridaria plenifolia (N.E.Br.) Stearn (1)
Aridaria primulina L.Bolus (1)
Aridaria rabiesbergensis L.Bolus (1)
Aridaria reflexa (Haw.) N.E.Br. (1)
Aridaria rosea L.Bolus (1)
Aridaria splendens (L.) Schwantes (1)
Aridaria striata L.Bolus (1)
Aridaria sulcata (Haw.) Schwantes (1)
Aridaria umbelliflora (Jacq.) Schwantes (1)
Aridaria vernalis L.Bolus (1)
Mesembryanthemum acuminatum Haw. (1)
Mesembryanthemum albicaule Haw. (1)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Mesembryanthemum albicaule Salm-Dyck (1)
Mesembryanthemum fastigiatum Haw., illegitimate name (1)
Mesembryanthemum fastigiatum Haw. var. *reflexum* (Haw.) Haw. (1)
Mesembryanthemum fastigiatum Salm-Dyck (1)
Mesembryanthemum flexuosum Haw. (1)
Mesembryanthemum flexuosum Salm-Dyck (1)
Mesembryanthemum nothum N.E.Br. (1)
Mesembryanthemum plenifolium N.E.Br. (1)
Mesembryanthemum reflexum Haw. (1)
Mesembryanthemum splendens L. (1)
Mesembryanthemum sulcatum Haw. (1)
Mesembryanthemum umbelliflorum Jacq. (1)
Nycteranthus acuminatus (Haw.) Schwantes, illegitimate name (1)
Nycteranthus albicaulis (Haw.) Schwantes, illegitimate name (1)
Nycteranthus bijliae (N.E.Br.) Schwantes, illegitimate name (1)
Nycteranthus blandus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus brevifolius (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus celans (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus constrictus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus dyeri (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus flexuosus (Haw.) Schwantes, illegitimate name (1)
Nycteranthus fourcadei (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus leptopetalus (L.Bolus) Friedrich (1)
Nycteranthus nothus (N.E.Br.) Schwantes, illegitimate name (1)
Nycteranthus plenifolius (N.E.Br.) Schwantes, illegitimate name (1)
Nycteranthus primulinus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus rabiesbergensis (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus roseus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus splendens (L.) Schwantes, illegitimate name (1)
Nycteranthus striatus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus sulcatus (Haw.) Schwantes, illegitimate name (1)
Nycteranthus umbelliflorus (Jacq.) Schwantes, illegitimate name (1)
Nycteranthus vernalis (L.Bolus) Schwantes, illegitimate name (1)
Pentacoilanthus splendens (L.) Rappa & Camarrone, invalid name (1)
Perapentacoilanthus acuminatus (Haw.) Rappa & Camarrone, invalid name (1)
Perapentacoilanthus brevifolius (L.Bolus) Rappa & Camarrone, invalid name (1)
Perapentacoilanthus splendens (L.) Rappa & Camarrone, invalid name (1)
Perapentacoilanthus sulcatus (Haw.) Rappa & Camarrone, invalid name (1)
Sphalmanthus acuminatus (Haw.) L.Bolus (1)
Sphalmanthus albicaulis (Haw.) L.Bolus (1)
Sphalmanthus bijliae (N.E.Br.) L.Bolus (1)
Sphalmanthus blandus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus celans (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus constrictus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus dyeri (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus flexuosus (Haw.) L.Bolus (1)
Sphalmanthus fourcadei (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus leptopetalus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus nothus (N.E.Br.) Schwantes (2)
Sphalmanthus plenifolius (N.E.Br.) L.Bolus, invalid name (1)
Sphalmanthus primulinus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus rabiesbergensis (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus reflexus (Haw.) L.Bolus (2)
Sphalmanthus roseus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus splendens (L.) L.Bolus, invalid name (1)
Sphalmanthus striatus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus sulcatus (Haw.) L.Bolus (1)
Sphalmanthus umbelliflorus (Jacq.) L.Bolus, invalid name (1)
Sphalmanthus vernalis (L.Bolus) L.Bolus, invalid name (1)
Perennial. Succulent. Ht up to 1 m. Alt 10–890 m. WC, EC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

suffruticosus (L.Bolus) Gerbaulet
Cryophytum suffruticosum L.Bolus (1)
Perennial. Succulent. Ht up to 0.7 m. Alt 200–350 m. WC
tenuiflorus (Jacq.) Gerbaulet
Aridaria longituba L.Bolus (1)
Aridaria macrosiphon L.Bolus (1)
Aridaria peersii L.Bolus (1)
Mesembryanthemum olivaceum Schltr. (1)
Mesembryanthemum tenuiflorum Jacq. (1)
Nycteranthus longitubus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus macrosiphon (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus peersii (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus tenuiflorus (Jacq.) Schwantes, illegitimate name (1)
Prenia olivacea (Schltr.) H.Jacobsen (1)
Sphalmanthus longitubus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus macrosiphon (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus nanus L.Bolus (1)
Sphalmanthus olivaceus (Schltr. & A.Berger) L.Bolus (2)
Sphalmanthus tenuiflorus (Jacq.) N.E.Br. (1)
Perennial. Succulent. Ht up to 0.03 m. Alt 180–350 m. WC
tortuosus (L.) Bittrich = **Sceletium tortuosum**
trichotomus (Thunb.) Gerbaulet
Aridaria ebracteata N.E.Br. (1)
Aridaria ebracteata N.E.Br. var. *brevipetala* L.Bolus (1)
Aridaria tetramera L.Bolus var. *parviflora* L.Bolus (1)
Aridaria tetramera L.Bolus var. *tetramera* (1)
Aridaria trichotoma (Thunb.) L.Bolus (1)
Dicrocaulon trichotomum (Thunb.) N.E.Br. (1)
Mesembryanthemum trichotomum Thunb. (1)
Nycteranthus ebracteatus (N.E.Br.) Schwantes var. *brevipetalus* (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus ebracteatus (N.E.Br.) Schwantes var. *ebracteatus*, illegitimate name (1)
Nycteranthus tetramerus (L.Bolus) Schwantes var. *parviflorus* (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus tetramerus (L.Bolus) Schwantes var. *tetramerus*, illegitimate name (1)
Nycteranthus trichotomus (Thunb.) Schwantes, illegitimate name (1)
Sphalmanthus tetramerus (L.Bolus) L.Bolus var. *parviflorus* (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus tetramerus (L.Bolus) L.Bolus var. *tetramerus*, invalid name (1)
Sphalmanthus trichotomus (Thunb.) L.Bolus, invalid name (1)
Perennial. Succulent. Ht up to 0.2 m. Alt 20–980 m. NC, WC
viridiflorus (Aiton) Gerbaulet
Aridaria trichosantha (A.Berger) N.E.Br. (1)
Aridaria viridiflora (Aiton) L.Bolus (1)
Mesembryanthemum trichosanthum A.Berger (1)
Mesembryanthemum viridiflorum Aiton (1)
Nycteranthus viridiflorus (Aiton) Schwantes, illegitimate name (1)
Perapentacoilanthus viridiflorus (Aiton) Rappa & Camarrone, invalid name (1)
Sphalmanthus viridiflorus (Aiton) N.E.Br. (1)
Perennial. Succulent. Ht up to 0.1 m. Alt 300–650 m. WC

PLATYTHYRA N.E.Br. 2405096
haeckeliana (A.Berger) N.E.Br. = **Aptenia haeckeliana**
pallens (Aiton) L.Bolus = **Prenia pallens** subsp. **pallens**
relaxata (Willd.) Schwantes = **Prenia pallens** subsp. **pallens**

PLEIOSPILOS N.E.Br. 2405097
(1) Phillips. 1940. *The Flowering Plants of South Africa* 20: t. 769.
(2) Bolus. 1953. *The Flowering Plants of Africa* 29: t. 1154.
(3) Glen. 1983. *The Flowering Plants of Africa* 47: tt. 1864, 1865B.
(4) Hartmann & Liede. 1986. *Botanische Jahrbücher* 106: 433–485.
(5) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 218–221.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

archeri L.Bolus = **Tanquana archeri**
barbarae Karrer = **P. bolusii**
beaufortensis L.Bolus = **P. bolusii**
bolusii (Hook.f.) N.E.Br.
Mesembryanthemum bolusii Hook.f. (4)
P. barbarae Karrer (4)
P. beaufortensis L.Bolus (4)
Perennial. Succulent. Ht up to 0.08 m. Alt 750–1100 m. WC, EC
borealis L.Bolus = **P. compactus** subsp. **canus**
brevisepalus L.Bolus = **P. compactus** subsp. **canus**
canus (Haw.) L.Bolus = **P. compactus** subsp. **canus**
clavatus L.Bolus = **Tanquana archeri**
compactus (Aiton) Schwantes subsp. **canus** (Haw.) H.E.K.Hartmann & Liede
Mesembryanthemum canum Haw. (4)
Mesembryanthemum magnipunctatum Haw. (4)
Mesembryanthemum nobile Haw. (5)
P. borealis L.Bolus (4)
P. brevisepalus L.Bolus (4)
P. canus (Haw.) L.Bolus (4)
P. dekenahi (N.E.Br.) Schwantes (4)
P. framesii L.Bolus (4)
P. grandiflorus L.Bolus (4)
P. kingiae L.Bolus (4)
P. latifolius L.Bolus (4)
P. latipetalus L.Bolus (4)
P. leipoldtii L.Bolus (4)
P. longisepalus L.Bolus (4)
P. magnipunctatus (Haw.) Schwantes (4)
P. magnipunctatus (Haw.) Schwantes var. *inaequalis* L.Bolus (4)
P. magnipunctatus (Haw.) Schwantes var. *sesquiuncialis* L.Bolus (4)
P. nobile (Haw.) Schwantes (4)
P. peersii L.Bolus (4)
P. rouxii L.Bolus (4)
P. sesquiuncialis (N.E.Br.) Schwantes (4)
P. willowmorensis L.Bolus (4)
Punctillaria cana L.Bolus (4)
Punctillaria dekenahi N.E.Br. (4)
Punctillaria magnipunctata (Haw.) N.E.Br. (4)
Punctillaria sesquiuncialis N.E.Br. (4)
Perennial. Succulent. Ht up to 0.04 m. Alt 600–1700 m. NC, WC, EC
compactus (Aiton) Schwantes subsp. **compactus**
Mesembryanthemum compactum Aiton (4)
Mesembryanthemum optatum N.E.Br. (5)
P. longibracteatus L.Bolus (4)
P. optatus (N.E.Br.) Schwantes (4)
Punctillaria compacta (Aiton) N.E.Br. (4)
Punctillaria optata (N.E.Br.) N.E.Br. (4)
Perennial. Succulent. Ht up to 0.05 m. Alt 950–1200 m. WC
compactus (Aiton) Schwantes subsp. **fergusoniae** (L.Bolus) H.E.K.Hartmann & Liede
P. fergusoniae L.Bolus (4)
Perennial. Succulent. Ht up to 0.05 m. Alt 800–1000 m. WC
compactus (Aiton) Schwantes subsp. **minor** (L.Bolus) H.E.K.Hartmann & Liede
P. minor L.Bolus (4)
Perennial. Succulent. Ht up to 0.03 m. Alt 440–960 m. EC
compactus (Aiton) Schwantes subsp. **sororius** (N.E.Br.) H.E.K.Hartmann & Liede
Mesembryanthemum sororium N.E.Br. (5)
P. dimidiatus L.Bolus (4)
P. sororius (N.E.Br.) Schwantes (4)
Punctillaria sororia (N.E.Br.) N.E.Br. (4)
Perennial. Succulent. Ht up to 0.05 m. Alt 750–1000 m. WC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

dekenahi (N.E.Br.) Schwantes = **P. compactus** subsp. **canus**
dimidiatus L.Bolus = **P. compactus** subsp. **sororius**
fergusoniae L.Bolus = **P. compactus** subsp. **fergusoniae**
framesii L.Bolus = **P. compactus** subsp. **canus**
grandiflorus L.Bolus = **P. compactus** subsp. **canus**
hilmarii L.Bolus = **Tanquana hilmarii**
kingiae L.Bolus = **P. compactus** subsp. **canus**
latifolius L.Bolus = **P. compactus** subsp. **canus**
latipetalus L.Bolus = **P. compactus** subsp. **canus**
leipoldtii L.Bolus = **P. compactus** subsp. **canus**
loganii L.Bolus = **Tanquana archeri**
longibracteatus L.Bolus = **P. compactus** subsp. **compactus**
longisepalus L.Bolus = **P. compactus** subsp. **canus**
magnipunctatus (Haw.) Schwantes = **P. compactus** subsp. **canus**
magnipunctatus (Haw.) Schwantes var. *inaequalis* L.Bolus = **P. compactus** subsp. **canus**
magnipunctatus (Haw.) Schwantes var. *sesquiuncialis* L.Bolus = **P. compactus** subsp. **canus**
minor L.Bolus = **P. compactus** subsp. **minor**
nelii Schwantes
P. pedunculatus L.Bolus (4)
P. tricolor N.E.Br. (4)
Perennial. Succulent. Ht up to 0.05 m. Alt 870–1250 m. WC, EC
nobile (Haw.) Schwantes = **P. compactus** subsp. **canus**
optatus (N.E.Br.) Schwantes = **P. compactus** subsp. **compactus**
pedunculatus L.Bolus = **P. nelii**
peersii L.Bolus = **P. compactus** subsp. **canus**
prismaticus (Schwantes) Schwantes = **Tanquana prismatica**
roodiae (N.E.Br.) Schwantes = **Tanquana prismatica**
rouxii L.Bolus = **P. compactus** subsp. **canus**
sesquiuncialis (N.E.Br.) Schwantes = **P. compactus** subsp. **canus**
simulans (Marloth) N.E.Br.
Mesembryanthemum simulans Marloth (4)
Perennial. Succulent. Ht up to 0.05 m. Alt 370–1000 m. EC
sororius (N.E.Br.) Schwantes = **P. compactus** subsp. **sororius**
tricolor N.E.Br. = **P. nelii**
willowmorensis L.Bolus = **P. compactus** subsp. **canus**

POLYMITA N.E.Br. 2405098
(1) Hartmann. 1996. *Bradleya* 14: 29–56.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 223.
albiflora (L.Bolus) L.Bolus
P. diutina (L.Bolus) L.Bolus (1)
P. pearsonii N.E.Br., naked name (1)
Ruschia albiflora L.Bolus (1)
Ruschia diutina L.Bolus (1)
Perennial. Succulent. Ht up to 0.45 m. Alt 670–1340 m. NC
diutina (L.Bolus) L.Bolus = **P. albiflora**
pearsonii N.E.Br., naked name = **P. albiflora**
steenbokensis H.E.K.Hartmann
Perennial. Succulent, shrub. Ht up to 0.4 m. Alt 750–1050 m. NC

PRENIA N.E.Br. 2405099
(1) Gerbaulet. 1996. *Botanische Jahrbücher* 118: 25–40.
(2) Gerbaulet. 1997. *Botanische Jahrbücher* 119: 145–211.
(3) Gerbaulet. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 224–227.
englishiae (L.Bolus) Gerbaulet
Aridaria englishiae (L.Bolus) N.E.Br. (1)
Mesembryanthemum englishiae L.Bolus (1)
Nycteranthus englishiae (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus englishiae (L.Bolus) L.Bolus, invalid name (1)
Perennial. Succulent. Ht up to 0.1 m. Alt 250–750 m. WC
olivacea (Schltr.) H.Jacobsen = **Phyllobolus tenuiflorus**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

pallens (Aiton) N.E.Br. subsp. **lancea** (Thunb.) Gerbaulet
Mesembryanthemum lanceum Thunb. (1)
Perennial. Succulent. Ht up to 0.15 m. Alt 150–1290 m. NC, WC
pallens (Aiton) N.E.Br. subsp. **lutea** L.Bolus
Perennial. Succulent. Ht up to 0.1 m. Alt 10–260 m. WC
pallens (Aiton) N.E.Br. subsp. **namaquensis** Gerbaulet
Perennial. Succulent. Ht up to 0.25 m. Alt 250–1100 m. NC
pallens (Aiton) N.E.Br. subsp. **pallens**
Mesembryanthemum loratum Haw. (1)
Mesembryanthemum pallens Aiton (1)
Mesembryanthemum pallescens Haw. (1)
Mesembryanthemum relaxatum Willd. (1)
Phyllobolus pallens (Aiton) Bittrich (2)
Platythyra pallens (Aiton) L.Bolus (1)
Platythyra relaxata (Willd.) Schwantes (1)
P. relaxata (Willd.) N.E.Br. (1)
Perennial. Succulent. Ht up to 0.15 m. Alt 10–950 m. WC
radicans (L.Bolus) Gerbaulet
Aridaria radicans L.Bolus (1)
Nycteranthus radicans (L.Bolus) Schwantes, illegitimate name (1)
Sphalmanthus radicans (L.Bolus) L.Bolus, invalid name (1)
Perennial. Succulent. Ht up to 0.05 m. Alt 950–1250 m. EC
relaxata (Willd.) N.E.Br. = **P. pallens** subsp. **pallens**
sladeniana (L.Bolus) L.Bolus
Mesembryanthemum sladenianum L.Bolus (1)
Synaptophyllum sladenianum (L.Bolus) N.E.Br. (1)
Perennial. Succulent. Ht up to 0.3 m. Alt 190–1050 m. N, NC
tetragona (Thunb.) Gerbaulet
Aridaria ausana (Dinter & A.Berger) Dinter & Schwantes (1)
Aridaria luteoalba L.Bolus (1)
Aridaria mutans L.Bolus (1)
Aridaria suffusa L.Bolus (1)
Aridaria tetragona (Thunb.) L.Bolus (1)
Mesembryanthemum ausanum Dinter & A.Berger (1)
Mesembryanthemum pfeilii Engl. (1)
Mesembryanthemum pseudoausanum Dinter, naked name (1)
Mesembryanthemum tetragonum Thunb. (1)
Nycteranthus ausanus (Dinter & A.Berger) Schwantes, illegitimate name (1)
Nycteranthus luteoalbus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus mutans (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus suffusus (L.Bolus) Schwantes, illegitimate name (1)
Nycteranthus tetragonus (Thunb.) Schwantes, illegitimate name (1)
Peratetracoilanthus tetragonus (Thunb.) Rappa & Camarrone, invalid name (1)
Psilocaulon pfeilii (Engl.) Schwantes (1)
Sphalmanthus suffusus (L.Bolus) L.Bolus, invalid name (1)
Sphalmanthus tetragonus (Thunb.) L.Bolus, invalid name (1)
Perennial. Succulent. Ht up to 0.7 m. Alt 350–1300 m. N, FS, NC, WC
vanrensburgii L.Bolus
Perapentacoilanthus vanrensburgii (L.Bolus) Rappa & Camarrone (1)
Perennial. Succulent. Ht up to 0.15 m. Alt 10–100 m. WC

PREPODESMA N.E.Br. 2405210
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 227.
orpenii (N.E.Br.) N.E.Br.
Aloinopsis orpenii (N.E.Br.) L.Bolus (1)
Rabiea tersa N.E.Br. (1)
Perennial. Succulent. Ht up to 0.05 m. Alt 1200–1500 m. NC
uncipetala N.E.Br. = **Hereroa wilmaniae**

PSAMMOPHORA Dinter & Schwantes 2405100
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: tt. 280A, 280B.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

(2) Hartmann. 1996. *Bradleya* 14: 29–56.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 228–230.
herrei L.Bolus = **P. longifolia**
longifolia L.Bolus
P. herrei L.Bolus (3)
Perennial. Succulent. Ht up to 0.05 m. Alt 10–750 m. N, NC
modesta (Dinter & A.Berger) Dinter & Schwantes
Perennial. Succulent. Ht up to 0.15 m. Alt 10–1050 m. N, NC
nissenii (Dinter) Dinter & Schwantes
Perennial. Succulent. Ht up to 0.03 m. Alt 20–550 m. N
pillansii L.Bolus = **Arenifera pillansii**
saxicola H.E.K.Hartmann
Perennial. Succulent, shrub. Ht up to 0.6 m. Alt 10–300 m. N

PSEUDOBROWNANTHUS Ihlenf. & Bittrich 2405155
nucifer Ihlenf. & Bittrich = **Brownanthus nucifer**

PSILOCAULON N.E.Br. 2405101
(1) Bolus. 1931. *The Flowering Plants of South Africa* 11: t. 414.
(2) Ihlenfeldt & Bittrich. 1985. *Botanische Jahrbücher* 105: 289–322.
(3) Klak & Linder. 1998. *Botanische Jahrbücher* 120: 301–375.
(4) Klak & Gerbaulet. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 230–236.
absimile N.E.Br. = **P. coriarium**
acutisepalum (A.Berger) N.E.Br. = **P. junceum**
album L.Bolus = **P. leptarthron**
annuum L.Bolus = **P. articulatum**
arenosum (Schinz) L.Bolus = **Brownanthus arenosus**
articulatum (Thunb.) N.E.Br.
Mesembryanthemum articulatum Thunb. (3)
Mesembryanthemum mucronulatum Dinter (3)
Mesembryanthemum secundum Thunb., naked name (3)
P. annuum L.Bolus (3)
P. asperulum N.E.Br. (3)
P. bryantii L.Bolus (3)
P. dejagerae L.Bolus (3)
P. duthiae L.Bolus (3)
P. hirtellum L.Bolus (3)
P. liebenbergii L.Bolus (3)
P. mucronulatum (Dinter) N.E.Br. (3)
P. puberulum Dinter, naked name (3)
P. pubescens N.E.Br. (3)
P. roseoalbum L.Bolus (3)
Perennial, occ. annual. Succulent. Ht 0.1–0.3 m. Alt up to 1500 m. N, FS, NC, WC, EC
asperulum N.E.Br. = **P. articulatum**
baylissii L.Bolus = **P. dinteri**
bicorne (Sond.) Schwantes
Mesembryanthemum bicorne Sond. (3)
Perennial, occ. annual. Succulent. Ht up to 0.05 m. Alt 20–1200 m. WC, EC
bijliae N.E.Br. = **P. junceum**
bryantii L.Bolus = **P. articulatum**
calvinianum L.Bolus = **P. junceum**
candidum L.Bolus = **P. junceum**
ciliatum (Aiton) Friedrich = **Brownanthus ciliatus** subsp. **ciliatus**
clavulatum (A.Berger) N.E.Br. = **P. subnodosum**
corallinum (Thunb.) Schwantes = **Brownanthus corallinus**
coriarium (Burch. ex N.E.Br.) N.E.Br.
Mesembryanthemum coriarium Burch. ex N.E.Br. (4)
Mesembryanthemum mentiens A.Berger (3)
P. absimile N.E.Br. (3)
P. mentiens (A.Berger) N.E.Br. (3)
P. stenopetalum L.Bolus (3)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

P. uncinatum L.Bolus (3)
Ruschia coriaria (Burch. ex N.E.Br.) Schwantes (3)
Perennial, occ. annual. Shrub, succulent. Ht 1.5–3 m. Alt 500–2000 m. N, FS, NC, WC, EC
dejagerae L.Bolus = **P. articulatum**
delosepalum L.Bolus = **P. junceum**
densum N.E.Br.
Perennial. Succulent. Ht? Alt up to 1100 m. NC
dinteri (Engl.) Schwantes
Mesembryanthemum dinteri Engl. (3)
P. baylissii L.Bolus (3)
P. fasciculatum N.E.Br. (3)
P. godmaniae L.Bolus var. *godmaniae* (3)
P. godmaniae L.Bolus var. *gracile* L.Bolus (3)
P. herrei L.Bolus (3)
P. littlewoodii L.Bolus (3)
P. littlewoodii L.Bolus forma *laxum* L.Bolus (3)
P. pageae L.Bolus var. *grandiflorum* L.Bolus (3)
P. pageae L.Bolus var. *pageae* (3)
P. variabile L.Bolus (3)
Perennial, occ. annual. Succulent. Ht up to 0.25 m. Alt 5–900 m. N, NC, WC
duthiae L.Bolus = **P. articulatum**
fasciculatum N.E.Br. = **P. dinteri**
filipetalum L.Bolus = **P. subnodosum**
fimbriatum L.Bolus = **P. salicornioides**
foliosum L.Bolus
Perennial, occ. annual. Succulent. Ht up to 1.2 m. Alt 20–750 m. NC
framesii L.Bolus = **P. junceum**
gessertianum (Dinter & A.Berger) Dinter & Schwantes
Mesembryanthemum gessertianum Dinter & A.Berger (3)
P. luteum L.Bolus (4)
Perennial, occ. annual. Succulent. Ht up to 0.25 m. Alt 750–2200 m. N
glareosum (A.Berger) Dinter & Schwantes = **P. salicornioides**
godmaniae L.Bolus var. *godmaniae* = **P. dinteri**
godmaniae L.Bolus var. *gracile* L.Bolus = **P. dinteri**
granulicaule (Haw.) Schwantes
Mesembryanthemum granulicaule Haw. (3)
Perapentacoilanthus granulicaulis (Haw.) Rappa & Camarrone, invalid name (3)
P. pauper L.Bolus (3)
Perennial, occ. annual. Succulent. Ht up to 0.25 m. Alt 20–1500 m. N, FS, NC, WC, EC
herrei L.Bolus = **P. dinteri**
hirtellum L.Bolus = **P. articulatum**
imitans L.Bolus = **P. junceum**
implexum N.E.Br. = **P. parviflorum**
inachabense L.Bolus = **P. salicornioides**
inconspicuum L.Bolus = **P. salicornioides**
inconstrictum L.Bolus = **P. subnodosum**
junceum (Haw.) Schwantes
Mesembryanthemum acutisepalum A.Berger (3)
Mesembryanthemum junceum Haw. (3)
Mesembryanthemum junceum Haw. var. *pauciflorum* Sond. (3)
Mesembryanthemum simile Sond. (3)
Mesembryanthemum simile Sond. var. *namaquense* Sond. (3)
Peratetracoilanthus junceus (Haw.) Rappa & Camarrone (3)
P. acutisepalum (A.Berger) N.E.Br. (3)
P. bijliae N.E.Br. (3)
P. calvinianum L.Bolus (3)
P. candidum L.Bolus (3)
P. delosepalum L.Bolus (3)
P. framesii L.Bolus (3)
P. imitans L.Bolus (3)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

P. laxiflorum L.Bolus (3)
P. leightoniae L.Bolus (3)
P. levynsiae N.E.Br. (3)
P. lewisiae L.Bolus (3)
P. namaquense (Sond.) Schwantes (3)
P. oculatum L.Bolus (3)
P. pauciflorum (Sond.) Schwantes (3)
P. planisepalum L.Bolus (3)
P. rogersiae L.Bolus (3)
P. semilunatum L.Bolus (3)
P. simile (Sond.) Schwantes (3)
P. simulans L.Bolus (3)
P. squamifolium N.E.Br. (3)
P. stayneri L.Bolus (3)
P. subintegrum L.Bolus (3)
P. utile L.Bolus (3)
Perennial, occ. annual. Succulent. Ht 0.1–0.6 m. Alt 20–1100 m. NC, WC, EC

kuntzei (Schinz) Dinter & Schwantes = **Brownanthus kuntzei**

laxiflorum L.Bolus = **P. junceum**

leightoniae L.Bolus = **P. junceum**

leptarthron (A.Berger) N.E.Br.
Mesembryanthemum leptarthron A.Berger (3)
P. album L.Bolus (3)
Perennial, occ. annual. Succulent. Ht 0.5–1 m. Alt 200–350 m. WC

levynsiae N.E.Br. = **P. junceum**

lewisiae L.Bolus = **P. junceum**

liebenbergii L.Bolus = **P. articulatum**

lindequistii (Engl.) Schwantes = **Aridaria noctiflora** subsp. **noctiflora**

littlewoodii L.Bolus = **P. dinteri**

littlewoodii L.Bolus forma *laxum* L.Bolus = **P. dinteri**

longipes L.Bolus = **Caulipsolon rapaceum**

luteum L.Bolus = **P. gessertianum**

marlothii (Pax) Friedrich = **Brownanthus marlothii**

melanospermum (A.Berger) N.E.Br. = **Aptenia geniculiflora**

mentiens (A.Berger) N.E.Br. = **P. coriarium**

micranthon L.Bolus, illegitimate name = **P. parviflorum**

mucronulatum (Dinter) N.E.Br. = **P. articulatum**

namaquense (Sond.) Schwantes = **P. junceum**

namibense (Marloth) Friedrich = **Brownanthus namibensis**

oculatum L.Bolus = **P. junceum**

otzenianum (Dinter) L.Bolus = **Lampranthus otzenianus**

pageae L.Bolus var. *grandiflorum* L.Bolus = **P. dinteri**

pageae L.Bolus var. *pageae* = **P. dinteri**

parviflorum (Jacq.) Schwantes
Mesembryanthemum micranthon Haw., illegitimate name (3)
Mesembryanthemum parviflorum Jacq. (3)
Mesembryanthemum tenue Haw. (3)
Peratetracoilanthus parviflorus (Jacq.) Rappa & Camarrone (3)
P. implexum N.E.Br. (3)
P. micranthon L.Bolus, illegitimate name (3)
P. tenue (Haw.) Schwantes (3)
Perennial, occ. annual. Succulent. Ht up to 0.02 m. Alt 20–360 m. WC

pauciflorum (Sond.) Schwantes = **P. junceum**

pauper L.Bolus = **P. granulicaule**

peersii L.Bolus = **Brownanthus corallinus**

pfeilii (Engl.) Schwantes = **Prenia tetragona**

pillansii (L.Bolus) Friedrich = **Brownanthus pubescens**

planisepalum L.Bolus = **P. junceum**

planum L.Bolus = **P. salicornioides**

pomeridianum L.Bolus = **Mesembryanthemum stenandrum**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

puberulum Dinter, naked name = **P. articulatum**
pubescens N.E.Br. = **P. articulatum**
rapaceum (Jacq.) Schwantes = **Caulipsolon rapaceum**
rogersiae L.Bolus = **P. junceum**
roseoalbum L.Bolus = **P. articulatum**
salicornioides (Pax) Schwantes
Mesembryanthemum glareosum A.Berger (3)
Mesembryanthemum salicornioides Pax (3)
Mesembryanthemum sinus-redfordiani Dinter, naked name (3)
Mesembryanthemum trothai Engl. (3)
P. fimbriatum L.Bolus (3)
P. glareosum (A.Berger) Dinter & Schwantes (3)
P. inachabense L.Bolus (3)
P. inconspicuum L.Bolus (3)
P. planum L.Bolus (3)
P. sinus-redfordiani Dinter ex Range, naked name (3)
P. trothai (Engl.) Schwantes (3)
P. woodii L.Bolus (3)
Perennial, occ. annual. Succulent. Ht up to 0.4 m. Alt 10–650 m. N, NC
schlichtianum (Sond.) Schwantes = **Brownanthus arenosus**
semilunatum L.Bolus = **P. junceum**
simile (Sond.) Schwantes = **P. junceum**
simulans L.Bolus = **P. junceum**
sinus-redfordiani Dinter ex Range, naked name = **P. salicornioides**
squamifolium N.E.Br. = **P. junceum**
stayneri L.Bolus = **P. junceum**
stenopetalum L.Bolus = **P. coriarium**
subintegrum L.Bolus = **P. junceum**
subnodosum (A.Berger) N.E.Br.
Mesembryanthemum clavulatum A.Berger (3)
Mesembryanthemum subnodosum A.Berger (3)
P. clavulatum (A.Berger) N.E.Br. (3)
P. filipetalum L.Bolus (3)
P. inconstrictum L.Bolus (3)
Perennial, occ. annual. Succulent. Ht up to 0.7 m. Alt 20–850 m. N, NC
tenue (Haw.) Schwantes = **P. parviflorum**
trothai (Engl.) Schwantes = **P. salicornioides**
uncinatum L.Bolus = **P. coriarium**
utile L.Bolus = **P. junceum**
variabile L.Bolus = **P. dinteri**
woodii L.Bolus = **P. salicornioides**

PUNCTILLARIA N.E.Br. 2405157
cana L.Bolus = **Pleiospilos compactus** subsp. **canus**
compacta (Aiton) N.E.Br. = **Pleiospilos compactus** subsp. **compactus**
dekenahi N.E.Br. = **Pleiospilos compactus** subsp. **canus**
magnipunctata (Haw.) N.E.Br. = **Pleiospilos compactus** subsp. **canus**
optata (N.E.Br.) N.E.Br. = **Pleiospilos compactus** subsp. **compactus**
roodiae N.E.Br. = **Tanquana prismatica**
sesquiuncialis N.E.Br. = **Pleiospilos compactus** subsp. **canus**
sororia (N.E.Br.) N.E.Br. = **Pleiospilos compactus** subsp. **sororius**

RABIEA N.E.Br. 2405102
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 237, 238.
albinota (Haw.) N.E.Br.
R. albinota (Haw.) N.E.Br. var. *longipetala* L.Bolus (1)
R. albinota (Haw.) N.E.Br. var. *microstigma* L.Bolus (1)
Perennial. Succulent. Ht up to 0.08 m. Alt? 'CP'
albinota (Haw.) N.E.Br. var. *longipetala* L.Bolus = **R. albinota**
albinota (Haw.) N.E.Br. var. *microstigma* L.Bolus = **R. albinota**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

albipuncta (Haw.) N.E.Br.
R. albipuncta (Haw.) N.E.Br. var. *major* L.Bolus (1)
Perennial. Succulent. Ht up to 0.03 m. Alt 1400–1700 m. FS
albipuncta (Haw.) N.E.Br. var. *major* L.Bolus = **R. albipuncta**
comptonii (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 1400–1600 m. FS
difformis (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 990–1500 m. EC
jamesii (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 990–1500 m. EC
lesliei N.E.Br.
Perennial. Succulent. Ht up to 0.05 m. Alt 1600–1880 m. FS
tersa N.E.Br. = **Prepodesma orpenii**

RHINEPHYLLUM N.E.Br. 2405103
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 264.
(2) Hartmann. 1999. *Bradleya* 17: 38–74.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 239–241.
broomii L.Bolus
Perennial. Succulent. Ht up to 0.03 m, when in flower. Alt 1200–1700 m. NC
comptonii L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 1400–1600 m. FS, WC
frithii (L.Bolus) L.Bolus = **Peersia frithii**
graniforme (Haw.) L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 800–1100 m. WC
inaequale L.Bolus
R. inaequale L.Bolus var. *latipetalum* L.Bolus (3)
Perennial. Succulent. Ht up to 0.05 m. Alt 1100–1600 m. EC
inaequale L.Bolus var. *latipetalum* L.Bolus = **R. inaequale**
luteum (L.Bolus) L.Bolus
Ruschia lutea L.Bolus (2)
Perennial. Succulent. Ht up to 0.05 m. Alt 800–1100 m. WC
macradenium (L.Bolus) L.Bolus = **Peersia macradenia**
muirii N.E.Br.
Perennial. Succulent. Ht up to 0.03 m. Alt 300–850 m. WC
obliquum L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 1200–1500 m. NC
parvifolium L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 300–900 m. EC
pillansii N.E.Br.
Perennial. Succulent. Ht up to 0.04 m. Alt 1000–1200 m. WC
rouxii (L.Bolus) L.Bolus = **Chasmatophyllum rouxii**
schonlandii L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 800–1500 m. NC
vanheerdei L.Bolus = **Peersia vanheerdei**

RHOMBOPHYLLUM (Schwantes) Schwantes 2405104
(1) Hartmann. 1998. *Bradleya* 16: 44–91.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 241–243.
albanense (L.Bolus) H.E.K.Hartmann
Hereroa albanensis L.Bolus (1)
Mesembryanthemum dyeri (L.Bolus) N.E.Br. (1)
Ruschia dyeri L.Bolus (1)
Perennial. Succulent. Ht up to 0.1 m. Alt 650–820 m. EC
dolabriforme (L.) Schwantes
Hereroa dolabriformis (L.) L.Bolus (1)
Mesembryanthemum dolabriforme L. (1)
Perennial. Succulent. Ht up to 0.3 m. Alt 700–1100 m. EC
dyeri (L.Bolus) H.E.K.Hartmann
Hereroa dyeri L.Bolus (1)
Perennial. Succulent. Ht up to 0.1 m. Alt 750–1000 m. EC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

nelii Schwantes
Perennial. Succulent. Ht? Alt 450–1200 m. EC
rhomboideum (Salm-Dyck) Schwantes
Bergeranthus rhomboideus (Salm-Dyck) Schwantes (1)
Mesembryanthemum rhomboideum Salm-Dyck (1)
R. rhomboideum (Salm-Dyck) Schwantes var. *groppiorum* Heinrich (1)
Perennial. Succulent. Ht ± 0.03 m, 0.1 m when in flower. Alt? EC
rhomboideum (Salm-Dyck) Schwantes var. *groppiorum* Heinrich = **R. rhomboideum**

RHOPALOCYCLUS Schwantes 2405201
herrei Schwantes = **Leipoldtia schultzei**
nelii Schwantes = **Leipoldtia schultzei**
weigangianus (Dinter) Dinter & Schwantes = **Leipoldtia weigangiana** subsp. **weigangiana**

ROODIA N.E.Br. 2405158
digitifolia N.E.Br. = **Argyroderma fissum**

RUSCHIA Schwantes 2405105
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: tt. 251, 277.
(2) Phillips. 1930. *The Flowering Plants of South Africa* 10: t. 393.
(3) Bolus. 1931. *The Flowering Plants of South Africa* 11: tt. 416, 418.
(4) Bolus. 1947. *The Flowering Plants of Africa* 26: t. 1013.
(5) Bolus. 1969. *The Flowering Plants of Africa* 39: t. 1530.
(6) Glen. 1986. *The Flowering Plants of Africa* 49: t. 1937.
(7) Glen. 1987. *The Flowering Plants of Africa* 49: t. 1960.
(8) Hartmann & Stüber. 1993. *Contributions from the Bolus Herbarium* 15: 1–75.
(9) Hartmann. 1996. *Bradleya* 14: 29–56.
(10) Hartmann. 1998. *Bothalia* 28: 67–82.
(11) Hartmann. 1998. *Bradleya* 16: 44–91.
(12) Hartmann. 1999. *Bradleya* 17: 38–74.
(13) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 244–284.
(14) Klak. 2001. *Phylogeny and character evolution in the* Lampranthus *group (Aizoaceae–Ruschioideae).* Unpublished Ph.D. thesis. University of Cape Town.
abbreviata L.Bolus
R. subaphylla Friedrich (12)
Perennial. Shrub, succulent. Ht up to 0.3 m. Alt 250–1500 m. N, NC
abrupta (A.Berger) G.D.Rowley = **Octopoma abruptum**
acocksii L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 700–900 m. NC
acuminata L.Bolus
Mesembryanthemum exacutum N.E.Br. (12)
Perennial. Succulent. Ht up to 0.2 m. Alt 500–900 m. WC
acutangula (Haw.) Schwantes
Mesembryanthemum acutangulum Haw. (12)
Mesembryanthemum vaginatum Haw. var. *acutangulum* A.Berger (12)
Perennial. Succulent. Ht up to 1.2 m. Alt ± 700 m. WC
addita L.Bolus = **Antimima addita**
aggregata L.Bolus
Perennial. Succulent. Ht up to 0.36 m. Alt ± 1200 m. NC
alata L.Bolus
Perennial. Succulent. Ht up to 0.18 m. Alt 200–350 m. WC
albertensis L.Bolus = **R. spinosa**
albiflora L.Bolus = **Polymita albiflora**
alborubra L.Bolus = **Antimima alborubra**
altigena (L.Bolus) L.Bolus
Mesembryanthemum altigenum L.Bolus (12)
Perennial. Succulent. Ht up to 0.13 m. Alt ± 1700 m. WC
amicorum (L.Bolus) Schwantes
Mesembryanthemum amicorum L.Bolus (13)
Perennial. Succulent. Ht 0.3–0.4 m. Alt? WC
amoena Schwantes = **Antimima amoena**
amphibolia G.D.Rowley = **Lampranthus amphibolius**
ampliata L.Bolus

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Mesembryanthemum ampliatum (L.Bolus) N.E.Br. (12)
Perennial. Succulent. Ht up to 0.25 m. Alt 20–250 m. NC

androsacea Marloth & Schwantes = **Antimima androsacea**

androsacea Marloth & Schwantes, naked name = **Antimima androsacea**

approximata (L.Bolus) Schwantes
Mesembryanthemum approximatum L.Bolus (12)
Perennial. Succulent. Ht 0.09–0.14 m. Alt 500–850 m. WC

archeri L.Bolus
R. archeri L.Bolus var. *sexpartita* L.Bolus (13)
Perennial. Succulent. Ht up to 0.33 m. Alt 750–1600 m. WC

archeri L.Bolus var. *sexpartita* L.Bolus = **R. archeri**

arenosa L.Bolus = **Lampranthus arenarius**

argentea L.Bolus = **Antimima argentea**

aristata L.Bolus = **Erepsia aristata**

aristulata (Sond.) Schwantes = **Antimima aristulata**

armata L.Bolus = **Arenifera stylosa**

aspera L.Bolus
Perennial. Succulent. Ht up to 0.22 m. Alt up to 1200 m. NC

atrata L.Bolus
Mesembryanthemum atratum (L.Bolus) N.E.Br. (12)
Perennial. Succulent. Ht up to 0.28 m. Alt up to 1000 m. NC

axthelmiana (Dinter) Schwantes
Mesembryanthemum axthelmianum Dinter (12)
Perennial. Succulent. Ht up to 0.5 m. Alt 900–2000 m. N

barnardii L.Bolus
Mesembryanthemum barnardii (L.Bolus) N.E.Br. (12)
Mesembryanthemum pseudorupicolum Dinter, naked name (12)
R. kakamasensis L.Bolus (12)
Perennial. Succulent, shrub. Ht up to 0.3 m. Alt 900–1200 m. N, NC

beaufortensis L.Bolus
Perennial. Succulent. Ht up to 0.12 m. Alt 950–1950 m. WC

bicolorata L.Bolus = **Stoeberia beetzii**

biformis (N.E.Br.) Schwantes = **Antimima biformis**

bijliae L.Bolus
Mesembryanthemum bijliae (L.Bolus) N.E.Br. (12)
Perennial. Succulent. Ht 0.06–0.09 m. Alt 800–950 m. WC

bina L.Bolus = **Antimima bina**

bipapillata L.Bolus
Perennial. Succulent. Ht up to 0.22 m. Alt 200–300 m. WC

bolusiae Schwantes
Mesembryanthemum albicute N.E.Br. (12)
R. rigida L.Bolus, not of (Haw.) Schwantes (12)
Perennial. Shrub, succulent. Ht up to 0.12 m. Alt 300–550 m. WC

bracteata L.Bolus = **Antimima bracteata**

brakdamensis (L.Bolus) L.Bolus
Mesembryanthemum brakdamense L.Bolus (12)
Perennial. Succulent. Ht 0.1–0.25 m. Alt up to 1200 m. NC

breekpoortensis L.Bolus
Perennial. Shrub, succulent. Ht up to 0.3 m. Alt? NC

brevibracteata L.Bolus
Perennial. Succulent, shrub. Ht? Alt up to 1200 m. NC

brevicarpa L.Bolus = **Antimima brevicarpa**

brevicollis (N.E.Br.) Schwantes = **Antimima brevicollis**

brevicyma L.Bolus
Perennial. Shrub, succulent. Ht up to 0.45 m. Alt? 'SA'

brevifolia L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt up to 1200 m. NC

brevipes L.Bolus
Mesembryanthemum firmum N.E.Br. (12)
R. brevipes L.Bolus var. *gracilis* L.Bolus (12)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht 0.3–0.45 m. Alt 800–950 m. WC
brevipes L.Bolus var. *gracilis* L.Bolus = **R. brevipes**
britteniae L.Bolus
Mesembryanthemum iteratum N.E.Br. (12)
Perennial. Succulent. Ht? Alt 600–900 m. EC
buchubergensis Dinter = **Antimima buchubergensis**
burtoniae L.Bolus
Perennial. Succulent. Ht up to 0.6 m. Alt 200–900 m. NC, WC
calcarea L.Bolus
Perennial. Succulent. Ht? Alt 1110–1210 m. NC
calcicola (L.Bolus) L.Bolus
Mesembryanthemum calcicola L.Bolus (12)
Perennial. Shrub, succulent. Ht? Alt 200–320 m. WC
callifera L.Bolus
Perennial. Succulent. Ht up to 0.13 m. Alt 800–950 m. WC
calycina L.Bolus = **Zeuktophyllum calycinum**
campestris (Burch.) Schwantes
Mesembryanthemum campestre Burch. (13)
Perennial. Succulent. Ht up to 0.45 m. Alt 800–950 m. NC
canonotata (L.Bolus) Schwantes
Mesembryanthemum canonotatum L.Bolus (12)
R. orsmondiae L.Bolus (12)
Perennial. Succulent. Ht up to 0.2 m. Alt 1100–1500 m. FS, NC
capornii (L.Bolus) L.Bolus
Lampranthus capornii (L.Bolus) L.Bolus (12)
Mesembryanthemum capornii L.Bolus (12)
Mesembryanthemum capornii L.Bolus forma *ferum* L.Bolus (12)
Mesembryanthemum capornii L.Bolus var. *longifolium* L.Bolus (12)
Perennial. Succulent. Ht? Alt 200–400 m. NC
capulata (L.Bolus) Schwantes = **R. cupulata**
caroli (L.Bolus) Schwantes
Mesembryanthemum caroli L.Bolus (13)
Perennial. Shrub, succulent. Ht? Alt 300–550 m. WC
caudata L.Bolus
Perennial. Succulent. Ht 0.25–0.4 m. Alt 200–460 m. WC
cedarbergensis L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt 600–1300 m. WC
centrocapsula H.E.K.Hartmann & Stüber
Perennial. Succulent. Ht? Alt 850–1250 m. NC
ceresiana L.Bolus
Perennial. Succulent. Ht? Alt 500–1200 m. WC
cincta (L.Bolus) L.Bolus
Mesembryanthemum cinctum L.Bolus (12)
Perennial. Succulent. Ht? Alt 150–330 m. WC
clavata L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 200–350 m. WC
cleista L.Bolus = **Eberlanzia sedoides**
compacta L.Bolus = **Antimima compacta**
complanata L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 1000–1800 m. EC
compressa L.Bolus = **Antimima compressa**
comptonii L.Bolus = **Drosanthemum pulverulentum**
concava L.Bolus = **Antimima dasyphylla**
concinna L.Bolus = **Antimima concinna**
condensa (N.E.Br.) Schwantes = **Antimima condensa**
congesta (Salm-Dyck) L.Bolus
Mesembryanthemum congestum Salm-Dyck (12)
Perennial. Succulent. Ht? Alt 50–750 m. EC
conjuncta L.Bolus = **Octopoma connatum**
connata L.Bolus = **Octopoma connatum**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

constricta L.Bolus = **Acrodon bellidiflorus**
copiosa L.Bolus
Perennial. Succulent. Ht 0.3–0.5 m. Alt 300–550 m. WC
coriaria (Burch. ex N.E.Br.) Schwantes = **Psilocaulon coriarium**
costata L.Bolus
Perennial. Succulent. Ht? Alt 500–800 m. WC
cradockensis (Kuntze) H.E.K.Hartmann & Stüber subsp. **cradockensis**
Eberlanzia cradockensis (Kuntze) Schwantes (8)
Eberlanzia horrescens (L.Bolus) L.Bolus (8)
Eberlanzia horrescens (L.Bolus) L.Bolus var. *densa* (L.Bolus) H.Jacobsen, invalid name (8)
Eberlanzia horrida (L.Bolus) L.Bolus (11)
Mesembryanthemum cradockense Kuntze (8)
Mesembryanthemum spinosum L. var. *cradockense* (Kuntze) A.Berger ex Range, naked name (12)
R. horrescens L.Bolus (8)
R. horrescens L.Bolus var. *densa* L.Bolus (8)
R. horrida L.Bolus (8)
Perennial. Succulent. Ht? Alt 500–1300 m. WC, EC
cradockensis (Kuntze) H.E.K.Hartmann & Stüber subsp. **triticiformis** (L.Bolus) H.E.K.Hartmann & Stüber
Eberlanzia triticiformis (L.Bolus) L.Bolus (8)
Eberlanzia triticiformis (L.Bolus) L.Bolus var. *subglobosa* L.Bolus (11)
Mesembryanthemum triticiforme L.Bolus (8)
Perennial. Succulent. Ht up to 0.5 m. Alt 800–1200 m. NC
crassa (L.Bolus) Schwantes
Mesembryanthemum crassum L.Bolus (12)
Perennial. Succulent. Ht up to 0.8 m. Alt 800–1300 m. WC
crassifolia L.Bolus = **Antimima crassifolia**
crassisepala L.Bolus
R. crassisepala L.Bolus var. *major* L.Bolus (12)
Perennial. Succulent. Ht? Alt 200–350 m. WC
crassisepala L.Bolus var. major L.Bolus = **R. crassisepala**
crassuloides L.Bolus = **Eberlanzia sedoides**
cupulata (L.Bolus) Schwantes
Mesembryanthemum cupulatum L.Bolus (12)
R. capulata (L.Bolus) Schwantes (12)
Perennial. Succulent. Ht up to 0.2 m. Alt 100–260 m. WC
curta (Haw.) Schwantes
Mesembryanthemum curtum Haw. (12)
Mesembryanthemum vaginatum Haw. var. *curtum* (Haw.) A.Berger (12)
Perennial. Shrub, succulent. Ht? Alt? 'SA'
cyathiformis L.Bolus = **Eberlanzia cyathiformis**
cymbifolia (Haw.) L.Bolus
Mesembryanthemum cymbifolium Haw. (12)
Mesembryanthemum deceptum N.E.Br., illegitimate name (12)
Perennial. Shrub, succulent. Ht up to 0.3 m. Alt 350–490 m. WC
cymosa (L.Bolus) Schwantes
Perennial. Succulent. Ht 0.2–0.4 m. Alt 500–850 m. WC
dasyphylla (Schltr.) Schwantes = **Antimima dasyphylla**
decumbens L.Bolus
Mesembryanthemum deflectum N.E.Br. (12)
Perennial. Succulent. Ht? Alt 800–1050 m. WC
decurrens L.Bolus
Mesembryanthemum decurrens (L.Bolus) N.E.Br. (12)
Perennial. Succulent. Ht? Alt 200–350 m. WC
decurvans L.Bolus
Perennial. Shrub, succulent. Ht up to 0.45 m. Alt 175–350 m. WC
defecta L.Bolus = **Antimima defecta**
deflecta L.Bolus = **Antimima defecta**
dejagerae L.Bolus
Mesembryanthemum dejagerae (L.Bolus) N.E.Br. (12)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.07 m. Alt 800–1200 m. WC
dekenahi (N.E.Br.) Schwantes = **Antimima dekenahi**
deminuta L.Bolus
Perennial. Succulent. Ht up to 0.05 m. Alt 1100–1700 m. N
densiflora L.Bolus
Perennial. Succulent. Ht up to 0.45 m. Alt 300–500 m. WC
depressa L.Bolus
Perennial. Succulent. Ht? Alt 50–275 m. EC
derenbergiana (Dinter) C.Weber = **Ebracteola derenbergiana**
dichotoma L.Bolus = **Eberlanzia dichotoma**
dichroa (Rolfe) L.Bolus
Cylindrophyllum dichroum (Rolfe) Schwantes (12)
Mesembryanthemum dichroum Rolfe (12)
R. dichroa (Rolfe) L.Bolus var. *alba* L.Bolus (12)
Perennial. Succulent. Ht up to 0.3 m. Alt 760–850 m. NC, WC
dichroa (Rolfe) L.Bolus var. *alba* L.Bolus = **R. dichroa**
dilatata L.Bolus
Perennial. Shrub, succulent. Ht? Alt 150–250 m. WC
disarticulata L.Bolus = **Antimima hantamensis**
dissimilis G.D.Rowley = **Lampranthus dissimilis**
distans (L.Bolus) L.Bolus = **Antimima distans**
diutina L.Bolus = **Polymita albiflora**
divaricata L.Bolus
Eberlanzia divaricata (L.Bolus) L.Bolus (8)
Eberlanzia tatasbergensis L.Bolus (8)
Eberlanzia vulnerans (L.Bolus) L.Bolus (8)
Mesembryanthemum spinescens Pax, naked name (12)
R. vulnerans L.Bolus (8)
Perennial. Succulent. Ht up to 0.35 m. Alt 150–1100 m. N, FS, NC
diversifolia L.Bolus
Mesembryanthemum variifolium N.E.Br. (12)
Perennial. Shrub, succulent. Ht up to 0.14 m. Alt 300–550 m. WC
dolomitica (Dinter) Dinter & Schwantes = **Antimima dolomitica**
drepanophylla (Schltr. & A.Berger) L.Bolus = **Esterhuysenia drepanophylla**
drepanophylla (Schltr. & A.Berger) L.Bolus var. *sneeubergensis* L.Bolus = **Esterhuysenia drepanophylla**
dualis (N.E.Br.) L.Bolus = **Antimima dualis**
dubitans (L.Bolus) L.Bolus = **Lampranthus dubitans**
duplessiae L.Bolus = **Acrodon bellidiflorus**
duthiae (L.Bolus) Schwantes
Mesembryanthemum duthiae L.Bolus (12)
Perennial. Succulent. Ht 0.07–0.1 m. Alt 20–650 m. WC
dyeri L.Bolus = **Rhombophyllum albanense**
ebracteata L.Bolus = **Eberlanzia ebracteata**
edentula (Haw.) L.Bolus
Braunsia edentula (Haw.) N.E.Br. (12)
Echinus edentulus (Haw.) N.E.Br. (12)
Mesembryanthemum edentulum Haw. (12)
Perennial. Shrub, succulent. Ht up to 0.3 m. Alt? 'SA'
elevata L.Bolus = **Antimima elevata**
elineata L.Bolus
Mesembryanthemum elineatum (L.Bolus) N.E.Br. (12)
Perennial. Shrub, succulent. Ht? Alt ± 1200 m. NC
emarcescens L.Bolus = **Antimima emarcescens**
emarcidens L.Bolus ex Jacobsen = **Antimima emarcescens**
erecta (L.Bolus) Schwantes
Mesembryanthemum erectum L.Bolus (12)
Perennial. Shrub, succulent. Ht up to 0.6 m. Alt 1000–1200 m. NC
erosa L.Bolus = **Antimima erosa**
esterhuyseniae L.Bolus

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Shrub, succulent. Ht up to 0.2 m. Alt 1000–1700 m. WC
evoluta (N.E.Br.) L.Bolus = **Antimima evoluta**
excedens L.Bolus = **Antimima excedens**
exigua L.Bolus
Perennial. Succulent. Ht? Alt 500–850 m. WC
exsurgens L.Bolus = **Antimima exsurgens**
extensa L.Bolus
Perennial. Shrub, succulent. Ht? Alt 1000–1200 m. NC
fenestrata L.Bolus = **Antimima fenestrata**
fergusoniae L.Bolus = **Antimima fergusoniae**
ferox L.Bolus = **R. intricata**
festiva (N.E.Br.) Schwantes
Mesembryanthemum festivum N.E.Br. (6)
Perennial. Succulent. Ht up to 0.3 m. Alt 200–350 m. WC
filamentosa (L.) L.Bolus = **Erepsia forficata**
filipetala L.Bolus
Mesembryanthemum filipetalum (L.Bolus) N.E.Br. (12)
Perennial. Succulent. Ht up to 0.32 m. Alt 300–550 m. WC
firma L.Bolus
Perennial. Succulent. Ht up to 0.4 m. Alt 200–350 m. WC
floribunda L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 200–350 m. WC
foliosa (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.6 m. Alt? 'SA'
forficata in sense of L.Bolus in part, misapplied name = **Acrodon purpureostylus**
forficata (L.) L.Bolus = **Erepsia forficata**
fourcadei L.Bolus
Mesembryanthemum fourcadei in sense of (L.Bolus) N.E.Br., not of L.Bolus, illegitimate name (12)
Perennial. Succulent. Ht? Alt 700–1100 m. WC, EC
framesii L.Bolus
Mesembryanthemum framesii (L.Bolus) N.E.Br., illegitimate name (12)
Perennial. Succulent. Ht up to 0.07 m. Alt 620–920 m. EC
fredericii (L.Bolus) L.Bolus
Mesembryanthemum fredericii L.Bolus (12)
Perennial. Succulent. Ht? Alt 300–700 m. WC
frutescens (L.Bolus) L.Bolus = **Stoeberia frutescens**
fugitans L.Bolus
Perennial. Succulent. Ht? Alt 200–550 m. NC, WC
fulleri L.Bolus = **Ebracteola fulleri**
gemina L.Bolus = **Cerochlamys gemina**
geminiflora (Haw.) Schwantes
Mesembryanthemum geminatum Jacq. (12)
Mesembryanthemum geminatum Salm-Dyck (12)
Mesembryanthemum geminiflorum Haw. (12)
Perennial. Shrub, succulent. Ht? Alt 50–500 m. WC
gibbosa L.Bolus = **Leipoldtia compacta**
glauca L.Bolus
Mesembryanthemum valens N.E.Br. (12)
Perennial. Succulent. Ht up to 0.03 m. Alt up to 1200 m. NC
globularis L.Bolus = **R. spinosa**
goodiae L.Bolus
Mesembryanthemum goodiae (L.Bolus) N.E.Br. (12)
Perennial. Succulent. Ht? Alt 700–1120 m. NC
gracilipes L.Bolus
Perennial. Succulent. Ht? Alt 1200–1500 m. NC
gracilis L.Bolus
Mesembryanthemum exile N.E.Br. (12)
Perennial. Shrub, succulent. Ht up to 0.15 m. Alt ± 120 m. WC
gracillima L.Bolus = **Antimima gracillima**
graminea H.Jacobsen = **Acrodon bellidiflorus**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

granitica (L.Bolus) L.Bolus = **Antimima granitica**
gravida L.Bolus = **Eberlanzia gravida**
griquensis (L.Bolus) Schwantes
Mesembryanthemum griquense L.Bolus (12)
Perennial. Shrub, succulent. Ht up to 0.4 m. Alt 800–1400 m. FS, NC
grisea (L.Bolus) Schwantes
Mesembryanthemum griseum L.Bolus (12)
Perennial. Succulent. Ht up to 0.3 m. Alt 500–1000 m. NC, WC
gydouwensis (L.Bolus) G.D.Rowley = **Lampranthus gydouwensis**
hallii L.Bolus = **Antimima hallii**
hallowayana L.Bolus = **Eberlanzia schneideriana**
hamata (L.Bolus) Schwantes
Mesembryanthemum hamatum L.Bolus (12)
Perennial. Shrub, succulent. Ht up to 0.45 m. Alt up to 3000 m. NW, FS, L, NC
hamatilis L.Bolus = **Antimima hamatilis**
haworthii H.Jacobsen & G.D.Rowley
Mesembryanthemum dilatatum Haw. (12)
Perennial. Shrub, succulent. Ht up to 0.9 m. Alt? 'CP'
herrei Schwantes = **Antimima herrei**
heteropetala L.Bolus
Perennial. Shrub, succulent. Ht up to 0.2 m. Alt 800–1100 m. WC
hexamera L.Bolus
Mesembryanthemum hexamerum (L.Bolus) N.E.Br. (12)
R. hexamera L.Bolus var. *longipetala* L.Bolus (12)
Perennial. Succulent. Ht? Alt 700–1100 m. NC
hexamera L.Bolus var. *longipetala* L.Bolus = **R. hexamera**
holensis L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 200–350 m. WC
hollowayana L.Bolus = **Eberlanzia schneideriana**
horrescens L.Bolus = **R. cradockensis** subsp. **cradockensis**
horrescens L.Bolus var. *densa* L.Bolus = **R. cradockensis** subsp. **cradockensis**
horrida L.Bolus = **R. cradockensis** subsp. **cradockensis**
hutchinsonii L.Bolus = **Amphibolia laevis**
imbricata (Haw.) Schwantes
Mesembryanthemum imbricatum Haw. (13)
Mesembryanthemum imbricatum Haw. var. *rubrum* Haw. (12)
Mesembryanthemum multiflorum Haw. var. *rubrum* (Haw.) Haw. (12)
Perennial. Shrub, succulent. Ht up to 0.6 m. Alt ± 175 m. WC
impressa L.Bolus
Mesembryanthemum impressum (L.Bolus) J.W.Ingram (12)
Perennial. Succulent. Ht up to 0.06 m. Alt 730–1100 m. WC
inclaudens L.Bolus = **Esterhuysenia inclaudens**
inclusa L.Bolus
Mesembryanthemum amplexum N.E.Br. (12)
Perennial. Succulent. Ht 0.06–0.08 m. Alt 800–1100 m. WC
inconspicua L.Bolus
Mesembryanthemum latens N.E.Br. (12)
Perennial. Succulent. Ht up to 0.15 m. Alt 100–1000 m. N, NC
incumbens L.Bolus
Perennial. Shrub, succulent. Ht up to 0.45 m. Alt 300–550 m. WC
incurvata L.Bolus
Mesembryanthemum incurvatum (L.Bolus) N.E.Br. (12)
Perennial. Succulent. Ht up to 0.5 m. Alt 300–550 m. WC
indecora (L.Bolus) Schwantes
Mesembryanthemum indecorum L.Bolus (12)
Perennial. Shrub, succulent. Ht up to 0.3 m. Alt 50–175 m. WC
indurata (L.Bolus) Schwantes
Mesembryanthemum induratum L.Bolus (12)
Perennial. Succulent. Ht? Alt 700–1400 m. EC
insidens L.Bolus = **Antimima insidens**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

integra Schwantes = **Smicrostigma viride**
intermedia L.Bolus
Perennial. Succulent. Ht 0.22–0.34 m. Alt 800–1450 m. WC
intervallaris L.Bolus = **Antimima intervallaris**
intricata (N.E.Br.) H.E.K.Hartmann & Stüber
Eberlanzia ferox (L.Bolus) L.Bolus (8)
Eberlanzia intricata (N.E.Br.) Schwantes (8)
Eberlanzia munita (L.Bolus) Schwantes (8)
Eberlanzia persistens (L.Bolus) L.Bolus (8)
Eberlanzia puniens (L.Bolus) L.Bolus (8)
Mesembryanthemum intricatum N.E.Br. (8)
Mesembryanthemum munitum L.Bolus (8)
Mesembryanthemum tuitum N.E.Br. on herbarium label, naked name (12)
R. ferox L.Bolus (8)
R. persistens L.Bolus (8)
R. puniens L.Bolus (8)
Perennial. Succulent. Ht up to 0.7 m. Alt 800–1500 m. FS, NC, WC, EC
intrusa (Kensit) L.Bolus = **Brianhuntleya intrusa**
ivori (N.E.Br.) Schwantes = **Antimima ivori**
jacobseniana L.Bolus = **Astridia longifolia**
kakamasensis L.Bolus = **R. barnardii**
karrachabensis L.Bolus
Perennial. Succulent. Ht? Alt 400–900 m. NC
karroidea L.Bolus = **Antimima karroidea**
karrooica (L.Bolus) L.Bolus
Mesembryanthemum karrooicum L.Bolus (12)
Perennial. Shrub, succulent. Ht up to 0.3 m. Alt 800–1100 m. WC
kenhardtensis L.Bolus
Perennial. Succulent. Ht up to 0.35 m. Alt 900–1150 m. NC
klaverensis (L.Bolus) Schwantes = **Antimima klaverensis**
klipbergensis L.Bolus
Perennial. Succulent. Ht up to 0.33 m. Alt 250–380 m. WC
knysnana (L.Bolus) L.Bolus
Mesembryanthemum knysnanum L.Bolus (12)
R. knysnana (L.Bolus) L.Bolus var. *angustifolia* L.Bolus (12)
Perennial. Shrub, succulent. Ht 0.3–0.4 m. Alt 50–650 m. WC, EC
knysnana (L.Bolus) L.Bolus var. *angustifolia* L.Bolus = **R. knysnana**
koekenaapensis L.Bolus = **Antimima koekenaapensis**
komkansica L.Bolus = **Antimima komkansica**
kuboosana L.Bolus
Perennial. Succulent. Ht? Alt 700–1150 m. NC
langebaanensis L.Bolus
Perennial. Succulent. Ht? Alt 20–175 m. WC
lapidicola L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 600–1070 m. WC
lavisii L.Bolus
Perennial. Succulent. Ht up to 0.4 m. Alt 20–220 m. WC
lawsonii (L.Bolus) L.Bolus = **Antimima lawsonii**
laxa (Willd.) Schwantes
Perennial. Succulent. Ht? Alt? 'SA'
laxiflora L.Bolus
Perennial. Succulent. Ht up to 0.5 m. Alt? NC
laxipetala L.Bolus
Mesembryanthemum laxipetalum (L.Bolus) N.E.Br. (12)
Perennial. Succulent. Ht 0.6–0.7 m. Alt 800–1100 m. WC
leightoniae L.Bolus = **Lampranthus francesiae**
leipoldtii L.Bolus = **Antimima leipoldtii**
leptocalyx L.Bolus
Perennial. Succulent. Ht? Alt 175–350 m. WC
lerouxiae (L.Bolus) L.Bolus

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Lampranthus lerouxiae (L.Bolus) N.E.Br. (12)
Mesembryanthemum lerouxiae L.Bolus (12)
Perennial. Succulent. Ht? Alt 750–1200 m. NC
leucanthera (L.Bolus) L.Bolus = **Antimima leucanthera**
leucosperma L.Bolus
Perennial. Shrub, succulent. Ht 0.1–0.2 m. Alt 175–1200 m. NC
levynsiae (L.Bolus) Schwantes = **Antimima pumila**
limbata (N.E.Br.) Schwantes = **Antimima limbata**
lineolata (Haw.) Schwantes
Mesembryanthemum lineolatum Haw. (6)
Perennial. Shrub, succulent. Ht up to 0.15 m. Alt 250–550 m. WC
lisabeliae L.Bolus
Perennial. Shrub, succulent. Ht? Alt 100–200 m. WC
littlewoodii L.Bolus
Perennial. Succulent. Ht? Alt 500–1050 m. WC
lodewykii L.Bolus = **Antimima lodewykii**
loganii L.Bolus = **Antimima loganii**
lokenbergensis L.Bolus = **Antimima lokenbergensis**
longifolia L.Bolus = **Acrodon bellidiflorus**
longipes L.Bolus = **Antimima longipes**
luckhoffii L.Bolus = **Antimima luckhoffii**
lutea L.Bolus = **Rhinephyllum luteum**
macovanii (L.Bolus) Schwantes ex H.Jacobsen = **R. macowanii**
macowanii (L.Bolus) Schwantes
Mesembryanthemum macowanii L.Bolus (12)
R. macovanii (L.Bolus) Schwantes ex H.Jacobsen (12)
Perennial. Shrub, succulent. Ht 0.15–0.2 m. Alt 20–175 m. WC
macrophylla L.Bolus = **Acrodon bellidiflorus**
macroura L.Bolus = **R. spinosa**
maleolens L.Bolus = **Antimima maleolens**
mallesoniae (L.Bolus) L.Bolus = **Esterhuysenia drepanophylla**
marginata L.Bolus = **Lampranthus marginatus**
mariae L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 400–1100 m. EC
marianae (L.Bolus) Schwantes
Mesembryanthemum marianae L.Bolus (12)
Perennial. Succulent. Ht up to 0.35 m. Alt 300–850 m. NC, WC
maritima (L.Bolus ex Toelken & Jessop) G.D.Rowley = **Amphibolia laevis**
mathewsii L.Bolus = **Antimima mucronata**
maxima (Haw.) L.Bolus
Astridia maxima (Haw.) Schwantes (12)
Mesembryanthemum maximum Haw. (12)
Perennial. Shrub, succulent. Ht up to 1.5 m. Alt 300–800 m. WC
maxwellii L.Bolus = **Antimima maxwellii**
menniei L.Bolus = **Antimima menniei**
mesklipensis L.Bolus = **Antimima mesklipensis**
meyerae Schwantes = **Antimima meyerae**
meyeri Schwantes = **Antimima papillata**
microphylla (Haw.) Schwantes = **Antimima microphylla**
middlemostii L.Bolus
Perennial. Shrub, succulent. Ht up to 0.4 m. Alt? NC
milleflora L.Bolus = **Eberlanzia dichotoma**
minutifolia L.Bolus = **Antimima minutifolia**
misera (L.Bolus) L.Bolus
Mesembryanthemum miserum L.Bolus (12)
Perennial. Shrub, succulent. Ht up to 0.37 m. Alt? 'SA'
modesta L.Bolus forma *glabrescens* L.Bolus = **Antimima modesta**
modesta L.Bolus forma *modesta* = **Antimima modesta**
mollis (A.Berger) Schwantes
Mesembryanthemum lene N.E.Br. (12)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Mesembryanthemum molle in sense of A.Berger, not of Aiton, illegitimate name (12)
Perennial. Shrub, succulent. Ht? Alt? 'SA'
montaguensis L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 850–1250 m. WC
monticola (Sond.) G.D.Rowley = **Ottosonderia monticola**
mucronata (Haw.) Schwantes = **Antimima mucronata**
muelleri (L.Bolus) Schwantes
Mesembryanthemum muelleri L.Bolus (13)
Perennial. Shrub, succulent. Ht up to 1.2 m. Alt 350–1200 m. N, NC
muiriana (L.Bolus) Schwantes
Mesembryanthemum muirianum L.Bolus (12)
Perennial. Succulent. Ht up to 0.25 m. Alt 700–1100 m. WC
multiflora (Haw.) Schwantes
Mesembryanthemum multiflorum Haw. (6)
Perennial. Shrub, succulent. Ht up to 1 m. Alt 250–850 m. WC
muricata L.Bolus
Mesembryanthemum pellanum N.E.Br. (12)
Perennial. Succulent. Ht? Alt 700–1100 m. N, NC
mutata G.D.Rowley = **Lampranthus mutatus**
mutica L.Bolus = **Antimima mutica**
namaquana L.Bolus = **Amphibolia rupis-arcuatae**
namaquana L.Bolus var. *quinqueflora* L.Bolus = **Eberlanzia ebracteata**
namusmontana Friedrich
Perennial. Succulent. Ht up to 0.35 m. Alt 450–1000 m. N
nana L.Bolus
Mesembryanthemum reductum N.E.Br. in part, illegitimate name (12)
Perennial. Succulent. Ht up to 0.04 m. Alt 750–1100 m. WC
neilii L.Bolus = **Stayneria neilii**
nelii Schwantes
Perennial. Succulent. Ht? Alt? 'SA'
neovirens Schwantes
Perennial. Succulent. Ht? Alt 50–175 m. EC
nieuwerustensis L.Bolus
Perennial. Succulent. Ht? Alt 350–590 m. WC
nobilis Schwantes = **Antimima nobilis**
nonimpressa L.Bolus
Perennial. Succulent. Ht? Alt 990–1500 m. EC
nordenstamii L.Bolus = **Antimima nordenstamii**
obtusa L.Bolus
Mesembryanthemum hebes N.E.Br. (12)
Perennial. Shrub, succulent. Ht up to 0.4 m. Alt up to 1200 m. NC
obtusifolia L.Bolus = **Antimima watermeyeri**
octojugis (L.Bolus) L.Bolus = **Octopoma octojuge**
octonaria (L.Bolus) G.D.Rowley = **Enarganthe octonaria**
odontocalyx (Schltr. & Diels) Schwantes
Mesembryanthemum odontocalyx Schltr. & Diels (12)
Perennial. Shrub, succulent. Ht? Alt 1000–1600 m. N
orientalis L.Bolus
Perennial. Succulent. Ht up to 0.35 m. Alt 700–950 m. EC
orsmondiae L.Bolus = **R. canonotata**
ottosonderi G.D.Rowley = **Ottosonderia monticola**
oviformis L.Bolus = **Antimima oviformis**
pakhuisensis L.Bolus = **Lampranthus pakpassensis**
pallens L.Bolus
Perennial. Succulent. Ht up to 0.6 m. Alt 20–175 m. NC
papillata L.Bolus = **Antimima papillata**
paripetala (L.Bolus) L.Bolus
Mesembryanthemum paripetalum L.Bolus (12)
Perennial. Succulent. Ht 0.3–0.6 m. Alt 20–175 m. NC
paripetala (L.Bolus) L.Bolus var. *occultans* L.Bolus = **Antimima perforata**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

parvibracteata L.Bolus = **Eberlanzia parvibracteata**
parviflora (Haw.) Schwantes
Mesembryanthemum parviflorum in sense of Haw., not of Jacq. (13)
Perennial. Shrub, succulent. Ht up to 0.9 m. Alt? 'SA'
parvifolia L.Bolus
Perennial. Shrub, succulent. Ht? Alt 800–1200 m. WC
patens L.Bolus
Mesembryanthemum diplosum N.E.Br. (12)
Perennial. Succulent. Ht up to 0.25 m. Alt 800–1400 m. WC
patulifolia L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 250–350 m. WC
pauciflora L.Bolus
Perennial. Succulent. Ht? Alt 800–1400 m. WC
paucifolia L.Bolus = **Antimima paucifolia**
paucipetala L.Bolus
Perennial. Shrub, succulent. Ht up to 0.24 m. Alt 980–1100 m. NC
pauper L.Bolus = **Antimima pauper**
peersii L.Bolus = **Antimima peersii**
perfoliata (Mill.) Schwantes
Mesembryanthemum perfoliatum Mill. (12)
Perennial. Shrub, succulent. Ht up to 0.6 m. Alt 800–1200 m. WC, EC
perforata L.Bolus = **Antimima perforata**
persistens L.Bolus = **R. intricata**
persistens L.Bolus (1963), not of L.Bolus (1932), illegitimate name = **Antimima persistens**
phylicoides L.Bolus
Mesembryanthemum phylicoides (L.Bolus) N.E.Br. (12)
Perennial. Shrub, succulent. Ht up to 0.15 m. Alt 100–330 m. NC
pillansii L.Bolus = **Eberlanzia schneideriana**
pilosula L.Bolus = **Antimima pilosula**
pinguis L.Bolus
Perennial. Succulent. Ht up to 0.1 m. Alt 900–1200 m. NC
piscodora L.Bolus = **Antimima piscodora**
polita L.Bolus = **Braunsia geminata**
pollardii Friedrich
Perennial. Shrub, succulent. Ht up to 0.3 m. Alt 250–980 m. N
primosii L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 1000–1200 m. NC
profunda L.Bolus = **Lampranthus profundus**
prolongata L.Bolus = **Antimima prolongata**
promontorii L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 120–175 m. WC
propinqua (N.E.Br.) Schwantes = **Antimima propinqua**
prostrata L.Bolus = **Antimima prostrata**
pulchella (Haw.) Schwantes (insufficiently known)
pulchella (Haw.) Schwantes var. *caespitosa* L.Bolus = **Antimima aristulata**
pulvinaris L.Bolus
Perennial. Succulent. Ht up to 0.07 m. Alt 1200–1800 m. EC
pumila L.Bolus = **Antimima pumila**
punctulata (L.Bolus) L.Bolus ex H.E.K.Hartmann
Lampranthus punctulatus (L.Bolus) L.Bolus (11)
Mesembryanthemum punctulatum L.Bolus (11)
R. unca (L.Bolus) L.Bolus var. *punctulata* (L.Bolus) L.Bolus (11)
Perennial. Succulent. Ht up to 0.1 m. Alt 800–1100 m. NC
pungens (A.Berger) H.Jacobsen
Mesembryanthemum pungens A.Berger (12)
Perennial. Succulent. Ht? Alt 170–800 m. EC
puniens L.Bolus = **R. intricata**
purpureostyla (L.Bolus) Bruyns = **Acrodon purpureostylus**
pusilla Schwantes = **Antimima pusilla**
putterillii (L.Bolus) L.Bolus

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht? Alt 1400–3000 m. FS, L, EC
pygmaea (Haw.) Schwantes = **Antimima pygmaea**
quadrisepala L.Bolus = **Octopoma quadrisepalum**
quarzitica (Dinter) Dinter & Schwantes = **Antimima quarzitica**
radicans L.Bolus
Perennial. Succulent. Ht? Alt 300–550 m. WC
rariflora L.Bolus
Perennial. Succulent. Ht? Alt 300–550 m. WC
recurva (Moench) H.E.K.Hartmann
Mesembryanthemum recurvum Moench (11)
Perennial. Succulent. Ht up to 0.35 m. Alt 120–350 m. EC
restituta G.D.Rowley = **Octopoma inclusum**
rigens L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 1200–1500 m. FS
rigida (Haw.) Schwantes
Mesembryanthemum rigidum Haw. (6)
Perennial. Succulent. Ht up to 0.4 m. Alt 50–250 m. WC
rigida L.Bolus, not of (Haw.) Schwantes = **R. bolusiae**
rigidicaulis (Haw.) Schwantes
Perennial. Succulent. Ht? Alt 300–550 m. WC?
robusta L.Bolus
Perennial. Succulent. Ht up to 0.5 m. Alt 700–1200 m. NC
roseola (N.E.Br.) Schwantes = **Antimima roseola**
rostella (Haw.) Schwantes
Mesembryanthemum rostellum Haw. (13)
Perennial. Succulent. Ht? Alt? 'SA'
rubra (L.Bolus) L.Bolus = **Astridia rubra**
rubricaulis (Haw.) L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 50–300 m. WC
rupicola (Engl.) Schwantes
Perennial. Succulent. Ht up to 0.7 m. Alt 50–1100 m. N
rupicola L.Bolus, illegitimate name = **Octopoma rupigenum**
rupigena L.Bolus = **Octopoma rupigenum**
rupis-arcuatae (Dinter) Friedrich = **Amphibolia rupis-arcuatae**
ruralis (N.E.Br.) Schwantes
Perennial. Succulent. Ht up to 0.15 m. Alt 1000–1400 m. NW
ruschiana (Dinter) Dinter & Schwantes
Perennial. Succulent. Ht up to 0.6 m. Alt 850–1000 m. N
sabulicola Dinter
Perennial. Succulent. Ht up to 0.3 m. Alt 800–1200 m. N
saginata L.Bolus = **Amphibolia saginata**
sandbergensis L.Bolus
Perennial. Succulent. Ht up to 0.16 m. Alt 600–800 m. NC
sarmentosa (Haw.) Schwantes
R. sarmentosa (Haw.) Schwantes var. *rigida* (Salm-Dyck) Schwantes (13)
Perennial. Succulent. Ht? Alt? WC
sarmentosa (Haw.) Schwantes var. *rigida* (Salm-Dyck) Schwantes = **R. sarmentosa**
saturata L.Bolus = **Antimima saturata**
saxicola L.Bolus = **Antimima saxicola**
scabra H.E.K.Hartmann
Perennial. Succulent. Ht up to 0.05 m. Alt 700–1300 m. NC
schlechteri Schwantes = **Antimima schlechteri**
schneideriana (A.Berger) L.Bolus = **Eberlanzia schneideriana**
schollii (Salm-Dyck) Schwantes
R. schollii (Salm-Dyck) Schwantes var. *caledonica* (L.Bolus) Schwantes (13)
Perennial. Succulent. Ht? Alt 400–650 m. WC
schollii (Salm-Dyck) Schwantes var. *caledonica* (L.Bolus) Schwantes = **R. schollii**
scopelogena G.D.Rowley = **Scopelogena verruculata**
sedoides (Dinter & A.Berger) Friedrich = **Eberlanzia sedoides**
semidentata (Haw.) Schwantes

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.25 m. Alt 550–900 m. WC
semiglobosa L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 150–250 m WC
senaria L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 190–650 m. NC
serrulata (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.15 m. Alt? WC
sessilis (Thunb.) H.E.K.Hartmann
Drosanthemum sessile (Thunb.) Schwantes (11)
Mesembryanthemum sessile Thunb. (11)
Perennial. Succulent. Ht? Alt 250–350 m. WC
simulans L.Bolus = **Antimima simulans**
singula L.Bolus
Perennial. Succulent. Ht? Alt? NC
sobrina (N.E.Br.) Schwantes = **Antimima sobrina**
socia (N.E.Br.) Schwantes = **Argyroderma fissum**
solida (L.Bolus) L.Bolus var. *solida* = **Antimima solida**
solida (L.Bolus) L.Bolus var. *stigmatosa* L.Bolus = **Antimima solida**
solitaria L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt 100–350 m. WC
spathulata L.Bolus = **Eberlanzia schneideriana**
sphaerophylla Dinter, naked name = **Eberlanzia schneideriana**
spinescens L.Bolus = **Arenifera spinescens**
spinosa (L.) Dehn
Eberlanzia aculeata (N.E.Br.) Schwantes (8)
Eberlanzia albertensis (L.Bolus) L.Bolus (8)
Eberlanzia globularis (L.Bolus) L.Bolus (8)
Eberlanzia hospitalis (Dinter) Schwantes (8)
Eberlanzia macroura (L.Bolus) L.Bolus (8)
Eberlanzia micrantha (Pax) Schwantes (8)
Eberlanzia mucronifera (Haw.) Schwantes (8)
Eberlanzia spinosa (L.) Schwantes (8)
Mesembryanthemum aculeatum N.E.Br. (8)
Mesembryanthemum hospitale Dinter (8)
Mesembryanthemum mucroniferum Haw. (8)
Mesembryanthemum spinosum L. (8)
Mesembryanthemum spinosum L. var. *micranthum* Pax (8)
R. albertensis L.Bolus (8)
R. globularis L.Bolus (8)
R. macroura L.Bolus (8)
Perennial. Succulent. Ht up to 0.35 m. Alt 250–1100 m. N, NC, WC, EC
staminodiosa L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 200–350 m. WC
stayneri L.Bolus = **Antimima stayneri**
stellata L.Bolus = **Antimima hantamensis**
stenopetala L.Bolus = **Antimima watermeyeri**
stenophylla (L.Bolus) L.Bolus = **Marlothistella stenophylla**
stokoei L.Bolus = **Antimima stokoei**
stricta L.Bolus
Perennial. Succulent. Ht up to 1 m. Alt up to 1200 m. NC
stricta L.Bolus var. *turgida* L.Bolus = **Amphibolia saginata**
strubeniae (L.Bolus) Schwantes
Perennial. Succulent. Ht up to 0.75 m. Alt 300–980 m. WC
stylosa L.Bolus = **Arenifera stylosa**
suaveolens L.Bolus
Perennial. Succulent. Ht up to 0.5 m. Alt 350–800 m. WC
subaphylla Friedrich = **R. abbreviata**
subglobosa L.Bolus = **Octopoma subglobosum**
subpaniculata L.Bolus
Perennial. Succulent. Ht? Alt 50–300 m. WC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

subsphaerica L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt 175–1200 m. NC
subteres L.Bolus
Perennial. Succulent. Ht? Alt 300–1200 m. WC
subtruncata L.Bolus var. *minor* L.Bolus = **Antimima subtruncata**
subtruncata L.Bolus var. *subtruncata* = **Antimima subtruncata**
succulenta L.Bolus = **Amphibolia succulenta**
tardissima L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt 600–900 m. NC, WC
tecta L.Bolus
Perennial. Succulent. Ht up to 0.57 m. Alt 250–370 m. WC
tenella (Haw.) Schwantes
Mesembryanthemum tenellum Haw. (6)
Perennial. Succulent. Ht up to 0.3 m. Alt 600–900 m. WC
testacea L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt 350–550 m. WC
tetrasepala L.Bolus = **Octopoma tetrasepalum**
thomae L.Bolus var. *microstigma* L.Bolus = **Esterhuysenia stokoei**
thomae L.Bolus var. *thomae* = **Esterhuysenia stokoei**
translucens L.Bolus = **Stoeberia beetzii**
tribracteata L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt up to 1200 m. NC
triflora L.Bolus
Perennial. Succulent. Ht up to 0.1 m. Alt 300–550 m. WC
triquetra L.Bolus = **Antimima triquetra**
truteri L.Bolus
Perennial. Succulent. Ht? Alt 700–1600 m. EC
tuberculosa L.Bolus = **Antimima tuberculosa**
tumidula (Haw.) Schwantes
Mesembryanthemum tumidulum Haw. (13)
Perennial. Succulent. Ht up to 0.6 m. Alt 170–450 m. WC
turneriana L.Bolus = **Antimima turneriana**
uitenhagensis (L.Bolus) Schwantes
Perennial. Succulent. Ht up to 0.35 m. Alt 120–450 m. EC
umbellata (L.) Schwantes
Mesembryanthemum umbellatum L. (13)
Perennial. Succulent. Ht 0.3–0.6 m. Alt 50–300 m. WC
unca (L.Bolus) L.Bolus = **Lampranthus uncus**
unca (L.Bolus) L.Bolus var. *punctulata* (L.Bolus) L.Bolus = **R. punctulata**
uncinata (L.) Schwantes
Perennial. Succulent. Ht up to 0.25 m. Alt? WC
unidens (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.16 m. Alt? 'CP'
utilis (L.Bolus) L.Bolus var. *giftbergensis* L.Bolus = **Stoeberia utilis**
utilis (L.Bolus) L.Bolus var. *utilis* = **Stoeberia utilis**
vaginata (Haw.) Schwantes
Mesembryanthemum vaginatum Haw. (6)
Perennial. Succulent. Ht up to 0.6 m. Alt? WC
valida Schwantes
Perennial. Succulent. Ht? Alt 350–700 m. NC
vanbredai L.Bolus
Perennial. Succulent. Ht up to 0.12 m. Alt 900–1200 m. EC
vanderbergiae L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 600–1200 m. EC
vanheerdei L.Bolus
Perennial. Succulent. Ht? Alt 100–420 m. NC
vanniekerkiae L.Bolus
Perennial. Succulent. Ht? Alt 500–950 m. WC
vanzylii L.Bolus = **Antimima vanzylii**
varians L.Bolus = **Antimima varians**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

velutina L.Bolus = **Eberlanzia schneideriana**
ventricosa (L.Bolus) Schwantes = **Antimima ventricosa**
verruculata (L.) G.D.Rowley = **Scopelogena verruculata**
verruculosa L.Bolus = **Antimima verrucosula**
versicolor L.Bolus
Perennial. Succulent. Ht? Alt 20–250 m. NC
vetovalida H.E.K.Hartmann
Perennial. Succulent. Ht? Alt? 'SA'
victoris (L.Bolus) L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 300–550 m. WC
villetii L.Bolus = **Antimima dualis**
virens L.Bolus
Perennial. Succulent. Ht? Alt ± 360 m. WC
virgata (Haw.) L.Bolus
Mesembryanthemum virgatum Haw. (13)
Antimima virgata (Haw.) Dehn (13)
Perennial. Succulent. Ht? Alt 900–1300 m. WC
viridifolia L.Bolus
Perennial. Succulent. Ht? Alt 800–1200 m. NC
vulnerans L.Bolus = **R. divaricata**
vulvaria (Dinter) Schwantes
Perennial. Succulent. Ht 0.3–0.4 m. Alt 900–1200 m. N
watermeyeri L.Bolus = **Antimima watermeyeri**
willdenowii Schwantes
Perennial. Succulent. Ht? Alt? 'CP'
wilmaniae (L.Bolus) L.Bolus var. *angustifolia* L.Bolus = **Ebracteola wilmaniae**
wilmaniae (L.Bolus) L.Bolus var. *vermeuleniae* (L.Bolus) L.Bolus = **Ebracteola wilmaniae**
wilmaniae (L.Bolus) L.Bolus var. *wilmaniae* = **Ebracteola wilmaniae**
wittebergensis (L.Bolus) Schwantes = **Antimima wittebergensis**

RUSCHIANTHEMUM Friedr. 2405106
gigas (Dinter) Friedrich = **Stoeberia gigas**

RUSCHIANTHUS L.Bolus 2405107
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 285, 286.
falcatus L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 1000–1590 m. N

SAPHESIA N.E.Br. 2405108
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 286.
flaccida (Jacq.) N.E.Br.
Perennial. Succulent. Ht up to 0.3 m. Alt 175–350 m. WC

SCELETIUM N.E.Br. 2405109
(1) Gerbaulet. 1996. *Botanische Jahrbücher* 118: 9–24.
(2) Gerbaulet. 1997. *Botanische Jahrbücher* 119: 145–211.
(3) Gerbaulet. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 287–290.
albanense L.Bolus = **S. crassicaule**
anatomicum (Haw.) L.Bolus = **S. emarcidum**
archeri L.Bolus = **S. rigidum**
boreale L.Bolus = **S. tortuosum**
compactum L.Bolus = **S. tortuosum**
concavum (Haw.) Schwantes = **S. tortuosum**
crassicaule (Haw.) L.Bolus
Mesembryanthemum crassicaule Haw. (1)
Pentacoilanthus crassicaulis (Haw.) Rappa & Camarrone, invalid name (1)
S. albanense L.Bolus (1)
Perennial. Succulent. Ht 0.15–0.25 m. Alt 50–950 m. WC, EC
dejagerae L.Bolus = **S. emarcidum**
emarcidum (Thunb.) L.Bolus ex H.Jacobsen
Mesembryanthemum anatomicum Haw. var. *anatomicum* (1)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Mesembryanthemum anatomicum Haw. var. *emarcidum* (Thunb.) DC. (1)
Mesembryanthemum anatomicum Haw. var. *fragile* Haw. (1)
Mesembryanthemum emarcidum Thunb. (1)
S. anatomicum (Haw.) L.Bolus (1)
S. dejagerae L.Bolus (1)
Tetracoilanthus anatomicus (Haw.) Rappa & Camarrone, invalid name (1)
Perennial. Succulent. Ht 0.1–0.15 m. Alt 700–1300 m. NC, WC, EC

exalatum Gerbaulet
Perennial. Succulent. Ht up to 0.15 m. Alt 700–1300 m. NC

expansum (L.) L.Bolus
Mesembryanthemum expansum L. (1)
Pentacoilanthus expansus (L.) Rappa & Camarrone, invalid name (1)
S. regium L.Bolus (1)
Perennial. Succulent. Ht up to 0.3 m. Alt 250–750 m. WC

framesii L.Bolus = **S. tortuosum**

gracile L.Bolus = **S. tortuosum**

joubertii L.Bolus = **S. tortuosum**

namaquense L.Bolus var. *namaquense* = **S. tortuosum**

namaquense L.Bolus var. *subglobosum* L.Bolus = **S. tortuosum**

ovatum L.Bolus = **S. tortuosum**

regium L.Bolus = **S. expansum**

rigidum L.Bolus
S. archeri L.Bolus (1)
Perennial. Succulent. Ht 0.1–0.2 m. Alt 550–950 m. WC

strictum L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 750–1100 m. WC

subvelutinum L.Bolus forma *luxurians* L.Bolus = **S. varians**

subvelutinum L.Bolus forma *subvelutinum* = **S. varians**

tortuosum (L.) N.E.Br.
Mesembryanthemum aridum Moench, illegitimate name (1)
Mesembryanthemum concavum Haw. (1)
Mesembryanthemum tortuosum L. (1)
Pentacoilanthus tortuosus (L.) Rappa & Camarrone, invalid name (1)
Phyllobolus tortuosus (L.) Bittrich (2)
S. boreale L.Bolus (1)
S. compactum L.Bolus (1)
S. concavum (Haw.) Schwantes (1)
S. framesii L.Bolus (1)
S. gracile L.Bolus (1)
S. joubertii L.Bolus (1)
S. namaquense L.Bolus var. *namaquense* (1)
S. namaquense L.Bolus var. *subglobosum* L.Bolus (1)
S. ovatum L.Bolus (1)
S. tugwelliae L.Bolus (1)
Tetracoilanthus concavus (Haw.) Rappa & Camarrone, invalid name (1)
Perennial. Succulent. Ht up to 0.2 m. Alt 500–950 m. NC, WC, EC

tugwelliae L.Bolus = **S. tortuosum**

varians (Haw.) Gerbaulet
Mesembryanthemum varians Haw. (1)
S. subvelutinum L.Bolus forma *luxurians* L.Bolus (1)
S. subvelutinum L.Bolus forma *subvelutinum* (1)
Perennial. Succulent. Ht up to 0.3 m. Alt 300–500 m. WC

SCHLECHTERANTHUS Schwantes 2405110
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 290, 291.

hallii L.Bolus
Perennial. Succulent. Ht up to 0.4 m. Alt 350–1200 m. NC

maximiliani Schwantes
Perennial. Succulent. Ht up to 0.3 m. Alt 350–1000 m. NC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

SCHONLANDIA L.Bolus 2405159
lehmannii (Eckl. & Zeyh.) L.Bolus = **Corpuscularia lehmannii**

SCHWANTESIA Dinter 2405111
(1) Zimmerman. 1996. *Cactus and Succulent Journal (US)* 68: 257–266.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 291–294.
acutipetala L.Bolus
Perennial. Succulent. Ht up to 0.2 m. Alt 800–1000 m. N, NC
australis L.Bolus = **S ruedebuschii**
borcherdsii L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 700–950 m. NC
constanceae N.Zimm.
Perennial. Succulent. Ht up to 0.2 m. Alt 800–980 m. N
herrei L.Bolus
S. herrei L.Bolus var. *herrei* forma *major* G.D.Rowley (2)
S. herrei L.Bolus var. *minor* L.Bolus (2)
Perennial. Succulent. Ht up to 0.2 m. Alt 650–980 m. NC
herrei L.Bolus var. *herrei* forma *major* G.D.Rowley = **S. herrei**
herrei L.Bolus var. *minor* L.Bolus = **S. herrei**
loeschiana Tischer
Perennial. Succulent. Ht up to 0.2 m. Alt 10–150 m. N
marlothii L.Bolus
Perennial. Succulent. Ht up to 0.25 m. Alt 450–650 m. NC
pillansii L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 700–1050 m. NC
ruedebuschii Dinter
S. australis L.Bolus (2)
Perennial. Succulent. Ht 0.1–0.3 m. Alt 900–1150 m. N, NC
speciosa L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 540–780 m. NC
succumbens (Dinter) Dinter in H.Jacobsen
Perennial. Succulent. Ht up to 0.2 m. Alt 800–1050 m. N
triebneri L.Bolus
Perennial. Succulent. Ht up to 0.15 m. Alt 1000–1160 m. NC

SCOPELOGENA L.Bolus 2405112
(1) Klak. 2000. *Bothalia* 30: 35–42.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 294, 295.
bruynsii Klak
Perennial. Shrub. Ht 0.3–0.6 m. Alt 800–2000 m. NC, WC
gracilis L.Bolus = **S. verruculata**
verruculata (L.) L.Bolus
Lampranthus verruculatus (L.) L.Bolus (1)
Mesembryanthemum verruculatum L. (1)
Ruschia scopelogena G.D.Rowley (1)
Ruschia verruculata (L.) G.D.Rowley (1)
S. gracilis L.Bolus (1)
Perennial. Shrub. Ht 0.3–0.6 m. Alt 100–1000 m. WC

SEMNANTHE N.E.Br. 2405113
lacera (Haw.) N.E.Br. var. *densipetala* L.Bolus = **Erepsia lacera**
lacera (Haw.) N.E.Br. var. *lacera* = **Erepsia lacera**

SINEOPERCULUM Van Jaarsv. 2405128
rourkei (L.Bolus) Van Jaarsv. = **Dorotheanthus rourkei**

SKIATOPHYTUM L.Bolus 2405114
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 301.
tripolium (L.) L.Bolus
Annual. Succulent. Ht up to 0.25 m. Alt 100–600 m. WC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

SMICROSTIGMA N.E.Br. 2405115
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 270.
(2) Hartmann. 1999. *Bradleya* 17: 38–74.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 302.
viride (Haw.) N.E.Br.
Erepsia viridis L.Bolus (3)
Ruschia integra Schwantes (2)
Perennial. Succulent. Ht up to 0.6 m. Alt 250–1300 m. WC

SPHALMANTHUS N.E.Br. 2405116
abbreviatus (L.Bolus) L.Bolus, invalid name = **Phyllobolus abbreviatus**
acocksii L.Bolus = **Phyllobolus saturatus**
acuminatus (Haw.) L.Bolus = **Phyllobolus splendens** subsp. **splendens**
albertensis (L.Bolus) L.Bolus, invalid name = **Phyllobolus pumilus**
albicaulis (Haw.) L.Bolus = **Phyllobolus splendens** subsp. **splendens**
anguineus (L.Bolus) L.Bolus, invalid name = **Phyllobolus oculatus**
arenicolus (L.Bolus) L.Bolus, invalid name = **Phyllobolus oculatus**
auratus (Sond.) L.Bolus, invalid name = **Phyllobolus nitidus**
baylissii L.Bolus = **Phyllobolus saturatus**
bijliae (N.E.Br.) L.Bolus = **Phyllobolus splendens** subsp. **splendens**
blandus (L.Bolus) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **splendens**
brevisepalus (L.Bolus) L.Bolus var. *brevisepalus*, invalid name = **Phyllobolus spinuliferus**
calycinus L.Bolus = **Phyllobolus canaliculatus**
canaliculatus (Haw.) N.E.Br. = **Phyllobolus canaliculatus**
carneus (Haw.) N.E.Br. = **Phyllobolus spinuliferus**
caudatus (L.Bolus) N.E.Br. = **Phyllobolus caudatus**
celans (L.Bolus) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **splendens**
commutatus (A.Berger) N.E.Br. = **Phyllobolus grossus**
congestus (L.Bolus) L.Bolus, invalid name = **Phyllobolus congestus**
constrictus (L.Bolus) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **splendens**
crassus L.Bolus = **Phyllobolus prasinus**
deciduus (L.Bolus) L.Bolus = **Phyllobolus deciduus**
decurvatus (L.Bolus) L.Bolus, invalid name = **Phyllobolus decurvatus**
decussatus (Thunb.) L.Bolus = **Aptenia geniculiflora**
defoliatus (Haw.) L.Bolus = **Aridaria noctiflora** subsp. **defoliata**
delus (L.Bolus) L.Bolus, invalid name = **Phyllobolus delus**
dinteri (L.Bolus) L.Bolus, invalid name = **Phyllobolus melanospermus**
dyeri (L.Bolus) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **splendens**
englishiae (L.Bolus) L.Bolus, invalid name = **Prenia englishiae**
flexuosus (Haw.) L.Bolus = **Phyllobolus splendens** subsp. **splendens**
fourcadei (L.Bolus) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **splendens**
fragilis N.E.Br. = **Phyllobolus oculatus**
framesii (L.Bolus) L.Bolus, invalid name = **Phyllobolus spinuliferus**
geniculiflorus (L.) L.Bolus = **Aptenia geniculiflora**
glanduliferus (L.Bolus) L.Bolus, invalid name = **Phyllobolus sinuosus**
godmaniae (L.Bolus) L.Bolus, invalid name = **Phyllobolus sinuosus**
gratiae (L.Bolus) L.Bolus, invalid name = **Phyllobolus grossus**
grossus (Aiton) N.E.Br. = **Phyllobolus grossus**
gydouwensis L.Bolus = **Phyllobolus grossus**
hallii L.Bolus = **Phyllobolus delus**
herbertii N.E.Br. = **Phyllobolus herbertii**
herrei L.Bolus = **Phyllobolus prasinus**
humilis L.Bolus = **Phyllobolus herbertii**
latipetalus (L.Bolus) L.Bolus, invalid name = **Phyllobolus latipetalus**
laxipetalus (L.Bolus) L.Bolus, invalid name = **Phyllobolus grossus**
laxus (L.Bolus) N.E.Br. = **Phyllobolus decurvatus**
leipoldtii L.Bolus = **Phyllobolus grossus**
leptopetalus (L.Bolus) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **splendens**
lignescens L.Bolus = **Phyllobolus lignescens**
ligneus (L.Bolus) L.Bolus, invalid name = **Phyllobolus melanospermus**
littlewoodii L.Bolus = **Phyllobolus nitidus**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

longipapillatus L.Bolus = **Phyllobolus oculatus**
longispinulus (Haw.) N.E.Br. = **Phyllobolus grossus**
longitubus (L.Bolus) L.Bolus, invalid name = **Phyllobolus tenuiflorus**
macrosiphon (L.Bolus) L.Bolus, invalid name = **Phyllobolus tenuiflorus**
melanospermus Dinter & Schwantes = **Phyllobolus melanospermus**
micans L.Bolus = **Phyllobolus resurgens**
nanus L.Bolus = **Phyllobolus tenuiflorus**
nitidus (Haw.) L.Bolus, invalid name = **Phyllobolus nitidus**
nothus (N.E.Br.) Schwantes = **Phyllobolus splendens** subsp. **splendens**
obtusus (L.Bolus) L.Bolus, invalid name = **Phyllobolus decurvatus**
oculatus (N.E.Br.) N.E.Br. = **Phyllobolus oculatus**
olivaceus (Schltr. & A.Berger) L.Bolus = **Phyllobolus tenuiflorus**
oubergensis (L.Bolus) L.Bolus, invalid name = **Phyllobolus pumilus**
pentagonus (L.Bolus) L.Bolus var. *occidentalis* (L.Bolus) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **pentagonus**
pentagonus (L.Bolus) L.Bolus var. *pentagonus*, invalid name = **Phyllobolus splendens** subsp. **pentagonus**
platysepalus (L.Bolus) L.Bolus, invalid name = **Phyllobolus grossus**
plenifolius (N.E.Br.) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **splendens**
pomonae (L.Bolus) L.Bolus, invalid name = **Phyllobolus oculatus**
praecox L.Bolus = **Phyllobolus sinuosus**
prasinus (L.Bolus) L.Bolus, invalid name = **Phyllobolus prasinus**
primulinus (L.Bolus) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **splendens**
pumulis (L.Bolus) L.Bolus, invalid name = **Phyllobolus pumilus**
quarternus (L.Bolus) L.Bolus, invalid name = **Phyllobolus spinuliferus**
quarziticus (L.Bolus) L.Bolus, invalid name = **Phyllobolus quartziticus**
rabiei (L.Bolus) N.E.Br. = **Phyllobolus rabiei**
rabiesbergensis (L.Bolus) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **splendens**
radicans (L.Bolus) L.Bolus, invalid name = **Prenia radicans**
recurvus (L.Bolus) L.Bolus, invalid name = **Phyllobolus sinuosus**
reflexus (Haw.) L.Bolus = **Phyllobolus splendens** subsp. **splendens**
rejuvenalis L.Bolus = **Phyllobolus spinuliferus**
resurgens (Kensit) L.Bolus = **Phyllobolus resurgens**
rhodandrus (L.Bolus) L.Bolus, invalid name = **Phyllobolus nitidus**
roseus (L.Bolus) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **splendens**
salmoneus (Haw.) N.E.Br. = **Phyllobolus canaliculatus**
saturatus (L.Bolus) L.Bolus, invalid name = **Phyllobolus saturatus**
scintillans (Dinter) Dinter & Schwantes = **Phyllobolus oculatus**
sinuosus (L.Bolus) L.Bolus, invalid name = **Phyllobolus sinuosus**
spinuliferus (Haw.) L.Bolus = **Phyllobolus spinuliferus**
splendens (L.) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **splendens**
stayneri L.Bolus = **Phyllobolus delus**
straminicolor (L.Bolus) L.Bolus, invalid name = **Phyllobolus sinuosus**
striatus (L.Bolus) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **splendens**
strictus (L.Bolus) L.Bolus, invalid name = **Phyllobolus spinuliferus**
suaveolens (L.Bolus) H.Jacobsen = **Phyllobolus lignescens**
subaequans (L.Bolus) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **pentagonus**
subpatens (L.Bolus) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **pentagonus**
subpetiolatus (L.Bolus) L.Bolus = **Phyllobolus grossus**
suffusus (L.Bolus) L.Bolus, invalid name = **Prenia tetragona**
sulcatus (Haw.) L.Bolus = **Phyllobolus splendens** subsp. **splendens**
tenuiflorus (Jacq.) N.E.Br. = **Phyllobolus tenuiflorus**
tetragonus (Thunb.) L.Bolus, invalid name = **Prenia tetragona**
tetramerus (L.Bolus) L.Bolus var. *parviflorus* (L.Bolus) L.Bolus, invalid name = **Phyllobolus trichotomus**
tetramerus (L.Bolus) L.Bolus var. *tetramerus*, invalid name = **Phyllobolus trichotomus**
trichotomus (Thunb.) L.Bolus, invalid name = **Phyllobolus trichotomus**
umbelliflorus (Jacq.) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **splendens**
vanheerdei L.Bolus = **Phyllobolus roseus**
varians (L.Bolus) L.Bolus = **Phyllobolus oculatus**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

vernalis (L.Bolus) L.Bolus, invalid name = **Phyllobolus splendens** subsp. **splendens**
viridiflorus (Aiton) N.E.Br. = **Phyllobolus viridiflorus**
watermeyeri (L.Bolus) L.Bolus, invalid name = **Phyllobolus spinuliferus**
willowmorensis (L.Bolus) L.Bolus, invalid name = **Phyllobolus grossus**

STAYNERIA L.Bolus 2405117
(1) Hartmann. 1999. *Bradleya* 17: 38–74.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 304.
neilii (L.Bolus) L.Bolus
Ruschia neilii L.Bolus (1)
Perennial. Succulent. Ht up to 1.5 m. Alt 300–700 m. WC

STOEBERIA Dinter & Schwantes 2405118
(1) Van Jaarsveld. 1994. *Aloe* 31: 68–76.
(2) Hartmann. 1996. *Bradleya* 14: 29–56.
(3) Hartmann. 1999. *Bradleya* 17: 38–74.
(4) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 305–308.
(5) Chesselet. 2002. *Bothalia* 32: 187–190.
apetala L.Bolus = **S. beetzii**
arborea Van Jaarsv.
S. porphyrea H.E.K.Hartmann (1)
Perennial. Succulent tree. Ht 2–3.5 m. Alt 50–1000 m. N, NC, WC
beetzii (Dinter) Dinter & Schwantes
Mesembryanthemum beetzii Dinter (4)
Ruschia bicolorata L.Bolus (3)
Ruschia translucens L.Bolus (5)
S. apetala L.Bolus (1)
S. beetzii (Dinter) Dinter & Schwantes var. *arborescens* Friedrich (1)
Perennial. Succulent. Ht 0.4–0.6 m. Alt 20–150 m. N, NC
beetzii (Dinter) Dinter & Schwantes var. *arborescens* Friedrich = **S. beetzii**
carpii Friedrich
Jensenobotrya vanheerdei L.Bolus (1)
Perennial. Succulent. Ht up to 1.5 m. Alt 50–850 m. N, NC
frutescens (L.Bolus) Van Jaarsv.
Mesembryanthemum frutescens L.Bolus (1)
Ruschia frutescens (L.Bolus) L.Bolus (1)
Perennial. Succulent. Ht up to 2.5 m. Alt 300–1300 m. N, NC, WC
gigas (Dinter) Dinter & Schwantes
Mesembryanthemum gigas Dinter (5)
Ruschianthemum gigas (Dinter) Friedrich (5)
Perennial. Succulent. Ht 0.4–0.6 m. Alt 150–600 m. N, NC
hallii L.Bolus = **Lampranthus amphibolius**
littlewoodii L.Bolus = **Lampranthus mutatus**
porphyrea H.E.K.Hartmann = **S. arborea**
rupis-arcuatae (Dinter) Dinter & Schwantes = **Amphibolia rupis-arcuatae**
utilis (L.Bolus) Van Jaarsv.
Mesembryanthemum utile L.Bolus (1)
Ruschia utilis (L.Bolus) L.Bolus var. *giftbergensis* L.Bolus (4)
Ruschia utilis (L.Bolus) L.Bolus var. *utilis* (1)
Perennial. Succulent. Ht up to 2 m. Alt 50–1000 m. N, NC, WC

STOMATIUM Schwantes 2405119
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 265.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 308–314.
acutifolium L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 800–1000 m. WC
agninum (Haw.) Schwantes
S. agninum (Haw.) Schwantes var. *integrifolium* (Salm-Dyck) Volk (2)
Perennial. Succulent. Ht up to 0.04 m. Alt 900–1500 m. EC
agninum (Haw.) Schwantes var. *integrifolium* (Salm-Dyck) Volk = **S. agninum**
alboroseum L.Bolus
S. niveum L.Bolus (2)

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.03 m. Alt 200–1150 m. NC, WC
angustifolium L.Bolus
Perennial. Succulent. Ht up to 0.02 m. Alt 900–1300 m. WC, EC
beaufortense L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 800–1100 m. WC
bolusiae Schwantes
Perennial. Succulent. Ht up to 0.02 m. Alt 1200–1500 m. FS, EC
braunsii L.Bolus
Perennial. Succulent. Ht? Alt? WC
bryantii L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 980–1300 m. NC
deficiens L.Bolus
Perennial. Succulent. Ht up to 0.02 m. Alt 990–1400 m. EC
difforme L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 800–1100 m. WC
duthiae L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 1150–1900 m. EC
ermininum (Haw.) Schwantes
Perennial. Succulent. Ht? Alt? 'CP'
fulleri L.Bolus
Perennial. Succulent. Ht up to 0.02 m. Alt 950–1050 m. NC
geoffreyi L.Bolus
Perennial. Succulent. Ht up to 0.02 m. Alt ± 2700 m. EC
gerstneri L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 1700–2200 m. EC
grandidens L.Bolus
Perennial. Succulent. Ht? Alt? 'CP'
integrum L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 1600–1800 m. EC
jamesii L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 900–1500 m. EC
latifolium L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 1190–1280 m. NC
lesliei (Schwantes) Volk
Perennial. Succulent. Ht? Alt? 'CP'
leve L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 900–1500 m. EC
loganii L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 800–1100 m. WC
meyeri L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 560–880 m. NC
middelburgense L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 1150–1900 m. EC
murinum (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.04 m. Alt 1300–1500 m. NC
musculinum Schwantes = **Chasmatophyllum musculinum**
mustelinum (Salm-Dyck) Schwantes
S. pyrodorum (Diels) L.Bolus (2)
Perennial. Succulent. Ht up to 0.04 m. Alt 900–1200 m. NC
niveum L.Bolus = **S. alboroseum**
patulum H.Jacobsen
Perennial. Succulent. Ht? Alt? 'CP'
paucidens L.Bolus
Perennial. Succulent. Ht? Alt? 'CP'
peersii L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 1200–1500 m. NC
pluridens L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt 900–1100 m. NC
pyrodorum (Diels) L.Bolus = **S. mustelinum**
resedolens L.Bolus

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Perennial. Succulent. Ht up to 0.03 m. Alt 1500–1750 m. NC
ronaldii L.Bolus
Perennial. Succulent. Ht up to 0.02 m. Alt 1400–1800 m. EC
rouxii L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 1250–1750 m. NC
ryderae L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 1400–1800 m. EC
suaveolens Schwantes
Perennial. Succulent. Ht up to 0.03 m. Alt 1200–1750 m. NC
suricatinum L.Bolus
Perennial. Succulent. Ht up to 0.05 m. Alt 800–1100 m. WC
trifarium L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 1300–1700 m. NC
villetii L.Bolus
Perennial. Succulent. Ht up to 0.03 m. Alt 800–1100 m. WC
viride L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 800–1100 m. WC

SYNAPTOPHYLLUM N.E.Br. 2405120
(1) Gerbaulet. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 314.
juttae (Dinter & A.Berger) N.E.Br.
Annual. Succulent. Ht up to 0.25 m. Alt 50–500 m. N
sladenianum (L.Bolus) N.E.Br. = **Prenia sladeniana**

TANQUANA H.E.K.Hartmann & Liede 2405160
(1) Hartmann & Liede. 1986. *Botanische Jahrbücher* 106: 433–485.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 315.
archeri (L.Bolus) H.E.K.Hartmann & Liede
Pleiospilos archeri L.Bolus (1)
Pleiospilos clavatus L.Bolus (1)
Pleiospilos loganii L.Bolus (1)
Perennial. Succulent. Ht up to 0.03 m. Alt 300–600 m. WC
hilmarii (L.Bolus) H.E.K.Hartmann & Liede
Pleiospilos hilmarii L.Bolus (1)
Perennial. Succulent. Ht up to 0.04 m. Alt 300–600 m. WC
prismatica (Schwantes) H.E.K.Hartmann & Liede
Mesembryanthemum prismaticum Marloth ex Schwantes (1)
Mesembryanthemum roodiae N.E.Br. (1)
Pleiospilos prismaticus (Schwantes) Schwantes (1)
Pleiospilos roodiae (N.E.Br.) Schwantes (1)
Punctillaria roodiae N.E.Br. (2)
Perennial. Succulent. Ht up to 0.05 m. Alt 300–600 m. WC

TETRACOILANTHUS Rappa & Camarrone 2405182
anatomicus (Haw.) Rappa & Camarrone, invalid name = **Sceletium emarcidum**
concavus (Haw.) Rappa & Camarrone, invalid name = **Sceletium tortuosum**

TITANOPSIS Schwantes 2405121
(1) Hammer. 1990. *Aloe* 27: 10–13.
(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 328–330.
calcarea (Marloth) Schwantes
T. fulleri Tischer (2)
Perennial. Succulent. Ht up to 0.04 m. Alt 850–1600 m. NW, FS, NC
fulleri Tischer = **T. calcarea**
hugo-schlechteri (Tischer) Dinter & Schwantes
T. hugo-schlechteri (Tischer) Dinter & Schwantes var. *alboviridis* Dinter (2)
Perennial. Succulent. Ht up to 0.3 m. Alt 550–1100 m. Distr.?
hugo-schlechteri (Tischer) Dinter & Schwantes var. *alboviridis* Dinter = **T. hugo-schlechteri**
luckhoffii L.Bolus = **Aloinopsis luckhoffii**
luederitzii Tischer = **T. schwantesii**
primosii L.Bolus = **T. schwantesii**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

schwantesii (Dinter) Schwantes
T. luederitzii Tischer (2)
T. primosii L.Bolus (2)
Perennial. Succulent. Ht up to 0.04 m. Alt 100–1000 m. N

TRICHOCYCLUS N.E.Br. 2405203
ciliatus N.E.Br. = **Brownanthus ciliatus** subsp. **ciliatus**
pubescens N.E.Br. ex C.A.Maass = **Brownanthus pubescens**

TRICHODIADEMA Schwantes 2405122
(1) Bolus. 1962. *The Flowering Plants of Africa* 35: t. 1367.
(2) Niesler. 1997. *Bradleya* 15: 13–27.
(3) Niesler. 2001. In Hartmann, *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 338–349.
attonsum (L.Bolus) Schwantes
Perennial. Succulent. Ht 0.1–0.15 m. Alt 300–1200 m. WC
aureum L.Bolus
Perennial. Succulent. Ht 0.12–0.13 m. Alt 890–1400 m. EC
barbatum (L.) Schwantes
T. stellatum (Mill.) Schwantes (2)
T. stelligerum (Haw.) Schwantes (2)
Perennial. Succulent. Ht up to 0.15 m. Alt 250–1500 m. EC
bulbosum (Haw.) Schwantes
Perennial. Succulent. Ht up to 0.2 m. Alt 50–850 m. EC
burgeri L.Bolus
Perennial. Succulent. Ht 0.02–0.06 m. Alt 400–950 m. WC
calvatum L.Bolus
Perennial. Succulent. Ht 0.09–0.13 m. Alt 200–530 m. WC
concinnum L.Bolus
Perennial. Succulent. Ht 0.035–0.13 m. Alt 100–300 m. EC
decorum (N.E.Br.) Stearn ex H.Jacobsen
Perennial. Succulent. Ht ± 0.18 m. Alt 250–816 m. EC
densum (Haw.) Schwantes
Perennial. Succulent. Ht ± 0.15 m. Alt 900–1400 m. EC
echinatum L.Bolus = **Delosperma echinatum**
emarginatum L.Bolus
Perennial. Succulent. Ht ± 0.035 m. Alt? 'CP'
fergusoniae L.Bolus
Perennial. Succulent. Ht ± 0.03 m. Alt 160–300 m. WC
fourcadei L.Bolus
Perennial. Succulent. Ht 0.08–0.11 m. Alt 50–400 m. EC
gracile L.Bolus
T. gracile L.Bolus var. *piliferum* L.Bolus (3)
T. gracile L.Bolus var. *setiferum* L.Bolus (3)
Perennial. Succulent. Ht up to 0.2 m. Alt 150–350 m. WC
gracile L.Bolus var. *piliferum* L.Bolus = **T. gracile**
gracile L.Bolus var. *setiferum* L.Bolus = **T. gracile**
hallii L.Bolus
Perennial. Succulent. Ht up to 0.06 m. Alt 560–1020 m. WC
hirsutum (Haw.) Stearn
Perennial. Succulent. Ht? Alt? 'CP'
imitans L.Bolus
Perennial. Succulent. Ht up to 0.33 m. Alt? 'CP'
inornatum L.Bolus = **Drosanthemum inornatum**
intonsum (Haw.) Schwantes
Perennial. Succulent. Ht 0.05–0.15 m. Alt 20–150 m. EC
introrsum (Haw. ex Hook.f.) Niesler
Perennial. Succulent. Ht up to 0.25 m. Alt 50–170 m. EC
littlewoodii L.Bolus
T. littlewoodii L.Bolus forma *alba* L.Bolus (3)
Perennial. Succulent. Ht 0.19–0.25 m. Alt 890–1050 m. N, NC
littlewoodii L.Bolus forma *alba* L.Bolus = **T. littlewoodii**

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

marlothii L.Bolus
Perennial. Succulent. Ht up to 0.04 m. Alt 190–380 m. WC
mirabile (N.E.Br.) Schwantes
T. mirabile (N.E.Br.) Schwantes var. *leptum* L.Bolus (3)
Perennial. Succulent. Ht 0.025–0.08 m. Alt 750–1200 m. WC
mirabile (N.E.Br.) Schwantes var. *leptum* L.Bolus = **T. mirabile**
obliquum L.Bolus
Perennial. Succulent. Ht up to 0.11 m. Alt 800–1500 m. WC
occidentale L.Bolus
Perennial. Succulent. Ht up to 0.022 m. Alt 50–365 m. WC
olivaceum L.Bolus
Perennial. Succulent. Ht up to 0.11 m. Alt 100–930 m. EC
orientale L.Bolus
Perennial. Succulent. Ht 0.065–0.1 m. Alt 50–1200 m. EC
peersii L.Bolus
Perennial. Succulent. Ht 0.07–0.09 m. Alt 800–1400 m. EC
pomeridianum L.Bolus
Perennial. Succulent. Ht up to 0.3 m. Alt up to 1250 m. N, NW, FS, NC, WC, EC
pygmaeum L.Bolus
Perennial. Succulent. Ht 0.01–0.03 m. Alt 20–250 m. WC
rogersiae L.Bolus
Perennial. Succulent. Ht up to 0.11 m. Alt 900–1650 m. EC
rupicola L.Bolus
Perennial. Succulent. Ht up to 0.28 m. Alt 30–500 m. EC
ryderae L.Bolus
Perennial. Succulent. Ht up to 0.08 m. Alt 600–1400 m. EC
setuliferum (N.E.Br.) Schwantes
T. setuliferum (N.E.Br.) Schwantes var. *niveum* L.Bolus (3)
Perennial. Succulent. Ht up to 0.23 m. Alt 150–1100 m. EC
setuliferum (N.E.Br.) Schwantes var. *niveum* L.Bolus = **T. setuliferum**
stayneri L.Bolus
Perennial. Succulent. Ht 0.04–0.06 m. Alt 50–500 m. EC
stellatum (Mill.) Schwantes = **T. barbatum**
stelligerum (Haw.) Schwantes = **T. barbatum**
strumosum (Haw.) L.Bolus
Perennial. Succulent. Ht up to 0.05 m. Alt? 'CP'
tenue L.Bolus = **Delosperma neethlingiae**

VANHEERDEA L.Bolus ex H.E.K.Hartmann 2405123
(1) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 347, 348.
angusta (L.Bolus) L.Bolus = **V. roodiae**
divergens (L.Bolus) L.Bolus = **V. roodiae**
primosii (L.Bolus) L.Bolus ex H.E.K.Hartmann
Perennial. Succulent. Ht ± 0.03 m. Alt 900–1000 m. NC
roodiae (N.E.Br.) L.Bolus ex H.E.K.Hartmann
V. angusta (L.Bolus) L.Bolus (1)
V. divergens (L.Bolus) L.Bolus (1)
Perennial. Succulent. Ht up to 0.6 m, when in flower. Alt 800–1100 m. NC

VANZIJLIA L.Bolus 2405124
(1) Phillips. 1927. *The Flowering Plants of South Africa* 7: t. 262.
(2) Hartmann. 1983. *Botanische Jahrbücher* 103: 499–538.
(3) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 348, 349.
angustipetala (L.Bolus) N.E.Br. = **V. annulata**
annulata (A.Berger) L.Bolus
V. angustipetala (L.Bolus) N.E.Br. (2)
Perennial. Succulent. Ht up to 0.4 m. Alt 20–350 m. NC, WC
rostella L.Bolus = **Cephalophyllum rostellum**

VLOKIA S.A.Hammer 2405185
(1) Hammer. 1994. *Cactus and Succulent Journal (US)* 66: 256.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 350.

ater S.A.Hammer

Perennial. Succulent. Ht ± 0.15 m. Alt 1200–1350 m. WC

WOOLEYA L.Bolus 2405125

(1) Bolus. 1960. *Journal of South African Botany* 27: 47–63.

(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 351.

farinosa (L.Bolus) L.Bolus

Perennial. Succulent. Ht ± 0.7 m. Alt up to 100 m. NC

ZEUKTOPHYLLUM N.E.Br. 2405126

(1) Hartmann. 1998. *Bradleya* 16: 44–91.

(2) Hartmann. 2001. *Illustrated handbook of succulent plants. Aizoaceae, F–Z*: 354.

calycinum (L.Bolus) H.E.K.Hartmann

Mesembryanthemum separatum N.E.Br. (1)

Octopoma calycinum (L.Bolus) L.Bolus (1)

Ruschia calycina L.Bolus (1)

Perennial. Succulent. Ht up to 0.09 m. Alt 700–850 m. WC

suppositum (L.Bolus) N.E.Br.

Mesembryanthemum suppositum L.Bolus (1)

Perennial. Succulent. Ht ± 0.2 m. Alt 550–850 m. WC

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 7

Chesselet, P. & Smith, G.F. 2002. The rediscovery of Ruschia acutangula (Haw.) Schwantes (Mesembryanthemaceae Fenzl). *Bradleya* 20: 17–22.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Bradleya 20/2002
pages 17 – 22

The rediscovery of *Ruschia acutangula* (Haw.) Schwantes (Mesembryanthemaceae Fenzl)

Pascale Chesselet[1] *and Gideon F. Smith*[2]

[1] Compton Herbarium, National Botanical Institute, Private Bag X7, Claremont 7735, South Africa (email: chesselet@nbict.nbi.ac.za).

[2] Office of the Research Director, National Botanical Institute, Private Bag X101, Pretoria 0001, South Africa (email: gfs@nbipre.nbi.ac.za).

Summary: The shrubby mesemb species, *Ruschia acutangula* (Haw.) Schwantes, was recently rediscovered on the foothills of Jonaskop between Villiersdorp and McGregor, in the Western Cape Province of South Africa. The species has been lost to science for a long time, possibly since its first discovery more than 175 years ago. An emended description and its known distribution are provided here. The conservation status of *R. acutangula* is uncertain, and the species is probably threatened due to loss of habitat to farmlands and other developments.

Zusammenfassung: Die strauchige Mittagsblumenart *Ruschia acutangula* (Haw.) Schwantes wurde kürzlich in den Vorbergen des Jonaskop zwischen Villiersdorp und McGregor in der Western Cape Province der Republik Südafrika wieder entdeckt. Die Art war für die Wissenschaft lange Zeit verschollen, möglicherweise seit der ersten Entdeckung vor über 175 Jahren. Hier werden eine vervollständigte Beschreibung veröffentlicht und Angaben über die Verbreitung gemacht. Der naturschutzmässige Gefährdungsgrad von *R. acutangula* ist unbekannt, und die Art ist vermutlich durch Standortverlust wegen landwirtschaftlichen und anderen Entwicklungen gefährdet.

Introduction

The botanically famous mountain peak Jonaskop, which reaches 1,646 m in altitude, forms part of the Riviersonderendberge in the Western Cape Province, South Africa, halfway between the towns of Villiersdorp and McGregor (Figure 1). With a restricted-access road to its summit, botanists know Jonaskop as an easily accessible altitudinal gradient (Rutherford, 1978) of vegetation from Succulent Karoo, through Renosterveld to Arid Fynbos and Afromontane vegetation at the summit. The site received international attention in the late 1970s and early 1980s for research on mammal (rodent) pollination of *Protea* species (Rourke & Wiens, 1978; Wiens *et al.*, 1983).

As a result of the natural history significance and under-collected status of many of the mountain peaks and ranges in southern Africa, various botanical aspects of the Anysberg and Touwsberg on the northwestern periphery of the Little Karoo in the southern Cape interior (Van Wyk & Smith, 2001: p.59, Map 10) and the Blouberg at the western extreme of the Soutpansberg in the Northern Province of South Africa (Van Wyk & Smith, 2001: p. 135, Map 21), for example, received detailed attention in 1990 and 1992 respectively, as part of the Plant Systematics Stimulation Programme of South Africa's then Foundation for Research Development (see items 22 and 23 in Table 1 in Smith *et al.* 1996). Part of further survey work resulting from field investigations carried out on the Klein Swartberg near the Little Karoo was published in a commemorative issue of *Opera botanica*, volume 121, 1993, which honoured Prof. Olov Hedberg of Sweden, who contributed much to our knowledge of African montane flora and vegetation. Numerous other small and large, under-explored southern African mountain ranges, such as Jonaskop, warrant similar comprehensive study.

This paper reports on the unexpected rediscovery of the little-known *Ruschia acutangula* (Haw.) Schwantes on the foothills of Jonaskop.

The rediscovery of *Ruschia acutangula*

Although the foothills of Jonaskop are cultivated with wheatlands and vineyards, tall and conspic-

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

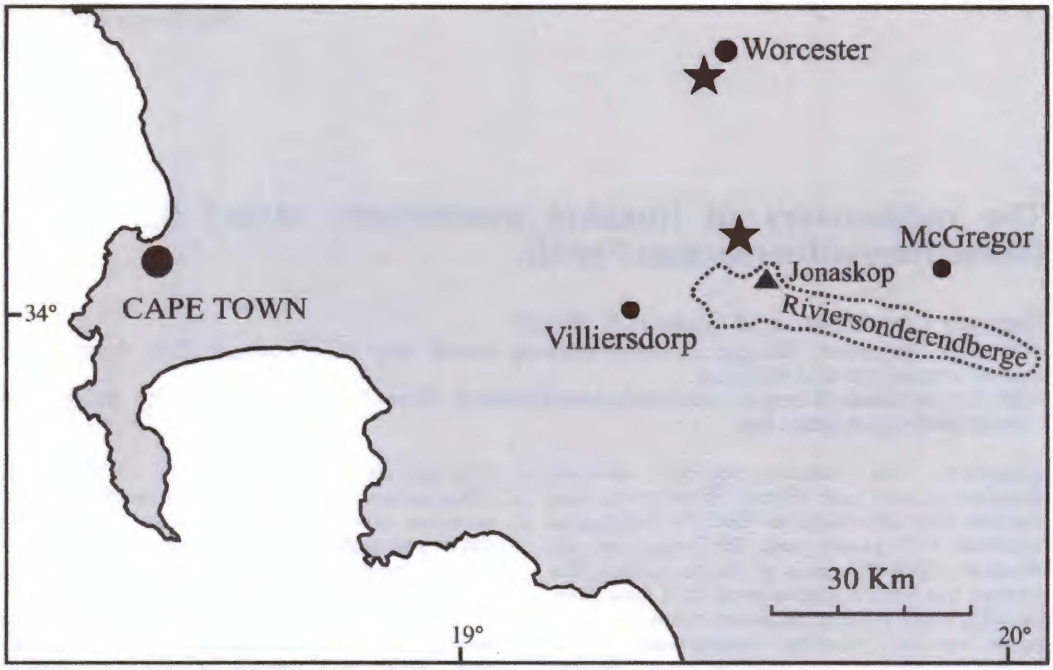


Figure 1. Known geographical distribution of *Ruschia acutangula* (★) in southern Africa.



Figure 2. Deryck de Witt (National Botanical Institute) pointing out *Ruschia acutangula* in its natural habitat on the foothills of Jonaskop in the southwestern Cape, South Africa. Photo: P. Chesselet.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

uous, white-flowering shrubs of the genus *Ruschia* Schwantes still occur in fallow areas and on the verges of dirt roads (Figure 2). Material of this shrub was collected by one of us (PC) on a field trip on 6th November 2001 and was determined to be the long-lost *Ruschia acutangula*. Of the approximately 220 species currently classified in *Ruschia*, only about 20 species have white flowers. In general, identification of species in the genus *Ruschia* is difficult for a number of reasons, but primarily because many species are not well known. However, in this case, the distinctive vegetative morphological characters enabled its positive identification as *R. acutangula*.

Haworth (1824) described the species from vegetative material only. An accurate, unpublished colour plate beautifully executed by Thomas Duncanson and housed at Kew provides the only anchor to fix the name (Figure 3). As no herbarium material exists that could be designated as the type, Hartmann (1999) designated the plate as an iconotype for the name in a recent overview of the genus *Ruschia*. The talented Duncanson served the Royal Botanic Gardens, Kew, as botanical illustrator for five years, from 1822 to 1826. During this time he completed more than 300 drawings that now form part of the Kew collection (Smith & Van Wyk, 1989). Many of these specimens were of succulent plants collected by, among other explorers, James Bowie, while he collected for Kew in South Africa (Smith, 1990).

Some 22 species that are currently included in the genus *Ruschia* were originally described by Haworth in the all-encompassing genus *Mesembryanthemum* L., of which several are difficult to identify as types are missing and iconotypes are not readily accessible to South African botanists. For example, *Ruschia acutangula* is so little known that it has been omitted from modern regional treatments of the Cape flora (Bond & Goldblatt, 1984; Goldblatt & Manning, 2000), and appears as a name only on checklists of taxa (Chesselet & De Wet, 1997; Smith *et al.*, 1998). Somewhat paradoxically, older treatments such as *Flora capensis* (Harvey & Sonder, 1894) and Salm-Dyck (1849), gave more detail on the species. Sonder (1894: 426) distinguished it from *Mesembryanthemum vaginatum* Haw. on the basis of its erect (not recurved) leaves, but gave the habitat as "Cape of Good Hope" only. In 1908 Alwin Berger, the celebrated succulent plant specialist who at the time worked at Thomas Hanbury's famous garden, La Mortola, on the Italian Riviera (Russo, 2001), placed M. *acutangulum* Haw. as a variety of *M. vaginatum*, but this was not upheld in later treatments, such as Jacobsen's *Handbook of Succulent Plant* vol. 3 (1960), the *Lexicon of Succulent Plants* (1974) and Hartmann's *Illustrated Handbook of Succulent Plants* (2001).



Figure 3. Detail of *Mesembryanthemum acutangulum* Haw. at present included in the synonymy of *Ruschia acutangula* (Haw.) Schwantes. Iconotype. Reduced photograph of an unpublished painting by Thomas Duncanson at Kew, painted on the 25 August 1826. Copyright of the Trustees of the Royal Botanic Gardens, Kew. Reproduced with permission.

As in the case of *Circandra serrata* (L.) N.E.Br., described by Linnaeus in 1753 and now

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

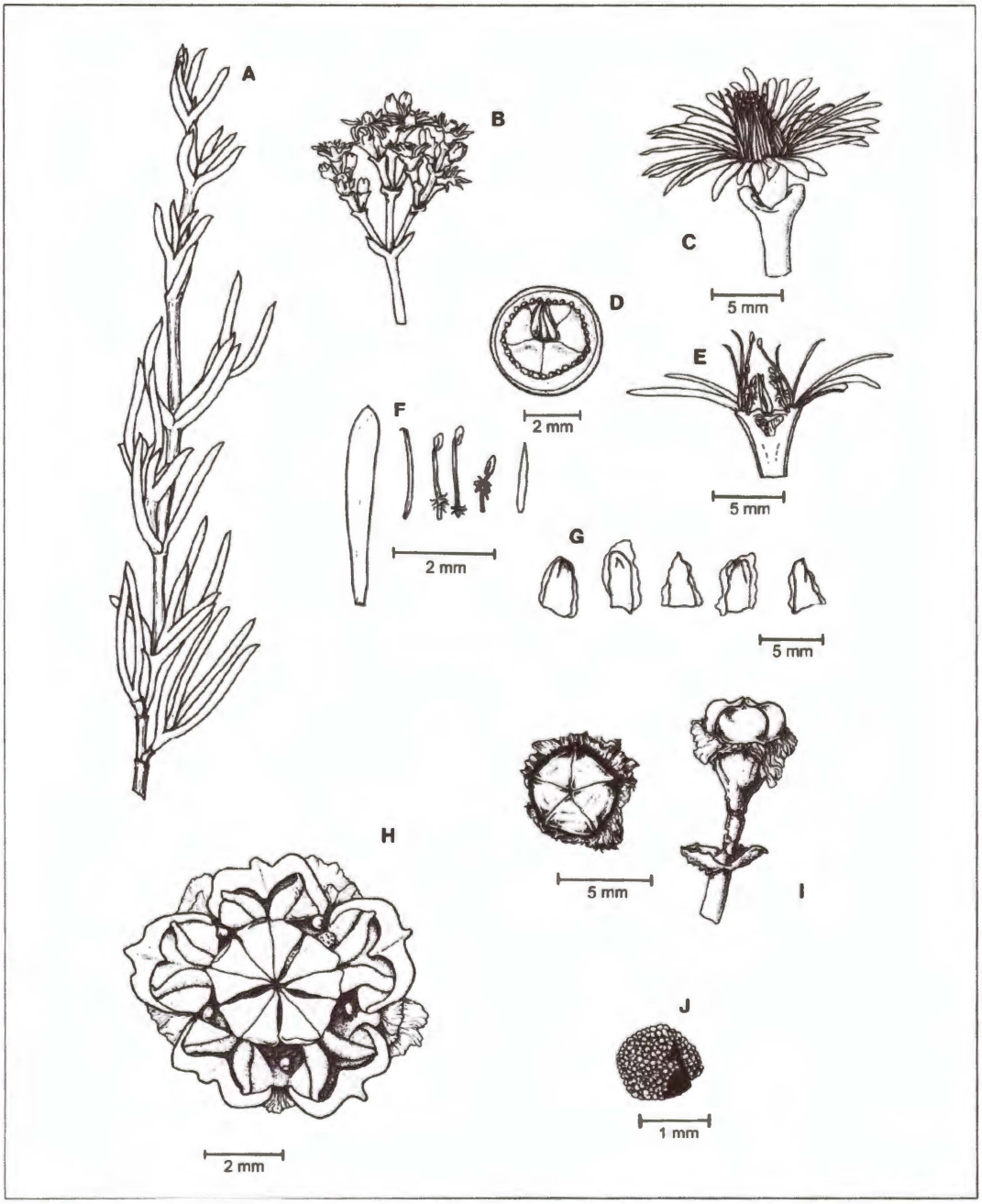


Figure 4. Morphology of *Ruschia acutangula*: A-I. A,vegetative shoot; B, complex cymose inflorescence; C, flower; D, flower with petals removed showing crested annular nectary; E, half flower; F, petaloid staminode, filamentous staminode, papillate filaments with anthers, and stigma; G, sepals with membranous margins; H, open fruit capsule showing covering membranes, closing bodies and expanding keels; I, external view of fruit from the side and from above; J, seed. Artist: Pascale Chesselet.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

extinct, this species grows on farmland and other areas that are being transformed. Since the rediscovery of *R. acutangula*, a second population has been reported close to the town of Worcester. Plants were collected for an environmental impact assessment at a site where road works are being planned (Pat Holmes, Cape Ecological Services, pers. comm.). An assessment of its conservation status will therefore most likely prove that it is highly threatened, because of habitat loss resulting primarily from extensive farming in its original natural habitat. With its morphological description and locality information now available, it will be possible in the future to assess the range of its distribution and its conservation status according to modern techniques (Victor, in press).

In a recent annotated list of species placed in *Ruschia* (Hartmann, 1999), only Thomas Duncanson's illustration at Kew could be used as the basis for the description. Furthermore, at the time the flowers and fruit as well as the ecology and geographical distribution range of this species were unknown. We therefore take this opportunity to emend and detail the descriptive morphology of the species.

Description

(Compare Figure 4.) Perennial, erect to densely branched shrub up to or exceeding 1 m; internodes purple, later ochre. Leaves triquetrous, margins and keel sharp, finely serrulate, tips acute, pointed, sheath connate with the stem. Flowers in complex cymose inflorescences, pedicel 5-10 mm long, bracteate, ± 18 mm in diameter; remaining open, with a strong almond-like fragrance; flowering October-November. Sepals 5, subequal, somewhat keeled, with membranous margins. Petals linear-lanceolate, white, filamentous staminodes present, stamens of three size classes, papillate at base, pollen yellow. Nectary annular and crested (lophomorphic holonectary). Ovary with parietal placentas, stigmas 5, filiform, acute. Fruit a 5-locular capsule of the *Ruschia*-type with white, rod-shaped closing bodies and covering membranes with prominent closing rodlets, 5-6 mm in diameter, 4-5 mm deep, valves raised by 2 mm. Seeds reddish brown, roundish, ± 1.2 mm long, ± 1.1 mm wide, rough-textured.

Nomenclature

Ruschia acutangula (Haw.) Schwantes in Jacobsen, *Rep. spec. nov. reg. veg.* **43**: 230 (1938).
Mesembryanthemum acutangulum Haw.: 424 (1824).
Mesembryanthemum vaginatum Lam. var. *acutangulum* (Haw.) A.Berger: 111 (1908).
Lectotype designated by Hartmann (1999) as drawing by Duncanson 23.8.1826, held at the Royal Botanic Gardens, Kew. This date is here corrected to 25.8.1826.

References

BERGER, A. (1908). *Mesembrianthemen und Portulacaceen*. Verlagsbuchhandlung von Eugen Ulmer, Stuttgart.

BOND, P. & GOLDBLATT, P. (1984). Plants of the Cape flora. A descriptive catalogue. *J. S. Afr. Bot.* Supp. Vol. **13**: 1-455.

CHESSELET, P. & DE WET, B.C. (1997). Mesembryanthemaceae Fenzl (vygie or ice plant family). Pp. 89-122 in: G.F. Smith, E.J. van Jaarsveld, T.H. Arnold, F.E. Steffens, R.D. Dixon & J.A. Retief (Eds), *List of southern African succulent plants*. Umdaus Press, Pretoria.

GOLDBLATT, P. & MANNING, J. (2000). Cape plants. A conspectus of the Cape flora of South Africa. *Strelitzia* **9**: 1-743. National Botanical Institute, Pretoria.

HARTMANN, H.E.K. (1999). An annotated list of the species placed in *Ruschia* (Aizoaceae). *Bradleya* **17**: 38-74.

HARVEY, W.H. & SONDER, O.W. (Eds) (1894). *Flora capensis*. Vol. **2**. Leguminosae to Loranthaceae. L.Reeve & Co., London.

HAWORTH, A.H. (1824). LXXIV. Decas tertia novarum Plantarum Succulentarum. *Phil. Mag.* **64**: 423-428.

JACOBSEN, H. (1938). XXII. Unstimmigkeiten in der Bezeichnung der Mesembryanthema. *Rep. spec. nov. reg. veg.* **43**: 222-230.

JACOBSEN, H. (1960). *A handbook of succulent plants*. Blandford Press, London.

JACOBSEN, H. (1974). *Lexicon of succulent plants*. Blandford Press, London.

LINNAEUS, C. (1753). *Species plantarum*, 1st ed., vol. 1, p. 485. Impensis Laurentii Salvii, Stockholm.

ROURKE, J.P. & WIENS, D. (1978). Rodent pollination in southern African *Protea* spp. *Nature* **276**: 71-73.

RUSSO, L. (2001). A mission in life: Thomas Hanbury and his garden at La Mortola, Italy. *Bradleya* **19**: 67-74.

RUTHERFORD, M.C. (1978) Karoo-fynbos biomass along an elevational gradient in the western Cape. *Bothalia* **12**: 55-560.

SALM-DYCK, J.M.F.A.H.I. (1849). *Mesembryanthemum acutangulum. Monographia Generum Aloes et Mesembryanthemi* Section 36, Figure 5 (Fascicle 5, Figure 21). Bonn.

SMITH, G.F. (1990). Neotypification of *Bowiea myriacantha*, basionym of *Aloe myriacantha* (Asphodelaceae: Alooideae). *Bot. Bull. Acad. Sin.* (n.s.) **31**: 315-320.

SMITH, G.F. & VAN WYK, A.E. (1989). Biographical

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

notes on James Bowie and the discovery of *Aloe bowiea* Schult. & J.H. Schult. (Alooideae: Asphodelaceae). *Taxon* **38**: 557-568.

SMITH, G.F., CHESSELET, P., VAN JAARSVELD, E.J., HARTMANN, H., HAMMER, S., VAN WYK, B-E., BURGOYNE, P., KLAK, C. & KURZWEIL, H. (1998). *Mesembs of the world.* Briza Publications, Pretoria.

SMITH, G.F., VAN WYK, A.E., JOHNSON, L.A.S. & VAN WYK, A.E. (1996). Southern African plant systematics: needs, priorities and actions. *S. Afr. J. Sci.* **92**: 314-320.

SONDER, O.W. (1894). Order LV. Mesembryaceae, Lindl. In W.H. Harvey & O.W. Sonder (Eds), *Flora capensis* **2**: 386-479. L.Reeve & Co., London.

VAN WYK, A.E. & SMITH, G.F. (2001). *Regions of floristic endemism in southern Africa. A review with emphasis on succulents.* Umdaus Press, Hatfield.

VICTOR, J. (In press). South Africa. In J. Golding (Ed.), Southern African plant Red Data List. *Southern African Botanical Diversity Network Report Series* No. 14. SABONET, Pretoria.

WIENS, D., ROURKE, J.P., CASPER, B.B., RICKART, E.A., LAPINE, T.R., PETERSON, C.J. & CHANNING, A. (1983). Nonflying mammal pollination of southern African proteas: A non-coevolved system. *Ann. Miss. Bot. Gard.* **70**: 1-31.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 8

Chesselet, P., Smith, G.F. & Van Wyk, A.E. 2001. A new tribal classification for the Mesembryanthemaceae Fenzl based on characters of the floral nectary. *Aloe* 38: 25–28.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

A new tribal classification for the Mesembryanthemaceae Fenzl based on characters of the floral nectary

Pascale Chesselet, Gideon F. Smith and Abraham E. van Wyk

In 1947, Gustav Schwantes proposed the first formal classification of mesemb genera into tribes and subtribes (Schwantes 1947). This scheme, revised and completed by H. Straka and H.-D. Ihlenfeldt, was published in Hans Herre's (1971) *Genera of the Mesembryanthemaceae*. Six tribes were recognized for the entire group. Although some of the groupings are still maintained today, others are considered to be artificial as they depend largely on superficial similarities. Modern researchers rely primarily on the informal classification of mesemb genera put forward by Hartmann (1991, 1993, 1998). This grouping system is based on a combination of reproductive (Hartmann 1988) and vegetative features. It subdivides the subfamily Ruschioideae into 12 groups (Table 1), each characterized by a combination of features. To date, no hierarchical system or hypothesis on relationships between the various groups has been published. Recently, Chesselet *et al.* (2000) put forward a "bubble diagram" arranging groups of genera and providing a preliminary basis for discussion of relationships and a template for evaluation of morphological characters in the mesembs.

The two major subfamilies of the Mesembryanthemaceae are easily distinguished by the position of the placenta in the ovary. In the Mesembryanthemoideae the placenta is situated on the central axis of the ovary or fruit. In the Ruschioideae the placenta is at the bottom or on the sides of the ovary. This distinction underlies basic differences in not only the fruit structure of these two subfamilies (Smith *et al.* 1998: 22–23), but also in aspects of their floral development (Ihlenfeldt 1960). In contrast to the highly variable fruit of the mesembs, particularly of the ruschioid taxa, the flowers are more consistent in structure, showing little variation between related genera (Liede & Hammer 1990).

Mesemb flowers are mostly insect-pollinated. Pollen vectors include bees, butterflies, moths and wasps (Vogel 1954; Gess & Gess 1989). Although wind pollination has been suggested for some taxa (Bittrich 1986), its presence in the group requires further investigation. In the majority of members brightly coloured, shiny petals and/or scent attract the pollinators, whereas nectar and/or pollen serves as reward. Nectar is secreted by distinct glandular areas (nectaries) located on the receptacle at the base of the petals and stamens (Fig. 1).

A recent comparative study to assess the systematic significance of floral nectaries in the mesembs showed that these structures are expressed in the form of six distinct morphological types (Chesselet *et al.* 2000): 1) hollow and shell-shaped — termed "koilomorphic" (Mesembryanthemoideae); 2) broad, flat and annular—termed a "broad, flat holonectary" (*Apatesia* Group); 3) broad, flat and divided—termed a "broad, flat meronectary" (*Cleretum* Group); 4) crested and divided—termed a "crested, lophomorphic meronectary" (*Delosperma, Stomatium* and *Bergeranthus* Groups); 5) crested and annular—termed a

Table 1. Current informal classification of genera from the subfamily Ruschioideae following groupings proposed by Hartmann (1991, 1993, 1998). Note: the insufficiently known *Calamophyllum* Schwantes is not included in this scheme.

***Apatesia* Group**	*Apatesia, Carpanthea, Caryotophora, Conicosia, Hymenogyne, Saphesia, Skiatophytum.*
***Cleretum* Group**	*Aethephyllum, Cleretum, Dorotheanthus.*
***Mitrophyllum* Group**	*Dicrocaulon, Diplosoma, Disphyma, Glottiphyllum, Hammeria, Jacobsenia, Meyerophytum, Mitrophyllum, Monilaria, Oophytum.*
***Delosperma* Group**	*Corpuscularia, Delosperma, Drosanthemum, Ectotropis, Gibbaeum, Lampranthus, Malephora, Mestoklema, Muiria, Oscularia, Trichodiadem.*
***Stomatium* Group**	*Chasmatophyllum, Faucaria, Frithia, Mossia, Neohenricia, Orthopterum, Rabiea, Rhinephyllum, Stomatium.*
***Titanopsis* Group**	*Aloinopsis, Deilanthe, Didymaotus, Dinteranthus, Ihlenfeldtia, Lapidaria, Lithops, Nananthus, Schwantesia, Tanquana, Titanopsis, Vanheerdea, Zeuktophyllum.*
***Dracophilus* Group**	*Conophytum, Dracophilus, Hartmanthus, Jensenobotrya, Juttadinteria, Namibia, Nelia, Psammophora, Ruschianthus.*
***Bergeranthus* Group**	*Bergeranthus, Bijlia, Carruanthus, Cerochlamys, Hereroa, Machairophyllum, Rhombophyllum.*
***Lampranthus* Group**	*Antegibbaeum, Braunsia, ?Carpobrotus, Circandra, Enarganthe, Erepsia, Esterhuysenia, Lampranthus, Namaquanthus, Scopelogena, Smicrostigma, Vlokia, Wooleya.*
***Ruschia* Group**	*Acrodon, Arenifera, Astridia, Ebracteola, Khadia, Marlothistella, Polymita, Ruschia, Stayneria.*
***Leipoldtia* Group**	*Antimima, Argyroderma, Cephalophyllum, Cheiridopsis, Cylindrophyllum, Fenestraria, Hallianthus, Jordaaniella, Leipoldtia, Octopoma, Odontophorus, Ottosonderia, Pleiospilos, Schlechteranthus, Vanzijlia.*
***Eberlanzia* Group**	*Amphibolia, Eberlanzia, Ruschianthemum, Stoeberia.*

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

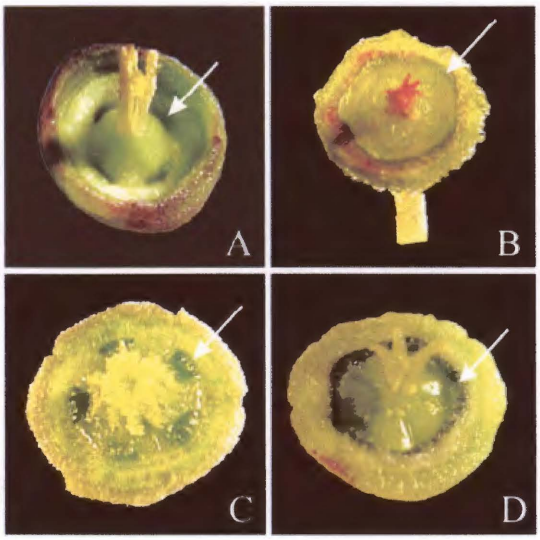


Figure 1. Floral nectaries in the Mesembryanthemaceae.
A. Koilomorphic meronectary in *Prenia tetragona* (Thunb.) Gerbaulet; **B.** Broad, flat meronectary in *Dorotheanthus maughanii* (N.E.Br.) Ihlenf. & Struck; **C.** Lophomorphic meronectary in *Drosanthemum speciosum* (Haw.) Schwantes; **D.** Lophomorphic holonectary in *Lampranthus mucronatus* L.Bolus.

"crested lophomorphic holonectary" (*Mitrophyllum*, *Dracophilus*, *Titanopsis*, *Lampranthus*, *Ruschia*, *Eberlanzia* and *Leipoldtia* Groups); 6) inconspicuous: either relictual or absent (rare, e.g. *Glottiphyllum*). In terms of character evolution, features of the floral nectaries can be separated into two characters, each containing a number of character states. The first character describes the structure of the nectary and can be summarized as follows:

holonectary ↔ meronectary ↔ holonectary

Primitively the nectary is composed of a ring (holonectary) (e.g. *Trianthema*, Aizoaceae, see Chesselet *et al.* 2000). In a number of mesemb genera, the nectary is segmented, with the number of segments matching the number of locules in the fruit. A further character state is the return to the ring-shaped nectary, but in this case the nectary is crested. This may be interpreted either as an evolutionary reversal or as an evolutionary innovation. The second character of the nectary relates to its shape. Primitively the nectary is slightly rounded or flat. It becomes shell-shaped and hollow (koilomorphic), or crested (lophomorphic).

Characteristics of the nectary are remarkably consistent within the various groups. They were plotted on a "bubble diagram" and assessed for their systematic significance by Chesselet *et al.* (2000). In the present study, the data have been converted to an evolutionary model (hypothesis) for the mesembs based on nectary types (Fig. 2). To indicate possible evolutionary branching at the base of the tree, nectary character states were plotted on a cladogram of the family (Fig. 3). In terms of nectary type, the family Mesembryanthemaceae is defined by the meronectary (Bittrich & Struck 1989), a state not

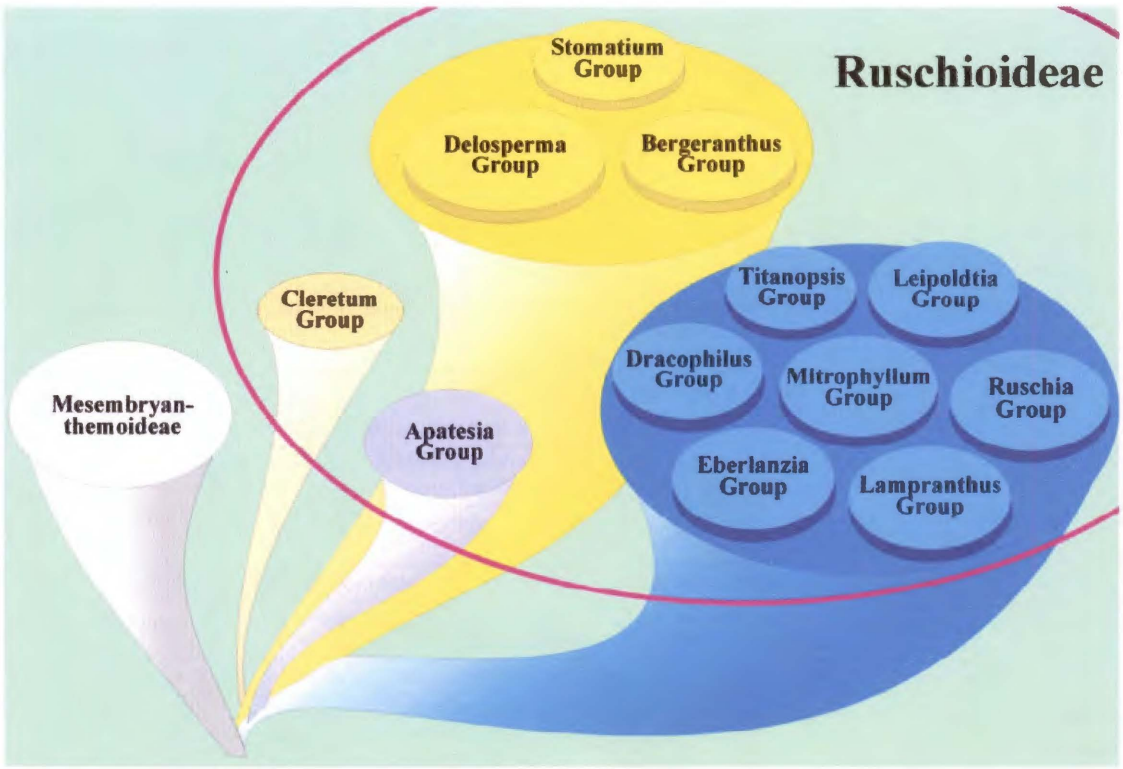


Figure 2. Evolutionary model for the Mesembryanthemaceae based on nectary types.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

known in any other family of the Order Caryophyllales, in which mesembs are classified. Subfamily Mesembryanthemoideae is defined by the koilomorphic nectary. In the Ruschioideae four major groups are circumscribed. The primitive *Apatesia* Group represents an early experimental stage in mesemb evolution. It has broad, flat holonectaries, and the return to the ancestral, undivided ring-shaped nectary may be interpreted as an evolutionary reversal. In this group, plants are mostly flat-leaved annuals or perennials. Fruit have reduced or no expanding tissue, and, unlike in most other mesembs, are schizocarpic and dehiscent upon drying. The *Cleretum* Group has broad, flat meronectaries, and is not defined by any synapomorphy in terms of nectary type. It consists of annual plants with semi-succulent, highly papillate, flat leaves and is regarded as sufficiently different from all the other mesemb groups (Ihlenfeldt & Struck 1986). The bulk of the Ruschioideae form two larger groups (Fig. 2). Both are defined by the lophomorphic nectary. In the group comprising the *Delosperma, Bergeranthus* and *Stomatium* Groups, the nectary remains divided (meronectary). This group includes species mostly from the summer-rainfall region. The larger group consisting of species from the *Mitrophyllum, Dracophilus, Titanopsis, Lampranthus, Ruschia, Eberlanzia* and *Leipoldtia* Groups shows a reversal back to the holonectary. Alternatively, the crested lophomorphic holonectary may be interpreted as another evolutionary innovation (synapomorphy) for this large group of ruschioid taxa. This group has diversified in the winter-rainfall Succulent Karoo, including Namaqualand.

For the first time in mesemb classification, the highly diverse ruschioid genera can be subdivided on the basis of clear synapomorphies relating to nectary type. Just as the subfamilies can be distinguished by the position of the placenta in the ovary, tribes can be distinguished according to types of floral nectaries. Two names of tribes proposed by Schwantes (1947) can be used here. The name Apatesieae Schwantes can be applied to Hartmann's (1991, 1993) *Apatesia* Group. The *Cleretum* group will be formalized under the new tribal name Dorotheantheae. The summer rainfall taxa belonging to the *Delosperma, Stomatium* and

Table 2. Proposed tribal classification of the subfamily Ruschioideae.

Groups	Proposed tribes
Apatesia Group	Apatesieae Schwantes
Cleretum Group	Dorotheantheae nom. prov.
Delosperma, Stomatium & Bergeranthus Groups	Delospermeae nom prov.
Mitrophyllum, Dracophilus, Titanopsis, Lampranthus, Ruschia, Eberlanzia & Leipoldtia Groups	Ruschieae Schwantes

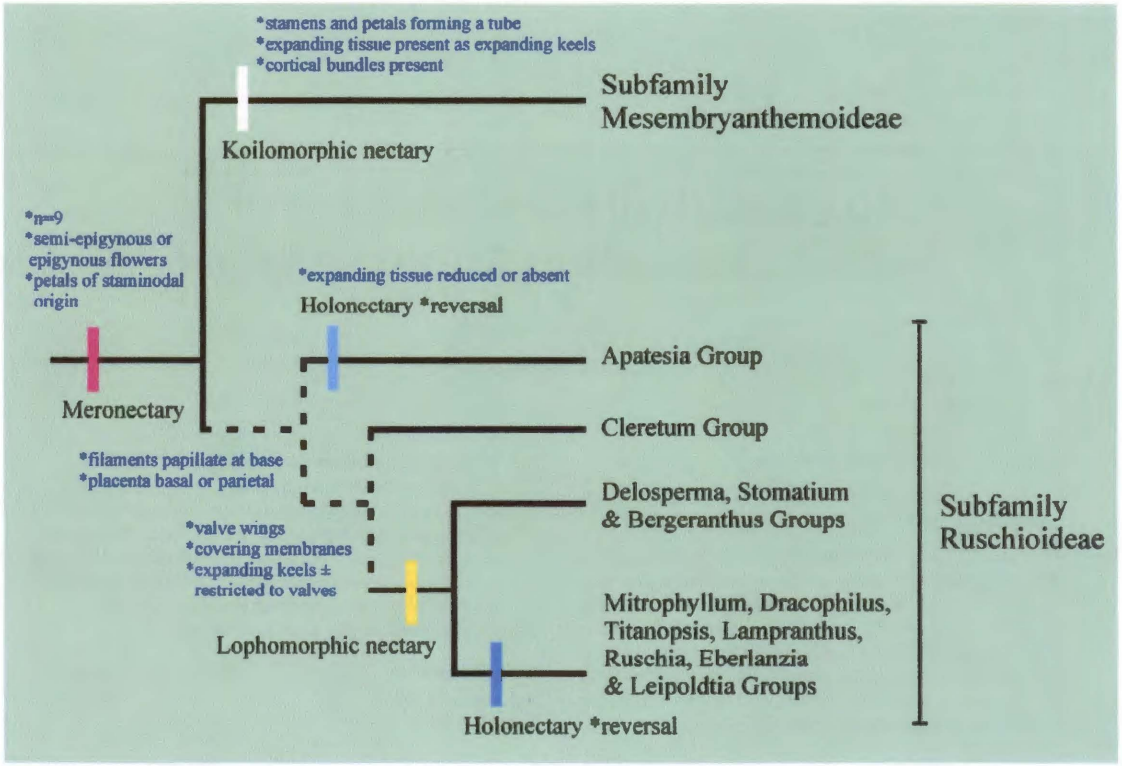


Figure 3. Character distribution of floral nectaries on the basal branches of the Mesembryanthemaceae.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Bergeranthus Groups are assigned to the tribe Delospermeae which will shortly be established. The remainder of the Ruschioideae is assigned to the previously named tribe Ruschieae Schwantes. The two provisionally proposed new tribal names will be formally published elsewhere.

Acknowledgements

We thank Dr Otto Leistner (National Botanical Institute) for useful discussion and encouragement and Prof. Hans Ihlenfeldt for communicating valuable information on mesemb nectaries by exchange of letters.

Literature

Bittrich, V. 1986. Untersuchungen zu Merkmalsbestand, Gliederung und Abgrenzung der Unterfamilie Mesembryanthemoideae (Mesembryanthemaceae Fenzl). *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 21: 5–116.

Bittrich, V. & Struck, M. 1989. What is primitive in the Mesembryanthemaceae? An analysis of evolutionary polarity of character states. *South African Journal of Botany* 55: 321–331.

Chesselet, P., Smith, G. F. & Van Wyk, A.E. 2000. Systematic and evolutionary significance of morphology in the Mesembryanthemaceae: interactive database and illustrated atlas for identification. *Aloe* 37: 46–51.

Gess, S.K. & Gess, F.W. 1989. Flower-visiting masarid wasps in Southern Africa (Hymenoptera: Vespoidea: Masaridae). *Annals of the Cape Provincial Museums. Natural History* 18: 95–134.

Hartmann, H.E.K. 1988. Fruit types in Mesembryanthema. *Beiträge zur Biologie der Pflanzen* 63: 313–349.

Hartmann, H.E.K. 1991. Mesembryanthema. *Contributions from the Bolus Herbarium* 13: 75–157.

Hartmann, H.E.K. 1993. Aizoaceae. Pp. 37–69 in: Kubitzki, K., Rohwer, J.G. & Bittrich, V. (eds), *The families and genera of vascular plants*, 2. Springer-Verlag, Berlin.

Hartmann, H.E.K. 1998. A Letter to the MSG. *Mesemb Study Group Bulletin* 2: 32–34.

Herre, H. 1971. *The genera of the Mesembryanthemaceae*. Tafelberg, Cape Town.

Ihlenfeldt, H.-D. 1960. Entwicklungsgeschichtliche, morphologische und systematische Untersuchungen an Mesembryanthemen. *Fedde's Repertorium* 63: 1–104.

Ihlenfeldt, H.-D. & Struck, M. 1986. Morphologie und Taxonomie der Dorotheanthinae Schwantes (Mesembryanthemaceae). *Beiträge zur Biologie der Pflanzen* 61: 411–453.

Liede, S. & Hammer, S. 1990. Aspects of floral structure and phenology in the genus *Conophytum* (Mesembryanthemaceae). *Plant Systematics and Evolution* 172: 229–240.

Schwantes, G. 1947. System der Mesembryanthemaceen. Separatabdruk aus *Sukkulentenkunde* 1: 1–7.

Smith, G.F., Chesselet, P., Van Jaarsveld, E.J., Hartmann, H., Hammer, S., Van Wyk, B-E., Burgoyne, P., Klak, C. & Kurzweil, H. 1998. *Mesembs of the world*. Briza, Pretoria.

Vogel, S. 1954. Blütenbiologische Typen als Elemente der Sippengliederung. In: Troll, W. & Von Guttenberg, H. (eds): *Botanische Studien* 1. Fischer, Jena.

Pascale Chesselet

Compton Herbarium, National Botanical Institute, Private Bag X7, Claremont 7735, South Africa.

Gideon F. Smith

Office of the Research Director, National Botanical Institute, Private Bag X101, Pretoria 0001, South Africa.

Abraham E. van Wyk

H.G.W.J. Schweickerdt Herbarium, Department of Botany, University of Pretoria, Pretoria 0002, South Africa.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 9

Chesselet, P., Smith, G.F. & Van Wyk, A.E. 2000c. The habit and peculiar inflorescence of *Ottosonderia monticola* (Sond.) L.Bolus, Mesembryanthemaceae. *Aloe* 37: 88–90.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

The habit and peculiar inflorescence of *Ottosonderia monticola* (Sond.) L.Bolus, Mesembryanthemaceae

Pascale Chesselet, Gideon F. Smith and Abraham E. Van Wyk

Introduction

Ottosonderia monticola (Sond.) L.Bolus is not widely known, it has neither caught the attention of succulent growers, nor is it well represented in herbarium collections. *Ottosonderia* is the only genus for which a picture of a flowering specimen was not included in Smith *et al.* (1998: 377). In this work it was treated in the *Leipoldtia*-like Shrubby Mesembs group. It is misrepresented in Herre's (1971: 247) classic generic treatment of the mesembs –the painting by Mary Page was based on an incomplete specimen with abnormal flowers showing basally-fused stigmas. For these reasons we feel that a short note on *O. monticola* is appropriate.

Even though the species is not well known, *Mesembryanthemum monticolum* Sond. was first described in *Flora Capensis* (Sonder 1862). Almost a hundred years later, the genus *Ottosonderia* was established to accommodate this species. It was named in honour of Dr Otto Sonder by Bolus (1958), who simultaneously described a second species, *O. obtusa* L.Bolus.

The genus is very localised in Namaqualand. As the name suggests, *O. monticola* is a montane species found near Bitterfontein, Stofkraal and Komkans, in the Western Cape Province. Its preferred habitat is along granitic shields in a winter rainfall area with less than 100 mm per annum (Hartmann 1991). The second species, *O. obtusa* occurs near Wallekraal, in the Northern Cape Province, at lower altitudes. This species is more robust, with thicker leaves, pale pink flowers, and much larger fruit. Although the flowering shoots protrude above the plant as in *O. monticola*, the upper leaves are not highly fused and do not differ greatly in form from the basal leaves.

Morphology

O. monticola is not spectacular at first sight, but on closer examination an unusual succulent growth form manifests in this species. The plant has two morphologically and functionally distinct leaf types – both green and photosynthesising, but the one large and associated with vegetative growth and the other smaller, associated with, and apparently protecting the reproductive structures (Fig. 1 C). The bracteose leaf-like structures of the inflorescence are referred to as hypsophylls by Hartmann (1993) – a more specific term to distinguish them from cataphylls; the latter being more or less scale-like leaves, preceding the foliage leaves and commonly functioning as protective organs of a bud. The hypsophylls provide a succulent cushion protecting and supporting the seemingly sessile flowers. Upon drying, the capsular fruit are subtended by a bractless pedicel ± 20 mm long. In the axils of these inflorescence leaves are nested the primordia, and the slightly developed, still unfused leaf pairs that emerge in the next season (Fig 1 A). Following this basically cymose pattern, inflorescences in *O. monticola*, can attain branching in three planes, effectively increasing the number of flowers produced in subsequent seasons. Leaf dimorphism, as manifested in *Ottosonderia*, thus provides an opportunity to study the contribution of heterochrony as a possible evolutionary mechanism in the diversification of the Mesembryanthemaceae. By studying developmental changes during the ontogeny of an organism, clues may be found as to the kinds of evolutionary changes that might have occurred during its phylogeny.

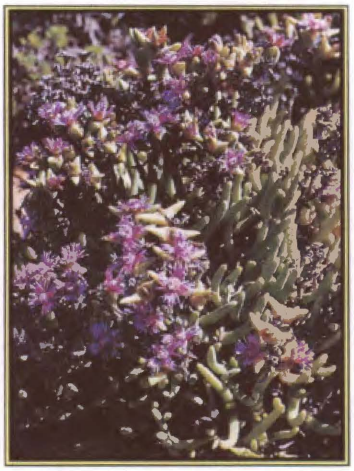


Figure 2. *Ottosonderia monticola* flowering at the Karoo National Botanical Garden, Worcester.

O. monticola is well adapted to water stress, it has a tough epidermis that, according to Hartmann (1993) has sunken stomata and a thin to moderate crystal layer in the outer epidermal walls. Apparently, as a water saving strategy, the plants support only one leaf pair per branch, other leaves have had their substance recycled and persist, leathery and dried out, surrounding the basal stems. After flowering, when the receptacle develops into a fruit, the sepals, petals and stigmas persist on the woody seed capsule (Fig. 1 H). The inflorescence (Fig. 1 C) elongates and the highly fused, stem-hugging leaves dry out each season leaving one succulent leaf pair at the tip of each branch.

Affinities

A persistent succulent inflorescence characterizes *Ottosonderia* –a genus with elements both of the Ruschiinae (Dehn, 1992) and the *Leipoldtiinae* Schwantes ex H.E.K.Hartmann (1983). On the basis of fruit morphology, the genus is closest to the *Ruschia-type* fruit of Hartmann (1988). Similarly, the genus *Octopoma*, currently included in the *Leipoldtia* group (Hartmann 1991, 1993), is considered to have *Ruschia*- type fruit (Hartmann 1988). Besides both genera being characteristically 8-locular in their fruit, *Ottosonderia* and *Octopoma*, particularly *O. connatum* (L.Bolus) L.Bolus, share several features of the fruit and the growth form. A recent treatment of *Octopoma* (Hartmann 1998) divides the genus into two groups on the basis of fruit morphology. One group has valve wings and large closing bodies in the fruit, the other has no valve wings,

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021



Figure 1. Morphology of *Ottosonderia monticola*. **A.** Flower, longitudinal section and position of axillary bud; **B**, highly fused inflorescence leaves supporting flower; **C**, growth of *O. monticola* with basal leaf pairs and complex cymose inflorescence with highly succulent fused leaf pairs; **D**, gynoecium with ring-like beaded nectary and eight stigmas, four sepals, two with membranous margins; **F**, stigma; **G**, stamens, filamentous staminodes and petal; **I**, longitudinal section through capsular fruit showing thick endocarpal closing bodies, central column and parietal placentas; **J**, open fruit with covering membranes, expanding keels and closing bodies. (Scale bar 5 mm).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

relatively small closing bodies and closing rodlets on the covering membranes. Species in this latter group are closest to *Ottosonderia*. In *O. monticola* the closing bodies are relatively small extensions of the thick, white endocarp. Prominent closing rodlets on the distal undersurface of the covering membranes dip towards the centre of the fruit (Fig. 1 I). The expanding keels on *O. monticola* are closely contiguous, diverging distally, rounded along the top ridge, and as high as their basal width (Fig. 1 J). Such expanding keels are known from *Ruschia* Schwantes, *Eberlanzia* Schwantes, *Astridia* Dinter (Hartmann 1988). The seeds of *O. monticola* are honey-coloured and relatively smooth, this together with the thick white endocarp of the fruit is strongly reminiscent of the fruits in the genus *Eberlanzia*. Schwantes (1949) erroneously placed *O. monticola* in the genus *Hymenocyclus* Dinter & Schwantes corresponding to the present day *Malephora* N.E.Br. However unlikely a combination this may seem, it highlights the difficulties in placing this unique plant within the system of mesemb genera, and considering molecular data might be one approach to establish its closest relatives.

Acknowledgements

We thank Mr Deon Viljoen of the Karoo National Botanical Garden for calling when *O. monticola* flowered.

References

Bolus, H.M.L. (1958). *Ottosonderia* gen. nov. *Notes on* Mesembryanthemum *and allied Genera* 3: 292.

Dehn, M. 1992. Untersuchungen zum Verwandtschaftskeis der Ruschiinae (Mesembryanthemaceae Fenzl). *Mitteilungen aus dem Institut für Allgemeine Botanik*. Hamburg 24: 91–198.

Hartmann, H.E.K. 1983. Untersuchungen zum Merkmalsbestand und zur Taxonomie der Subtribus Leipoldtiinae (Mesembryanthemaceae). *Bibliotheca Botanica* 136: 1–67.

Hartmann, H.E.K. 1988. Fruit types in Mesembryanthema. *Beiträge zur Biologie der Pflanzen* 63: 313–349.

Hartmann, H.E.K. 1991a. Mesembryanthema. *Contributions from the Bolus Herbarium* 13: 75–157.

Hartmann, H.E.K. 1993. Aizoaceae. Pp. 37–69 in: Kubitzki, K., Rohwer, J.G. & Bittrich, V. (ed.), *The families and genera of vascular plants*, 2. Springer-Verlag, Berlin.

Hartmann, H.E.K. 1998. New combinations in Ruschioideae, based on studies in *Ruschia* (Aizoaceae). *Bradleya* 16: 44–91.

Herre, H. 1971. *The genera of the Mesembryanthemaceae*. Tafelberg, Cape Town.

Schwantes, G. 1949. *Hymenocyclus monticolus* (Sond.) Schwantes. *National Cactus and Succulent Journal* 4: 58.

Smith, G.F., Chesselet, P., Van Jaarsveld, E.J., Hartmann, H., Hammer, S., Van Wyk, B.E., Burgoyne, P., Klak, C. & Kurzweil, H. 1998. *Mesembs of the world*. Briza Publications, Pretoria.

Sonder, O.W. *Mesembryaceae*. In: Harvey, W.H. & Sonder, O.W. (1862). *Flora Capensis* 2: 428.

Pascale Chesselet

Compton Herbarium,
National Botanical Institute,
Private Bag X7, Claremont 7735,
South Africa.

Gideon F. Smith

Office of the Research Director,
National Botanical Institute,
Private Bag X101, Pretoria 0001,
South Africa.

Abraham E. Van Wyk

H.G.W.J. Schweickerdt Herbarium,
Department of Botany,
University of Pretoria,
Pretoria 0002, South Africa.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 10

Chesselet, P. & Smith, G.F. 2001. *Antimima aristulata* comb. nov. (Mesembryanthemaceae Fenzl); a heterophyllous succulent from Cape Town, South Africa. *Bradleya* 19: 121–123.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Bradleya 19/2001
pages 121 – 123

Antimima aristulata comb. nov. (Mesembryanthemaceae Fenzl); a heterophyllous succulent from Cape Town, South Africa

Pascale Chesselet[1] *and Gideon F. Smith*[2]

[1] Compton Herbarium, National Botanical Institute, Private Bag X7, Claremont 7735, South Africa. (email: chesselet@nbict.nbi.ac.za).

[2] Office of the Research Director, National Botanical Institute, Private Bag X101, Pretoria 0001, South Africa. (email: gfs@nbiprc.nbi.ac.za).

Summary: The nomenclatural history of a heterophyllous shrubby succulent mesemb, known from granite outcrops on the Cape Peninsula, South Africa, is discussed. Based on available information the name *Ruschia pulchella* (Haw.) Schwantes is considered as insufficiently known. The new combination *Antimima aristulata* (Sond.) Chesselet & G.F.Sm. is made to accommodate and provide an unambiguous reference for this mesemb species.

Zusammenfassung: Die nomenklatorische Geschichte des heterophyllen, strauchigen, sukkulenten Mesembs von den Granitfelsvorkommen der Kap-Halbinsel von Südafrika wird diskutiert. Auf Grund der vorhandenen Information wird der Name *Ruschia pulchella* (Haw.) Schwantes als ungenügend bekannt betrachtet. Die neue Kombination *Antimima aristulata* (Sond.) Chesselet & G.F.Sm. wird publiziert, um für diese Mesemb-Art eine eindeutige Bezeichnung zur Verfügung zu stellen.

Nomenclatural history and taxonomy

A number of mesemb species in the genus *Antimima* N.E.Br. emend. Dehn are heterophyllous. As the term implies, heterophyllous plants are characterized by the development of different leaf pair types. In the plant figured here (Figure 1), leaves are sharply triquetrous in winter and in early spring when the plant flowers. They are replaced by more rounded, micro-papillate (highly textured) leaves in the dry summer season. Plants of the same species collected at different times of the year can look quite different from each other and this may have resulted in some confusion in plant identifications. The phenomenon of heterophylly has not yet been studied in the genus *Antimima* and is poorly understood in terms of ecophysiology and structural-functional relationships.

A heterophyllous, creeping mesemb grows in crevices and shallow soil pockets on the granite outcrops on Table Mountain and Lion's Head, Cape Town, South Africa. It also occurs at other localities on the Cape Peninsula and its distribution range extends to similar outcrops of the Cape Granite Suite near Paarl and Stellenbosch. Naming this plant proved quite problematic as a name is not available for it in the correct genus. This species is generally referred to as *Ruschia pulchella* (Haw.) Schwantes, which we consider to be an ambiguous and often misapplied name. The holotype of the basionym, *Mesembryanthemum pulchellum* Haw., published in 1803, could not be traced (Hartmann, 1999) and neither a specimen nor an illustration used by Haworth was found at Kew (R.G. Chinnock, ex-Australian Botanical Liaison Officer, pers. comm.). Haworth (1803) also gave no indication of the distribution of the species. The rather broad description of *M. pulchellum* provided by Haworth fits taxa belonging to the genus *Antimima* N.E.Br. emend. Dehn, specifically the group defined by *Antimima microphylla* (Haw.) Dehn (Dehn, 1988), a characteristically heterophyllous assemblage containing approximately 50 species, many of which have sharply triquetrous leaves.

A figure labelled *M. pulchellum* was published in Salm-Dyck (1837), but to designate this plate as a lectotype would be problematic due to its stylized nature and the consequent difficulties in linking it unequivocally to *M. pulchellum* Haw. *Ruschia pulchella* is included in a recent annotated list of species placed in *Ruschia* Schwantes (Hartmann, 1999). A description of the species is provided and its distribution broadly referred to as "South Africa", but no indication is given that the species belongs in *Antimima* rather than in *Ruschia*.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021



Figure 1. *Antimima aristulata* (Sond.) Chesselet & G.F.Sm. painted by Mary Page in 1923. This illustration shows the plant with larger triquetrous leaves flowering in August and the form with smaller, rounder and more papillate summer leaves in the background. The painting belongs to the Bolus Herbarium collection of illustrations housed at the University of Cape Town (Smith & Walker, 2001).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

In 1862, almost sixty years after Haworth described *M. pulchellum*, Sonder published the name *Mesembryanthemum aristulatum* in *Flora Capensis*, citing *Ecklon & Zeyher* 2023 from the Sonder Herbarium as the original material. Ecklon and Zeyher had misidentified this plant as the Linnaean *M. forficatum* L., a species from the Cape Peninsula currently included in *Erepsia* N.E.Br. (Liede, 1989; Hartmann, 1999). *M. aristulatum* was transferred to *Ruschia* (Schwantes, 1927) and is still listed in this genus by Hartmann (1999) who, for reasons that are unclear, questions the presence of the type at Kew. The holotype of this name is housed in the General Phanerogamic Herbarium, at the Swedish Museum of Natural History in Stockholm (S). Examination of the type material of *M. aristulatum* Sond., collected in "stony places on the sides of Lionsmountain", reveals that this plant matches specimens generally referred to as *R. pulchella*. The type sheet of *M. aristulatum* has been annotated by H.M.L. Bolus as "*R. pulchella* (Haw.) Schwantes". Characteristics of this heterophyllous species with sharply triquetrous, or rounded papillate leaves, shallow fruit with large closing bodies, and lacerate, diverging expanding keels all suggest it belongs in the genus *Antimima* N.E.Br. emend. Dehn.

For practical reasons, many recent collections have been named *R. pulchella* var. *caespitosa* L. Bolus, because the type of this name is available at the Bolus Herbarium (BOL). Recently this name was sunk under *R. pulchella* (Haw.) Schwantes (Hartmann, 1999). This is not accepted because the species is clearly misplaced in *Ruschia*, and because we consider the name to be ambiguous. In addition, the diagnosis provided by Hartmann (1999) states "pedicels with bracteoles more hairy than the foliage leaves at their middle". This does not match species from Table Mountain or Lion's Head. Although the name *M. pulchellum* is older than *M. aristulatum* and conserving the name may seem preferable, we regard the species as insufficiently known and maintain that it should be excluded from *Ruschia*. The following combination is therefore made:

Antimima aristulata (Sond.) Chesselet & G.F.Sm. **comb. nov.**
Mesembryanthemum aristulatum Sond. in *Flora Capensis* **2**: 424 (1861). Type: South Africa, **Cape, Lions Mt., August**, *Ecklon & Zeyher* 2023 (holo-, S!).
Ruschia aristulata (Sond.) Schwantes in *Zeits. Sukk.-kunde* **3**: 19 (1927).
Ruschia pulchella (Haw.) Schwantes var. *caespitosa* L. Bolus in *Notes on Mesembryanthemum and allied Genera* **2**: 123 (1929). Type: No locality, July–August 1929, R.H. Compton s.n. BOL 18956 (holo-, BOL).

Insertae Sedis
Mesembryanthemum pulchellum Haw. *non satis cognitum* in *Miscellanea naturalia* 72 (1803). Type: not found.
Ruschia pulchella (Haw.) Schwantes *non satis cognita* in *Zeitschr. Sukk.-kunde* **3**: 20 (1927).
Mesembryanthemum pulchellum Willd. in *Enumeratio plantarum Horti regii botanici Berolinensis* 537 (1809).
Mesembryanthemum canescens Haw. in *Revisiones plantarum succulentarum* 135 (1821).

Acknowledgements
We thank Dr Arne Anderberg of the General Phanerogamic Herbarium, Swedish Museum of Natural History, Stockholm (S) for the loan of valuable plant material, Dr Bob Chinnock (ex-ABLO) for searching the Herbarium at Kew for Haworth's material of *M. pulchellum* and Mr Barrie Low of Coastec for collections of live material. We also thank Mr Terry Trinder-Smith, from the Bolus Herbarium (BOL), University of Cape Town, for permission to reproduce the painting by Mary Page of *Mesembryanthemum aristulatum*.

References
DEHN, M. (1988). Untersuchungen zum Merkmalsbestand und zur Stellung der Gattung *Antimima* N.E.Br. emend. Dehn (Mesembryanthemaceae Fenzl). *Mitt. Inst. Allg. Bot. Hamburg* **22**: 189–215.
HARTMANN, H.E.K. (1999). An annotated list of the species placed in *Ruschia* (Aizoaceae). *Bradleya* **17**: 38–74.
HAWORTH, A.H. (1803). *Miscellanea naturalia*. J. Taylor, London.
HAWORTH, A.H. (1821). *Revisiones plantarum succulentarum*. R. & A. Taylor, London.
LIEDE, S. (1989). Untersuchungen zum Merkmalsbestand und zur Taxonomie der 'Erepsiinae' (Mesembryanthemaceae). *Beitr. Biol. Pflanzen* **64**: 391–479.
SALM-DYCK, J.F.M.A.H.I. (1837). *Monographia Generum Aloes et Mesembryanthemi*. Sect. 34, Fig. 1; Fasc. 2, Fig. 17.
SCHWANTES, G. (1927). Zur Systematik der Mesembrianthemen. *Zeitschr. Sukk.-kunde* **3**: 19.
SMITH, G.F. & WALKER, C.C. (2001). The botanical paintings of Mary Maud Page. *Bradleya* **19**: 124.
STEARN, W.T. (1939). An annotated index to Salm-Dyck's "Monographia Generum Aloes et Mesembryanthemi." *Cactus J. (Croydon)* **7**: 66–85.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 11

Chesselet, P. & Van Wyk, A.E. 2002. Mesembs with nut-like schizocarpic fruit and *Ruschianthemum* Friedrich sunk under *Stoeberia* Dinter & Schwantes Mesembryanthemaceae. *Bothalia* 187–189.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

MESEMBRYANTHEMACEAE

MESEMBS WITH NUT LIKE SCHIZOCARPIC FRUIT AND *RUSCHIANTHEMUM* FRIEDRICH SUNK UNDER *STOEBERIA* DINTER & SCHWANTES

INTRODUCTION

Fruit of most Mesembryanthemaceae are hygrochastic: they open, disperse seed and close again in response to moisture. This moisture-mediated mode of seed dispersal is achieved through a sophisticated mechanism based on the hygroscopic properties of expanding keels that function to open and close the valves or lids of loculicidal capsules (Hartmann 1988; Croizat 1993). In the more complex hygrochastic fruit, the amount of seed dispersed and their trajectories, are controlled through various structures such as covering membranes and closing bodies (Parolin 2001). However, modes of dispersal in Mesembryanthemaceae vary widely depending on the construction of the fruit. The genus *Carpobrotus* N.E.Br., for example, has edible berry-like fleshy fruit (sour fig), with seeds embedded in thick, sticky mucilage. A few genera possess xerochastic fruit that dehisce when dry.

XEROCHASTIC FRUIT

Mesemb genera with fruit which open when dry are found mostly in the tribe Apatesieae emend. Chesselet, G.F.Sm. & A.E.van Wyk (Chesselet *et al.* 2001). Species of *Conicosia* N.E.Br., for example, have capsules which function as shakers, in a way similar to that of poppies. In addition to having seeds in their locules, the fruit of *Conicosia* and *Skiatophytum* L.Bolus have seed chambers or pockets, the 'Samentaschen' of Schwantes (1949, 1957), in which a few seeds are entombed in woody tissue. A few genera possess schizocarpic fruit which break up into mericarps when dry. The terms schizocarp and mericarp are not used in their strictest sense here, because the mericarps of mesembs are formed by two halves of neighbouring carpels (Leistner 1958). The genus *Hymenogyne* Haw. has schizocarpic fruit which break up into 8–12 one-seeded, flat, broadly winged, circular mericarps. Seeing that the fruit of certain species of *Conicosia* may disintegrate in a comparable way, Schwantes (1927) erected the genus *Herrea* which is no longer considered distinct. The retention of seeds in seed pockets outside the locules was mentioned above for *Conicosia* and *Skiatophytum*. Among the Apatesieae this syndrome has reached its highest degree of development in *Caryotophora skiatophytoides* Leistner (Figure 3G, H). Its fruit is a schizocarp which breaks up into 3 or 4 nut-like mericarps. Two genera outside the Apatesieae also encompass species with seed enclosed in hard, woody, nut-like mericarps: *Brownanthus* and *Ruschianthemum*.

EVOLUTION OF NUT LIKE MERICARPS

The evolutionary development of nut-like fruit from hygrochastic capsules may be regarded as a convergent adaptive feature, since this has occurred more than once in the evolution of the Mesembryanthemaceae, with *Ruschianthemum gigas* (Dinter) Friedrich as an example from subfamily Ruschioideae (Figure 3A–D), and *Pseudobrownanthus nucifer* Ihlenf. & Bittrich from subfamily Mesembryanthemoideae (Figure 3E, F). We speculate that in these two species, the evolution of nuts may be a seed-protecting mechanism that has evolved under the extreme arid conditions that these species experience, both taxa being restricted to southern Namibia and the Richtersveld, South Africa. From a structural perspective, Hartmann (1988) ascribes the evolutionary derivation of nuts or nutlets in the mesembs to a process of increased sclerenchymatization of all tissues in the fruit. This phenomenon is supposedly associated with the evolutionary replacement of raindrops by wind as the prime dispersal agent in species exhibiting these characteristics (Hartmann 1988, 2001). However, diaspores are not accompanied by wings or plumes and the evolutionary change to nutlets may rather be an adaptation to larger seed size which may confer a competitive advantage to the seedlings, especially in areas with unpredictable follow-up rains. In *Caryotophora skiatophytoides* Leistner (Figure 3G, H) and in *Skiatophytum tripolium* (L.) L.Bolus (Figure 3I), the selective pressures are different from those acting in the arid parts of Namibia and South Africa. Both species occur in the fynbos vegetation of Western Cape, South Africa, with *C. skiatophytoides* from near Bredasdorp and *S. tripolium* from the Cape Peninsula and surrounding areas. Ecological factors that characterize this Mediterranean climate region include summer aridity, mineral-poor soils, wind and fire. *C. skiatophytoides* is only found in post-fire vegetation. This perennial plant is known to resprout from suckers following fire, whereas the annual *S. tripolium* reseeds after fire. In both cases seeds germinate with difficulty (Hickey & Van Jaarsveld 1995) and the nut-like fruit of

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

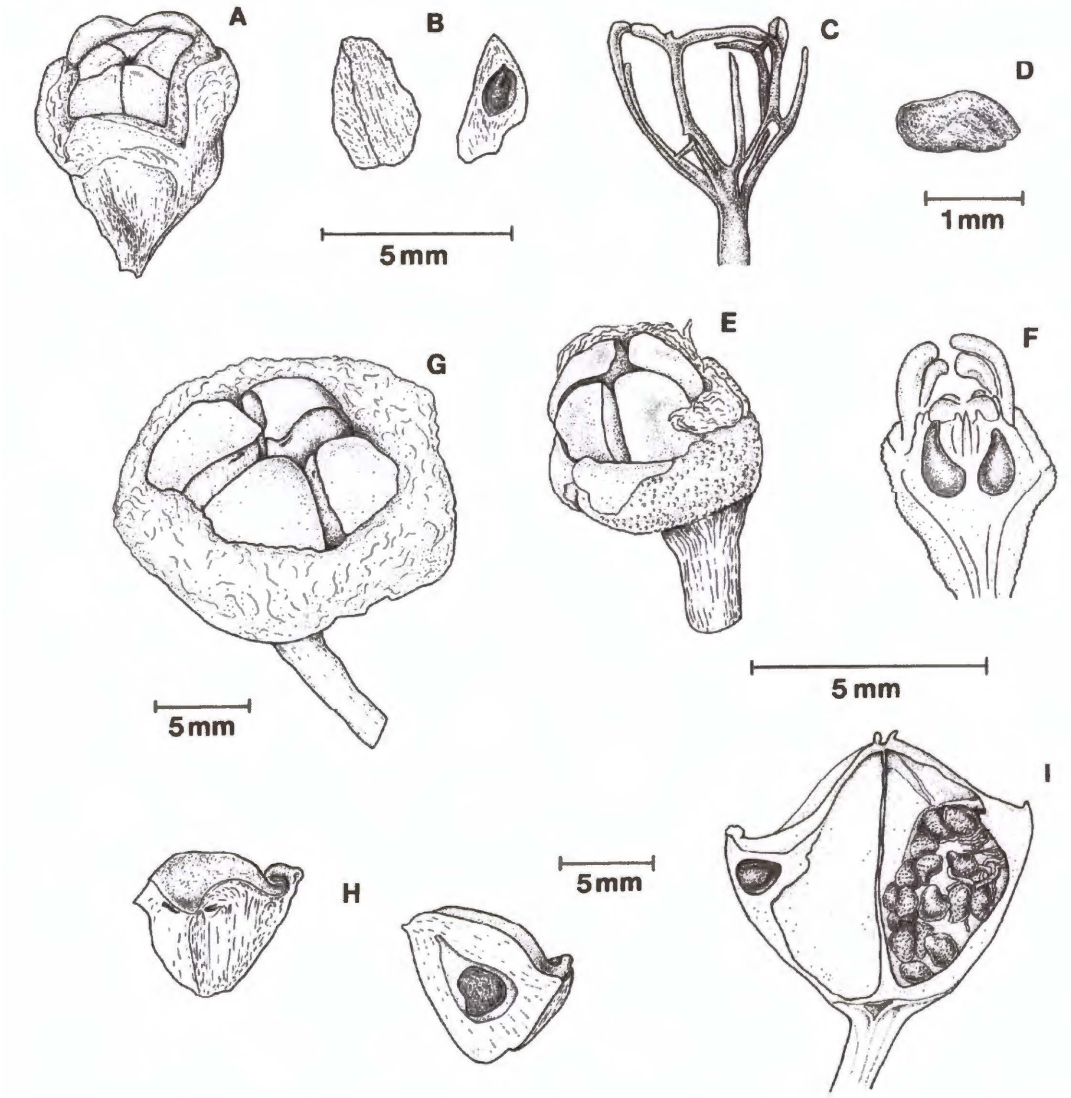


FIGURE 3.—Mesembs with nut-like schizocarpic fruit. A–D, *Stoeberia gigas*; E, F, *Brownanthus nucifer*; G, H, *Caryotophora skiatophytoides*; I, *Skiatophytum tripolium*. Scale bars: A–C, E–I, 5 mm; D, 1 mm. Artist: P. Chesselet.

C. skiatophytoides decay slowly in habitat. Hickey & Van Jaarsveld (1995) suggest that delayed seed germination is a survival strategy commonly found in fynbos plants.

BROWNANTHUS, RUSCHIANTHEMUM AND *STOEBERIA*

The unusual nut-like fruit of *Ruschianthemum gigas* and of *Pseudobrownanthus nucifer* were thought to be sufficient reason to establish the monotypic genera *Ruschianthemum* and *Pseudobrownanthus* (Friedrich 1960; Ihlenfeldt & Bittrich 1985). The widely accepted importance of fruit structure in the taxonomic subdivision of the family provided justification for these generic separations e.g. Dehn (1992), however, increasingly, fruit types are not regarded as superior characters for generic delimitation and all characters need to be considered (Klak 2001). In a recent study of *Brownanthus*, Pierce & Gerbaulet (1997) argued that *P. nucifer* is but a specialized member of *Brownanthus* which now contains 12 species, including the new combination *Brownanthus nucifer* (Ihlenf. & Bittrich) S.M.Pierce & Gerbaulet. This taxonomic decision is supported by molecular data, and *Pseudobrownanthus* is deeply embedded within *Brownanthus* (C. Klak, BOL, University of Cape Town, pers. comm.), suggesting that the nut-like fruit represents an autapomorphy for the species rather than a character providing resolution at genus level. The relative importance assigned to a character set, such as fruit structure,

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

and especially its relevance at a particular rank in the taxonomic hierarchy, needs to be carefully considered when establishing new genera based on autapomorphies. In an analysis of the genera of the Mesembryanthemaceae, Chesselet *et al.* (1995) showed a high number of monotypic genera in this family. Many taxonomists have misgivings about very large genera and genera with only one species, yet both are integral to classification schemes (Williams 1964). But, some monotypic genera are founded on peculiarities, and under such circumstances genus and species concepts may converge, as in the case of *Pseudobrownanthus*. In this paper, we use similar argumentation to resurrect *Stoeberia gigas* (Dinter) Dinter & Schwantes.

The type of *Ruschianthemum gigas* (Dinter) Friedrich was collected in the Klinghardt Mountains of southern Namibia in September 1922 by Moritz Kurt Dinter, a renowned botanist and botanical explorer of Namibia. Prior to the establishment of *Ruschianthemum*, *Mesembryanthemum gigas* Dinter (Dinter 1923) was placed in the genus *Stoeberia* Dinter & Schwantes emend. Friedrich, emend. Dehn (Schwantes 1927–1928; Friedrich 1960; Dehn 1992), together with *S. beetzii* (Dinter) Dinter & Schwantes and *S. rupis-arcuatae* (Dinter) Dinter & Schwantes, a species that is now classified in the genus *Amphibolia* L.Bolus. *Ruschianthemum* was established by Friedrich (1960) on account of its unusual fruit structure—the mature fruit of *R. gigas* is a five-locular schizocarp which breaks into nutlets consisting of parts of the septum enclosing one seed and the remains of valve wings and expanding keels adhering to each unit. Following the release of the nutlets, persistent dorsal and apical connecting vascular bundles present in the capsule remain on plants as a fibrous, basket-like skeleton (see Smith *et al.* 1998: 363; Burgoyne 2000: 8). Although used as a diagnostic feature of *Ruschianthemum* (Dehn 1992), similar basket-like fruit remains have now also been noted in *Stoeberia frutescens* (L.Bolus) Van Jaarsv. When not in fruit, *R. gigas* may be easily mistaken for a *Stoeberia* which it closely resembles (Van Jaarsveld 1994).

Ruschianthemum has been classified together with *Stoeberia*, *Amphibolia* and *Eberlanzia* Schwantes in the '*Eberlanzia* Group' by Hartmann (1998). This group shares the following characteristics: stems whitish; capsules with valve wings and closing bodies which are mostly small and often deep inside the locules so that they appear absent. In this group, *Ruschianthemum* is closest to *Stoeberia* (Hartmann 2001), sharing with it the nearly club-shaped leaves and the rich dichasial inflorescences. The flowers of *Ruschianthemum* closely resemble those in the genus *Stoeberia*—they are relatively small and numerous, with pink-tipped filamentous staminodes arranged in a cone; *S. carpii* Friedrich with its large white flowers, is unique in the genus but fruit and vegetative characters support its current placement in *Stoeberia*. Both genera have the lophomorphic holonectary characteristic of genera placed in Tribe Ruschieae Schwantes by Chesselet *et al.* (2001, in press).

In Schwantes' (Schwantes 1927–1928) key to mesemb genera, *Stoeberia* is distinguished from other genera by its capsule with rudimentary covering membranes that are developed as a narrow rim, with valve wings, and very large placental tubercles (closing bodies) and stigmas that are short, dark and feathered. In the present circumscription of *Stoeberia* the valves do not close again completely once they have opened, and hard (sclerified) valve wings and recurved valve rims characterize the fruit (Chesselet *et al.* 2000). If we amend these diagnostic characters to sclerification of fruit tissue in a broader sense, we can accommodate *R. gigas* in *Stoeberia* and reassign this species accordingly.

Stoeberia gigas *(Dinter) Dinter & Schwantes* in Zeitschrift für Sukkulentenkunde 3: 17 (1927).

Mesembryanthemum gigas Dinter in Feddes Repertorium 19: 153 (1923). *Ruschianthemum gigas* (Dinter) Friedrich in Mitteilungen der Botanischen Staatssammlung, München 3: 564 (1960). Type: Namibia, Klinghardt Mountains, September 1922, *Dinter 3791* (B!, holo.).

REFERENCES

BURGOYNE, P.M. 2000. Will the real *Ruschianthemum gigas* please stand up! *Aloe* 37: 8.

CHESSELET, P., MÖSSMER, M. & SMITH, G.F. 1995. Research priorities in the succulent plant family Mesembryanthemaceae Fenzl. *South African Journal of Science* 91: 197–209.

CHESSELET, P., SMITH, G.F., BURGOYNE, P.M., KLAK, C., HAMMER, S.A., HARTMANN, H.E.K., KURZWEIL, H., VAN JAARSVELD, E.J., VAN WYK, B-E., & LEISTNER, O.A. 2000. Mesembryanthemaceae. In O.A. Leistner, Seed plants of southern Africa: families and genera. *Strelitzia* 10: 360–410.

CHESSELET, P., SMITH, G.F. & VAN WYK, A.E. 2001. A new tribal classification for the Mesembryanthemaceae Fenzl based on characters of the floral nectary. *Aloe* 38: 25–28.

CHESSELET, P., SMITH, G.F. & VAN WYK, A.E. in press. A new tribal classification of the Mesembryanthemaceae: evidence from floral nectaries. *Taxon*.

CROIZAT, L. 1993. On the structural and developmental history of the capsule of *Mesembryanthemum s.l. Kirkia* 14: 145–169.

DEHN, M. 1992. Untersuchungen zum Verwandtschaftskreis der Ruschiinae (Mesembryanthemaceae Fenzl). *Mitteilungen aus dem Institut für Allgemeine Botanik, Hamburg* 24: 91–198.

DINTER, K. 1923. Beiträge zur Flora von Südwestafrika. *Feddes Repertorium* 19: 153.

FRIEDRICH, H.-Chr. 1960. Mesembryanthemenstudien 1. Beitrag zur Kenntnis der Gattungen *Stoeberia* Dtr. & Schw. und *Ruschianthemum* Friedr. gen nov. *Mitteilungen der Botanischen Staatssammlung, München* 3: 554–567.

HARTMANN, H.E.K. 1988. Fruit types in Mesembryanthema. *Beiträge zur Biologie der Pflanzen* 63: 313–349.

HARTMANN, H.E.K. 1998. A letter to the MSG. *Mesemb Study Group Bulletin* 2: 32–34.

HARTMANN, H.E.K. 2001. *Illustrated handbook of succulent plants*: Aizoaceae F–Z. Springer-Verlag, Berlin.

HICKEY, B. & VAN JAARSVELD, E. 1995. Propagation of three rare and endangered vygies. *British Cactus and Succulent Journal* 13: 141–146.

IHLENFELDT, H-D. & BITTRICH, V. 1985. Morphologie, Gliederung und Abgrenzung der Gattung *Psilocaulon* N.E.Br. *s.l.* (Mesembryanthemaceae). *Botanische Jahrbücher* 105: 289–322.

KLAK, C. 2001. *Phylogeny and character evolution in the* Lampranthus *group (Aizoaceae Ruschioideae)*. Ph.D. thesis, University of Cape Town.

LEISTNER, O.A. 1958. A new monotypic genus of the Mesembryanthemaceae. In H.M.L. Bolus, *Notes on* Mesembryanthemum *and allied genera* 3: 289–291.

PAROLIN, P. 2001. Seed expulsion in fruits of Mesembryanthema (Aizoaceae): a mechanistic approach to study the effect of fruit morphological structures on seed dispersal. *Flora* 196: 313–322.

PIERCE, S.M. & GERBAULET, M. 1997. *Brownanthus* Schwantes (Mesembryanthemoideae, Aizoaceae); two new species and a new combination from the Richtersveld and southwestern Namibia. *Aloe* 34: 42–44.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

SCHWANTES, G. 1927. Einige neue Mesembrianthemaceen. *Möllers Deutsche Gärtner-Zeitung* 42: 436.

SCHWANTES, G. 1927–1928. Zur Systematik der Mesembrianthemen. *Zeitschrift für Sukkulentenkunde* 3: 16–30.

SCHWANTES, G. 1949. Biology and systematics of Mesembryanthemum. *The National Cactus & Succulent Journal*, December 1949: 73, 74.

SCHWANTES, G. 1957. *Flowering stones and mid-day flowers*. Ernest Benn, London.

SMITH, G.F., CHESSELET, P., VAN JAARSVELD, E.J., HARTMANN, H., HAMMER, S., VAN WYK, B.-E., BURGOYNE, P., KLAK, C. & KURZWEIL, H. 1998. *Mesembs of the world*. Briza Publications, Pretoria.

VAN JAARSVELD, E. 1994. A synopsis of the genus *Stoeberia*. *Aloe* 31: 68–76.

WILLIAMS, C.B. 1964. *Patterns in the balance of nature and related problems in quantitative ecology*. Academic Press, London.

P. CHESSELET* and A.E. VAN WYK**

* Compton Herbarium, National Botanical Institute, Private Bag X7, 7735 Claremont, Cape Town. E-mail: chesselet@nbict.nbi.ac.za; http://www.nbi.ac.za

** H.G.W.J. Schweickerdt Herbarium, Department of Botany, University of Pretoria, 0002 Pretoria. E-mail: avanwyk@scientia.up.ac.za

MS. received: 2001-10-31.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 12

Chesselet, P. & Anderson, F. 2003. *Dorotheanthus rourkei*. Mesembryanthemaceae. South Africa. *Flowering plants of Africa* 58: 70–73.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Flowering Plants of Africa 58: 70–73 (2003)

Dorotheanthus rourkei Mesembryanthemaceae

South Africa

Dorotheanthus rourkei *L.Bolus* in Journal of South African Botany 35: 143, 144 (1969); *Sineoperculum rourkei* (L.Bolus) Van Jaarsv.: 5–10 (1982).

The last paper published by Dr H.M. Louisa Bolus, at the age of 92, included descriptions of four new mesemb species, among these the spectacular annual *Dorotheanthus rourkei* (Bolus 1969). This species was described from material collected by Dr John Rourke in deep red sands south of Garies, Namaqualand, in 1967, a remarkably good year with abundant rainfall.

A second collection was made northwest of Nuwerus by Dr Rourke and Mr Harry Hall in 1974, another exceptionally wet year. Live plants were brought back on this occasion and Fay Anderson painted the illustrated specimen. On this trip, Dr Rourke reported that plants covered several hectares of a fallow wheat field in a solid blanket of scintillating scarlet. Although described in 1969, specimens of this species were collected as early as 1929 by Mr Hans Herre. The flowers of *Dorotheanthus rourkei* are exceptional in that the scarlet petals shine in the sun, as if dusted with a gold powder—a phenomenon of light almost impossible to reproduce in watercolour. Other colour forms do exist, however, and range from whitish to rarely pure yellow to salmon-pink. The species is known from Succulent Karoo vegetation in very dry, red, well-drained sands, on flat to hilly coastal plains that are granitic in origin (Figure 1). Plants experience rainfall of between 100–200 mm per annum (Van Jaarsveld 1982).

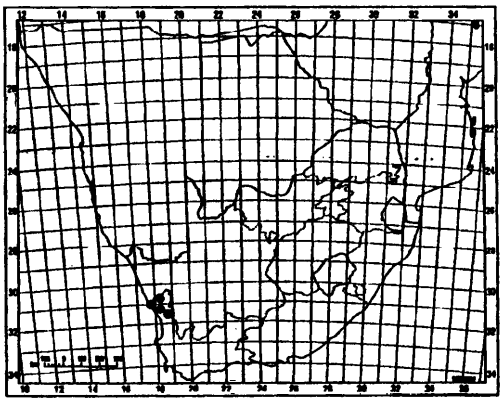


FIGURE 1.—Known geographical distribution of *Dorotheanthus rourkei*.

PLATE 2191.—1, habit, × 1; 2, petal, × 2; 3, flower, with petals and sepals removed, × 2; 4, longitudinal section of flower, × 2; 5, closed fruit, × 1; 6, open fruit, × 1. Voucher specimen: *Rourke 1423* in Compton Herbarium, Kirstenbosch. Artist: Fay Anderson. Painted from material collected in the field near Nuwerus, Western Cape Province, South Africa.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

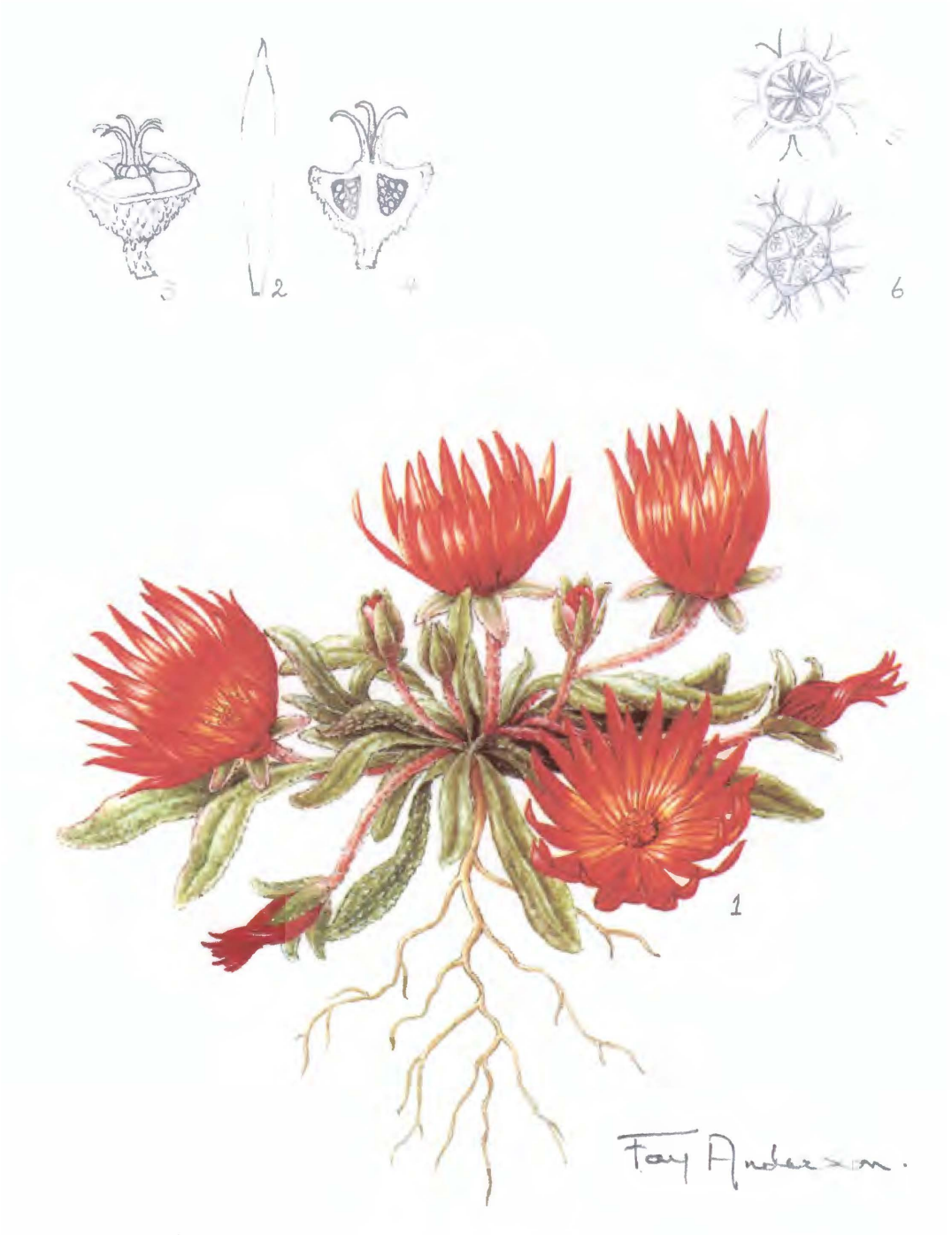


Plate 2191 ***Dorotheanthus rourkei***

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

A number of plants have been named for Dr John Rourke, including *Leucadendron rourkei* I.J.M.Williams, *Diosma rourkei* I.J.M.Williams and *Grubbia rourkei* Carlquist. As a specialist on the Cape flora, Dr Rourke's primary interest has been in the systematics of the Proteaceae but his wide-ranging interests encompass many aspects of Cape history. He has been curator of the Compton Herbarium, Kirstenbosch, since 1972.

The genus *Dorotheanthus* was established by Prof. Gustav Schwantes and named for his mother Dorothea (Schwantes 1927). It comprises small annual herbs with semisucculent leaves and stems that glisten with shining water-filled cells. Flowers are solitary and usually large, colourful and very attractive. *D. bellidiformis* (*Bokbaaivygie*) is a particularly well-known garden annual in South Africa and in many other parts of the world. In contrast, *D. rourkei* is very difficult to cultivate—seeds do not germinate readily in cultivation, but germination can be improved if the seeds are sown in a pot in summer, kept dry and hot and then watered liberally in autumn. With this requirement of a tremendous baking of seed banks during the summer months *D. rourkei* is, however, successfully cultivated in Australia.

Dorotheanthus rourkei is distinguished from other members of the genus by a number of features: colour of the flower is unique, the pure violet of the petal bases in some populations is without equal, and the intensity of the scarlet exceeds even that of *Drosanthemum speciosum*; the petals are sharply acuminate, a feature not present in any other species of *Dorotheanthus*. Characters of the fruit also differ from other species of *Dorotheanthus* as the fruit do not have covering membranes over the locules and valve wings are absent. However, subtribe Dorotheanthinae, which comprises three small genera of semisucculent annual plants (*Dorotheanthus*, *Cleretum* and *Aethephyllum*) is characterised by a highly variable fruit structure (Ihlenfeldt & Struck 1986). According to Dr John Rourke (pers. comm.), Bolus (1969) was uncertain of her placement of this species in the genus *Dorotheanthus*. Differences in fruit structure are commonly used to justify the placement of species within genera of the mesembs, and in 1982 Van Jaarsveld established the genus *Sineoperculum* to accommodate this species. However, in a recent treatment of the Dorotheanthinae the species was returned to *Dorotheanthus* (Ihlenfeldt & Struck 1986; Struck & Hartmann 2001). *D. rourkei* is retained in *Dorotheanthus* following observations on the variation of fruit morphology in the genus (Struck 1989). The species of (subgenus) *Dorotheanthus* show seven types of capsules differing in the extension or even lack of covering membranes. These fruit types follow a topocline roughly from south to north: as aridity increases, the covering membranes become more and more reduced, the capsules tend to be simpler and more brittle, and seed retention decreases. This

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

succession of capsule types can be interpreted as an adaptation to increasingly dryer localities—with the capsules of *D. rourkei* at the dry end. Nevertheless, the morphological 'gap' between the covering membranes being present versus absent has been considered by Struck (1989) as significant enough to treat *D. rourkei* as a distinct species.

Description.—Annual herbaceous semisucculent plant up to 70 mm high and 140 mm in diameter; herbaceous parts distinctly papillose. *Leaves* spathulate to linear, 25–40 × 7 mm; petioles 15–60 mm long. *Receptacle* obconical, up to 4 mm long, up to 5 mm in diameter, or in fruit up to 10 mm in diameter. *Sepals* 5, obtuse, 8–10 mm long, at base 2–4 mm wide, with prominent venation and very narrowly margined. *Petals* 4-seriate, acute or acuminate, very broad near middle, up to 4 mm wide, 30 mm long, mostly scarlet or deep red, rarely salmon-coloured with dark red bases or yellow or white. *Staminodes* 3-seriate; filaments usually red, 2–3 mm long; anthers yellow. *Stigmas* 5, narrowly subulate, 3 mm long in flower and 5 mm long in immature fruit, sometimes united at base into a style, persistent on fruit and splitting when valves open. *Fruit* a hygrochastic capsule, covering membranes reduced to ledges on septa, valve wings absent. *Seeds* numerous, smooth, pale brown. Plate 2191.

REFERENCES

BOLUS, H.M.L. 1969. Notes on *Mesembryanthemum* and allied genera. *Journal of South African Botany* 35: 143, 144.

IHLENFELDT, H-D. & STRUCK, M. 1986. Morphologie und Taxonomie der Dorotheanthinae Schwantes (Mesembryanthemaceae). *Beiträge zur Biologie der Pflanzen* 61: 411–453.

SCHWANTES, G. 1927. *Dorotheanthus* gen. nov. *Möllers Deutsche Gärtner-Zeitung* 42: 283.

STRUCK, M. 1989. The biology of the fruit capsules in *Dorotheanthus* Schwantes (Mesemb.). *Veld & Flora* 75: 41–43.

STRUCK, M. & HARTMANN, H.E.K. 2001. *Dorotheanthus*—Ruschioideae. In H.E.K. Hartmann (ed.), *Illustrated handbook of succulent plants: Aizoaceae A–E.* Springer, Berlin, Heidelberg, New York.

VAN JAARSVELD, E.J. 1982. *Sineoperculum* Van Jaarsveld: 'n nuwe monotipiese genus in die familie Mesembryanthemaceae. *Journal of South African Botany* 48: 5–10.

P. CHESSELET* and FAY ANDERSON**

* Compton Herbarium, National Botanical Institute, Private Bag X7, Claremont, 7735 South Africa.

** 6 Murray Road, Kenilworth, 7700 South Africa.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 13

Chesselet, P., Hammer, S.A. & Oliver, I. 2003. *Brianhuntleya*, a new genus endemic to the Worcester-Robertson Karoo, South Africa. Notes on African plants. Mesembryanthemaceae. *Bothalia* 33:160–164.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

MESEMBRYANTHEMACEAE

BRIANHUNTLEYA, A NEW GENUS ENDEMIC TO THE WORCESTER-ROBERTSON KAROO, SOUTH AFRICA

INTRODUCTION

A fundamental principle emerging from Aristotle's biological work, in about 335 BC, and upon which the earliest classification systems were built, is translated as 'the *species* is defined by the *genus* and the *difference*' (Greuter 2002). This Aristotelian logic is at the core of the Linnaean classification system and can be applied to any hierarchical system. The concept becomes more challenging in the case of genera containing single species, and, unlike early classification systems, most modern ones do contain high numbers of monotypic genera (Williams 1964). This has also been shown for Mesembryanthemaceae (Chesselet *et al.* 1995), and currently, 27 genera out of 124, including the one described here, are monotypic. It is one thing to lament monotypes, quite another to find a logical alternate home for, e.g., *Didymaotus* N.E.Br. When a species is sufficiently different from all others, it is necessary to create a new genus to accommodate the 'difference'.

A new monotypic genus, *Brianhuntleya* Chesselet, S.A.Hammer & I.Oliver is here described. It comprises a single species, *Brianhuntleya intrusa* (Kensit) Chesselet, S.A.Hammer & I.Oliver. Formerly placed in *Ruschia* Schwantes, it is removed from the genus on the basis of a unique suite of characters. The morphology, distribution, ecology and phylogenetic affinities of *Brianhuntleya* are discussed.

Our new genus is named in honour of Prof. Brian John Huntley, Chief Executive Officer of the National Botanical Institute, South Africa, since 1990. We feel that it is appropriate to name this genus *Brianhuntleya* in appreciation of his considerable contribution to the advancement of biodiversity research and conservation in southern Africa.

In recent years a number of new genera have been described in Mesembryanthemaceae, of which several pay tribute to botanists, notably *Ihlenfeldtia* H.E.K.Hart-

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

mann (Hartmann 1992); *Hartmanthus* S.A.Hammer (Hammer 1995a) and *Hammeria* Burgoyne (Burgoyne *et al.* 1998). Curiously, all three of these are bitypic.

A live plant in fruit (*Chesselet & Oliver 485*), collected near Worcester, on the road to Robertson, in December 2002, was brought to the Compton Herbarium at Kirstenbosch for identification. The singular combination of characteristics, particularly of the pedicel, calyx and fruit, precluded a suitable generic placement in the current system for mesembs. However, it was necessary to search for a species name, as Louisa Bolus had named most mesembs, and often more than once, during the years of intensive collecting and describing of new species in the first half of the 20th Century, and indeed the plant was finally identified as *Ruschia intrusa* (Kensit) L.Bolus. It is significant that we had trouble finding a 'Bolus name': it didn't occur to us that anyone would ever have placed this plant in *Ruschia*!

The following combination of features distinguishes *B. intrusa* from all other mesembs: 'intruse' calyx tube; unique, finely striate wax cover of the leaves, echinate, highly papillate seed; sigmoid, succulent pedicel that withers, allowing fruit to break off from the mother plant and disperse seed from the well-separated fruit; flat bowl-shaped capsule base enabling rain-splash dispersal in detached fruit (usually found in some multilocular fruit).

Brianhuntleya *Chesselet, S.A.Hammer & I.Oliver*, gen. nov. (Ruschieae Schwantes; Mesembryanthemaceae Fenzl). Type species: *B. intrusa* (Kensit) Chesselet, S.A.Hammer & I.Oliver.

Fruticulus perennis caespitosus repens, radice palari centrali radicibusque vadosis e nodis basalibus enatis; rami prostrati lignosi reliquuis dessicatis parum priorum foliorum tectis. *Folia* trigona connata, basin versus rubicunda, carinata griseo-viridia, tegmine cereo crasso striato, pro parte in lamellas foliis crescendibus delabente, unum vel duo pares foliorum ad extremitates ramulorum brevium. *Flos* solitarius in pedicello longo crasso sigmoideo carnoso, fructu ubi maturo exarescenti desiccanti disrumpentique. *Pedicellus* ebracteatus, sed evolutio pedicelli florisque concurret cum productione paris foliorum quod primo bracteas simulare potest. *Calyx* truncatus, tubum formans, sepalis 5 subaequilongis, 3 membranaceis. *Petala* magenteo-purpurea, uniseriata, staminodia filamentosa nulla; staminum classes staturae tres, stamina basin versus papillata, apicibus roseis, conum centralem circum stigmata formantes, polline pallide flavo; styli subulati, longitudine mediocri. *Nectarium* cristatum annulare (holonectarium lophomorphum). *Fructus* capsula 5-locularis hygrochastica, basi crateriformi, supra elevata; valvae apertae horizontales, corpora claudentia magna, loculorum exitos obstantia, propter texturam spongiosam albida, membranae tegentes centrum fructus versus elevatae, liminibus claudentibus in superficie inferiora distali; dispersio seminum ope ejectionis per membranes tegentes carinae dilatantes divergentes, a laminis dilatantibus distinctae, brunneae, laceratae, in subulam desinentes; alae valvarum nullae. *Semina* rubiginosa, ± 1 mm longa, propter papillas longas echinata.

Perennial, tufted, creeping dwarf shrub with a central taproot and shallow roots arising from nodes at base of plant; branches prostrate, woody, covered with dried remains of previous leaf pairs. *Leaves* trigonous, fused, reddish at base, keeled, grey-green with thick, striate, wax cover that flakes off partially as leaves expand, one or two leaf pairs at ends of short shoots. *Flowers* solitary, borne on long, thick, sigmoid succulent pedicel that shrivels, dries out and breaks off when fruit is ripe. *Pedicel* without bracts, but development of pedicel and flower coincides with production of a leaf pair that in early stages may resemble bracts. *Calyx* truncate, forming a calyx tube, 5 sepals more or less of equal length, 3 membranous. *Petals* magenta-purple, in a single whorl; filamentous staminodes absent; three size classes of stamens, with papillate bases and pink tips, forming a central cone around stigmas; pollen pale yellow; styles subulate, of medium length. *Nectary* crested, annular (lophomorphic holonectary). *Fruit* 5-locular, hygrochastic capsule, base bowl-shaped and top raised; valves opening to horizontal position, closing bodies large, blocking exits of locules, whitish from spongy tissue, covering membranes raised towards centre of fruit, with closing ledges on distal undersurface; ejection dispersal through covering membranes; expanding keels diverging, distinct from expanding sheets, brown, lacerate, ending in an awn; valve wings absent. *Seeds* reddish, ± 1 mm long, echinate from long papillae.

The genus includes a single species:

Brianhuntleya intrusa *(Kensit) Chesselet, S.A.Hammer & I.Oliver*, comb. nov.

Mesembryanthemum intrusum Kensit in Bolus & Kensit in Transactions of the Royal Society of South Africa 1: 151 (1909). *Ruschia intrusa* (Kensit) L.Bolus: 220 (1950). Lectotype: Cape, hills near Robertson, July 1901, *Marloth 4592* (BOL!).

Emended species description

Tufted plant, 70–100 mm high; branches decumbent, woody, old leaves persistent on plant. *Leaves* trigonous, 50–60 × 7–8 mm, grey-green, reddish at bases, waxy, keel indistinct; arising from between 2 pairs of young green leaves in axil of older pair. *Flowers* up to 35 mm diam., spreading; pedicel 30–50 mm long, succulent. *Sepals* 5, of subequal length, 3 membranous, up to 3 mm long; petals up to 17 × 1.5 mm, 1-seriate, pale rose-purple; nectary green, annular and crested; top of ovary raised, convex; stigmas 5, subulate, acuminate, 2 mm long; stamens in 3 rows, 2–4 mm long, pinkish at tips; anthers and pollen pallid. *Fruit* 5-locular, hygrochastic capsule, 7.5–9.0 mm diam., 4 mm deep, valves raised, 4 mm high; seed 1 mm long. Flowers open for a few hours in the afternoon. *Flowering time*: late May–June in cultivation and July in the wild. Figure 3.

Etymology: the specific epithet *intrusum*, from the Latin *intrusus*, is used in the botanical context to describe a form that appears pushed or thrust inwards. In this context Bolus used the term to describe the 'very peculiar truncate somewhat intruse calyx tube' characteristic of this species (Bolus & Kensit 1909).

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

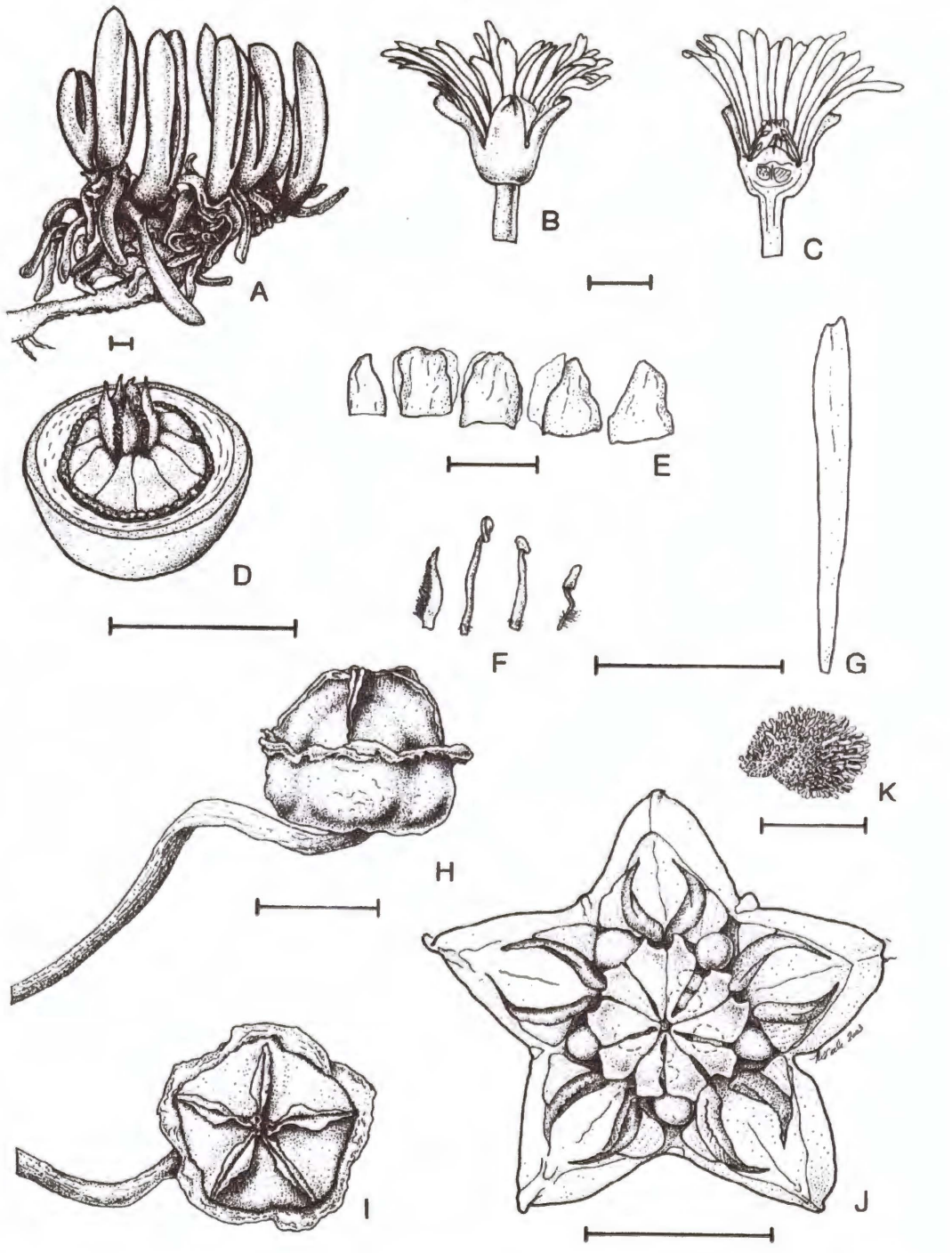


FIGURE 3.—Morphology of *Brianhuntleya intrusa*. A, habit, showing upright leaf pairs and creeping stems with accumulated dead leaves from previous growth; B, flower showing 'intruse' calyx; C, l/s flower; D, gynoecium with ring-like beaded nectary; E, five subequal sepals; F, stigma and three size classes of stamens; G, petal from single whorl. H–J, fruit: H, side view showing flat base, raised valves and long, withered pedicel; I, top view; J, open fruit with large whitish closing bodies, covering membranes and expanding keels. K, echinate seed. Scale bars: A–J, 5 mm; K, 1 mm.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

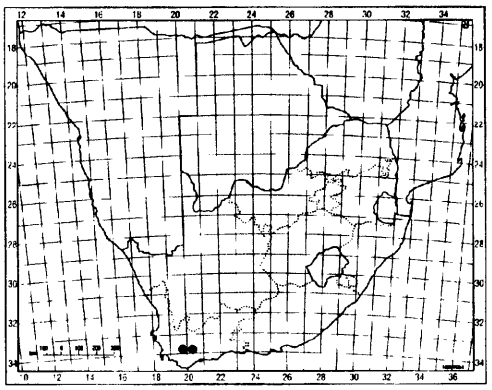


FIGURE 4.—Known geographical distribution of *Brianhuntleya intrusa*.

Distribution and ecology: the genus *Brianhuntleya* is endemic to the Worcester-Robertson Karoo, part of the Succulent Karoo Biome, from which 11 genera and 37 species of mesembs are known (Chesselet *et al.* in prep.). The monotypic genus *Stayneria* L.Bolus is the only other mesemb genus endemic to the Worcester-Robertson Karoo, where it is confined to Renosterveld in the Breede River Valley, from Worcester to McGregor.

B. intrusa is known from populations at Worcester, Robertson, Montagu, McGregor and Bonnievale, all in the Breede River Valley, where it is restricted to eroded Malmesbury Shale sometimes interspersed with small chunks of surface quartzite (Figure 4). Plants grow on low hills at altitudes ranging from 200–250 m, in full sun, with mixed succulent vegetation that includes *Ruschia caroli*, *Adromischus filicaulis*, *Poellnitzia rubriflora* and *Conophytum ficiforme*. Near Bonnievale it grows with *Acrodon purpureostylus*.

In horticulture *B. intrusa* is very resilient, not sensitive to over-watering, and it produces its splendid flowers at a time when most vygies are without flowers. It becomes quite luxuriant if well watered, forming a grey-green ground cover, reminiscent of some species of *Carpobrotus* N.E.Br. It is so undeservedly obscure in horticulture that a recent plant list noted that, until recently, no one had ever purchased it.

With only a few known populations, *B. intrusa* is already in a conservation programme at the Karoo Desert NBG. Live plants were collected in a salvage operation for *ex situ* and *in situ* conservation from a site of planned road works at the Gorees Hoogte Pass near Robertson. Once road works are complete, the area will be restored.

Systematic affinities: when Bolus (née Kensit) described *Mesembryanthemum intrusum* (Bolus & Kensit 1909), she suggested that the new species is affiliated to *M. divergens* Kensit, now *Antegibbaeum fissoides* (Haw.) Schwantes ex C.Weber from near Matjiesfontein, and to *M. brevipes* Schltr., now known as *Argyroderma fissum* (Haw.) L.Bolus, from the Knersvlakte. This latter association seems highly unlikely. However, both Klak *et al.* (2003) and Hartmann (2001a) follow Bolus's suggestion that *B. intrusa* may be closely related to the monotypic *Antegibbaeum* Schwantes ex C.Weber. Echinate seeds, which are characteristic of *B. intrusa*, feature in a number of genera in Mesembryanthemaceae including *Acrodon* N.E.Br., *Antegibbaeum*, *Braunsia* Schwantes and *Namaquanthus* L.Bolus.

It may be deduced from a recent molecular study of relationships in the *Lampranthus* Group (Klak *et al.* 2003), that *B. intrusa* would resolve as a clade with *Hammeria*, *Antegibbaeum*, *Smicrostigma* N.E.Br., *Zeuktophyllum* N.E.Br., *Vlokia* S.A.Hammer and '*Braunsia*' *vanrensburgii* (L.Bolus) L.Bolus. Diagnostic features of the fruit, however, conflict significantly with the proposed grouping of the above genera by Klak *et al.* (2003).

One cannot rule out the possibility that *B. intrusa* may belong to the mysterious '*Calamophyllum*', a genus erected by Schwantes (1927) based on cultivated plants. Species included in *Calamophyllum* were originally described by Haworth in the 1790s under *Mesembryanthemum* and have not been definitely identified since. Problems of correct identification in this genus are not surprising, as descriptions are conflicting and distributions unknown (Jacobsen 1960; Herre 1971; Smith *et al.* 1998; Hartmann 2001b). Some features that may support this possibility include the grey-green leaves of ± cylindrical shape, the long pedicel of *C. teretifolium* (Haw.) Schwantes, the leaves of *C. teretiusculum* (Haw.) Schwantes that may be impunctate (Hartmann 2001b), and the flowers seen in *Mesembs of the World* (Smith *et al.* 1998), as well as the illustration of the ovary with raised top and five stigmas shown in R. Darroll's illustration in Herre's (1971) *Genera of the Mesembryanthemaceae*.

Brianhuntleya grows sympatrically with *Acrodon purpureostylus* (L.Bolus) Burgoyne near Bonnievale, and it is remarkable how easily these plants can be confused with each other, both having similar grey-green leaves with reddish bases, creeping growth forms and detachable fruit. Nonetheless, *A. purpureostylus* is easily distinguished by its unwaxed leaves, *Acrodon*-type flowers (striate pink petals, stamens collected in a cone, plumose stigmas and pale pollen), and shiny orange, well-exposed stems reminiscent of species of *Jordaaniella* H.E.K.Hartmann. When Dehn (1992) revised the Ruschiinae, he annotated specimens of *Ruschia intrusa* as belonging to the genus *Acrodon* although this was later rejected. However, *B. intrusa* has pale pollen and echinate seed in common with species of *Acrodon*.

The transfer of *Ruschia purpureostyla* (L.Bolus) Bruyns to *Acrodon* (Burgoyne 1998) raised much controversy (Klak 2000; Hartmann 2001b). The lophomorphic holonectary of *A. purpureostylus*, shown to be a significant taxonomic character by Chesselet *et al.* (2002), precludes its inclusion in *Cerochlamys* N.E.Br, a genus with a lophomorphic meronectary, as suggested by Hartmann (2001b). The fruit of *A. purpureostylus* is similar to that of *B. intrusa* as it also has a withering pedicel and detaches from the mother plant, unlike the rather solid fruit with thick persistent pedicels of other species of *Acrodon* N.E.Br. The unusual fruit of *A. purpureostylus* either casts some doubt on its current generic placement or highlights strong selection for detachable fruit in their

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

mutual environment. The base is rounded and not flat as in *B. intrusa* and the covering membranes are not as raised or hardened, closing bodies are larger and spongier, the valves open to the upright position (as in other *Acrodon* and *Ruschia* species) and do not fold back to the horizontal position as in *B. intrusa*, thus excluding the possibility of these two species being congeneric.

A link to the *Leipoldtia* Group of Hartmann (1991) is suggested by *Brianhuntleya*'s unique fruit structure and overall resemblance to members of the genera *Cephalophyllum* N.E.Br. and *Cheiridopsis* N.E.Br. The floral resemblance may be more than superficial; it is remarkable how closely the flowers of *B. intrusa* resemble those of a typical 'showy' *Cephalophyllum* and how little they look like those of most *Ruschia* species (those being much smaller, and often bunched). In cultivation, *B. intrusa* crosses with *Cephalophyllum subulatoides* (Haw.) N.E.Br., a Little Karoo species, providing further support for its affinity to members of the *Leipoldtia* Group. The flat, bowl-shaped base is only known from genera such as *Cheiridopsis* and *Cephalophyllum*, however, these genera have multilocular fruits, whereas *Brianhuntleya* has a five-locular fruit. It is indeed a singular entity, and its placement has intrigued mesemb specialists for many years (Hammer 1995b; Hartmann 2001a; Klak *et al.* 2003).

ACKNOWLEDGEMENTS

We thank Overhex Wineries and Haw & Inglis (Pty) Ltd for taking an active interest in our indigenous flora and Dr Hugh Glen for the Latin translation.

Other specimens examined

WESTERN CAPE.—3319 (Worcester): Langvlei, (–DC), *Bruyns 9057* (BOL); Robertson, between McGregor and Bonnievale, (–DD), *Glen 624* (BOL). 3320 (Montagu): Bonnievale, (–CC), *R.H. Compton NBG1138/24* (BOL); *J. Lewis NBG1975/33* (BOL).

REFERENCES

BOLUS, H.M.L. 1950. *Notes on* Mesembryanthemum *and allied genera* 3: 220.

BOLUS, H.M.L. & KENSIT, L. 1909. Contributions to the African Flora. *Transactions of the Royal Society of South Africa* 1: 147–163.

BURGOYNE, P.M. 1998. Finding a place in the sun: where does *Ruschia purpureostyla* belong? *Aloe* 35: 60, 61.

BURGOYNE, P.M., SMITH, G.F. & CHESSELET, P. 1998. *Hammeria*, a new genus of Aizoaceae from South Africa. *Cactus and Succulent Journal* 70: 203–208.

CHESSELET, P., MÖSSMER, M. & SMITH, G.F. 1995. Research priorities in the succulent plant family Mesembryanthemaceae Fenzl. *South African Journal of Science* 91: 197–209.

CHESSELET, P., SMITH, G.F. & VAN WYK, A.E. 2002. A new tribal classification of Mesembryanthemaceae: evidence from floral nectaries. *Taxon* 51: 295–308.

CHESSELET, P., VAN WYK, A.E., GRIFFIN, N.J. & SMITH, G.F., in press. Patterns of floristic diversity in Mesembryanthemaceae. *Aloe*.

DEHN, M. 1992. Untersuchungen zum Verwandtschaftskreis der Ruschiinae (Mesembryanthemaceae Fenzl). *Mitteilungen aus dem Institut für Allgemeine Botanik, Hamburg* 24: 91–198.

GREUTER, W. 2002. The ancient Greek roots of biological sciences. *Flora Mediterranea* 12: 5–10.

HAMMER, S.A. 1995a. *Hartmanthus*, a new genus in Aizoaceae. *Haseltonia* 3: 77–82.

HAMMER, S.A. 1995b. A few observations on *Ruschia schwantii*. *Piante Grasse* 15: 51–58.

HARTMANN, H.E.K. 1991. Mesembryanthema. *Contributions from the Bolus Herbarium* 13: 75–157.

HARTMANN, H.E.K. 1992. *Ihlenfeldtia*, a new genus in Mesembryanthema (Aizoaceae). *Botanische Jahrbücher* 114: 29–50.

HARTMANN, H.E.K. 2001a. *Illustrated handbook of succulent plants. Aizoaceae A–E*. Springer.

HARTMANN, H.E.K. 2001b. *Illustrated handbook of succulent plants. Aizoaceae F–Z*. Springer.

HERRE, H. 1971. *The genera of the Mesembryanthemaceae*. Tafelberg, Cape Town.

JACOBSEN, H. 1960. *A handbook of succulent plants, vol. III. Mesembryanthemums (Ficoidaceae)*: 913–1441. Blanford, Poole.

KLAK, C. 2000. Taxonomic studies in the Aizoaceae from South Africa: three new species and some new combinations. *Bothalia* 30: 35–42.

KLAK, C., HEDDERSON, T.A. & LINDER, H.P. 2003. A molecular systematic study of the *Lampranthus* Group (Aizoaceae) based on the chloroplast *TrnL-trnF* and nuclear ITS and *5S* NTS sequence data. *Systematic Botany* 28: 70–85.

SCHWANTES, G. 1927. Zur Systematik der Mesembrianthemen. *Zeitschrift für Sukkulentenkunde* 3: 15, 28.

SMITH, G.F., CHESSELET, P., VAN JAARSVELD, E.J., HARTMANN, H., HAMMER, S., VAN WYK, B-E., BURGOYNE, P., KLAK, C. & KURZWEIL, H. 1998. *Mesembs of the World*. Briza Publications, Pretoria.

WILLIAMS, C.B. 1964. *Patterns in the balance of nature and related problems in quantitative ecology*. Academic Press, London.

P. CHESSELET*, S. HAMMER** and I. OLIVER***

* Compton Herbarium, National Botanical Institute, Private Bag X7, 7735 Claremont, Cape Town.

** Sphaeroid Institute, 845 Mason Road, Vista, California 92084, USA.

*** Karoo Desert NBG, P.O. Box 152, 6850 Worcester, South Africa.

MS. received: 2003-07-07.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 14

Chesselet, P. 2001. A new combination in *Antimima* N.E.Br. (Mesembryanthemaceae). *Aloe* 38: 17.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

A new combination in *Antimima* N.E.Br. (Mesembryanthemaceae)

Pascale Chesselet

A recent publication by Hartmann (1999) provides an annotated list of all species currently placed in *Ruschia* Schwantes, a large genus in the Mesembryanthemaceae Fenzl containing 224 species (Chesselet *et al.* 2000). *Ruschia insidens* L.Bolus is listed without comment or description. In a previous publication, Hartmann (1998) transferred 95 species from *Ruschia* to *Antimima* N.E.Br. as a consequence of the emended description of *Antimima* by Dehn (1988). Recently, Klak (2000) made the new combination *Antimima excedens* (L.Bolus) Klak for a species from the Knersvlakte, Namaqualand.

A plant collected from the sandstone plates on the plateau of the Oorlogskloof Nature Reserve, outside Nieuwoudtville and also known from the Gifberg, was identified as *Ruschia insidens* L.Bolus. In the absence of herbarium type material of the genus *Ruschia* (on loan in Hamburg), the identification was confirmed using a painting of live material of the type specimen (by Beatrice Carter) held at the Bolus Herbarium (BOL). Characteristics of the plant and investigation of the fruit showed that this species should be transferred to *Antimima*.

Criteria for inclusion of species into Antimima are outlined by Hartmann (1998). The following features are of relevance here:

- In the fruit, very large closing bodies are present at the distal exits of the locules. Although many of the fruit were heavily predated, losing the internal structure, some intact fruit were found with the large closing bodies typical of the genus *Antimima*.
- On the valves of the fruit the diverging expanding keels are broad and lacerate, almost merging with the expanding sheets.
- Very narrow closing ledges are present on the underside of the covering membranes.
- The fruit has a very shallow base.
- Plants are heterophyllous, with different leaf pairs developing according to season. The long-sheathed leaf pairs form papery, protective, sleeve-like covers; the assimilating pair are fused basally. Both leaf types are apiculate and papillate, with longer papillae along the margins. The species can therefore be included in the group defined by *Antimima* microphylla (Haw.) Dehn.

***Antimima insidens* (L.Bolus) Chesselet, comb. nov.**

Ruschia *insidens* L.Bolus, *Notes on* Mesembryanthemum *and allied Genera* part 2: 77 (1929).

Type: South Africa, Northern Cape, Calvinia div., Nieuwoudtville, April 1929, R.H. Compton s.n. NBG 1505/26 (BOL, holo.; painting BOL!).

Mesembryanthemum insidens (L.Bolus) N.E.Br., *Gardeners' Chronicle* 87: 32 (1930).

Acknowledgements

I thank Wessel Pretorius from the Oorlogskloof Nature Reserve (Northern Cape Nature Conservation), Barrie Low (Coastec) and Toni Milewski for a delightful field trip.

Literature

Chesselet, P., Smith, G.F., Burgoyne, P.M., Klak, C., Hammer, S.A., Hartmann, H.E.K., Kurzweil, H., van Jaarsveld, E.J., van Wyk, B-E., & Leistner, O.A. 2000. Mesembryanthemaceae. In: Leistner O.A. (ed.). Seeds plants of southern Africa: families and genera. *Strelitzia* 10: 360–410.

Dehn, M. 1988. Untersuchungen zum Merkmalsbestand und zur Stellung der Gattung *Antimima* N.E.Br. emend. Dehn (Mesembryanthemaceae Fenzl). *Mitteilungen aus dem Institut für Allgemeine Botanik. Hamburg* 22: 189–215.

Hartmann, H.E.K. 1998. New combinations in *Antimima* (Ruschioideae, Aizoaceae) from southern Africa. *Bothalia* 28: 67–82.

Hartmann, H.E.K. 1999. An annotated list of the species placed in *Ruschia* (Aizoaceae). *Bradleya* 17: 38–74.

Klak, C. 2000. Taxonomic studies in the Aizoaceae from South Africa: three new species and some new combinations. *Bothalia* 30: 35–42.

Pascale Chesselet

Compton Herbarium, National Botanical Institute,
Private Bag X7, Claremont 7735, South Africa.
e-mail: chesselet@nbict.nbi.ac.za

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Appendix 15

Taxon x character state matrix for identification of mesembs genera.

Note: This matrix is presented simply to confirm its generation using LucID. It has been modified and is being adapted for the Internet site www.mesembs.org. Taxa do not necessarily match the genera in chapter 6 and characters do not necessarily match or follow the order of the character list presented under 6.2.

```
#Lucid Interchange Format File v. 1.1

[..Character List..]
Distribution (Global)
 South Africa
 Namibia
 Botswana
 Lesotho
 Swaziland
 Mozambique
 Zimbabwe
 Angola
 Madagascar & Reunion
 Eastern Africa
 Australia & New Zealand
 USA
 Chile
 Mediterranean
Distribution (South Africa)
 Western Cape
 Northern Cape
 Eastern Cape
 Free State
 North-West Province
 Limpopo
 Gauteng
 KwaZulu/ Natal
 Mpumalanga
Overall appearance
 Semi-succulent, fleshy herb, often soft-leaved, sometimes glistening
 Stem-succulent
 Creeping succulent
 Tufted, or clump-forming or rosette-leaved succulent
 Stone plants consisting mostly of succulent leaves (stems not
visible)
 Succulent-leaved shrub (including dwarf shrubs)
 Spiny succulent-leaved shrub or subshrub
Life cycle
 Annual
 Biennial
 Perennial with annual branches
 Perennial
Flower colour
 Cream, yellowish
 Greenish
```


Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

White
Pale pink
Pink with stripe
Pink
Orange
Magenta
Red
Yellow
Yellowish-orange with stripe

Copper-coloured
Multi-coloured
Bicoloured, pink or magenta and white
Inflorescence characteristics
1, solitary
2
3, cymose
angular cyme
Many-flowered dichasia; compound cyme
Succulent cymose inflorescence
Number of locules
3
4
5
6
7
8
9
10
11
12
more than 12
Placentation
Axile
parietal to basal
Pedicel
sessile or sub-sessile
short pedicel
long pedicel
Long, highly succulent pedicel that withers when fruit is ripe
Leaf shape
Flat, mesophytic
flattish, withering to skeleton
Linear, mesophytic
Flattish, grooved upper surface, semi-succulent
Trigonous or triquetrous
Cylindrical, semi-cylindrical
Clavate
Tongue, strap-shaped, succulent
Fused and stem-sheathing at base, diverging at tips, highly succulent
Ovate
Spatulate
Falcate or lunate
Fused to form conical, oblong, or spherical bodies
Globose, forming a rounded body. fused basally
Rhomboid
Leaf surface characteristics
Sticky, with sand adhering
Distinctly waxy
Visible bladder cells, glistening and shiny in the light

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

bladder cells elevated and pointed at one or both ends
Xeromorphic bladder cells, hard water cells (10x lens)
Elongated, hair-like bladder cells
Smooth and untextured
Pellucid dots (subepidermal tannin idioblasts)
Papillate, rough to the touch
Velvety, from soft hairs
Echinate, prickly
Scattered visible hairs
Rough with white bumps or pustules
Leaf surface with ridges, woolly appearance
Textured with ridges and markings
Leaf margins and keel
Small bladder cells at margins
Undulated when young
Undulated or pinnatifid in adult leaf
Margins ciliate
Serrated margins or keel
Hard teeth, or bristles on margins or keel
Keel oblique or twisted
margins and keel unremarkable
Number of sepals
4
5
6
7
8
9
Relative lengths of sepals
almost equal
Unequal, with 2 or 3 longer ones
Flower size
Small (<20 mm)
Medium (20-40 mm)
Large (>40)
Diurnal floral rhythm
Opening in sunshine, midday
Opening in the afternoon
Opening in the early evening
Opening at night
Continuously open
Flowering time (seasonal)
Winter
Spring
Summer
Autumn
Petaloid staminodes
Present, spreading
Present, gathered with stamens in central cone
Present, not gathered with stamens in central cone
Absent (0 to few)
Floral nectaries
Koilomorphic meronectary
Broad, flat meronectary
Broad, flat holonectary
Lophomorphic meronectary
Lophomorphic holonectary
Nectary inconspicuous, absent
Bracts
Present, 1 pair
Present, 2 pairs

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Absent
Fruit dehiscence
hygrochastic, opening when wet
xerochastic, dehiscent when dry
Fleshy, indehiscent
Small 5-locular schizocarp, disintegrates into carpels
Small (4)5-locular nut (xerochastic)
Open fruit - covering membranes
Absent (Mesembryanthemoideae)
Absent, reduced to a limb
Present, small
Present, half to two thirds locule covered
Present, well developed
Open fruit - closing bodies
Absent
Absent, large spongy closing ledge
Absent, dense mass of funicular hairs at opening of locules
Present, bifid or two-lobed
Present, small, white
Present, small, sometimes rod or hood-shaped
Present, lens-shaped, large, splits longitudinally
Present, large and white
Open fruit - valve wings and flaps
Large flaps
Valve wings present, well developed
Valve wings well developed, hard (sclerified), rounded
valve wings present, awn like
valve wings absent
Leaves (petiolate..)
Petiolate
Stem clasping
Not petiolate
Leaf pair types
One type only (isophyllous)
Different shaped leaves at different seasons (heterophyllous)
Different shaped leaves on different parts of the plant
Heterophyllous in seedling stages only
Leaf pairs (degree of fusion)
Free
Basally connate
Partly fused
Entirely fused
Leaf Tips
Pointed
Rounded
Apiculate or mucronate
Tipped with diadem of hairs
Windowed
Rhomboid
Falcate
Leaf arrangement
Leaves alternate
Leaves alternate in inflorescences
Leaves opposite
Leaves distichous
Leaf sheaths
Absent
Old leaf sheaths persistent, papery or parchment-like
leaves, enclosed by brown to black sclerotic sheaths
Internodes enclosed by sclerotic bases old leaf sheaths
Stem

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

```
 Visible, internodes easily seen
 Visible, but very short, bearing a tuft of leaves
 present, hidden by highly fused sheathing leaves
 Visible, very short, hidden by densely packed leaves along branches
 Not visible (internodes abbreviated)
Stem consistency
 Fleshy (soft)
 Succulent (hard)
 Spongy or corky
 Woody
Stem shape
 4-angled
 Winged
 cylindrical
 articulated, beaded
Stem surface texture
 Papillate with large easily visible, glistening water cells
 Xeromorphic water cells
 Hairy
 Papillate when young
 Smooth
 With fringe of hair at nodes
Stem colour (mature stems)
 Greenish
 Yellowish
 Brownish
 Whitish or grey
 Bluish green
 Reddish
Branches
 Procumbent or decumbent or sprawling (not rooting at nodes)
 Creeping or saltating (rooting at nodes)
 Erect
 Climbing
Roots
 Fibrous, not enlarged, or slightly thickened
 Caudiciform stem and swollen roots
 Single or multiple swollen tubers (potato-like)
 Thick underground branching root (woody)
 Becoming thick and fleshy with age
 Roots, thick, spreading laterally, giving rise to suckers

[..Taxon List..]
Aptenia
Aridaria
Aspazoma
Brownanthus
Caulipsolon
Dactylopsis
Mesembryanthemum
Phyllobolus
Prenia
Psilocaulon
Sceletium
Synaptophyllum
Acrodon
Aethephyllum
Aloinopsis
Amphibolia
Antegibbaeum
Antimima
```


Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Apatesia
Arenifera
Argyroderma
Astridia
Bergeranthus
Bijlia
Braunsia
Brianhuntleya
Carpanthea
Carpobrotus
Carruanthus
Caryotophora
Cephalophyllum
Cerochlamys
Chasmatophyllum
Cheiridopsis
Cleretum
Conicosia
Conophytum
Corpuscularia
Cylindrophyllum
Deilanthe
Delosperma
Dicrocaulon
Didymaotus
Dinteranthus
Diplosoma
Disphyma
Dorotheanthus
Dracophilus
Drosanthemum
Eberlanzia
Ebracteola
Ectotropis
Enarganthe
Erepsia
Esterhuysenia
Faucaria
Fenestraria
Frithia
Gibbaeum
Glottiphyllum
Hallianthus
Hammeria
Hartmanthus
Hereroa
Hymenogyne
Ihlenfeldtia
Jacobsenia
Jensenobotrya
Jordaaniella
Juttadinteria
Khadia
Lampranthus
Lapidaria
Leipoldtia
Lithops
Machairophyllum
Malephora
Marlothistella
Mestoklema

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Meyerophytum
Mitrophyllum
Monilaria
Mossia
Namaquanthus
Namibia
Nananthus
Nelia
Neohenricia
Octopoma
Odontophorus
Oophytum
Orthopterum
Oscularia
Ottosonderia
Pleiospilos
Polymita
Psammophora
Rabiea
Rhinephyllum
Rhombophyllum
Ruschia
Ruschianthemum
Ruschianthus
Saphesia
Sarcozona
Schlechteranthus
Schwantesia
Scopelogena
Skiatophytum
Smicrostigma
Stayneria
Stoeberia
Stomatium
Tanquana
Titanopsis
Trichodiadema
Vanheerdea
Vanzijlia
Vlokia
Wooleya
Zeuktophyllum

[..Main Data (txs)..]
1400000000000044144044410100000001300300030000001330000100000000001000
0010300300030000000100000000000000000000010000031010100000111100110000
0000100001000000000000100003001000100000000000110100010000100010001000
0001000001001100010
1100000000000011100000000000100001303303000000000001000110000000001000
0000000100000000000000010000000000000000100000010103031001102000100000
0000100001000000000000000000011000010000000000010100010000000000100000
0000010000010100000
1000000000000011000000000000000000130300000000000100000011000000001000
0000001100000000000001000000000000000000110000010100000001001000100000
0000100001000000000000100000111000100000000001010100010000000000100000
0000010000010100000
1100000100000011000000001000000001100000000000001010000110000000001000
0000000100000000000001300000000030000000110000101301000001100001100000
0000100001000000000000100000011000130000000000010100010000010000100100
0031330031010100000

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

1000000000000011000000001000000010001000000000001010000010000000001000
0000000100000000000000010000000000000000000000001000000110000011000
0000100001000000000000100000011000100000000000010100010000010000100
0101000001000001000
1000000000000010000000000010000000010000000000010000000100000000101
0000000100000000000000010000000000000000100001010000001000010001000
0000100001000000000000100000111000000001000001000010000001000000000
0000000000000100000
1100000100111111100000010100003301303303000300003030100310000000001000
0010000110000003000100000000000000300000010000311111000001101001100000
0000100001000000000000100003011000130000000001110100010000100011101000
0001000001010100000
1100000000000011111000000300013000103300330330000010300003100000000101 1
0030000100000000000303000000000000000001100000011030033111010011000 0
0000100001000000000000100000011000010000000001110100010000101000101000
0001010001010101000
1100000000000011100000010100000001001001000100000010100100000000001001
0010000000000000010000100000000000000001100000001010000011110001000 0
0100100001000000000000100000011000010000000001101000100001001001000 0
0101010001010100000
1000000000100011111000001000003301333303000000001010000110000000001000
0000000100000000000001340000000000000000110000001000000000100100100000
0000100001000000000000100000011000130000300000110100010000010000100 10
0001310031010100000
1000000000000011100000010100000001101100000100001010000113000000010 11
0011000000000000000100000000000000000000113000000100000011313000100000
0000100001000000000000100000011000010000000001101000100001000001010 0
0401030001031100000
0100000000000000000000010100001000001000000000000000100100000000010 01
0010000000000000000000100000000100000001000000110000000001000011000 0
0000100001000000000000100000101000010000000000010100010000100000100 00
0101000011000100000
1000000000000010100000000310000001000010000000001030000010000000001 01
1300001000000000000000010000000000001100011000100101000001000001000 01
0100100000000100000010000130011000010000000000010100010001001000100 00
0100110000000100000
1000000000000010000000010000001000000000000010000100000031300000000101
0010000000000000001000000000000010000001000001100010001100000101000
0001100000100010000000000010010001000010000000101000100001000001010 0
0001000011000100000
1000000000000011100000000010000001000001000110001330000003333333010 1
0000000000011000000000001000010000000300011000103100110011000001000 01
0000100000300310000000010000011000010000000000010100000001000000000 00
0000000000000000100
1100000000000011000000000001000010000110100000010100000100000000010 1
0000003510000000001000010000000000000000010000100000000000100010000 01
0100100000000100001100010000011000010001000000010100010000001100100 00
0100101001010100000
1000000000000010000000000010000001000000010000001000000001000000001 01
0000000100000000000000010000000000000000010000100110000110010010000 1
0010100000000110000000000000110000100000000000101000000010000000000 0
0000000000000100000
1100000000000011110000000110130001003033010000031330000013000000001 01
0000003300030000003000030300000000003000010000201001000313330100000 01
0100100000000130003001000000011100013003300000010110010010000100100 00
0100110001011100000
1000000000000010000000010000001000000000000010000100000000003333300100
1010030000000000003000000000000000000000010000010001000000101000001 00
0000100000010010000000030031001000100000000000010100001000100000100 00
0101000001000100000

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

1000000000000011000000010000001000001000000100001000000013000000001010010300000000000000

1100000000000001000000000000100001003003030000000030100010000000001010000000010000000000000031000000000000000010000101001000313330100000010103100000001000010000000000011000010001100000010100010000000100100000010010100000011000000000000010110100000100000010010000100000013300000100000000010100000000000000310000000000000000010000000101000033330100000010104100000000100000100010000011000010010100000010100000010000000000000000000000100000011000000000000010000000100000000100010000000000010100000100000000000000000000000

100000000000000100000000001010000100100001000000100000001000000000100
100000010000001000010000000000000000000001000001013100000100000100001
000010000000014100000001000001010000100000000001001001000000010010000
0100010001010100000
100000000000000010000000001010000100100003010000101000001330000000101
000000110000001000030000000000000000000010000010101000011111100000001
010010000010014100000000000000101000010000000000100100100000011001100
0100010000010100000
100000000000001100000000001000000100100003010000100000001330000000100
100000010000001000010000000000000000000010000010101000010011000000001
010010000010014100000001000001010000100000000001000011000000100001000
0100010000010100000
100100000000000011001010010000000100100000000000100000001300000000111
000000133000000000000000100000000000000001000010100000100010500100010
000010000010001000000000001001100001000000000001010001000000010010000
0100010000100100000
100000000000000100000000000001000010000000100000010000000003333330101
000000010000000000000001000000000000000013300001001100001000100000001
010010000000011000000010000011000010001000000010100000010000000000000
0000000000000100000
010000000000000000000000001000000100300100000000100000000000333330111
000000103003000000100000010000000000000001000001010100001100000100001
000110000010001000000001000001100001000000000001010000000100000000000
0000000000000100000
112000000000000111101000001000000100300000011000100000000333330000111
000000100000000000000000100001000000000001000000010100000111100100001
010010000000010000000000000011000010010000000010100000001000000000000
0000000000000000100
100000000000000100000000001000000100130000000000131000001000000000101
000000100000000000000001000000000000000001000001010000011000100000001
010010000010001000000001000001100010000100000001010000000100000000000
0000000000000100000
100000000000000111000000010000000133030000000000100000011100000000101
000000313000000000000000100001000000000001000010100001000010000100014
000110000010011000000000001001100001000100000001010000000100000000000
0000000000000100000
100000000000000110000000001010000100100101000000133000000331000000101
000000100000000000000000100000000000033001300000100000000100010000001
010310000000010000100001001001103001000000000001010001000000010010000
0101010010010100000
100000000000000100000000001010000100300310010000100000000003313000111
000000100000000000000000101000000000010011000000010100001100000100001
000010000000010000000100000011000010000000000010100000001000000000000
0000000000000100000
100000000000000100000000000010000010010010100000110000000310000000101
000000000000000100001000000000000000000000013000001010000100010000001
010010000011004000000001000001010000000000000001001000000100000000000
0000000000000100000
100000000000000010000000001000000100000000010000100000001100000000110
000000100000000000000000100000000000010001000010001010001001000100010
000110000010001000000001000001100000000010000001010000000100000000000
0000000000000100000
100000000000000110000000000010000010011010000000013301000100000000131
000000100000030000100001000000000000030001000000100000011110010000010
010010000000011000000010000011000000000000000001010001000000110010000
0100010011010100000
100000000000000110000000000101000010000000100000000000100033100000010 0
000000110010000000000000100000000000000001000000101010000100110000000 1
000110000000010000100000001001001000000010000001010001000000010010000
0100010010010100000

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

```
1000000000000011100000000001000001003300100100001330000000000111001010000000000100100000100000000003113300000101000300100010000101001000000100000001010000011000000000010000101000010010000000000000100000
1000000000000001000000000001000010010000000000131000000003313330101000000001000000000000000000000000300001000010010100000010010000001010010000000100000101010000011000001000100000101000010001000000010010000010100000
1100000000000001000000000010000001001001010000001000000011300000001010000000110000000000010000000000000000000100000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0100100000100010000000000000011000000001000000010100010001000100100001000010000000000000000000000000000000000000000000000000000000000000000000000000000000000
1000000000000001110000000001000000100000010010000100000000011110000111000000130000000000000000010000100000000000010000010000000000133001000010000000000010001000000000100000000000000000000000000000000000000000000
0100100000000110000000000000011000000010300000010100000001000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
1000000000000011100000000110000001001000000100001000000010000000001010000111000010000000000000000000000000000000000000000000000000000000000000000000000000000
0000000130000000000000000010000100000000001330010000100000000000010001000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0100100000000110000000000000011000000010300000010100000001000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0000000000000000100
1000000000000011100000000110000001001000000100001000000010000000001010000111000010000000000000000000000000000000000000000000000000000000000000000000000000000
0000000110000000000000000000010000000300010000000101000001100001000100001100000100010000000000000000000000000000000000000000000000000000000000000000000000000
0001100000100010000000010000011000000000000000001010001000100010010000010100000100300
1000000000000001100000000010000001000000000100001330000010000000001000010000000000000000000000000000000000000000000000000000000000000000000000000000000000000
1000001000000300300000011000030000000000010000100111011000110000100010100000100300
0100100000000100010000010000011000000030000300010100000010000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0000000000000000100
1101000000000011111110100100130001003031013000001310100013000000001010000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0000001300100300000000003300000000000333001100000011110000313110040000101100000013000010000031000310004000010111000000000000000000000000000000000000000000000
0100111011111010030000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
1100000000000001000000000000100001001003010000000000100010000000001010000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0000000100000000000000100000000000000000010000011000000011000100000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0100000010000000000100000000011000000001000000010100010000000100100001000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0100001000010100000
0100000000000000000000000000010000001101000000100001310000010000000001010000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0000000000000100001000030300000000000000010000000001000310001000000100000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0100100000100010000000010000011000000000000000100101000000010000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0000000000000000100
1000000000000010000000010000000001001000000000001000000010000000001000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
1010100000000000000000010000000000000000001000001001000000110100000100000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0001010000000000000000000000011000000000000000010100010000100000100000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0101000011000001000
0000000000100000000000000300100001001101010000001010000110000000001100000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0000001000000000001000011000030000001300010000010000000001000000000200000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0000010000000000000000000000011000010000000000010100010000000200100000101000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0101000003010100000
1000000000000001000000000000100001001001010000001000000000000011100101000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0000000001000000000000100000000000001000010000100000000100041000000100000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0100100000000100001000000000110000000001000000101000100000001001000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0100010000010100000
1100000000000001000000000011000001103000000100001000000001000000000101000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
1000001000000000000000000010000000000100010000010010100000010001000010000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0001100000100010000000010000011000000000200000010100000001000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0000000000000100000
1000000000000010000000000000100001003001000100000000010001000000000101000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0000001100000000000000001000000000000000001000010100100000010000100001000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0100100000001010000000000010011000000001300000010100010000100100100000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0100000111010100000
1000000000000010000000010000003101001000000000001000000311100000001000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
1010100000000000000000010000000001000000010000010011000001101000001000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0001100000000000000000000000011000000000000000010100011000100000100000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0101000001000100000
```


Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

```
10000000000000101000000000001000010010010000000010000000011110000110
00000000010000000000000000000000000000010000010100000101100100000000
20011000000001100000000100000110000000001000000101000101000001001000
0100010010010100000
10000000000000100000000000001000010010000000000000010100003113000001
00000010000000000000000100000000000000001100010001100001100100000001
01001000000011000000000001001100000000000000001010001000000010010000
0100010010010100000
11000000000000010000000000001000010011000000000000001000130000000001
00000003100000000000000100000000000000001100000100100001100010000001
01001000100001100001000110000110000000031000000101000100000001001000
0100011000010100000
10000000000000111100000000100000010010000001000010000000013000000001
00000010000010000000000010000100000001001110000000001110011000010001
00011000001000100000001000001100000000000000001010000000100000000000
0000000000000100000
10000000000000100000000000010000010000000001000010000000000110000101
00000010000000010000001000000000000000011000000000100000010001000001
01001000000001000010000001000110000000000030000101000000010000000000
0000000000000100000
11000000000000010100000000100000010030033001300010000000313333000011
00000010000010000000000010000100000000000110001010001000111000010000
10
00011000000101000000000000001100000000000000001010000000100000000000
0000000000000100300
11000000000000011110000000000100001303303010300000100000001333000000101
00000001000000000001100000000000000000001111000011000001110010000010
00011000001104100000001000001100001000001000001010001001000010010000
0100011010010103000
10000000000000010000000000010000010000001001000013300000003333333010 1
10000000000000010000003030000000000010001111101001010001000000100001
01001000000011000000010000011000000000003000010100000001000000000000
0000000000000100000
10000000000000110000000000001000010010000000000110000000000010000111
00000000010000000000001100000000000000001000000001000001100010000001
01001000000001000000010100000100100000000000000101000100000010010000
0100010000010100000
10000000000000100000000000010000010000010100000010000000111000000101
00000010000000000001000000000000000000001000100001000011000100000001
01001000000011000000000001001100000000000000001010000000100000000000
0000000000000100000
10000000000000010000000000001000010010000000000010000000000000001100101
00000011000000000000000000000001000000001100000010001000010000100000001
01001000000010401000000100000110000000011000000101000100000001001000 0
0200011011000100000
10000000000000010000000000001000010010000000000010000000000000010000111
00000010000000000000000010000000000001000100000010000000000010100000001
01001000000001401000000001000110000000011000000101000100200001001000 0
0100010000010100000
```


Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

UNIVERSITY OF PRETORIA

PLAGIARISM POLICY AGREEMENT

The University of Pretoria places great emphasis upon integrity and ethical conduct in the preparation of all written work submitted for academic evaluation.

While academic staff teaches you about referencing techniques and how to avoid plagiarism, you too have a responsibility in this regard. If you are at any stage uncertain as to what is required, you should speak to your lecturer before any written work is submitted.

You are guilty of plagiarism if you copy something from another author's work (eg a book, an article or a website) without acknowledging the source and pass it off as your own. In effect you are stealing something that belongs to someone else. This is not only the case when you copy work word-for-word (verbatim), but also when you submit someone else's work in a slightly altered form (paraphrase) or use a line of argument without acknowledging it. You are not allowed to use work previously produced by another student. You are also not allowed to let anybody copy your work with the intention of passing if off as his/her work.

Students who commit plagiarism will not be given any credit for plagiarised work. The matter may also be referred to the Student Disciplinary Committee for a ruling. Plagiarism is regarded as a serious contravention of the University's rules and can lead to expulsion from the University.

The declaration which follows must accompany all written work submitted while you are a student of the University of Pretoria. No written work will be accepted unless the declaration has been completed and attached.

Full names of candidate
.....

Student
number:.....

Date:.....

Declaration

1. I understand what plagiarism is and am aware of the University's policy in this regard.

SIGNATURE OF CANDIDATE:

.....

SIGNATURE OF SUPERVISOR:

.....

This document must be signed and submitted to the Head: Student Administration within two months of registering for the research component of the programme.

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

UNIVERSITY OF PRETORIA

DECLARATION OF ORIGINALITY

This document must be signed and submitted with every essay, report, project, assignment, dissertation and/or thesis.

Full names of student:

.....

Student number:.....

Declaration

1. I understand what plagiarism is and am aware of the University's policy in this regard.

2. I declare that this ..... (eg essay, report, project, assignment, dissertation, thesis, etc) is my own original work. Where other people's work has been used (either from a printed source, Internet or any other source), this has been properly acknowledged and referenced in accordance with departmental requirements.

3. I have not used work previously produced by another student or any other person to hand in as my own.

4. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.

SIGNATURE
STUDENT:.....

SIGNATURE
SUPERVISOR:.....

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

Candidate's expectations:

1. Supervisor to be easily accessible.
2. Clear mediation mechanisms (refer to the General Regulations and Information of the University of Pretoria pertaining to the Student Communication Channel, Section B.15.) to deal with any grievances, personal problems or disagreements that may arise between the candidate and the supervisor.
3. All work submitted to the supervisor to be returned within a reasonable time (maximum turnover of one month), accompanied by written comments on the manuscript as well as separate general comments.
4. Other expectations:

.....
.....
.....
.....
.....
.....
.....

5. Comments by supervisor on the abovementioned:

.....
.....
.....
.....
.....
.....

Supervisor's plans and commitments:

1. The supervisor must set out, where applicable, his/her plans for providing supervision in terms of the time chart. The supervisor must indicate any expected absence on leave/sabbaticals (providing alternative arrangements for supervision if away for more than two months in any one year).

.....
.....

Supervision arrangements:

.....
.....

Candidate's plans and commitments:

1. The candidate must indicate any matters that may have an impact on the time chart he/she provided (eg work pressure).

.....
.....
.....
.....

Candidate's undertakings:

.....
.....
.....

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021

INTELLECTUAL PROPERTY ISSUES
(Refer to the General Regulations and Information of the University, Regulation G.57.6)

Authorship: Authorship should be discussed and agreed upon by all parties concerned. Any additional remarks regarding authorship must be noted by the supervisor*:

.....

The intellectual property rights of the outcome of the research will be determined by the agreement that the candidate has with the University of Pretoria and which is in line with the policy of the University of Pretoria.

.....

*in the case that the candidate is employed by an institution other than the University of Pretoria an agreement as to which address is used on the publication needs to be signed. If such an agreement does not exist, the candidate must publish under the name of the University of Pretoria in line with the General Regulations of the University of Pretoria.

DEREGISTRATION
Should a candidate fail to maintain satisfactory academic progress at any phase of his/her period of study, the supervisor may, in consultation with the candidate, send the candidate a warning letter indicating the seriousness of the matter. This letter should also include written instructions on the conditions that need to be met in order to achieve/accomplish satisfactory progress/performance. The candidate will then be placed on probation and be monitored for a period of three months. Should the candidate fail to rectify his/her progress and/or improve his/her performance, he or she will have his/her registration terminated by the Dean on the recommendation of the Postgraduate Committee (General Regulation G.4).

A candidate can appeal the decision to terminate his/her registration. An Appeals Committee would be formed consisting of the Vice-Principal responsible for Research and Postgraduate Studies and two members of the Senate Committee for Research. The two members of the Senate Committee for Research are appointed by the Vice-Principal. The candidate must state his/her case in writing and a written response should be solicited from the supervisor. The Appeals Committee must base its judgement on these written submissions. The decision of the Appeals Committee is final.

Candidate's comments:
.....
.....
.....

SIGNATURE OF THE CANDIDATE

Name	Signed	Date

SIGNATURE OF THE SUPERVISOR

Name	Signed	Date

OBSERVATIONS BY THE HOD

I have reviewed this completed Memorandum of Understanding and I am satisfied that it reflects the shared understanding of the supervisor and the candidate and that the Department is able to meet the obligations to the candidate set out in this Memorandum of Understanding:

Name	Signed	Date

Digitised by the Department of Library Services in support of open access to information, University of Pretoria, 2021