

## Revision of the endemic southwest African dung beetle subgenus *Scarabaeus* (*Pachysoma*) MacLeay, including notes on other flightless Scarabaeini (Scarabaeidae: Scarabaeinae)

The subgenus *Scarabaeus* (*Pachysoma*) MacLeay, 1821 is revised. All thirteen species of the subgenus are endemic to the west coast of southern Africa. A key to all *S.* (*Pachysoma*) species is provided, and their distributions are mapped. Two new species *Scarabaeus* (*Pachysoma*) *endroedyi* and *Scarabaeus* (*Pachysoma*) *glentoni* from the southwestern Cape are described. The subspecies *S.* (*P.*) *denticollis penrithae* (Zunino) is synonymised with *S.* (*P.*) *denticollis denticollis* (Péringuey). The synonymy of *S.* (*P.*) *hessei* (Ferreira) with *S.* (*P.*) *hippocrates* (MacLeay) is confirmed. *S.* (*P.*) *valeflorae* (Ferreira) previously considered a synonym of *S.* (*P.*) *schinzi* (Fairmaire) is reinstated as a valid species. The missing type series of *Pachysoma hessei* Ferreira is traced. A lectotype is designated for *Scarabaeus aesculapius* Olivier, three paralectotypes are designated for *Pachysoma marginatus* Péringuey and one paralectotype for *Pachysoma denticolle* Péringuey. Notes on the type series, distribution records, morphological variation and known biology, are provided for all flightless Scarabaeini. A checklist of all valid species and their synonyms of *Pachysoma*, *Neopachysoma*, *Mnematium* and *Neomnematium* is included.

KEYWORDS: Coleoptera, Scarabaeini, Afrotropical, systematic revision, *Scarabaeus* (*Pachysoma*), biology, distribution.

\*Formatted for submission to 'Journal of Natural History' as J. du G. HARRISON, C.H. SCHOLTZ and S.L. CHOWN, currently in the singular person for thesis purposes.

### Introduction

The genus *Pachysoma* MacLeay, 1821 was last revised by Holm and Scholtz (1979). In a study that focussed on all the flightless Scarabaeini Mostert and Holm (1982) synonymised *Pachysoma* with *Scarabaeus* Linnaeus, 1758 and raised *Neopachysoma penrithae* Zunino to a subspecies of *Scarabaeus denticollis* (Péringuey). The only subsequent papers on *Pachysoma* include the first detailed study of the foraging and burrow construction of *Pachysoma striatum* Castelnau by Scholtz (1989) and the unofficial use by Endrödy-Younga (1989) of *Pachysoma* and *Neopachysoma* Ferreira, 1953 as subgenera.

The genera *Pachysoma* and *Neopachysoma* (*sensu* Ferreira 1966) are treated here as a single subgenus of *Scarabaeus*, viz. *Scarabaeus* (*Pachysoma*) (refer to chapter 2 for rationale). Holm and Scholtz (1979) included the species of *Mnematium* MacLeay, 1821 within *Pachysoma*. Their system is not followed here, because *Mnematium*, *Neomnematium*

Janssens, 1938 and *Mnematidium* Ritsema, 1889 are included within *Scarabaeus sensu lato* (see chapter 2). All subsequent use of *Pachysoma* herein is at the subgeneric level.

*S. (Pachysoma)* currently comprises thirteen species endemic to the sandy coastline from Cape Town (33°56'S 18°28'E) in South Africa to Walvis Bay (22°58'S 14°30'E) in Namibia (figure 1). The northerly distribution of *S. (Pachysoma)* is abruptly halted at the Kuiseb River (23°03'S 14°27'E), which marks the end of the sandy central Namib dune sea. While the southern and easterly limits of *S. (Pachysoma)* are defined by the Cape Fold Mountains and escarpments rising from the coastline (see Kruger 1983) as topographical and climatic barriers preventing the southerly and easterly expansion of *S. (Pachysoma)* species. Holm and Scholtz (1979) were the first authors to record the unique foraging behaviour in *Pachysoma*. Unlike typical ball rolling *S. (Scarabaeus)*, *S. (Pachysoma)* do not make dung balls but collect dry dung pellets and detritus, which they drag forward to preconstructed burrows (refer to chapter 2 for details on their biology).

Holm and Scholtz (1979) examined 664 specimens of *S. (Pachysoma)*. Substantial new material (totalling 2629 specimens) and two new species enable *S. (Pachysoma)* to be reexamined. The study by Holm and Scholtz (1979) was based mainly on new material from Namibia. Very little new material (since Ferreira 1953a,b, 1966) of the South African species was available for them to study. This imbalance is rectified by a combination of subsequent collecting efforts from various institutions (see Endrödy-Younga 1996), and access to previously unavailable material. The new material (i.e. not examined by Holm and Scholtz (1979)) was obtained from the following sources: (1) the systematic coastal survey (1973-1989), by the late Sebastian Endrödy-Younga, from the Kunene River (17°16'S 11°48'E Angola's southern border) to Cape Town (Endrödy-Younga 1996); (2) collecting trips to Namibia between 1977-1981, led by Erik Holm (formerly Head of the Department of Entomology, Pretoria University); (3) pitfall trapping by Eugene Marais and Ashley Kirk-Spriggs of the State Museum of Namibia; (4) donation of the Desert Ecological Research Unit of Namibia (DERU) collection to the State Museum of Namibia; (5) access to the remains of Ferreira's collection in the National Museum in Bloemfontein; (6) reorganisation of the South African Museum collection (Cochrane 1995); (7) while most recently, collecting done specifically by JDUGH for the purposes of this study.

From June 1996 to January 1997, the South African West coast from Alexander Bay (28°40'S 16°30'E) to Cape Town (33°56'S 18°28'E) was specifically surveyed for *S. (Pachysoma)* species. Before fieldwork commenced all the available locality data (from museum material and publications) was mapped onto 1:250 000 Topo-cadastral maps. Collecting efforts were thus focussed on gaps in distributions, range extensions, and unlikely locality records. Specific efforts were made to expand upon known distributions and investigate the continuity of previously suspected clines. Thus all material collected since the last revision, (1979-1997) including most material used for the last revision is examined (a total of 2629 specimens).

In this study two new species of *S. (Pachysoma)* are described and all species are revised. Existing species are not redescribed as this has been adequately done elsewhere (Ferreira 1953a, 1966). Observations on biology are recorded for all the South African species,

some for the first time. The habitat preference of *S. (Pachysoma)* species is included, based on known distributions and confirmed by field work. Distribution maps and a revised key are provided for all *S. (Pachysoma)* species. The accuracy (use of a Global Positioning System in degrees°, minutes" and seconds') and number of unique localities (563) for *S. (Pachysoma)* are substantially increased. This provides a valuable database for conservation planners to use when making recommendations to insure the future conservation of these endemic species.

## Material and Methods

*Material examined* is in the following depositories and acronyms unless marked by an asterisk follow Arnett *et al.* (1999):

AMGS	Albany Museum, Grahamstown, South Africa.
BMNH	The Natural History Museum, London, United Kingdom.
BMSA	National Museum Bloemfontein, Bloemfontein, South Africa.
COCS*	Mr C.R. Owen Collection, Somerset West, South Africa.
CPMM	Dr Alvaro de Castro Provincial Museum, Lourenço Marques, Mozambique.
DMSA	Durban Natural Science Museum, Durban, South Africa.
MIZT	Università di Torino, Torino (M.Zunino Collection), Italy.
MNHN	Muséum National d'Histoire Naturelle, Paris, France.
MMKZ	Alexander McGregor Memorial Museum, Kimberly, South Africa.
NHMB	Naturhistorisches Museum, Basel, Switzerland.
NHRS	Naturhistoriska Riksmuseet, Stockholm, Sweden.
SAMC	South African Museum, Cape Town, South Africa.
SANC	South African National Collection of Insects, Pretoria, South Africa.
SMTD	Staatliches Museum für Tierkunde, Dresden, Germany.
SMWN	National Museum of Namibia, Windhoek, Namibia.
TMSA	Transvaal Museum, Pretoria, South Africa.
UPSA	University of Pretoria Collection, Pretoria, South Africa.
USSA*	University of Stellenbosch Collection, Stellenbosch, South Africa.
UZIU	Uppsala University, Uppsala, Sweden.
ZMHB	Museum für Naturkunde der Humboldt-Universität, Berlin, Germany.

Selected material was borrowed from the BMNH and only material not determined by Holm and Scholtz (1979) was lent by the SMWN. The MMKZ is currently housed and curated by the BMSA (who code it as AMMM). Most of the material examined were dry pinned specimens. However, fragments of dead specimens were collected and often represent the only evidence that a *S. (Pachysoma)* species occurs at a particular locality. These pieces were pinned and labelled and are referred to in the material examined as (p.). The numbers (#) of specimens examined is summarized as follows: ( $\Sigma$ #) total number of specimens; [#] specimens

studied by Holm and Scholtz (1979); (#♀ #♂) females and males; (#uns.) unsexed individuals; (#diss.) male genitalia dissected/examined; (#eth.) specimens preserved in ethanol; (#p.) pieces/fragments. Specimens were sexed using the following external characteristics: presence (♂) or absence (♀) of pheromone glands on the lateral abdominal sternites; dimorphic protibia or protibial spurs; and width of the last abdominal sternite at the apex of the pygidium (narrow♂; broad♀).

*Label data.* All information on type material is cited verbatim (for the first time) using a comma to separate lines on the same label and a forward slash (/) to separate consecutive labels on the same pin. Additional information when included is placed in parentheses ( ). Data on the reverse of labels, which is easily overlooked, is shown by a double forward slash (//). The following terminology is used when referring to the lettering on type labels: written (handwritten); printed (letters not embossed into the paper); typed (letters embossed into the paper). Unless otherwise specified, black ink was used to write, type or print labels. Where reference is made to an author's handwriting, it was confirmed by comparison with handwriting known to belong to the author. Locality data for nontype specimens are amended for clarity only where necessary and listed alphabetically according to country. Where material collected by JDUGH includes many localities, these are listed sequentially. Localities outside the apparent distribution range of a species are included at the end of material examined as potentially incorrectly labelled or vague locality records.

*Types.* Ferreira (1953a,b) and Péringuey (1888) described six and two species of *Pachysoma*, respectively, although two of Ferreira's species are viewed as synonyms. Confusion surrounding valid Péringuey and Ferreira types, necessitated checking all labelled 'type' material against that listed or referred to in the original description. This was necessary because the types of Péringuey and Ferreira species were not always labelled as such. Furthermore, a duplicate series of specimens collected at the same locality by the same collector often exists for Ferreira types (e.g. *P. gariepinum* and *P. granulatum*). To prevent future confusion I have checked all 'labelled Ferreira types' against those listed by her, and made amendments where necessary. New labels for unlabelled but traced paratypes (only *P. gariepinum*) are printed onto yellow card, using the spelling and date of Ferreira's type labels. Institutions from which type material was not seen, but where Holm and Scholtz (1979) verified the type to be housed are included in brackets [ ]. Braces { } are used for types not examined, but to show where the original author deposited the specimen/s. Types deposited by Holm and Scholtz (1979) in the UPSA collection have been moved to collections as listed under type material. Labels for primary and secondary types of new species described herein are laser printed in black ink onto red (Holotype ♂) and yellow (Allotype ♀ and paratypes) card using the following format: HOLOTYPE ♂, SCARABAEUS (PACHYSOMA) endroedyi, HarrisonScholtzChown, Manuscript date 2000.

*Distribution maps.* Grid references in degrees and minutes are given for all localities. Where the grid reference was excluded from the original label, it was traced using Leistner and Morris (1976), Skead (1973) or calculated from 1:250 000 and 1:500 000 Topo-cadastral maps

for South Africa and Namibia respectively. Grid references for flightless Scarabaeini occurring in Madagascar, Somalia, Libya, Angola, and Syria were obtained from the 'National Imagery and Mapping Agency (NIMA) GEOnet Names Server' (Rohrer 1999). Using all available locality data maps were drawn with 'MAPPIT' Geographical Mapping System, Version 2.0 (Arnold *et al.* 1996). Locality records well outside the established distribution range are mapped as labelled open circles, for example ○ Sneekop. Grid references are only repeated in the text where necessary, as the grid reference for the majority of localities mentioned are included in the material examined for the respective species under discussion.

**Morphology.** Terminology used follows Lawrence and Britton (1991), and Torre-Bueno (1989). Using external morphology specimens were sorted into morphospecies, after which microscopic examination separated species. Male genitalia were examined when necessary and proved a reliable and robust method for distinguishing species. Genitalia were especially useful in the *hippocrates* species complex.

Certain morphological attributes of *S. (Pachysoma)* species can potentially mislead accurate species identification. These pitfalls include the following: (1) variable expression of elytral and pronotal waxy indument. These species *S. (P.) striatus*, *S. (P.) gariepinus*, *S. (P.) endroedyi*, the Olifants to Groen River *S. (P.) hippocrates*, and northern populations of *S. (P.) aesculapius* all exhibit indument to varying degrees. The indument absorbs the colour of the substrate and varies due to abrasion and age of the specimen. For example, *S. (P.) gariepinus* from near the Buffels River (29°55'S 17°40'E) are easily identified by their red indument, while the same species from Hohenfels (28°30'S 16°37'E) have grey to white indument; (2) well preserved dead specimens/s, that have been finely abraded by sand and wind-action, are very glossy in appearance with altered or obliterated micro-sculpture and subsequently can be misleading. However, unabraded specimens are usually available from the same locality for comparison, and the protibial and clypeal wear reveals their age; (3) colouration from the sand type of micro-sculpture, pronounced elytral rim and elytral intervals. Care should be taken to focus on the actual micro-sculpture rather than the apparent colour or highlights. This is especially true of the northern population of *S. (P.) aesculapius* that have their elytral intervals highlighted (by the white clay from their substrate) to such an extent that they appear to represent another species; (4) very small individuals are also confusing, especially when associated with malformation or when only one sex is present. The adult size of dung scarabs (within species limits) is dependant on the food resource (provisioned by the adults) and environmental factors during their development (Davidson and Roberts 1968, Davidson *et al.* 1972). Very small individuals and malformed specimens are probably the result of insufficient food or adverse growth conditions or both. For example, very small females of *S. (P.) striatus* from Roodam (31°04'S 17°48'E) and Dembergdraai (30°47'S 17°43'E) were previously thought to represent a new species (Endrödy-Younga pers. comm.).

**Dissection and examination of male genitalia.** The male genitalia of Coleoptera are generally diagnostic for species identification (D'Hotman and Scholtz 1990a), and can be especially useful in species where the external morphology hardly differs (e.g. *S. (P.)*

*hippocrates* and *S. (P.) glentoni*). D'Hotman and Scholtz (1990b) observed that the genitalia of the Scarabaeinae genera are similar, but they vary considerably in structural detail, enabling their use for species identification. Male genitalia were examined from the northern, central and southern extreme of a species' distribution and from any geographic outliers. However, the preparation technique used and orientation of the male aedeagi can lead to misinterpretation of the structure and form of the genitalia. To facilitate reliable comparison of genitalia the following procedure was used: (1) specimens' labels were removed and placed in a unit tray before the beetle was relaxed in boiled distilled water (ca. 90 °c). Due to the tight seal of the pygidium, the beetle was usually removed after about three minutes and the pygidium prised open then replaced to enable the internal tissue to soften; (2) genitalia were removed with forceps, rinsed in warm water, and without removing the internal sac the base of the aedeagus was oriented dorsally onto a pointed mounting card and glued with water soluble glue ('Otto Rings Fluessiger Leim Syndetikon™', available from Bioform in Germany); (3) the specimen and aedeagus were then both labelled with the species acronym and a number, e.g. hipp1; (4) where necessary genitalia previously dissected and mounted on their sides, were softened and remounted to simplify comparison. After it was discovered that extended exposure (> 3 min) to hot water results in the anterior apex of the parameres swelling and altering the appearance of the genitalia, long exposure to hot water was avoided; (5) genitalia were aligned sequentially on a balsa strip, according to their geographic position (i.e. from south to north), which enabled microscopic comparison across a geographic range. In this way the presence of clines versus abrupt and distinct changes in aedeagal morphology were discernable; (6) on completion of the comparison, each aedeagus was placed on the pin underneath its respective specimen.

**Measurements.** Were made using a Mitutoyo™ calliper (No. 505-646) to two decimal places in millimetres. Body length equals the distance between the medial incision on the clypeus to the furthest point of the abdomen; body width equals the maximum distance across the thorax.

**Illustrations.** Drawings were done by Erik Holm (formerly UPISA), and previously published in Holm and Scholtz (1979) and Mostert and Holm (1982). Additional drawings (figures 20-21; 26a,b; 37-39a,b; 43-44a,b; 54-56; 58-60a,b,c; 64-65a,b,c) were drawn by JDUGH using a *camera lucida* (Wild™ Typ. 308700), on a dissecting microscope (Wild™ M38). The drawings are not shown to scale.

## Systematics

### Subgenus *Scarabaeus (Pachysoma)* MacLeay

*Pachysoma* MacLeay, 1821: 507. Type species *Pachysoma hippocrates* MacLeay, by original designation.

*Irrorhotides* Shipp, 1896: 116. Type species *Irrorhotides fryi* Shipp, by monotypy.

*Neopachysoma* Ferreira, 1953a: 37. Type species *Pachysoma denticolle* Péringuey, by original designation.

## Diagnosis

*Clypeus*: 'Clypeal scraper' composed of medially incised ridge with or without medial tooth.

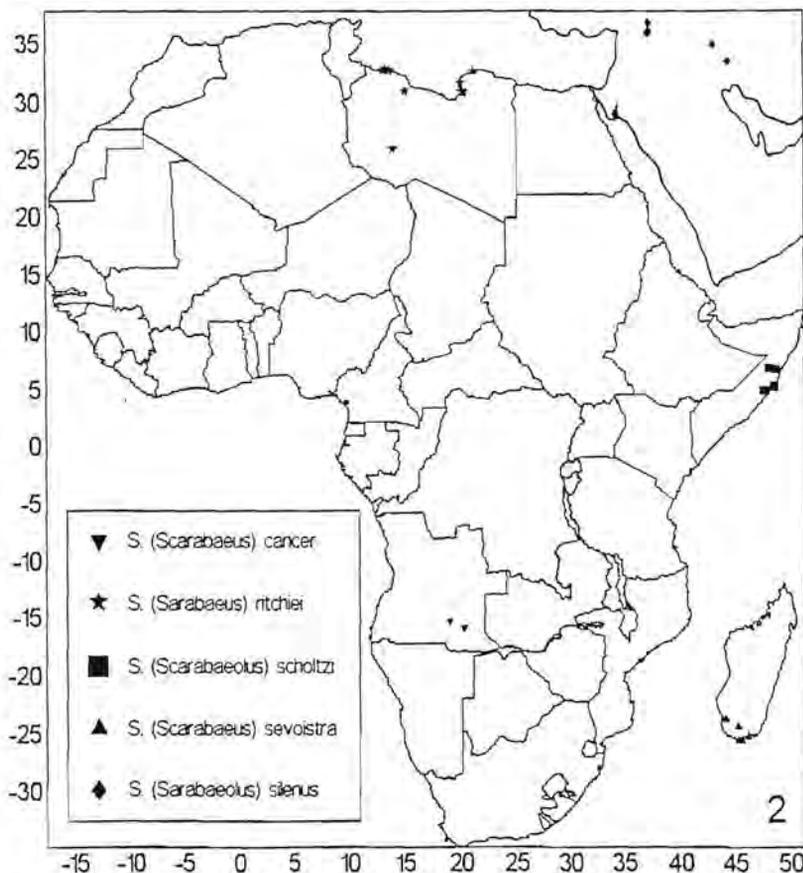
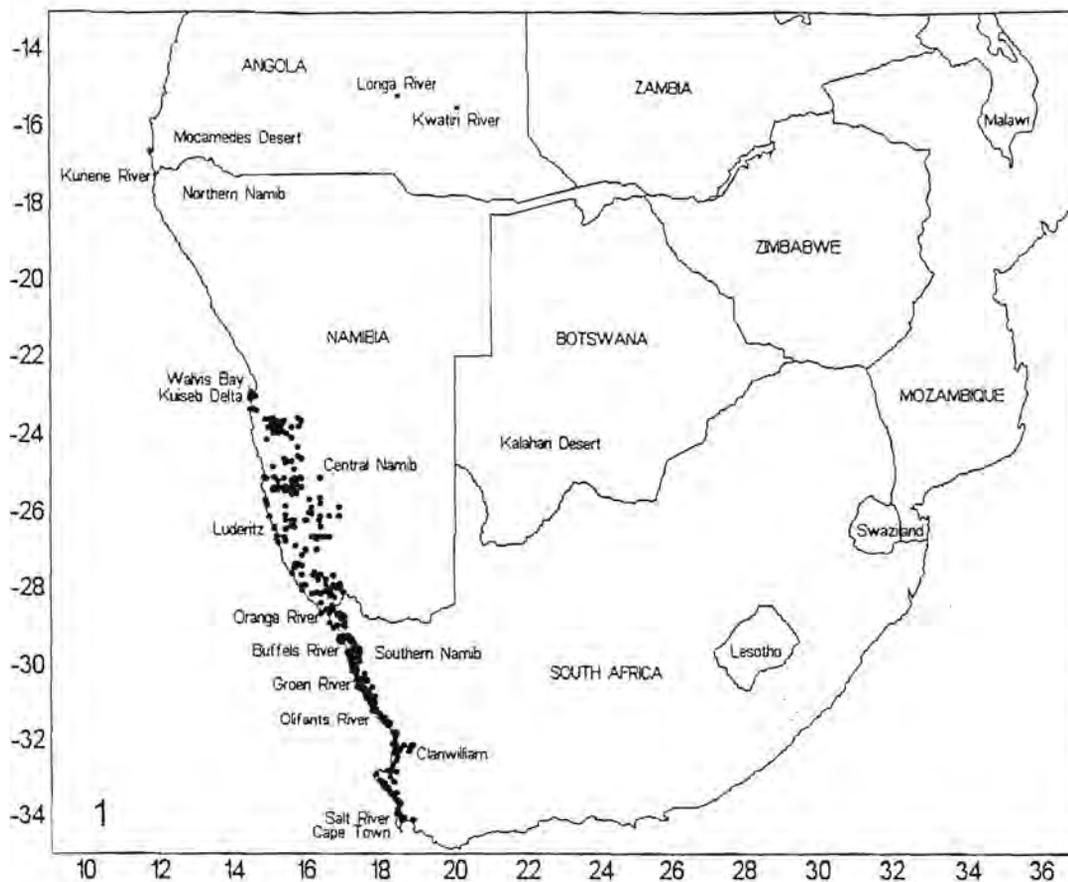
*Mouthparts*: *Epipharynx*; Anterior lobes slightly setose; lateral setal combs formed by two fused rows of setae; anterior median process tear shaped. *Maxilla*; ventral articulatory sclerite of galea composed of highly sclerotized disc, which is notched anteriorly. *Mandibles*; Coarsely serrated mola surfaces. *Labium*; Inner ligular lobes, well developed and highly sclerotized with short tuft of setae on apex.

*Comments*. Holm and Scholtz (1979) provide a thorough discussion on *Pachysoma*, and only a few general remarks will be made here. I believe *Scarabaeus (Pachysoma) MacLeay* represents a derived branch of *Scarabaeus* (see Harrison *et al.* 200x), which probably evolved as a response to aridification. This is contrary to their primitive or ancient origin as suspected by Balthasar (1963). They have a restricted coastal distribution to southwestern African coastal sands from Cape Town (33°56'S 18°28'E) in South Africa to Walvis Bay (22°58'S 14°30'E) in Namibia. All species are flightless and feed on dry dung or detritus, which they drag forward to their burrows. Their preferred habitat includes a variety of sandy habitats, as shown by their psammophilous adaptations, (i.e. elongated body setae and spatulate mesotarsal spurs).

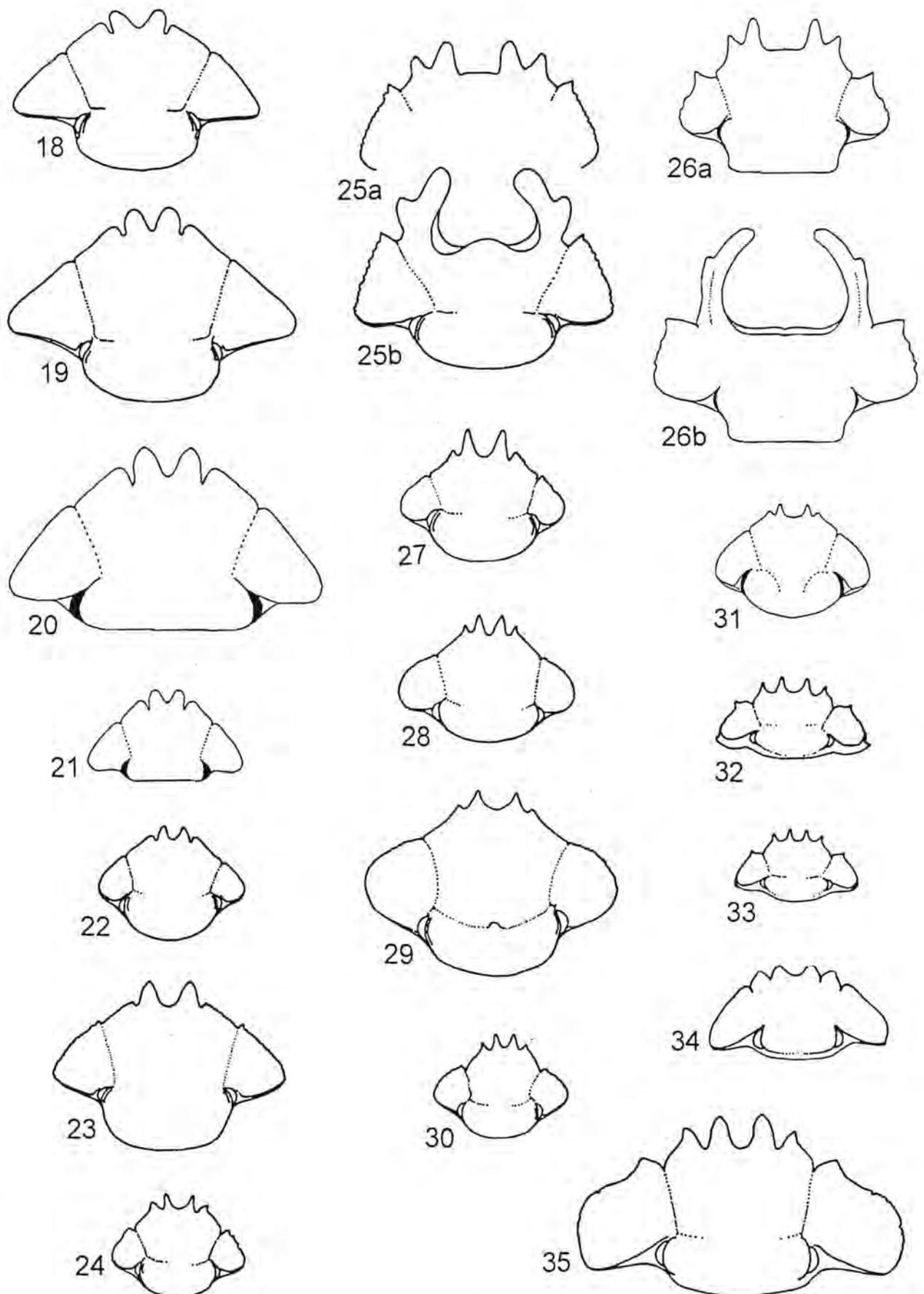
### Key\* to the species of *Scarabaeus (Pachysoma) MacLeay*

1	Sub-elytral ridge present . . . . .	9
—	Base of elytra rounded, without a ridge on base . . . . .	2
2(1)	Distance between medial clypeal teeth at least one-third width of clypeus in front; male with clypeal teeth strongly produced into hornlike structures (figures 25, 26) . . . . .	3
—	Distance between medial clypeal teeth at least one-quarter of width of clypeus in front . . . . .	4
3(2)	Distance between second and third protibial teeth notably greater than between others; serrations between protibial teeth (figure 43) . . . . .	<i>schinzi</i> (Fairmaire)
—	No serrations between or proximal to protibial teeth (figure 44) . . . . .	<i>valeflorae</i> (Ferreira)
4(2)	Frons with prominent tubercle between eyes (figure 29); specimens large, shiny, reddish brown to black; with median and two lateral longitudinal depressions on pronotal disc . . . . .	<i>rodriguesi</i> (Ferreira)
—	Frons without tubercle . . . . .	5

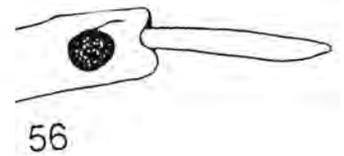
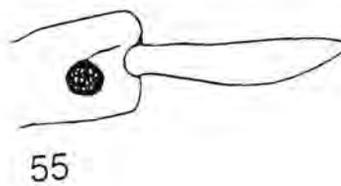
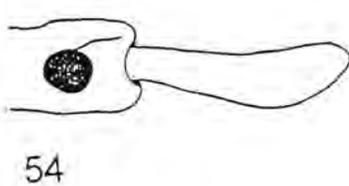
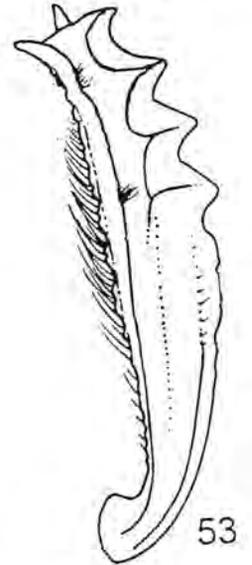
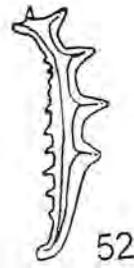
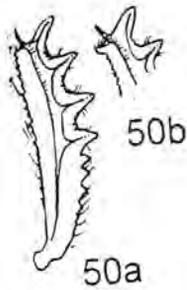
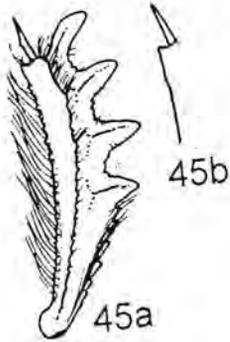
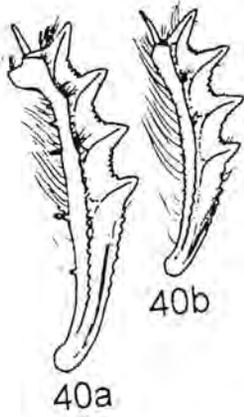
5(4)	Outer margin of genae smooth (figure 22); posterior, lateral pronotal edges hooked; males with protibia (figure 40) and metatibia strongly modified . . . . .	
	. . . . . <b>striatus</b> (Castelnau)	
—	Outer margin of genae serrated or irregular (e.g. figure 23) . . . . .	6
6(5)	Pronotum with median and two oblique lateral depressions on disc . . . . .	7
—	Pronotal disc evenly rounded . . . . .	8
7(6)	Protibia with denticulate projection on inside, opposite sub-apical outside serration; specimens mostly with orange to black on elytra; protibia with two long rows of spines on inside, males with protibial spur bifurcate (figure 48) . . . . .	
	. . . . . <b>denticollis</b> (Péringuey)	
—	Protibia without internal projections opposite sub-apical outside serration (figure 42); elytra markedly flat and deeply striate . . . . .	<b>bennigseni</b> (Felsche)
8(6)	Elytra smooth, shiny; protibia with sub-apical projection on inside (figure 46)	
	. . . . . <b>rotundigenus</b> (Felsche)	
—	Elytra striate; pronotum and elytra greyish black with band of indument around outer margin; protibia not dimorphic, spur simple (figure 41) . . . . .	
	. . . . . <b>gariepinus</b> (Ferreira)	
9(1)	Metatarsal claws equal in length or longer than last tarsal segment . . . . .	10
—	Metatarsal claws shorter than last tarsal segment . . . . .	11
10(9)	Protibial spurs bifurcate (figure 37); mesotarsal spurs spatulate, with basal extension (figure 54) . . . . .	<b>hippocrates</b> (MacLeay)
—	Mesotarsal spur spatulate but not expanded (figure 55); parameres asymmetrical, short, surface irregular (figure 59); restricted distribution from north of Lambert's Bay (32°05'S 18°18'E) to just south of the Olifants River (ca. 31°45'S 18°14'E) . . . . .	<b>glentoni</b> sp. n.
11(9)	Band of indument around base of elytra; protibial spurs bifurcate (figure 39); mesospur parallel sided (figure 56); metatarsal claws shorter than last tarsal segment . . . . .	<b>endroedyi</b> sp. n.
—	Metafemur with two dense, semicircular combs of bristles on the underside . . . . .	<b>fitzsimonsi</b> (Ferreira)
12	Genae straight in front, without any points, and hardly separated from clypeus by an incision (figure 18); distribution south of the Olifants River (31°42'S 18°12'E) to Cape Town (33°55'S 18°25'E) . . . . .	<b>aesculapius</b> Olivier

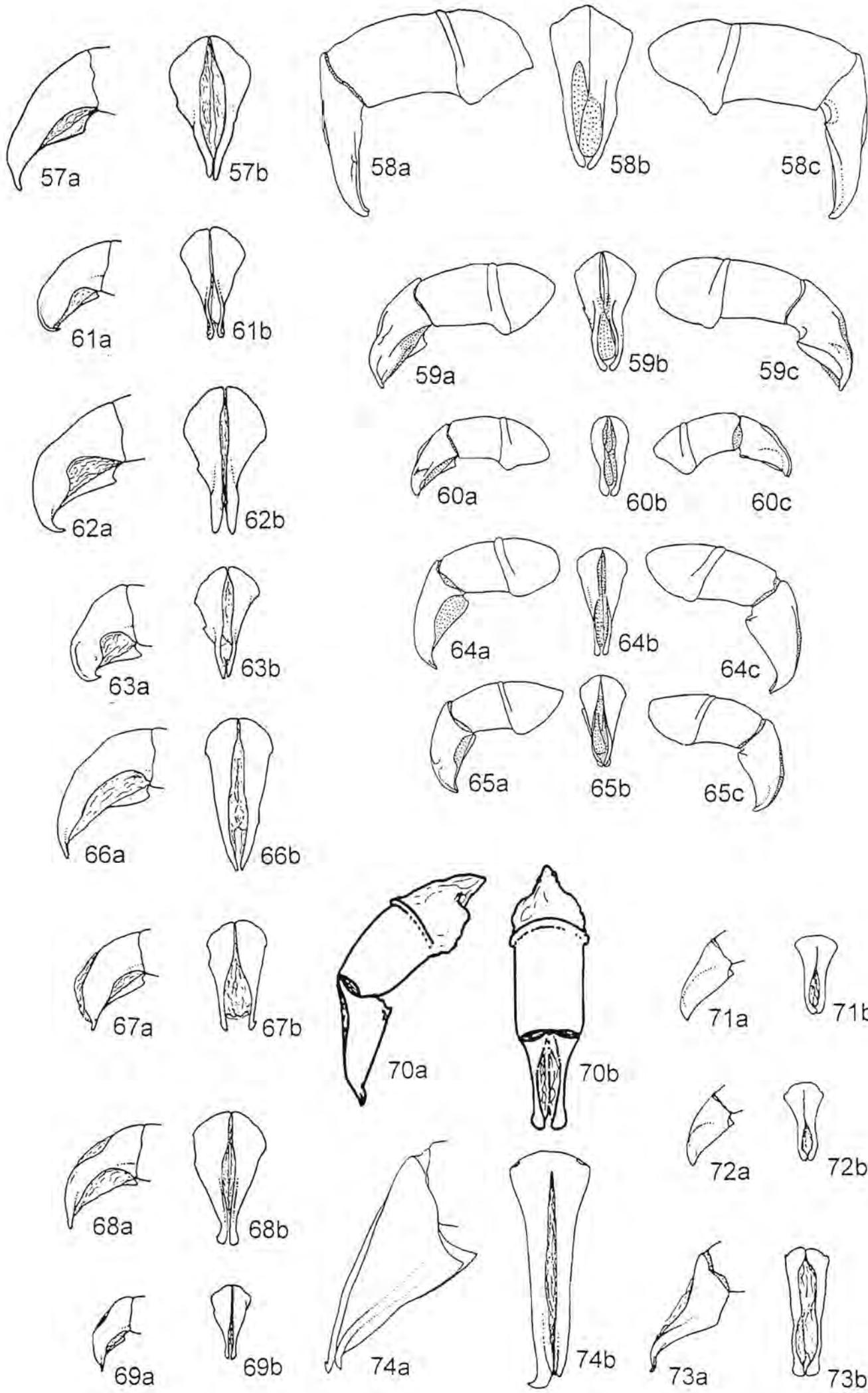


FIGURES 1-2. (1) Distribution of *Scarabaeus* (*Pachysoma*) ● in southern Africa, occurring from Cape Town (33°56'S 18°28'E) to Walvis Bay (22°58'S 14°30'E). The only known localities in Angola for the flightless *Scarabaeus cancer* ■ (formerly *Mnematium*), are included. (2) Distribution map of other flightless *Scarabaeus* species (formerly *Mnematium* and *Neomnematium*).



FIGURES 18-35. Head of *Scarabaeus* (*Pachysoma*) species in dorsal view. (18) *S. (P.) aesculapius*; (19) *S. (P.) hippocrates*; (20) *S. (P.) glentoni*; (21) *S. (P.) endroedyi*; (22) *S. (P.) striatus*; (23) *S. (P.) gariepinus*; (24) *S. (P.) bennigseni*; (25) *S. (P.) schinzi*; (a) female, (b) male; (26) *S. (P.) valeflorae*; (a) female, (b) male; (27) *S. (P.) fitzsimonsi*; (28) *S. (P.) rotundigenus*; (29) *S. (P.) rodriguesi*; (30) *S. (P.) denticollis*. Head of flightless *Scarabaeus* (*Scarabaeolus*) species in dorsal view. (31) *S. (Scarabaeolus) scholtzi*; (32) *S. (Scarabaeolus) silenus*. Head of flightless *Scarabaeus* (*Scarabaeus*) species in dorsal view. (33) *S. (Scarabaeus) ritchiei* (34) *S. (Scarabaeus) sevoistra*; (35) *S. (Scarabaeus) cancer*.





Key\* modified from Holm and Scholtz (1979).

**Scarabaeus (Pachysoma) aesculapius** Olivier, 1789

(Figures 3, 18, 36, 57)

*Scarabaeus aesculapius* Olivier, 1789: 154; Olivier, 1790: 172; Hausmann 1807: 252; Mostert and Holm, 1982: 275. Lectotype designated here: No locality, (1♂ BMNH).

*Pachysoma aesculapius* (Olivier): MacLeay, 1821: 507; MacLeay, 1833: 55; Castelnau, 1840: 68; Reiche 1841: 212; Reiche, 1842: 89; Péringuey 1902: 77; Felsche 1907: 273; Gillet 1911a: 6; Ferreira 1953a: 15; Ferreira 1961: 22; Ferreira 1966: 57; Ferreira 1969: 20; Holm and Scholtz, 1979: 229.

*Ateuchus barbatus* Thunberg, 1818: 409; Gillet 1911a: 6; Ferreira 1953a: 15; Ferreira 1961: 22. [Holotype]: No locality: [1 UPSS].

*Pachysoma validum* Boheman, 1857: 180; Péringuey, 1902: 78; Felsche 1907: 273; Gillet: 1911a: 6; Ferreira 1961: 22. [Lectotype]: Caffraria, Walberg: [1 NHRS].

*Diagnosis.* Clypeus bidentate, genal and clypeal edges unserrated and continuous (figure 18); protibia not sexually dimorphic, with simple protibial spurs (figure 36); well-developed sub-elytral ridge, slight elytral indument present in northern populations; metatarsal claws shorter than last tarsal segment; size range in populations increases from small in south to larger in north.

*Distribution, Habitat and Conservation.* Historically distributed from Cape Town (33°56'S 18°28'E) to the mouth of the Olifants River (34°05'S 18°33'E), (figure 3). Locality records and fieldwork suggest that the Olifants River might be a barrier to the northward extension of *S. (P.) aesculapius* distribution. The southern populations (Somerset West; Cape Flats; Salt River; material only dated between 1882 and 1886) are possibly now extinct, as the most recent collection of *S. (P.) aesculapius* in the south is from the Modder River (33°28'S 18°20'E) in 1987. Currently, the coastal section of the Modder River Farm (or Modderrivier) is run as a private nature reserve (Davis pers. comm.).

*S. (P.) aesculapius* appear to prefer firm sand on coastal hummocks, river banks and vegetated dunes. The short tarsal claws, hardly spatulate mesospurs and shorter tibial brushes than *S. (P.) hippocrates* support this field observation.

The West Coast National Park (WCNP) is the closest conservation area for *S. (P.) aesculapius*. A single record of *S. (P.) aesculapius* in the WCNP labelled ([Hopefield crossed out] Saldanha) and dated 1960, is in the SAMC. Although this locality is possible, it remains unconfirmed by all subsequent collecting. I suspect the use of a generalized label (same label format is used for five *S. (P.) hippocrates*) referring to the Hopefield District rather than Saldanha Bay itself. Three days were spent by JDUGH during December 1996 in a variety of habitats in the WCNP looking specifically for *S. (P.) aesculapius*. No sign of this species was found, but adults and many fragments of *S. (P.) hippocrates* were collected. However as *S. (P.)*

*aesculapius* may be more cryptic in habits than *S. (P.) hippocrates*, one cannot exclude the possibility that *S. (P.) aesculapius* does occur in the WCNP, but currently it seems unlikely. As most of the historical distribution range of *S. (P.) aesculapius* is within modified or developing coastline, and since *S. (P.) aesculapius* might not be in the WCNP it must be regarded as the most threatened South African *S. (Pachysoma)* species.

*Comments on locality data.* All the specimens labelled Salt River have been ascribed to Salt River in Cape Town, and not to Salt River near Vredendal (as done by Holm and Scholtz 1979) for the following reasons. These specimens match in all aspects of morphology, (i.e. genitalia, pronotal microsculpture and body size) to the southern population (i.e. specimens labelled Cape Town). They were all collected during 1882 when Salt River in Cape Town was probably still a suitable locality for this species. No collectors have recorded *S. (P.) aesculapius* north of the Olifants River (which might be a barrier to the northern extension of the range of *S. (P.) aesculapius*). Salt River (Vredendal) is north of this suspected boundary.

The single female labelled Bontebok National Park (BNP) Swellendam, matches *S. (P.) aesculapius* in morphology from Leipoldtville. Additionally, this record is undoubtedly incorrect as the Cape fold mountains (Kruger 1983) act as a barrier to the eastward movement of *S. (Pachysoma)* species. According to Irish (pers. comm.) currently at the BMSA, the catalogue number (NMBH26926) for this specimen falls directly between long series of material from the BNP and other southern Cape localities from a single field trip. Thus retrospectively, there is no way of determining where the specimen actually came from. During February 1998 the BNP was visited by JDUGH and no habitat remotely suitable for *S. (P.) aesculapius* was found.

A single male collected by Koch and labelled Strandfontein (close to where *S. (P.) aesculapius* were collected by JDUGH for this study), conforms to all aspects of morphology to *S. (P.) aesculapius* from the southern population. Koch (1952) lists the areas visited during the expedition on which this specimen was collected. They travelled from Cape Town to Strandfontein. I suspect that this specimen comes from the southern population, as it does not conform with *S. (P.) aesculapius* specimens collected near Strandfontein. The *S. (P.) aesculapius* from Zambia, Monze (16°16'S 27°29'E) are clearly incorrectly labelled.

*Morphological variation.* The smallest specimens of *S. (P.) aesculapius* collected are all from the south (Cape Town, Cape Flats, Somerset West and Salt River). These populations share similar genitalia when viewed anteriorly, i.e. very narrow and straight parameres, and only 70% of the thorax is distinctly punctate. The type series of *Scarabaeus aesculapius* (length 21-24 mm; width 15-17 mm) is probably based on the southern population and distributed according to Boheman (1857) in all of Caffraria (i.e. 'Caffraria tota'). Moving northwards from the Modder River to Strandfontein the parameres in anterior view are stouter with a distinct widening before the two paramere points meet, with 90% of the pronotal disc deeply and irregularly punctate. Populations in the north (from Leipoldtville inland) are characterised by having slight elytral indument and consequently very distinct elytral interstriae with single setose granules, interspersed by a smooth ridge (there are five ridges per elytron). This population probably represents individuals described as *Pachysoma validum* (length 27mm; width 19mm)

occurring in the 'Caffraria interiore' (Boheman 1857). Holm and Scholtz (1979) examined the holotype of *Ateuchus barbatus* Thunberg and matched it to a female of *S. (P.) aesculapius* from Dwarskersbos. Curiously however, the original description of *A. barbatus* records the clypeus as quadridentate (Thunberg 1818), while the clypeus of *S. (P.) aesculapius* is definitely bidentate.

Although specimens from the opposite ends of the *S. (P.) aesculapius* distribution share characteristics unique to them, the material examined suggests a cline in morphology rather than a clear division into two separate species or subspecies. For example, of the six *S. (P.) aesculapius* from Grootdrift the indument and elytral soil staining is marked in one male, but variable to absent in all other specimens.

*Biology.* All seven burrows of *S. (P.) aesculapius* excavated by JDUGH contained only dry dung pellets. *S. (P.) aesculapius* occurs sympatrically with *S. (P.) hippocrates* and *S. (P.) glentoni*, which both prefer detritus rather than dry dung pellets. This suggests that these species coexist by having different dietary preferences.

Péringuey (1900) mentions that *S. (P.) hippocrates*, *S. (P.) aesculapius*, *S. (P.) striatus*, and *S. (P.) denticollis* are diurnal. Holm and Scholtz (1979) questioned Péringuey's claim as they did not find any *S. (P.) aesculapius* active during the day other than by excavating their burrows. During December 1996 most *S. (P.) aesculapius* collected were from burrow excavation, but individuals were also seen to be active for a short period in the early morning (ca. 7:00-9:00 am), and late afternoon (ca. 16:00-18:00 pm). The larvae are unknown.

*Comments.* Similar to *S. (P.) hippocrates*, but smaller, *S. (P.) aesculapius* has a dull cuticle, and well-preserved specimens from the north of their range have slight indument that highlights their elytral intervals.

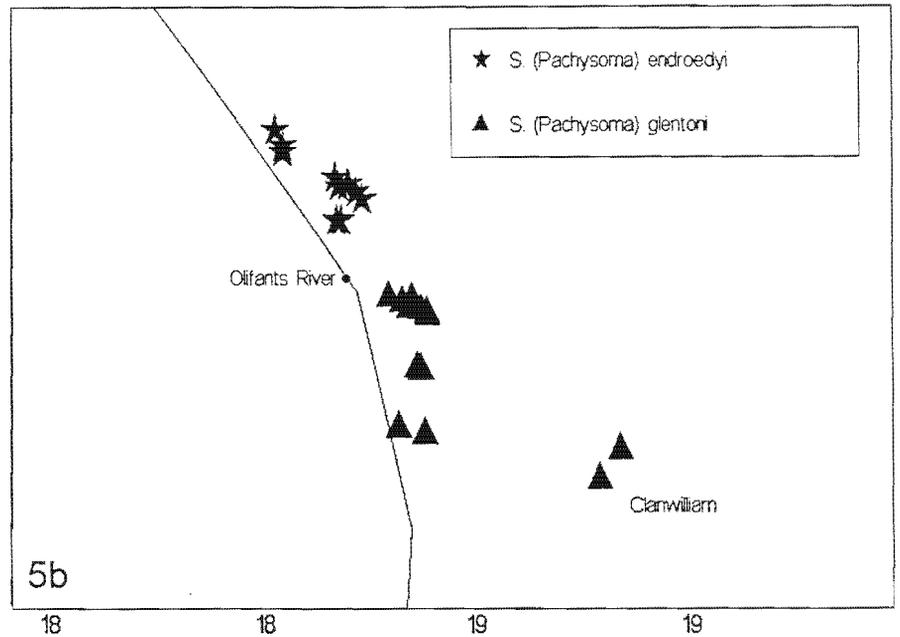
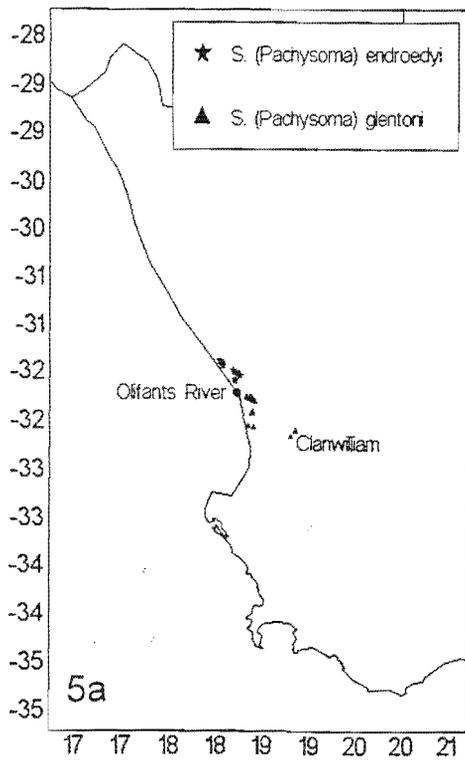
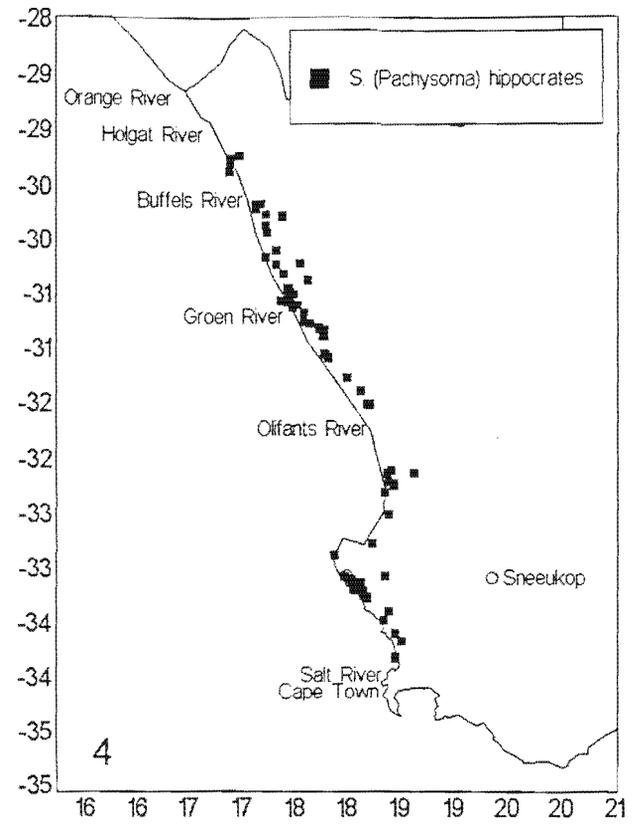
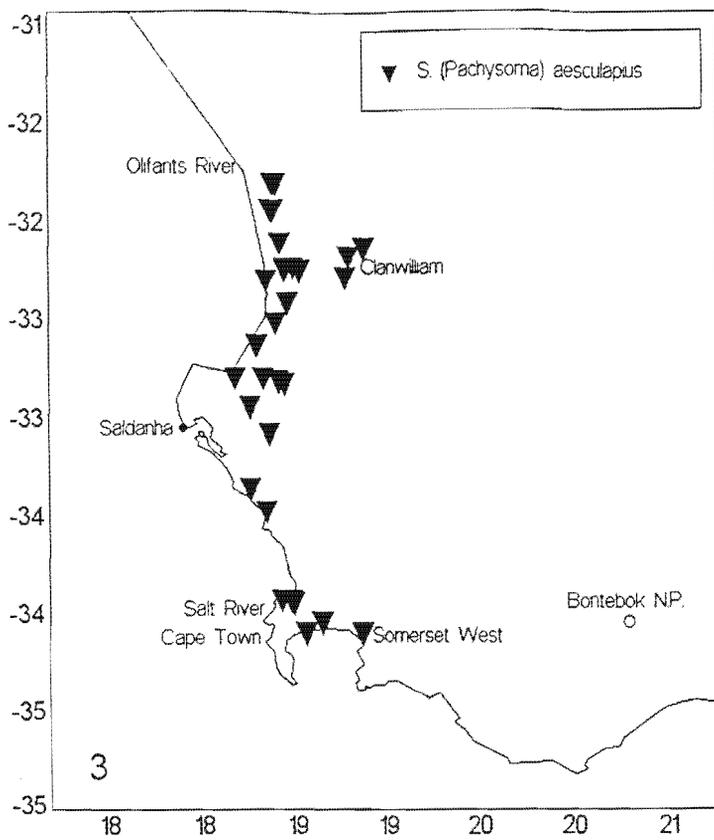
*Types.* Holm and Scholtz (1979) could not trace the type of *Scarabaeus aesculapius* Olivier, 1789. An old repined specimen of *S. (P.) aesculapius* labelled in the exact manner as MacLeay's holotype of *Pachysoma hippocrates*, was found in the BMNH collection (refer to type material below for label data). MacLeay described the genus *Pachysoma* in 1821 and included two species in the genus, i.e. *P. hippocrates* and *P. aesculapius*. The possibility exists that MacLeay had borrowed a specimen or specimens from Olivier, which MacLeay then labelled as his type or compared with *P. aesculapius* material in the BMNH, before labelling it as his type. As Olivier's types are considered lost, this specimen either came from the Olivier series or was at least compared to Oliviers' type of *S. aesculapius*. Thus it is designated as the lectotype of *Scarabaeus aesculapius* Olivier, 1789. This specimen agrees in microsculpture and genital structure, with *S. (P.) aesculapius* from near the Modder River (33°28'S 18°20'E).

Péringuey (1902) could find no differences between *P. aesculapius* from Somerset West and one of Boheman's 'co-type' of *P. validum*. Of the two paralectotypes of *S. (P.) validum* examined, both southern (1♂ BMNH) and northern (1♀ TMSA) populations of *S. (P.) aesculapius* may be represented (see morphological variation above). Which would explain why Péringuey (1902) found no differences.

From the Boheman series of *Pachysoma validum*, Holm and Scholtz (1979) designated a male lectotype (1♂ NHRS) and three paralectotypes (2x NHRS), (1♂ BMNH). An additional female paralectotype (see type material for label data) is however in the TMSA collection.

*Type material examined* (Σ3 spec. [5], 1♀ 2♂, 2♂ diss.). **SOUTH AFRICA:** LECTOTYPE ♂, *Scarabaeus aesculapius* Olivier, designated here: 1751 (typed) / M'Leay's Type / (refer to type discussion above, white paper disk, with a red border with type printed, M'Leay's written above type in the same hand writing as the holotype label of *Pachysoma hippocrates*) / *Pachysoma aesculapius* [M'Leay's type] Oliv. (written on white paper, same writing as before, brackets [ ] on original label), (1♂ BMNH); PARALECTOTYPES 2 of [3]: *Pachysoma validum* Boheman, designated by Holm and Scholtz (1979): Caffraria, J.Wahlb, Type, ♀ (four labels stuck onto one card [probably by Endrödy-Younga]) / Typus (typed in black on red card) / 378 77 (red paper, 378 printed, 77 written) / *validum* Bhm (written on white paper) / Paralectotypus, *Pachysoma validum* Boheman, Holm & Scholtz, (this paralectotype is not recorded by Holm and Scholtz (1979) as being in the TMSA collection), (1♀ TMSA); Caffraria. / J.Wahlb / C.Bon Spei / Fry Coll. 1905-100. / Paralectotype (typed on white circle with a light blue border) / *P.validum* paralectotype Holm & Scholtz 1978, (1♂ BMNH).

*Additional material examined* (Σ173 specs. [42], 61♀ 107♂, 28♂ diss., 5uns., 2eth., 7p.). **SOUTH AFRICA:** Western Cape; **Brackfontein Farm** 32.56S 18.15E, 23. viii.1983, E-Y:1968, sandy ground & grid, leg. Endrödy & Penrith, (1♀ TMSA); **C.(ape) Flats**, (34.02S 18.38E), xii.(18)85, (1♀ SAMC); **Cape, Cape Town**, (33.56S 18.28E), 1882, // Pres. Lightfoot // (1♀ SAMC); Cape T.(own), (33.56S 18.28E), xii. (18)85, (1♂ SANC); C.(ape) T.(own), (33.56S 18.28E), x.(18)86, (1♂ SANC); Cape Town, 65 km N, 33.21S 18.15E, 30.viii.1983, E-Y:1999B, ground traps 63 days, Endrödy, Penrith, groundtraps with meat bait (1♂ TMSA); **Clanwilliam**, (32.07.05S 18.52.05E), 29.ix.(19)27, A.Engelbrecht, NMBH3679, (1♂ BMSA); Cape Col., Clanwilliam, (32.07.05S 18.52.05E), (1♀ SAMC); Clanwilliam, near **Lambert's Bay**, Suurfontein C 527, 32°05'29S 18°24'41E, 17-19.xii.1996, J.duG.Harrison, site 206, dunes, white sand, dune periphery, (1♀ TMSA); Clanwilliam, near **Leipoldtville**, 32°14'S 18°31'E, 19.xii.1996, J.duG.Harrison, site 207, Langveirivier bank, soft white sand, (1♀ 1♂ SANC), (1♀ 1♂eth. TMSA); Clanwilliam, 11.7km W, (ca.32.10S 18.47E), near **Ysterfontein**, 5.viii.1997, C.R.Owen, (2♀ COCS); E Doubleday, (not traced), Cape, Ent. Club. 44-12, (1x BMNH); 10km N, **Dwarskersbos**, (32.37S 18.17E), 20.xii.1977, E.Holm, (1♀ 3♂ TMSA), (3♂ SANC), *idem*, but Comp(ared) to type, Paralectotype, *Ateuchus barbatus* Thunberg, (HT: UPS), Holm & Scholtz 1978, (1♀ TMSA); **Grootdrif Farm**, 32.24S 18.27E, 29.viii.1981, E-Y:1860, day, sandy hill, Endrödy-Younga, (3♀ 3♂ TMSA); **Hopefield**, (33.04S 18.21E), Saldanha Bay crossed out, // ix. (19)60 //, (2♀ SAMC); **Jakkalsvlei**, (ca. 32.16S 18.46E at Jakkalsvlei), R364 to Jakkalsvlei, South 11.3km, 5.viii.1997, C.R.Owen, (1♀ 2♂ COCS); **Klein Klipheuwel**, 32.14S 18.26E, 26.viii.1981, E-Y:1851B, groundtraps 63 days, Endrödy-Younga, hand-collected around traps at setting, (1♀ TMSA); **Leipoldtville**, (32.13S 18.29E), **Eland's Bay**, (32.17S 18.20E), //



FIGURES 3-5. Distribution of *Scarabaeus* (*Pachysoma*) species in South Africa. Questioned locality records or range extensions are shown by an open circle. (3) *S. (P.) aesculapius*; (4) *S. (P.) hippocrates*; (5a) *S. (P.) endroedyi* and *S. (P.) glentoni* mapped at large scale to compare with *S. (P.) hippocrates*; (5b) *S. (P.) endroedyi* and *S. (P.) glentoni* mapped at small scale.

xi.1948, Mus. Exp. //, (1♀ 4♂ SAMC), *idem*, but NMBH3678, (1♂ BMSA); Leipoldville, (32.13S 18.29E), x.1991, C.R.Owen, (1♂ COCS); **Modder River 721**, 33.28S 18.20E, 28-29.viii.1987, (1♀ 6♂ SANC), 7-8.ix.1987, (2♀ 6♂ BMNH), 17-18.ix.1987, (5♀ 4♂ UPSA), 20-21.x.1987, (3♀ 12♂ TMSA), 29-30.x.1987, (2♀ 2♂ BMSA), 10-11.xi.1987, (5♀ 8♂ SMWN), 21-22.xi.1987, (2♀ 7♂ SAMC), 28-29.xi.1987, (1♀ 4♂ UPSA), 12-14.xii.1987, (2♀ 2♂ ZMHB), (1♀ 1♂ UPSA), A.L.V. Davis, Ex. cattle dung baited pitfall, Fynbos thicket, sand; **Piketberg**, 52km NW, 32.48S 18.24S, 27.iv.1976, 60m, Davis & Aschenborn, (1♀ 1♂ SANC); Piketberg, (32.53S 18.45E), 30.x.1942, NMBH03680, (1♀ BMSA); Piketberg D., Bottel Fontein 11, near Brakkuil, 32°30'S 18°23'E, 19-20.xii.1996, J.duG.Harrison, site 208, vegt. sand rises, soft white sand, (1♀ 1♂ TMSA), (2p SANC); Piketberg D., **Rocherpan N.R., Bookram 30**, 32°37'S 18°17'E, 20-21.xii.1996, J.duG.Harrison, site 209, behind 1° dunes, white sand plain, (1♂ TMSA); **Salt River Flats**, (Cape Town, ca. 33.56S 18.59E), (and not 31.15S 17.52E), 3.x.(18)82, (1♀ SAMC); **Salt River**, (Cape Town, ca. 33.55S 18.28E), x.1882, (1♀ SANC), (1♀ 1♂ SAMC); Salt River, (Cape Town, ca. 33.55S 18.28E), xi.1882, (1♂ SAMC); **Strandfontein, NAT. Olifants R. Mouth**, (34.05S 18.33E), xi.1949, C.Koch, (1♂ TMSA); **Vredendal D.**, nr. **Strandfontein**, Byneslaagte 274, Onderputs, 31°47'29S 18°22'59E, 14.xii.1996, J.duG.Harrison, site 202, Grootzandleegte R., Y. firm sand plain, (1♀ 1♂ SANC); nr. Strandfontein, Byneslaagte 274, Onderputs, 31°47'01S 18°22'11E, 14-15.xii.1996, J.duG.Harrison, site 203, Grootzandleegte R., Y. firm sand plain, (2♀ 6♂ SAMC); **Fonteintjie 466**, near Witwater, 31°54'58S 18°21'37E, 15.xii.1996, J.duG.Harrison, site 204a, sand rise, yellow sand, (2♀ 4♂ TMSA), (5p SANC); **Somerset West**, (34.05S 18.51E), 27.iii.(18)83, (1♀ SANC); **Velddrift**, 32.47S 18.10E, 17.x.1971, Bornemissza & Kirk (1♂ SANC); Velddrif, 14km E, 32.47S 18.19E, 10.x.1973, I.D. Temby, DRU1256, (1♀ SANC); Velddrift, 24km E, 32.49S 18.26S, 10.x.1973, I.D. Temby, DRU1255, (1♂ SANC); No locality data: (2 SANC), (2 SAMC); No locality data but Ex. Coll. Dr.H.Brauns, (small specimens probably from near Cape Town), (3♂ TMSA).

Specimens from the following localities may be incorrectly labelled because they are outside the species' established range: SOUTH AFRICA: Swellendam, **Bontebok National Park**, 34.04S 20.27E, 27-31.x.1987, Entomol. dept., NMBH26926, (1♀ BMSA); Hopefield (crossed out), **Saldanha Bay**, (33.01S 17.57E), // ix.(19)60 // (1♂ SAMC); ZAMBIA: **Monze**, (ca. 16.16S 27.29E), xii.1988, C.R. Owen, (2♂ DNSM), *idem*, but ii.1989, (1♀ 3♂ DNSM).

### ***Scarabaeus (Pachysoma) hippocrates*** (MacLeay, 1821)

(Figures 4, 19, 37, 54, 58)

*Pachysoma hippocrates* MacLeay, 1821: 507; MacLeay, 1833: 55; Castelnau 1840: 68;

Péringuey 1902: 77; Gillet 1911a: 6; Ferreira 1953a: 16; Ferreira 1961: 23; Ferreira 1966: 57; Ferreira 1969: 21; Holm and Scholtz, 1979; 230. Holotype: No locality (1♂ BMNH).

*Pachysoma macleayi* Castelnau, 1840: 68; Ferreira 1961: 23; Holm and Scholtz, 1979; 230.

*Pachysoma hessei* Ferreira, 1953a: 18; Ferreira 1961: 23; Ferreira, 1969: 21; Holm and Scholtz, 1979: 230. Holotype: Namaqualand, Wallekraal (1♂ SAMC).

*Scarabaeus hippocrates* (MacLeay): Mostert and Holm, 1982: 275.

*Diagnosis.* Clypeus bidentate, genae and clypeal edge unserrated and continuous (figure 19); protibial spurs bifurcate in both sexes, males have ventral inner edge of protibia elbowed and serrated (this characteristic varies clinally from very marked south of the Olifants River to absent in specimens from the north (i.e. Port Nolloth) (figures 37a,b); metatarsal claws longer than last tarsal segment; genitalia as in figures 58a,b,c.

*Distribution, Habitat and Conservation.* Coastal southwestern South Africa, recorded from Cape Town, Bloubergstrand (33°48'S 18°27'E) to Port Nolloth (29°15'S 16°53'E) in Namaqualand (figure 4). Their habitat preference includes vegetated soft to firm sand of coastal hummocks and hillocks, the periphery of dune systems, and river beds and banks. *S. (P.) hippocrates* occur within the West Coast National Park and the proposed Groen-Spoeg National Park. Habitat modification threatens certain populations of *S. (P.) hippocrates*, viz. those of Bloubergstrand and Port Nolloth.

*Comments on locality data.* The Sneekop (33°07'S 19°37'E), (5000ft) locality near Wellington, is probably due to an incorrectly labelled specimen. This specimen was collected by Dr K.H. Barnard, who worked at the SAMC from 1911-1964. Dr Barnard was a keen mountaineer, who collected and described 10 species of the high altitude specialist *Colophon* Gray (Lucanidae). Endrödy-Younga (1988), revised *Colophon* and the only locality label resembling the above is for *Colophon stokoei* from 'Upper Snoukop, Wellington, 4500-5000ft., January, K.H.Barnard & R.Primos'. Additionally, Endrödy-Younga (1988) records that '...the data published by Barnard are not consistent with those of the labels...' suggesting that Barnard was not a stickler for detail. No other *S. (Pachysoma)* specimens were collected by Dr Barnard. This single male agrees with *S. (P.) hippocrates* from Bloubergstrand near Cape Town. Sneekop is well outside the established coastal distribution range of all *S. (Pachysoma)* species, and no *S. (Pachysoma)* have been reliably collected from high altitudes (1525 m). The Bain's Kloof pass to Wellington was visited by JDUGH and the only remotely suitable habitat for *S. (Pachysoma)* is along the sandy river beds of the Wit and Bobbejaan rivers.

*Morphological variation.* The *hippocrates* species complex contains three species, viz. *S. (P.) hippocrates*, *S. (P.) glentoni* and *S. (P.) endroedyi*. It was suspected that the distribution of *S. (P.) hippocrates* extends from Cape Town to the Olifants River while *S. (P.) hessei* occurs north of the Olifants River to Port Nolloth. This suspicion was tested, but no distinct change was found in the aedeagal morphology across this potential barrier (Olifants River). Individual aedeagi from disjunct populations, e.g. Port Nolloth (29°15'S 16°53'E) and Modder River (33°28'S 18°20'E) differ significantly, but when all populations were examined there is only evidence of a gradual clinal change. Furthermore, the populations comprising the cline exhibit very slight unique genitalic and other morphological features. This suggests that *S. (P.) hippocrates* is currently undergoing speciation. Furthermore, within a population the male

genitalia can show distinct differences. For example in the Port Nolloth and Sand Kop (29°42'S 17°06'E) populations the development of a spine on the left paramere is variable.

Examination of the external morphology revealed the same trend, but evidently *S. (P.) hippocrates sensu lato* includes a main-cline composed of four subclines (listed below) within it. The main cline (for the entire geographic range of *S. (P.) hippocrates*) varies in the following features: (1) aedeagal morphology; (2) variation in size, large in the south to smallest in the north; (3) variation in the expression of the dimorphic elbowed protibia, very slight in the north to very marked in the south. Further detailed examination of all specimens revealed four subclines within *S. (P.) hippocrates*, i.e. excluding the sister species [*S. (P.) aesculapius*, *S. (P.) endroedyi* and *S. (P.) glentoni*]. These populations may be isolated by river courses (i.e. natural barriers) and include: (1) a Cape Town to Lambert's Bay population, distinguished by large size and dimorphic protibia; (2) an Olifants to Groen River population, recognizable by a reduction in the dimorphism of the protibia, and the presence of waxy indument on the periphery of the elytra; (3) a Groen to Buffels River population, characterised by an even smaller difference in the protibia between sexes, and no waxy indument; (4) a Buffels River to Port Nolloth (possibly extending to the Holgat River, but as yet unconfirmed), characterised by small size, practically no dimorphism of the protibia, but very orange setal colour in mature sclerotized specimens (teneral specimens of other populations may have this colour). Thus, no consistent and easily recognizable suite of characters could be found to justify the existence of *S. (P.) hessei* at subspecific or specific level. To divide *S. (P.) hippocrates* into four subspecies would make identification very difficult for a nonspecialist. I therefore choose to regard *S. (P.) hippocrates* as a species with distinct south to north clinal variation, and consequently the synonymy of *S. (P.) hessei* with *S. (P.) hippocrates* is maintained.

**Biology.** *S. (P.) hippocrates* occur sympatrically with *S. (P.) aesculapius* south of the Olifants River, and with *S. (P.) striatus* north of the Olifants River. Of 36 nests excavated by JDUGH, five contained only pellets, six contained both detritus and pellets while 25 contained only detritus. This suggests that *S. (P.) hippocrates* prefers detritus. Two separate attempts were made to breed *S. (P.) hippocrates* in the lab. Three pairs between (1.ix.1996-23.i.1997) and six pairs between (9.ix.1998-4.xii.1998) of *S. (P.) hippocrates* were placed in round 25l buckets and 5l square bread bins respectively. Sand, detritus and dry pellets from their collection site were used. They dug burrows, foraged regularly, but did not breed.

**Comments.** *S. (P.) hippocrates* is very similar to *S. (P.) glentoni* (see diagnosis of these species for the differences) but is easily and reliably differentiated by the male genitalia and geographic distribution.

**Types.** The holotype of *Pachysoma hippocrates* has no locality label, but the type locality is recorded by MacLeay (1821) as Cap. Bonae Spei. It is a large (length 35.20 mm; width 22.34 mm) specimen with very worn protibia, and its genitalia were first dissected by JDUGH for this study. Holm and Scholtz (1979) suspected it came from the southern extreme of the species' distribution. The size and male genitalia confirm their suspicion, however, it does

not match any labelled material from the southern populations, except a single male labelled C. Bon Spei that conforms to it in size, microsculpture and identical male genitalia.

Ferreira (1953a), lists the holotype, allotype and twelve paratypes of *Pachysoma hessei* in the SAMC collection, and one paratype in the CPMM collection. Holm and Scholtz (1979) were only able to trace the holotype, allotype and two paratypes in the SAMC collection. The remaining ten paratypes from the SAMC were discovered during reorganisation (1993 onwards) of the collection (see Cochrane 1995).

*Type material examined* ( $\Sigma$ 14 spec. [5], 3♀ 11♂, 9♂ diss.). **SOUTH AFRICA:** HOLOTYPE ♂, *Pachysoma hippocrates* MacLeay: [1] *Hippocrates* (written onto faded white triangle) / 58.60. (written onto blue disk) / Type (printed on white disk, surrounded by a red circle) / *Pachysoma hippocrates* (Kirby MS), Type McLeay. (written onto now faded white paper) / *Pachysoma hippocrates* M'Lea, Holotype (written onto white rectangular card, surrounded by a red line, UPSA label) / *Pachysoma hippocrates* Holotype dissected J.duG. Harrison 1998 / (1♂ BMNH). HOLOTYPE ♂, *Pachysoma hessei* Ferreira: Wallekraal, Namaqualand, (30.22.05S 17.37.05E) // Mus., Expd., Oct.1950. // (printed locality label) / Holotypus, ♂, *Pachysoma Hessei*, 1951, Maria C. Ferreira / *Pachysoma hessei* Ferreira (= *hippocrates* M'Leay), det. Holm & Scholtz 1978, (written onto UPSA holotype label) / (1♂ SAMC), *idem*, but / Allotypus, ♀, *Pachysoma Hessei*, 1951, Maria C. Ferreira / *Pachysoma hessei* Ferreira (= *hippocrates* M'Leay), det. Holm & Scholtz 1978, (written onto UPSA paratype label) / (1♀ SAMC), PARATYPES: *idem*, but Type, SAM/Ent. 2678, (printed onto green card), (8♂ SAMC), (1♂ TMSA), {1 CPMM}; Wallekraal, Namaqualand, (30.22.05S 17.37.05E), S.A.M., Oct.1950 (written) / Type, SAM/Ent. 2678 / (1♀ SAMC), (1♀ TMSA).

*Additional material examined* ( $\Sigma$ 308 specs. [45], 92♀ 185♂, 77♂ diss., 5uns., 26eth., 81p.). **SOUTH AFRICA:** Western Cape; **Abrahamskraal farm**, 33.14S 18.09E, 25.viii.1983, E-Y:1976B, groundtraps with faeces bait 70 days, Endrödy, Penrith, (4♂ TMSA); **Atlantis Area**, (ca. 33.35S 18.27E), 30.xii.1985, Owen, (1♀ TMSA); near Atlantis, (ca. 33.35S 18.27E), 8.x.1986, C.R.Owen, BM 1987-57, (2♀ 1♂ BMNH); **Bloubergstrand**, (33.48S 18.27E), 25.xi.1964, A.L.Capener, (1♂ SANC); Piketberg D., **Bottel Fontein 11**, near Brakkuil, 32°30'S 18°23'E, 19-20.xii.1996, J.duG.Harrison, site 208, vegt. sand rises, soft white sand, (1♀ abdomen with 4 legs TMSA); Hopefield D., Langebaan, West Coast National Park, **Bottelary 353**, 33°07'05S 18°05'12E, 21.xii.1996, J.duG.Harrison, site 210, vegt. yellow sand, (1♀ BMNH); Bottelary 353, 33°09'10S 18°07'22E, 21.xii.1996, J.duG.Harrison, site 212, vegt. white sand, (5♂ BMNH), (2p SANC); Bottelary 353, 33°07'06S 18°05'23E, 21.xii.1996, J.duG.Harrison, site 213, vegt. white sand, (1♂ BMNH); Bottelary 353, 33°09'24S 18°05'51E, 22.xii.1996, J.duG.Harrison, site 214, vegt. dune, white sand, (1♀ BMNH); Bottelary 353, 33°08'04S 18°04'50E, 22.xii.1996, J.duG.Harrison, site 215, vegetated dune, white sand/humus, (1♀ BMNH), (5p SANC); **C. Bon Spei** (Cape of Good Hope), (written onto white paper) / Fry Coll., 1905-100. (printed onto white paper) / (point mounted male genitalia dissected here) /

*Pachysoma AEsculapius*. Oliv., P.B.Spei., (written onto white paper), (1 ♂ TMSA); **Darling**, C.C. (33.23S 18.23E), x.(19)05, L. Péringuey, (1♂ SANC), (2♀ 1♂ SAMC); Darling, C.C. (33.23S 18.23E), 1905, L. Péringuey, (1♂ SANC), (2♂ SAMC), (1♂ TMSA); Darling, C.C. (33.23S 18.23E), (19)05, J.M.Baiu ?, (2♂ UPSA), (1♀ 5♂ SANC), (4♀ 6♂ SAMC), (2♂ MGMK), (2♀ 2♂ TMSA); Darling, (33.23S 18.22E), (19)06, H.M.Dudley, (spelling ?), (1♂ DNSM), (2♀ 1♂ SAMC); **Donkergat**, (Postberg Nature Reserve 33.05S 18.00E), (or near Atlantis 33.39S 18.30E), 1.v.1983, M.Stiller, (1♀ USSA); **Elandsbay Forestry**, 32.18S 18.21E, 28.viii.1981, E-Y:1853B, groundtraps with meat bait 60 days, Endrödy-Younga, (1♀ 1♂ TMSA); Hopefield D., West Coast National Park, **Geelbek 360**, 33.10S 18.08E, 7-8.xi.1996, T.J.Robinson, (2♀ 10♂ UPSA); Hopefield D., West Coast National Park, Geelbek, 33.10S 18.08E, 17-18.ix.1987, (1♀ 2♂ BMSA), 28-29.ix.1987, (2♀ 5♂ SANC), 13-14.x.1987, (1♀ 2♂ ZMHB), 20-21.x.1987, (1♀ 1♂ MNHN), A.L.V.Davis / Ex. cattle dung baited pitfall, Fynbos thicket mosaic, Sand; Geelbek Forestry, 33.12S 18.08E, 25.viii.1983, E-Y:1975B, groundtraps with banana bait 70 days, Endrödy, Penrith, (1♀ TMSA); Langebaan, 12km Farm Geelbek, (ca. 33.16S 18.10E), 11-13.x.1978, sand shrubland, A.L.V. Davis (1♀ SANC); Langebaan, 12km SE Farm Geelbek, (ca. 33.16S 18.10E), 30.vii.1979, A.L.V. Davis, DRU2660, (1♂ SANC); Geelbek 360, 33°13'07S 18°08'52E, 21.xii.1996, J.duG.Harrison, site 211, vegt. dunes, white sand, (2♂ SMWN); Geelbek 360, 33°11'35S 18°08'49E, 23.xii.1996, J.duG.Harrison, site 218, active dunes, white sand, (1♂ SANC); **Hopefield**, (Saldanha Bay crossed out), 33.04S 18.21E // ix.1960 // (1♂ UPSA), (2♀ 2♂ SAMC); *idem*, but / compared to type *P. hippocrates* MacLeay, Holm & Scholtz, no locality, worn protibia, (1♀ TMSA); **Klein Klipheuwel**, 32.14S 18.26E, 26.viii.1981, E-Y:1851B, hand-collected around traps at setting, Endrödy-Younga, (1♀ TMSA); Clanwilliam, nr. Lambert's Bay, **Kookfontein 88**, 32°03'54S 18°22'39E, 16.xii.1996, J.duG.Harrison, site 205, vegt. dune, firm yellow sand, (1♂ TMSA); **Lambert's Bay**, 9km N, (ca. 32.07.05S 18.22.05E), 28.ix.1974, Houston, Davis, Tribe, (1♂ SANC); Lambert's Bay, 6km E, 32.06S 18.24E, 1.ix.1979, E-Y:1628, white dunes day, Endrödy-Younga, (1♂ TMSA); **Langebaan**, Cape, (33.06S 18.02E), 1.x.1977, N.J.Duke, (2♂ TMSA); Leipoldville, 12km W, (ca. 32.12S 18.23E), 27.iv.1976, Davis & Aschenborn, DRU2283, (2♀ SANC); **Modder River 721**, 33.28S 18.20E, 13-14.x.1987, (1♂ TMSA), 20-21.x.1987, (1♀ 1♂ TMSA), 10-11.xi.1987, (1♂ SAMC), 28-29.xi.1987, (2♂ UPSA), A.L.V. Davis / Ex. cattle dung baited pitfall, Fynbos thicket, sand; **Saldanha Bay**, C.C., (33.07S 17.52E), 1913, (2♀ SAMC); Saldanha, (33.03S 17.58E), x.(18)92, (1♂ SAMC); **Stofbergfontyn 365**, 33°10'16S 18°03'02E, 22.xii.1996, J.duG.Harrison, site 216, behind 1° dunes, white sand, (1♂ BMNH) (4♂ 1p SANC); Stofbergfontyn 365, 33°11'25S 18°04'12E, 22.xii.1996, J.duG.Harrison, site 217, behind 1° dunes, white sand, (1♀ 2♂ 10p SANC); **Velddrif**, 3km E, 32.46S 18.14E, 31.viii.1981, E-Y:1870, groundtraps with faeces bait, Endrödy-Younga, (1♂ TMSA); **Vredenburg**, (32.52.05S 17.52.05E), 10.vii.1944, (NMBH 3681), (1♂ BMSA); **Ysterfontein** (Clanwilliam), (32.07.05S 18.37.05E), (Saldanha Bay crossed out) // ix.1960 // (2♀ SAMC); **Yzerfontein**, 8km N, 33.15S 18.11E, 25.viii.1983, E-Y:1978B, ground traps with meat bait 70 days, Endrödy, Penrith, (4♂ TMSA); No locality data, (4x BMNH).  
Synonym of *Scarabaeus (Pachysoma) hippocrates*, i.e. *Pachysoma hessei* Ferreira, 1953a.

**SOUTH AFRICA: Northern Cape; Namaqualand; Dembergdraai F.**, (Groen Rivers Valley 504), 30.47S 17.43E, 24.viii.1979, sand blown hill, E-Y:1590, leg Endrödy-Younga, (3♂ TMSA); Dembergdraai F., (Groen Rivers Valley 504), 30.47S 17.43E, 24.viii.1979, groundtraps, 63 days with meat bait, E-Y:1589B, leg Endrödy-Younga, (2♂ TMSA); Dembergdraai F., 30.47S 17.43E, 18.ix.1994, E-Y:3014B, Endrödy-Younga & Bellamy, groundtraps with banana bait for 7 days, (1♀ 1♂ TMSA); Dembergdraai F., 30.48S 17.43E, 19.ix.1994, E-Y:3021, Endrödy-Younga & Bellamy, on red sandy ground, (1♂ TMSA); **Gemsbok Vlake Farm** (498), 30.30S 17.29E, 30.viii.1977, hand-collected, dunes, day, E-Y:1361 Endrödy-Younga, (2♂ TMSA); **Graskom**, 30.18S 17.23E, 15-18.ix.1982, S.Louw, NM8642, (1♂ BMSA); same data but, M.-L. Penrith / H54563, (1♀ 1♂ SMWN); **Karooevlei**, Van Rhynsdorp, (Karooevlei, Klein Kogel Fontein 148), 31.06S 17.51E, 13.x.1948, (1♀ SAMC); **Hondeklipbay**, 16km E, (ca. 30.21S 17.26E), ix.1991, C.R.Owen, (1♀ 1♂ COCS); **Kommandokraal Farm** (624), 31.30S 18.12E, 30.viii.1979, hand-collected on sand, E-Y:1622, Endrödy-Younga, (1♂ TMSA); Kommandokraal Farm W (624), 31.29S 18.11E, 23.ix.1994, E-Y:3035, E-Y: Endrödy-Younga & Bellamy, on ground, (1♀ TMSA); Kommandokraal Farm (624), 31.30S 18.12E, 22.ix.1994, E-Y:3033, Endrödy-Younga & Bellamy, on sandy ground, (4♀ 5♂ TMSA); **McDougall's Bay**, 4km S of Port Nolloth, 29.17S 16.53E, 29.xi.1994, Scholtz, Chown, Klok (2♂ UPSA), (3♂ TMSA); **Port Nolloth**, 29.15S 16.53E, xi.1994, Scholtz, Chown, Klok (13p SANC); Port Nolloth, 29.22.05S 16.52.05E, 1911, C.L.Biden, (1♂ SAMC); **Quaggafontein** (478), 30.13S 17.33E, 29.viii.1977, E-Y:1353, hand-collected, day, Endrödy-Younga, (2♀ TMSA); Quaggafontein (478), 30.13S 17.33E, 29.viii.1977, E-Y:1356B, groundtraps, 60 days, with meat bait, Endrödy-Younga, (1♂ TMSA); **Rooidam Farm**, (Wit Water 557), 31.04S 17.48E, 26.ix.1994, E-Y:3046, white vegetated dunes, Endrödy & Bellamy, (3♂ TMSA); Rooidam Farm, (Wit Water 557), 31.02S 17.46E, 20.ix.1994, E-Y:3026, ground and light, Endrödy-Younga, (1♂ TMSA); **Strandfontein Farm**, (Strand Fontein 499), 30.33S 17.22E, 3.ix.1977, E-Y:1374, hand-collected, dunes, day, Endrödy-Younga, (1♀ TMSA); **Soutpan**, 10km E., (near Salt River mouth), 31.15S 17.59E, 13.ix.1987, E-Y:2493, in cattle grid, Endrödy-Younga, (1♀ 1♂ TMSA); No locality data, Dr. Smith, S.Afr. 44-6 (1 BMNH).

**SOUTH AFRICA: Northern Cape; Namaqualand; De Dam 541**, 30°52'06S 17°45'24E, 4.xii.1996, J.duG.Harrison, site 173, dead in mud, firm yellow sand, (1p SANC); **De Klipheuveld 435**, near Soutfontein, 30°39'40S 17°34'55E, 1.xii.1996, J.duG.Harrison, site 163, sand plain fynbos, yellow sand near vegetated dunes, (1♂ TMSA); **De Witflacte 551**, near Hardevlei, 30°52'50S 17°45'50E, 4.xii.1996, J.duG.Harrison, site 174, vegetated dune, firm/soft yellow sand, (1p SANC); **Driekop 500**, 30°36'34S 17°27'41E, 30.viii.1996, J.duG. Harrison, site 78, vegetated old dune, yellow sand, (2p SANC); Driekop 500, 30°35'09S 17°31'06E, 30.viii.1996, J.duG.Harrison, site 80, Bitter River bank, yellow sand, (1♂ 2p SANC); **Graafwater, Farm 156**, 31°22'38S 18°01'23E, 6.xii.1996, J.duG.Harrison, site 186, firm Y. sand plain, nr. veegt. dunes (1♀ 3♂ 1p SANC); **Groen River, Roode Heuveld 502**, 30°45'24S 17°38'24E, 4.xii.1996, J.duG.Harrison, site 168, Groen River bank, red sand, (1♂ SAMC); **Kanoep 491**, nr. Swartfontein, 30°26'41S 17°25'41E, 22.xi.1996, J.duG.Harrison, site 150, Spoeg R. bed, white

sand banks, (5♂ SANC), (2♂ TMSA); Kanoep 491, near Swartfontein, 30°28'22S 17°26'37E, 23-24.xi.1996, J.duG.Harrison, site 151, Bitter R. Dunes, dune periphery, white sand, (1p SANC); Kanoep 491, near Swartfontein, 30°28'14S 17°26'23E, 23-24.xi.1996 J.duG.Harrison, site 151a, Bitter R. Dunes, interdune slack, white/red sand, (1♀ 2♂ SMWN); **Klein Duin 154**, 29°13'01S 16°57'45E, 29.vii.1996, J.duG.Harrison, site 23, vegetated rise bf. white dunes, dead, (2p SANC); Klein Duin 154, 29°13'17S 16°57'49E, 29.vii.1996, J.duG.Harrison, site 24, white sand dunes, (2p SANC); Klein Duin 154, 29°13'04S 16°57'54E, 29.vii.1996, J.duG.Harrison, site 26, white sand dunes, vegetated slack, (4p SANC); **Kleinsee, Sand Kop 322**, 29°40'07S 17°07'22E, 1.viii.1996, J.duG.Harrison, site 30, vegetated dune, yellow sand, (4♀ 1♂ BMNH) (3p SANC); Kleinsee, Sand Kop 322, 29°42'40S 17°06'51E, 3-6.viii.1996, (4♀ 7♂ UPSA) (2p SANC), 22.viii.1996, (1♀ 4♂ SAMC) (14eth. TMSA) (8p SANC), J.duG.Harrison, site 31, vegetated dune, yellow sand; **Kleinsee, Honde Vlei 325**, 29°45'25S 17°13'11E, 7.viii.1996, J.duG.Harrison, site 32, vegetated dune, yellow sand, (1♂ TMSA); Kleinsee, Sand Kop 322, 29°39'55S 17°10'34E, 28-30.x.1996, Harrison & Scholtz, site 113, vegetated dune, red sand, (12♀ 18♂ UPSA) (17p SANC); Kleinsee, Sand Kop 322, 29°40'16S 17°08'05E, 28.x.1996, Harrison & Scholtz, site 114, firm yellow sand plain, (1p SANC); near **Koingnaas**, 30°02'41S 17°12'44E, 12.viii.1996, Harrison & Scholtz, site 41, DeBeers Game Farm, vegetated dune, white sand, (1p SANC); Koingnaas 475, 30°13'37S 17°19'00E, 3.ix.1996, J.duG.Harrison, site 82, Swartlontjiesrivier bank, yellow sand, (1♂ UPSA); Koingnaas 475, 30°13'20S 17°18'46E, 22.xi.1996, J.duG.Harrison, site 141, Swartlontjies R. bank, yellow sand, (9eth. TMSA); **Kourootje 316**, 29°45'07S 17°20'39E, 9.viii.1996, Harrison & Scholtz, site 37, yellow sand, vegetated dune near, (1p SANC); Kourootje 316, near Komaggas, 29°46'44S 17°22'22E, 10.xi.1996, J.duG.Harrison, site 121, sand plain fynbos, vegt. dune y/r sand, (1♂ 2eth. TMSA); **Kwaas 501**, 30°43'39S 17°31'23E, 14.viii.1996, Harrison & Scholtz, site 47, Vegt. dune, yellow soft sand, (2♀ SMWN); Kwaas 501, 30°42'38S 17°34'36E, 1.xii.1996, J.duG.Harrison, site 164, sand plain fynbos, yellow sand, (1♀ SAMC); **Roode Heuvel 502**, 30°44'23S 17°34'27E, 21.vii.1996, J.duG.Harrison, site 10, sand plain fynbos, red sand, (1♂ 1p SANC); **Rondabel 542**, 30°49'01S 17°46'07E, 4.xii.1996, J.duG.Harrison, site 170b, vegetated dune, soft yellow sand, (2♀ 1♂ 1p SANC); **Samsons Bak 330**, near Kleinsee, 29°55'22S 17°13'34E, 20.xi.1996, J.duG.Harrison, site 130, firm yellow sand, near vegt. dune, (1p SANC); Sand Kop 322, 29°39'55S 17°10'34E, 19.viii.1996, J.duG.Harrison, site 62&113, vegetated dune, red sand, (1♂ BMSA); **Somnaasbaai, Somnaas 474**, 30°09'S 17°13'E, 20.x.1996, J.duG.Harrison, site 101, white sand nr. active white dunes, (1p SANC); **Soutfontein 'Dorp'**, De Klipheuvel 435, 30°36'S 17°35'E, 3.ix.1996, J.duG.Harrison, site 84, Bitter River Bed, (1eth. TMSA); **Strand Fontein 499**, 30°33'S 17°25'E, 20.vii.1996, J.duG.Harrison, site 6, Bitter River Dunes, interdune slack, (1p SANC); Strand Fontein 499, 30°33'45S, 17°26'25E, 13.viii.1996, Harrison & Scholtz, site 43&44, Bitter River Dunes, white sand, (1p SANC); Strand Fontein 499, Bitter R. Dunes, 30°32'28S 17°26'18E, 29.viii.1996, J.duG.Harrison, site 75, interdune slack, white/red sand, (1p SANC); Strand Fontein 499, Bitter River Dunes, 30°32'42S 17°25'45E, 14.ix.1996, J.duG.Harrison, site 91, dune periphery, soft white sand, 2m high shrubs, (1♀ SANC); Strand

Fontein 499, Bitter River Dunes, 19.x.1996, Cameron Mocke, site 102, (1x SANC); Strand Fontein 499, 30°33'32S 17°25'34E, 24-25.xi.1996, J.duG.Harrison, site 152, Bitter River, foredunes nr. sea, soft white sand, (4♀ 3♂ ZMHB); Strand Fontein 499, 30°34'00S 17°26'51E, 24.xi.1996, J.duG.Harrison, site 153, Bitter R. Dunes, vegt. white sand, (1♂ UPSA); Strand Fontein 499, Bitter R. Dunes S., 30°33'57S 17°26'37E, 26-27.xi.1996, J.duG.Harrison, site 155, dune periphery, soft white sand, (1♂ UPSA); Strand Fontein 499, Bitter River Dunes, 30°32'28S 17°26'18E, 4.ix.1996, J.duG.Harrison, (1♀ UPSA); **Wit Water 557**, near Kotzesrus, 31°01'18S 17°46'33E, 5.xii.1996, J.duG.Harrison, site 177, Brak River, yellow sand bank, (1♀ 1p SANC); Wit Water 557, near Rooidam, 31°02'29S 17°46'46E, 5.xii.1996, J.duG.Harrison, site 179, vegetated dune, yellow sand, (1♂ 4p SANC); **Zonnekwa 328**, near Kleinsee, 29°50'56S 17°13'23E, 20.xi.1996, J.duG.Harrison, site 127, vegetated dune, yellow sand, (1♀ TMSA); **Zoutpan 471**, near Koingnaas, 30°05'51S 17°19'05E, 21.xi.1996, J.duG.Harrison, site 137, sand plain fynbos, yellow sand near vegt. dunes, (1p SANC); S.Afr: Vredendal D., **Graafwater**, Farm 156, 31°22'38S 18°01'23E, 6.xii.1996, J.duG.Harrison, site 186, firm Y. sand plain, nr. vegt. dunes, (1♀ 3♂ UPSA); Vredendal D., **Kommandokraal**, on Farm 624, near Koekenaap, 31°29'58S 18°11'47E, 8-9.xii.1996, J.duG.Harrison, site 191, vegetated dune, yellow sand, (1♂ TMSA); Vredendal D., Kommandokraal, on Farm 624, near Koekenaap, 31°29'02S 18°10'08E, 10.xii.1996, J.duG.Harrison, site 193, vegetated dune, yellow sand, (1p SANC); Kommandokraal, 31.31S 18.13E, 100m, 23.ix.1985, AVEvans, CLBellamy, (1♂ UPSA); Vredendal D., **Skilpadvlei**, Farm 620 near Koekenaap, 31°34'05S 18°12'06E, 11.xii.1996, J.duG.Harrison, site 194, vegetated dune, yellow sand, (1♀ 1♂ UPSA) (2p SANC).

A single specimen from the following locality may be incorrectly labelled because it occurs outside the species' established range: **SOUTH AFRICA; Sneekop**, Wellington, (ca. 33°07'05S 19°37'05E), 5000ft, // xi.1922, K.H.Barnard //, (1♂ SAMC).

***Scarabaeus (Pachysoma) glentoni* Harrison, Scholtz and Chown sp. n.**

(Figures 5, 20, 38, 55, 59)

*Description.*

Size (mm). Body length, mean ♂29.70; ♀29.12; range ♂26.72-36.28; ♀25.54-31.98. Pronotal width, mean ♂19.16; ♀17.71; range ♂16.38-22.96; ♀15.78-18.58 (n = 12♂ 12♀). Colour. Cuticle black, setae rufous, antennal clubs golden.

*Head (Dorsal)* (figure 20). Clypeus bidentate, teeth rounded and separated by V-shaped incision; clypeal and genal margins unserrated, almost continuous, separated at clypeal-genal suture by small incision; whole head finely granular, becoming punctate around periphery; large setiferous granules adjacent eye and genae; posterior edge of genae rounded. (*Ventral*). Rim of setae on clypeus and genae edge; clypeal teeth raised into two ridges separated by hollow depression, posterior raised rim with single pointed tooth; line of setae on either side of clypeal ridges; mandibles robust, mentum bilobed, each lobe with stiff setae pointing forwards; antennae lamellate, 9-segmented, club composed of last 3 segments.

*Pronotum.* Head amplexed into prothorax; anterior lateral edge, irregularly notched, posterior lateral edge, serrate from setal fringe; setal fringe, long on outside edge tapering to short medially; disc globose; midline area unsculptured, centrally widened to form unsculptured diamond-shape; adjacent disc deeply punctate, anterior edges granular; distinct patch of fine granules on posterior lateral edge; posterior edge curved inwards.

*Legs; Protibia (Dorsal)* (figure 38b). Quadridentate, teeth pointed, curved downwards, apical surface smooth, basal half transversely furrowed; serrations between teeth; proximal half of protibia with smooth undulations, basal half smooth and continuous; medial setiferous carina; setal border on inner and proximal outer edges, long; setae between teeth, short; inner edge markedly deflected medially; spurs short, stout, bifid and curved downwards. (*Ventral*) (figure 38a). Apical surface of teeth smooth; outer surface scattered with shallow broad punctures, inner edge with fine granules; medial inner lateral edge deflected downwards and bordered with row of irregular but distinct setiferous knobs; medially at base of protibia are 2 rows, outer composed of small setiferous knobs (about 4-5) while inner of carina, both merge into inner protibial deflection. *Mesotibia.* Short and robust, outer edge with 3 bands of seta, inner edge with 2 bands; mesospur slightly spatulate (figure 55), apex forms blunt point; tarsal insertion slightly sub-apical; 2 almost equal in length tarsal claws, both longer than last tarsal segment. *Metatibia (Dorsal).* Medial ridge, proximal side smooth, distal side with long setal brush; spurs thin, pointed, round in cross section, slightly deflected in centre; 2 equal and curved tarsal claws; claws almost equal to just longer than last tarsal segment. (*Lateral*). 3 curved setal brushes on the tibia.

*Elytra.* Elytra fused, humeral callus absent; well-developed sub-elytral ridge; elytral rim broad; 6 faint striae per elytron, most visible when viewed laterally; 6 interstriae per elytron with rows of irregularly spaced, fine, setiferous granules.

*Abdomen.* Mesocoxae contiguous, mesosternal ridge absent; abdominal sternites with single row of setiferous granules becoming irregularly spaced as sternite widens laterally; bilobed protuberances in males (absent in females) on lateral edge of sternites 2,3,4, (numbered 1-6 from metacoxae) only.

*Pygidium.* Dorsoventral midline unsculptured; sides scattered with small granules, bilateral smooth rim around edge of pygidium.

*Aedeagus.* Short, asymmetrical, see figures 59a,b,c.

*Female.* Differs from male as follows; Protibia (*Ventral*). Proximal carina very reduced at (X 40); inner lateral edge with slight deflection, and row of anterior facing setiferous notches (X 40). Abdomen. Width of the last abdominal sternite, broad at pygidium; prominent protuberances on sternites 3-5, absent.

*Comments.* *S. (P.) glentoni* is externally virtually indistinguishable from *S. (P.) hippocrates*. The male genitalia provide the most reliable character for distinguishing these two species (figures 59a,b,c vs. 58a,b,c). Externally *S. (P.) glentoni* is distinguished from *S. (P.) hippocrates* by the narrow almost parallel sided mesotarsal spurs (figure 54 vs. 55), and a distinct patch of granules on the posterior of the pronotum. The localised distribution of *S. (P.)*

*glentoni* (figures 5a,b) as opposed to the much wider distribution of *S. (P.) hippocrates* (figure 4), separates the two species. Very abraded mesospur of *S. (P.) hippocrates* (figure 54 unabraded), resemble the narrow mesospurs of *S. (P.) glentoni* (figure 55 unabraded), care should be taken not to confuse the two species on this character.

*Distribution, habitat and conservation.* Localised to north of Lambert's Bay and south of the Olifants River, extending inland to Clanwilliam (figure 5a,b). Known habitats include the firm vegetated sand of river banks (Olifants and Groot-Sandleegte Rivers) and coastal hummocks. *S. (P.) glentoni* has not been collected in or around larger dunes, and does not occur within any proclaimed conservation area.

*Biology.* *S. (P.) glentoni* was observed collecting detritus, which was dragged forward to preconstructed burrows. A single male was observed at its burrow entrance, releasing what was probably pheromone. The beetle adopted a head down position, and using the hind legs, it would rhythmically stroke its abdominal sternites and then flick its legs backwards. This action was interspersed by short breaks (5-10 s), where the hind legs were held outstretched, but not moved. This behaviour was also observed in *S. (P.) gariepinus* and *S. (P.) hippocrates*.

*Etymology.* Named for a keen naturalist, Mr Jon Glenton, who encouraged JDUGH's interest in biology from an early age. Mr Glenton provided the Land-Rover that enabled JDUGH to collect this new species.

*Type material examined* ( $\Sigma$ 120 specs., 31♀ 89♂, 18♂ diss., 15♂eth.). **SOUTH AFRICA:** HOLOTYPE ♂, S.Afr., SW Cape, Nortier Farm, 32.03S-18.19E / 25.8.1981; E-Y:1847, day, red sand, leg. Endrödy-Younga (1♂ TMSA); *idem* but, ALLOTYPE ♀ (1♀ TMSA); 108 PARATYPES: S.Afr., SW Cape, Nortier Farm, 32.03S-18.19E / 25.8.1981; E-Y:1847, day, red sand, leg. Endrödy-Younga (4♀ 7♂ TMSA), (1♀ 1♂ BMNH), *idem* but, SAM-COL-A043134 (1♀ 2♂ SAMC); S.Afr., SW Cape, Nortier Farm, 32.03S-18.19E / 23.8.1981; E-Y:1840, day, red sand, leg. Endrödy-Younga (2♀ 5♂ TMSA); S.Afr., SW Cape, Nortier Farm, 32.03S-18.19E / 25.8.1981; E-Y:1845, groundtraps, leg. Endrödy-Younga / groundtrap with faeces bait (1♂ TMSA). S.Afr: Vredendal D., nr. Strandfontein, De Boom 273, Skerpklip, 31°45'31S 18°20'55E, 12-14.xii.1996, leg. J.duG.Harrison / Univ.Pret.Zoo&Ento., J.duG,Harrison 1996, site 199 No., Grootsandleegte R. Bank, Y/R sand, (2♀ 4♂ SANC), (2♀ 4♂ ZMHB), *idem* but, T1425 (5♂ SMWN), (4♂ eth. TMSA); S.Afr: Vredendal D., nr. Strandfontein, De Boom 273, Skerpklip, 31°45'18S 18°17'38E, 14.xii.1996, leg. J.duG.Harrison / Univ.Pret.Zoo&Ento., J.duG,Harrison 1996, site 200, No., Grootsandleegte R.Bed, white sand, (1♀ TMSA); S.Afr: Vredendal D., nr. Strandfontein, Byneslaagte 274, Onderputs, 31°47'29S 18°22'59E, 14.xii.1996, leg. J.duG.Harrison, site 202, Grootsandleegte R., Y. firm sand plain, (5♂ MNHN), (6♂ BMNH), *idem* but, T306 (5♂ BMSA); S.Afr: Vredendal D., nr. Strandfontein, Byneslaagte 274, Onderputs, 31°47'01S 18°22'11E, 14-15.xii.1996, leg. J.duG.Harrison, site 203, Grootsandleegte R., Y. firm sand plain, (3♀ TMSA), (1♂eth. TMSA); S.Afr: Vredendal D., Fonteintjie 466, near Witwater, 31°55'17S 18°22'08E, 15.xii.1996, leg. J.duG.Harrison, site 204, sand rise, yellow sand, (1♀ 4♂ SANC), (1♂ UPSA), (10♂eth. TMSA); S.Afr: Vredendal D., Fonteintjie 466, near Witwater,

31°54'58S 18°21'37E, 15.xii.1996, leg. J.duG.Harrison, site 204a, sand rise, yellow sand, (5♂ TMSA), (1♀ 2♂ UPSA), (2♀ 2♂ COCS) *idem* but, SAM-COL-A043135 (3♀ 5♂ SAMC), *idem* but, T1425 (2♀ 5♂ SMWN); S.Afr: Clanwilliam, nr. Lambert's Bay, Kookfontein 88, 32°03'54S 18°22'39E, 16.xii.1996, leg. J.duG.Harrison / Univ.Pret.Zoo&Ento., J.duG.Harrison 1996, site 205 No., Vegt. dune, firm yellow sand (1♀ 1♂ TMSA); S.Afr. C.P. 12km N., of Clanwilliam, (ca. 32.06S 18.50E), 14 October 1981, VB Whitehead / SAM-COL-A043133 (1♀ SAMC); S.Afr: Clanwilliam, 11.7km W, ca. 32.10S 18.47E, 5.viii.1997, C.R.Owen (3♀ 1♂ TMSA); (No locality data) / Ferreira Collection / NMBH3677 / National Museum of Bloemfontein, Dept. Entomology / 234 (written in blue ballpoint on yellow card, possibly by Ferreira) / T306 (1♂ BMSA).

***Scarabaeus (Pachysoma) endroedyi* Harrison, Scholtz and Chown sp. n.**

(Figures 5, 21, 39, 56, 60)

*Description.*

*Size* (mm). Body length: mean ♂22.92; ♀24.28; range ♂20.66-24.70; ♀22.30-26.40. Pronotal width: mean ♂14.54; ♀14.20; range ♂12.78-15.98; ♀12.84-15.18 (n = 12♂ 12♀). *Colour*. Cuticle black; elytral indument grey-white to brown; antennal club golden; seta rubescent to brown.

*Head*(Dorsal) (figure 21). Clypeus bidentate; teeth short, apex rounded, separated by smooth V-shaped incision; genal and clypeal edge unserrated, almost continuous, separated at genal-clypeal incision; head finely granular, setose granules restricted to genae and posterior of head between eyes. (Ventral). Rim of setae around clypeal and genal edge; clypeal teeth raised into 2 ridges, posterior rim, with single pointed tooth; mandibles robust, mentum bilobed, stiff setae pointing forward on lobe; lamellate antennae, 9-segmented, club formed by last 3 segments, which are covered with fine golden setae; ventral eye smaller than dorsal eye.

*Pronotum*. Head amplexed into prothorax; concavity bordered by bilateral rim; anterior lateral edge, unequally notched; posterior lateral edge, serrate from setal fringe; fringe, long on outer edge tapering to short medially; disc globose and setiferously granula-punctate; medial diamond-shape and posterior lateral edges, finely shagreened.

*Legs; Protibia* (Dorsal) (figure 39b). Quadridentate, teeth pointed, curved downward, apical surface smooth, basal half transversely furrowed; blunt serrations between and proximal to teeth, becoming smooth on proximal half of protibia; medial setiferous carina; setal border, long on inner edge and proximal outer edge, short between teeth; inner edge, deflected inwards medially; spur weakly bifid and curved downward. (Ventral) (figure 39a). Surface granular, apical section of teeth smooth; proximal carina and single row of setae dissipate before proximal tooth; inner edge deflected downwards, bordered with row of irregular, distinct knobs.

*Mesotibia*. Mesotibia short and robust; outer edge with 3 bands of seta; spurs slightly spatulate, apex blunt; tarsal insertion slightly sub-apical; 2 unequal tarsal claws, both shorter than last tarsal segment. *Metatibia* (Dorsal). Proximal side of medial ridge smooth, distal side with long setal brush; spurs thin, apex pointed, round in cross section, slightly deflected in centre; 2 equal

and curved tarsal claws, shorter than or almost equal to last tarsal segment. (Lateral). 3 curved setal brushes on tibia.

*Elytra*. Fused, humeral callus absent; well-developed sub-elytral ridge and rim; elytra bordered by band of indument; 6 striae per elytron, scattered with minute, irregular setose granules.

*Abdomen*. Mesocoxae contiguous, mesosternal ridge absent; abdominal sternites with single row of setiferous granules becoming irregularly spaced as sternite widens laterally; bilobed protuberances in males (absent in females) on lateral edge of sternites 2,3,4, (numbered 1-6 from metacoxae) only.

*Pygidium*. Irregularly speckled with small granules; bilateral smooth rim around edge of pygidium.

*Aedeagus*. Parameres short, asymmetrical, see figures 60a,b,c.

*Female*. Differs from male as follows; Protibia (Ventral). Proximal carina and single row of setae very reduced at (X 40); inner lateral edge with slight deflection, and row of anterior facing setiferous notches (X 40). Abdomen. Width of the last abdominal sternite, broad at pygidium; prominent protuberances on sternites 3-5 wanting.

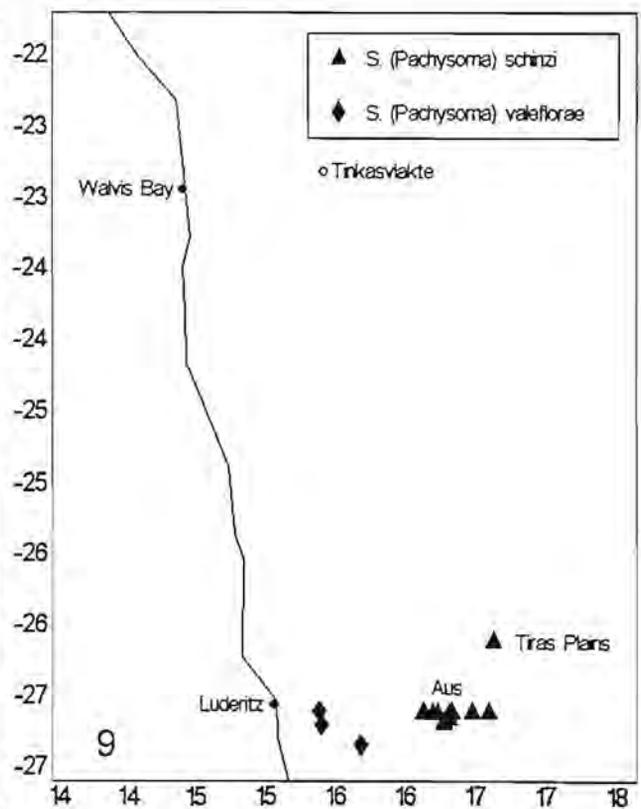
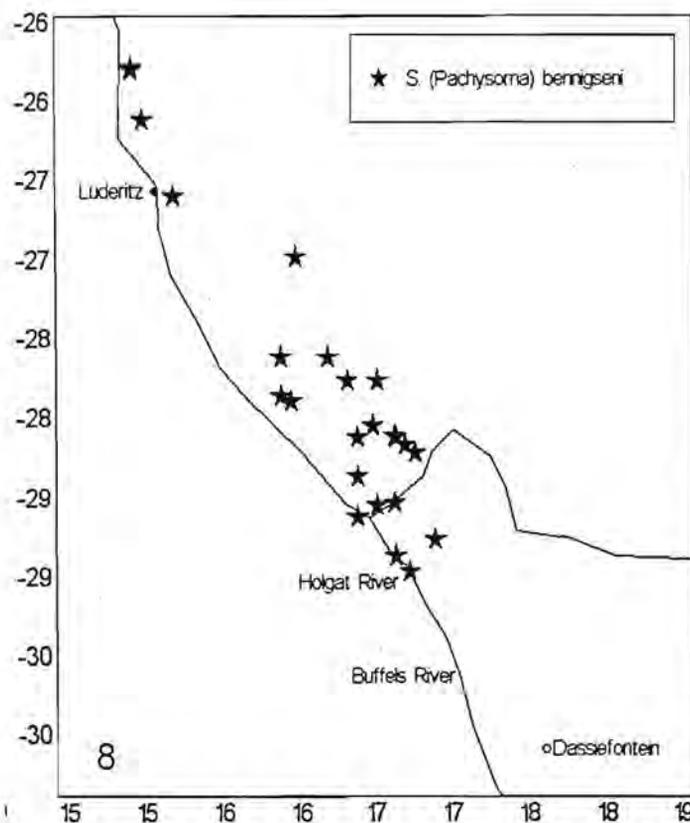
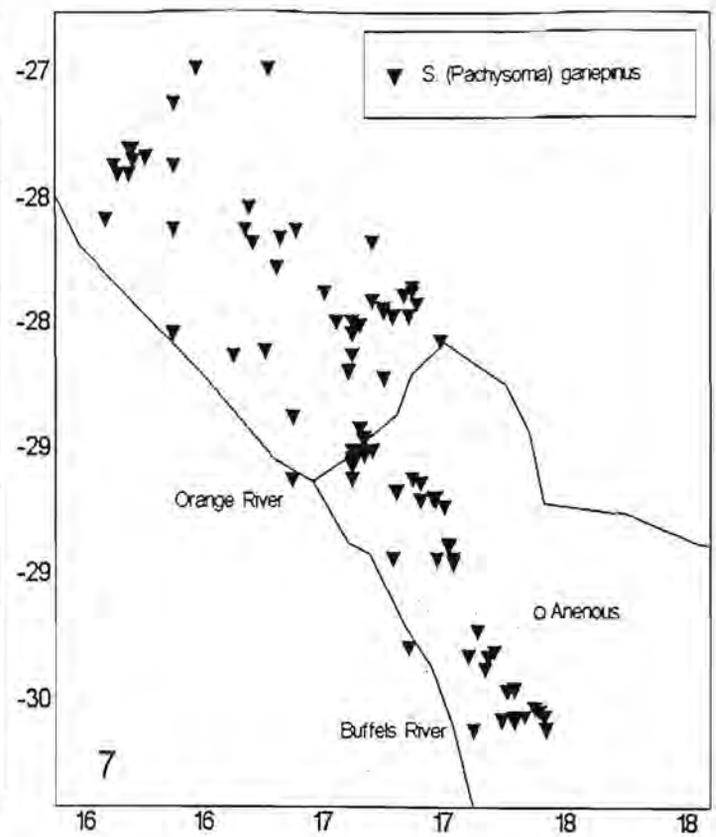
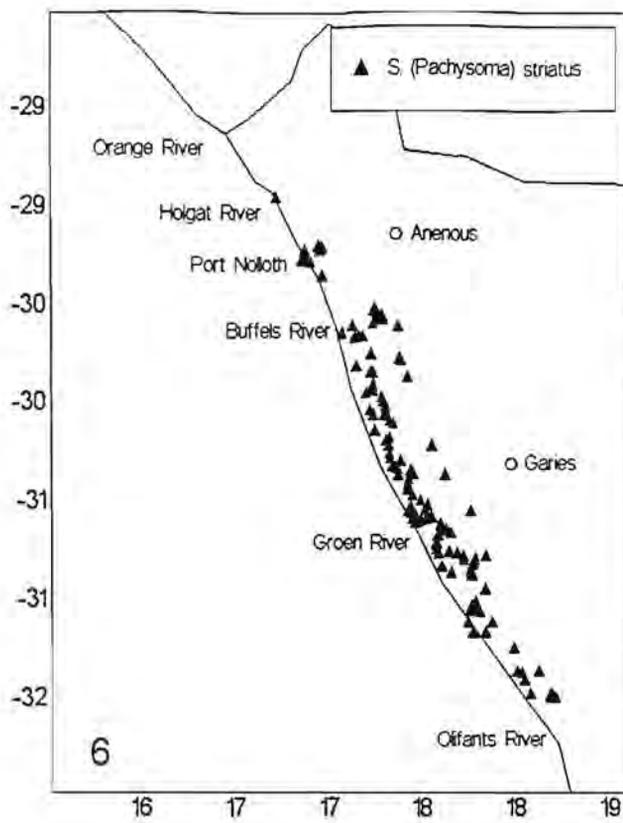
*Comments*. The smallest species within the *hippocrates* species complex. Similar to *S. (P.) hippocrates* but with elytral indument like *S. (P.) striatus* and *S. (P.) gariepinus*. The sympatric population of *S. (P.) hippocrates* also exhibits elytral indument, but to a lesser degree. The two species are easily distinguished as *S. (P.) hippocrates* is larger and has metatarsal claws longer than the last tarsal segment, while *S. (P.) endroedyi* metatarsal claws are shorter.

*Distribution, habitat and conservation*. Restricted to southwestern South Africa, occurring just north of the Olifants River. The localised distribution (figures 5a,b) might be an artifact of the absence of roads passing through their habitat (thus preventing easy collection), or lack of suitable habitats further northwards. Preferred habitats include the vegetated firm sand of coastal hillocks and sand dunes. This species does not occur within a proclaimed conservation area. The increase in recreational development around Strandfontein (31°45'S 18°14'E), and Koekenaap (31°32'S 18°14'E) potentially threatens the future survival of this species.

*Biology*. Seven nests of this species were excavated by JDUGH. One contained pellets and six contained a combination of detritus and pellets. *S. (P.) endroedyi* thus may be a mixed dung and detritus feeder. All specimens were collected during daylight. Their foraging behaviour is typical of *S. (Pachysoma)*. The larvae are unknown.

*Etymology*. Named for the late Dr Sebastian Endrödy-Younga, who recognised this species as new and collected most of the type series. JDUGH is indebted to Sebastian for encouraging and guiding his interest in beetle collecting and systematics.

*Type material examined* ( $\Sigma$ 135 spec.[0], 47♀ 88♂, 16♂ diss.). **SOUTH AFRICA**: HOLOTYPE ♂, S.Afr: Namaqualand, **Kommandokraal** farm, 31.30S-18.12E / 23.9.1994; E-Y:3033, on sandy



FIGS. 6-9. Distribution of *Scarabaeus (Pachysoma)* species in South Africa and Namibia. Questioned locality records or range extensions are shown by an open circle. (6) *S. (P.) striatus*; (7) *S. (P.) gariepini*; (8) *S. (P.) bennigseni*; (9) *S. (P.) schinzi* and *S. (P.) valeflorae*.

ground, Endrödy & Bellamy, (1♂ TMSA); *idem*, but ALLOTYPE ♀, (1♀ TMSA); *idem*, but PARATYPES, (2♀ 4♂ BMNH), (12♀ 23♂ TMSA), (2♂ UPSA), (2♂ MNHN), (2♂ ZMHB), *idem*, but T307 (2♂ BMSA), *idem*, but T1424 (2♂ SMWN); S.Afr., Namaqualand, Kommandokraal Frm., 31.30S-18.12E / 30.8.1979; E-Y:1622, singled on sand, leg. Endrödy-Youngae, (2♂ TMSA); S.Afr., Namaqualand, **Koekenaap**, 31.32S-18.14E / 30.8.1979; E-Y:1623, red dunes night, leg. Endrödy-Youngae, (2♂ TMSA); S.Afr., Namaqualand, Koekenaap, 31.32S-18.14E / 31.8.1979; E-Y:1624, red dunes day, leg. Endrödy-Youngae, (4♀ 5♂ TMSA); S.Afr., Namaqualand, Koekenaap, 31.32S-18.14E / 31.8.1979; E-Y:1625, groundtraps, 59 days, leg. Endrödy-Youngae / groundtraps with banana bait (1♂ TMSA), *idem*, but groundtraps with meat bait (1♂ TMSA); *idem*, but groundtraps with faeces bait (1♂ TMSA); South Africa: Cape, Kommandokraal, 31.31S-18.13E, 100m, 23-IX-1985, AVEvans, CLBellamy / T1424 (2♀ 4♂ SMWN); S. Africa, C.P. , Kommandokraal 624, Vredendal, 31°30'S, 18°12'E / 23 Sept. 1985, Louw, v. Rensburg, NMBH 15818 / T307 (1♀ BMSA); Kommandokraal, Cape, R.S.A., 31°30'S, 18°12'E., 19 Sept. 1982, M.-L.Penrith / H54679 / T1424 (1♀ SMWN); S.Afr.; W Cape, KommandokraalfarmW (sic), 31.29S-18.11E / 23.9.1994; E-Y:3035, on ground, Endrödy & Bellamy (5♂ TMSA); S.Afr; Namaqualand, **Koekenaaphilldunes** (sic), 31.32S-18.14E / 23.9.1994; E-Y:3032, groundtraps, 3 days, Endrödy & Bellamy / groundtraps with banana bait (1♂ TMSA); S.Afr; SW Cape, Koekenaap dunes, 31.32S 18.14E / 22.9.1994; E-Y:3030, ground & hummocks, Endrödy & Bellamy (6♀ 3♂ TMSA), *idem*, but SAM-COL-A043137 (6♀ 3♂ SAMC); S.Afr: Vredendal D., **Graafwater on Farm 156**, 31°22'38S 18°01'23E, 6.xii.1996, leg. J.duG.Harrison / Univ.Pret.Zoo&Ento., J.duG.Harrison 1996, Site 186 No., firm Y. sand plain, nr. veget. dunes (1♂ TMSA); S.Afr: Vredendal D., **Elsie Erasmus Kloof 158**, 31°24'46S 18°02'30E, 7-8.xii.1996, leg. J.duG.Harrison / Univ.Pret.Zoo&Ento., J.duG.Harrison 1996, site 188 No., vegt. 'old' dune, yellow sand, (2♀ 4♂ BMNH), *idem*, but T1424 (2♀ 4♂ SMWN); S.Afr: Vredendal D., Kommandokraal, on Farm 624, near Koekenaap, 31°29'58S 18°11'47E, 8-9.xii.1996, leg. J.duG.Harrison / Univ.Pret.Zoo&Ento., J.duG.Harrison 1996, site 191 No., vegetated dune, yellow sand, (1♂ SANC); S.Afr: Vredendal D., Kommandokraal, on Farm 624, near Koekenaap, 31°29'02S 18°10'08E, 10.xii.1996, leg. J.duG.Harrison / Univ.Pret.Zoo&Ento., J.duG.Harrison 1996, site 193 No., vegetated dune, yellow sand, (1♀ 2♂ SANC); S.Afr: Vredendal D., **Vleitjies, Farm 620** near Koekenaap, 31°34'53S 18°10'15E, 11.xii.1996, leg. J.duG.Harrison / Univ.Pret.Zoo&Ento., J.duG.Harrison 1996, site 195 No., Olifants R. vegt., dune/bank, red sand, (2♀ 5♂ SANC); S.Afr: Vredendal D., Vleitjies, Farm 620 near Koekenaap, 31°34'53S 18°10'56E, 12.xii.1996, leg. J.duG.Harrison / Univ.Pret.Zoo&Ento., J.duG.Harrison 1996, site 196 No., Olifants R., vegt. dune, soft red sand / T307 (2♀ 1♂ BMSA).

***Scarabaeus (Pachysoma) striatus*** (Castelnau, 1840)

(Figures 6, 22, 40, 61)

*Pachysoma striatum* Castelnau, 1840: 68; Péringuey 1902: 81; Gillet 1911a: 6; Ferreira 1953a: 36; Ferreira 1961:24; Holm and Scholtz, 1979; 233. [Holotype lost?], type locality Cape.

*Pachysoma marginatum* Péringuey, 1888: 92; Péringuey, 1902: 77; Gillet 1911a: 6; Ferreira, 1953a: 22; Ferreira 1961: 24; Ferreira, 1966: 58; Ferreira 1969: 21. Lectotype ♂, Port Nolloth (1♂ TMSA).

*Irrorhotides fryi* Shipp. 1896: 116; Ferreira, 1953a: 22; Ferreira 1961: 24. {Holotype ?}, {Type in Frey collection? NHMB}.

*Scarabaeus striatus* (Castelnau): Mostert and Holm, 1982: 275.

*Diagnosis.* Clypeus bidentate, genal and clypeal edge unserrated and almost contiguous (figure 22). Protibia and metatibia sexually dimorphic, protibial spurs simple in both sexes (figures 40a,b). Pronotum with a hook on outer posterior edges. Elytra striated, elytral rims with band of waxy indument. Metatarsal claws shorter than last tarsal segment.

*Distribution, Habitat and Conservation.* Distributed from the Holgat to the Olifants River (figure 6). Preferred habitats include the firm consolidated sand of vegetated coastal hummocks, hillocks, dunes and river banks. Contained within the proposed Groen-Spoeg National Park.

*Comments on locality data.* The Holgat River Mouth record extends the known distribution of *S. (P.) striatus* about 30 km northwards. The high security mining area between Kleinsee and Port Nolloth accounts for the lack of records here. This area was surveyed early in the season of 1996, but only dead specimens of *S. (P.) striatus* were found on Oubeep 173 at 29°21'55S 16°57'32E.

Garies and Anenous Pass fall outside the expected coastal distribution of *S. (P.) striatus* (figure 6). These specimens were probably collected closer towards the coast, but the closest inland locality known was used to record their location.

*Morphological variation.* Elytral sculpture, body size and the expression of indument in *S. (P.) striatus* vary within and between populations. Very small females of *S. (P.) striatus* from Dembergdraai (30°47'S 17°43'E) and Rooidam (31°04'S 17°48'E) were thought to represent a new species (Endrödy-Younga pers. comm.). However, upon examination they conform in all aspects to typical female *S. (P.) striatus*.

*Biology.* Refer to Scholtz (1989) for a detailed study on the foraging and burrow construction of this species. Of 28 burrows excavated by JDUGH, 26 contained only dry dung pellets while two contained both detritus and pellets. This suggests that *S. (P.) striatus* is predominately a dry pellet feeder rather than a detritus feeder. Scholtz (1989) found that the natural forage of the Port Nolloth population of *S. (P.) striatus* was rodent pellets. However, the vast majority of the pellets excavated by JDUGH were sheep, but even small fragments of dry ostrich dung were collected. Thus it appears that *S. (P.) striatus* will collect any suitable dry dung that it can relocate.

*S. (P.) striatus* were successfully bred under lab conditions on two separate occasions. Four pairs 1.ix.1996-23.i.1997 and six pairs 9.ix.1998-4.xii.1998 of *S. (P.) striatus* collected from Strand Fontein (30°33'S 17°26'E), were placed in round 25l buckets and 5l square bread bins respectively. Sand, dry sheep pellets and detritus from their collection site (Strand Fontein Farm

in Namaqualand) were provided. They dug burrows, foraged regularly, and bred successfully. The 1996 sample produced two third-instar larvae (prepupa), one pupa and one teneral adult. Two third-instar larvae (prepupa) and one pupa were bred in 1998. No evidence of the use of a brood pear to contain the larvae was found in *S. (Pachysoma)*. Which is additionally confirmed by the larval morphology because the characteristic hump defining all dung ball confined larvae is absent in *S. (Pachysoma) striatus* and *S. (Pachysoma) gariepinus* larvae. When excavated the larvae were in clean moist sand a few centimetres from the closest nest evidence (i.e. larval or adult frass and/or a decomposed dung plug). The pupae were surrounded by a fragile casing constructed from sand grains cemented together. This suggests that *S. (Pachysoma)* larvae are open nest feeders that move away from their nests as prepupae, before pupating in clean sand. The nature of the larval food itself needs to be verified, as no larvae were found in a nest. However, the possibilities include the rehydrated dung pellets or detritus provisioned by the adults, or they might feed on the adult faeces (i.e. already processed dung and detritus).

Klemperer and Lumaret (1985) studied the nesting biology of *Geotrupes (Thorectes) sericeus* (Geotrupidae) a flightless species restricted to sandy coastal dunes in western France. Their study provides valuable insight into the biology of flightless species nesting in sand and feeding on dry dung. Female *T. sericeus* lay an egg at the terminal end of a chamber before provisioning it with a plug of unhomogenized dry rabbit pellets. The egg chamber is thus outside the dung mass and the larvae are free-living. Related species *T. albarracinus* and *T. laevigatus*, which nest in soil have their egg chamber contained within the homogeneous brood mass of sheep dung (Klemperer and Lumaret 1985). It is worth determining whether *S. (Pachysoma)* females also lay their eggs at the terminal ends of the food chamber, away from the food itself. This is very likely as Klemperer and Lumaret (1985) suggest that '...ovipositing outside the brood mass may have a selective advantage where nests are made during the wet season in sandy environments. Water is more likely to drain away from a chamber in sand, but an egg inside a dung mass is more likely to 'drown'. This is because the dung mass will retain water by capillary suction...' (Scholtz 1989 shows this capillary action with dry pellets used by *S. (P.) striatus*). Other Geotrupidae that nest in sand, viz. *Typhaeus typhoeus* and *Ceratophyus hoffmannseggii* always oviposit outside the brood chamber (Klemperer and Lumaret 1985). *T. sericeus* pupate inside the original brood chamber but *Typhaeus typhoeus* that prefer sandy soils (Brussaard and Visser 1987) pupate in the surrounding sand (Main 1917), as observed in *S. (Pachysoma)*.

*Comments.* Similar to *S. (P.) gariepinus*, but differentiated by the distinct posterior pronotal hooks.

*Types.* Castelnau's (1840) description of *Pachysoma striatum* suggests a single female specimen was examined (length 9 lig width 6 lig). The line (lin. or lig.) equals one-twelfth of an inch (Torre-Bueno 1989). Thus, this specimen measured about 19.08 mm long and 12.72 mm wide. The type locality was recorded as 'Cap de Bonne-Espérance' and the specimen was deposited in the collection of M.Gory.

Based on Castelnau's (1840) description of *P. striatum* only, Péringuey (1900) remarked that *P. striatum* represented either a small specimen of *Pachysoma hippocrates* or that *P. striatum* might be identical to *Pachysoma marginatum*. Holm and Scholtz (1979) were unable to find the type of *Pachysoma striatum* Castelnau, and suggest it is probably lost. Because *P. striatum* was the closest species in size, morphology, and distribution to *P. marginatum* (20-25 mm long 14-16 mm wide), Holm and Scholtz (1979) synonymised *P. marginatum* with *P. striatum*. However, the possibility does exist that *S. (P.) endroedyi* sp.n. is what Castelnau (1840) described as *Pachysoma striatum*. *S. (P.) endroedyi* was not known to Holm and Scholtz (1979) and occurs sympatrically with *P. striatum*, overlaps in size with *P. striatum* and has elytral indument like *P. striatum*. However, without the holotype of *P. striatum*, and only the short description by Castelnau (1840) no further conclusions can be made.

Péringuey's (1888) description of *Pachysoma marginatum* includes references to both sexes, lists a range in body size (length 20-25 mm; width 14-16mm) and mentions that *P. marginatum* is 'pretty common at Port Nolloth, Namaqualand'. These observations suggest that several specimens were examined. He deposited the types in the SAMC collection and in his personal collection. According to Cochrane (1995), Dr Hesse removed all suspected types from Péringuey's private collection, labelled them with green (holotype) and orange (paratypes) labels and deposited them in the SAMC collection. The only possible type material listed by Ferreira (1953a) are three males from Port Nolloth collected by Warden, dated between 1885 to 1899. Only one undated specimen from this series was examined from the UPSA collection. Holm and Scholtz (1979) were unable to find any labelled type material and rightfully designated the earliest collected specimen from Port Nolloth as the male lectotype. Subsequently however, two specimens from the type locality both determined in Péringuey's hand, one older than the designated lectotype and the other not dated were discovered in the SAMC and DMSA collections respectively. These specimens are designated here as paralectotypes. A single pinned aedeagus labelled in Péringuey's hand as follows: '*Pachysoma marginatum*, armature of ♂', was also discovered in the SAMC (refer to discussion on *S. (P.) denticollis* types). This aedeagus probably originates from the holotype of *P. marginatum*, which appears to be lost. Because a lectotype has already been designated by Holm and Scholtz (1979) this aedeagus is designated as paralectotype of *P. marginatum*.

*Type material examined* ( $\Sigma$ 4 specs. [1], 1♀ 3♂, 1♂ diss.). **SOUTH AFRICA:** LECTOTYPE ♂, *Pachysoma marginatum* Péringuey, designated by Holm and Scholtz (1979): Pt. Nolloth, (29.17S 16.51E), 29.11.(18)85 / *Pachysoma marginatum* Péringuey, Lectotype, Holm and Scholtz 1978, (1♂ TMSA). PARALECTOTYPES 1♀ 1♂ 1♂ aedeagus, designated here: Cape, Port Nolloth, (29.17S 16.51E) // Rev. G.H.Fisk, Dec v. 1884 //, / ♀ (written by Péringuey? on white paper, now faded) / *Pachysoma marginatum* LP (written by Péringuey on white paper, now faded), (1♀ SAMC); Pt. Nolloth, L.Namaqua. (written on white paper, now faded) / *Pachysoma marginatum* (written by Péringuey on white paper, now faded) / Durban Museum (printed on

white card), (1♂ SAMC); *Pachysoma marginatum* armature of ♂ (written by Péringuey), (male genitalia mounted onto white card with a brass minuten), (1♂ aedeagus only SAMC).

*Additional material examined* ( $\Sigma$ 759 specs. [86], 275♀ 439♂, 4♂diss., 45eth., 137p.). **SOUTH AFRICA: Buffels river valley**, 29.35S 17.17E, 4.x.1976, E-Y:1256, on sandy hill, Endrödy-Younga, (2♂ TMSA); Buffels rivier valley, 29.35S 17.17E, 31.viii.1976, E-Y:1197, groundtraps 33 days, Endrödy-Younga, (1♀ 1♂ TMSA); Buffels rivier, 29.55S 17.39E, 27.x.1977, E-Y:1397, on red ground, Endrödy-Younga, (1♀ TMSA); **Dembergdraai**, 30.47S 17.43E, 24.viii.1979, E-Y:1590, sandblown hill, Endrödy-Younga, (2♂ TMSA); Dembergdraai, 30.47S 17.43E, 26.x.1979, E-Y:1656, on hard red sand, Endrödy-Younga, (1x TMSA); Dembergdraai, 30.47S 17.43E, 18.ix.1994, on ground, day, E-Y:3015, Endrödy-Younga & Bellamy, (1♀ 5♂ TMSA); Dembergdraai farm, 30.47S 17.43E, 19.ix.1994, groundtraps 6 days, hand-collected around traps at setting, E-Y:3019, Endrödy-Younga, (6♀ 2♂ TMSA); Dembergdraai, 30.48S 17.43E, 19.ix.1994, on red sandy ground, E-Y:3021, Endrödy-Younga & Bellamy, (1♀ TMSA); **Eiland Punt Noord 549**, 30.52S 17.39E, 25.viii.1996, A.Mackenzie, (1♀ UPSA); **Geelduine**, 30.04S 17.14E, 16-18.vi.1987, J.Irish, E.Marais, (1♀ 2♂ SMWN); **Gemsbok Vlakte Farm**, 30.30S 17.29E, 30.viii.1977, E-Y:1361, hand-collected, dunes, day, Endrödy-Younga, (1♀ 1♂ TMSA); Gemsbok Vlakte Farm, 30.30S 17.29E, 28.x.1977, E-Y:1399, hand-collected, dunes, day, Endrödy-Younga, (1♂ TMSA); **Graskom**, 30.18S 17.23E, 15-18.ix.1982, M-L.Penrith, H54563, (4♀ 17♂ SMWN); Graskom 610, 30.18S 17.23E, 15-18.ix.1982, S.Louw, NMBH 8641, (2♀ 17♂ BMSA); **Groenriviermond**, (ca. 30.50S 17.36E), 30.ix.1972, H.D.Brown, E.Koster, A.Prinsloo, (3♀ SANC); Groenrivier Mouth, 30.50S 17.36E, 3.ix.1977, E-Y:1379, hand-collected, dunes, night, Endrödy-Younga, (1♂ TMSA); Groenrivier, 30.50S 17.36E, 29.x.1977, E-Y:1402, hand-collected, white dunes, Endrödy-Younga, (1♀ 5♂ TMSA), Groen River, (ca.30.50S 17.36E), viii.1990, C.R.Owen, (3x COCS); Groen River, (ca.30.50S 17.36E), 10.ix.1997, A.Mackenzie, (4x UPSA); **Grootmis**, 20km E, (ca. 29.37.05S 17.07.05E), 4.x.1972, H.D.Brown, E.Koster, A.Prinsloo, (1♀ SANC), **Holgat River Mouth**, 28.58S 16.43E, 25-27.ix.1988, J.Irish, E.Marais, (2♀ 3♂ SMWN); **Hondeklipbay**, 12 km E, 30.21S 17.25E, 30.viii.1977, E-Y:1359, groundtraps with faeces bait, 58 days, Endrödy-Younga, (1♀ TMSA); Hondeklipbay, 16km E, (ca.30.21S 17.26E), 24.x.1986, C.R.Owen, (2x COCS); Hondeklipbaai, 6km E, SE3017Ad, (30.22.05S 17.22.05E), 27.ix.1974, Houston, Davis, Tribe, (1x SANC); 7km WNW of Wallekraal on road to Hondeklip Bay, (ca. 30.22S 17.27E), 14-16.ix.1992, F.W. & S.K. Gess, (1♀ 1♂ AMGH); **Karroovlei**, (31.22.05S 18.07.05E), 13.x.(19)48, (1♂ SAMC); **Katdoringvlei**, 31.07S 17.52E, 27.viii.1979, hand-collected on sand, E-Y:1604, Endrödy-Younga, (1♀ 1♂ TMSA); Katdoringvlei, 31.07S 17.52E, 28.x.1979, E-Y:1664, hand-collected on sand, day, Endrödy-Younga, (5♀ 2♂ TMSA); **Klein Kogel Fontein**, 31.10S 17.50E, 27.viii.1979, E-Y:1607, hand-collected, Endrödy-Younga, (3♂ TMSA); **Kleinsee**, (29.39S 17.04E), xii.(19)48, J.H.Power, (1♀ 1♂ AMMM); Kleinsee, 12km E, 29.36S 17.14E, 4.ix.1987, E-Y:2474, ground & vegetation, Endrödy-Younga, (1♀ 3♂ TMSA); **Koingnaas**, 1km NE, 30.11S 17.19E, 100m, 3.ix.1986, AVEvans, CLBellamy, (3♀ 4♂ UPSA); **Kommandokraal 624**, Vredendal, 31.30S 18.12E, 23.ix.1985, Louw, v.

Rensburg, NMBH 15818, (1♂ BMSA); Kommandokraal Farm W, 31.29S 18.11E, 23.ix.1994, E-Y:3035, on ground, Endrödy-Younga & Bellamy, (2♀ 10♂ TMSA); **Kotzersrus**, 30.57S 17.50E, 23.viii.1979, E-Y:1581, white dunes, day, Endrödy-Younga, (7♀ 16♂ TMSA); Kotzersrus, 30.57S 17.50E, 23.viii.1979, E-Y:1583B, groundtraps with faeces bait, 62 days, Endrödy-Younga, (1♀ TMSA); **Namaq.L.** C.L.L. Biden, 1911, (1♀ SAMC); **Port Nolloth**, (29.17S 16.51E), Nov.(18)90, (1♂ SAMC); Pt. Nolloth, (29.17S 16.51E), B.Warden, (1♂ SAMC); Port Nolloth, (29.17S 16.51E), 1911, C.L.Bidens, (1♀ TMSA), (1♂ UPSA), (5♂ SAMC); Port Nolloth, (29.17S 16.51E), viii.1911, C.L.Biden, (3♂ SAMC), (1♂ 1♀ SANC); Port Nolloth, (29.17S 16.51E), x.1911, Lightfoot, (2♀ 1♂ SAMC); Pt. Nolloth, (29.17S 16.51E), x.1911, R.M.Lightfoot, (1♂ UPSA); Port Nolloth, (29.17S 16.51E), ix.(19)21, Name?, NM9025, Donation Natal Museum, (1x BMSA); Port Nolloth, (29.17S 16.51E), xi.(19)40, (1x SANC); Port Nolloth, C.P., (29.17S 16.51E), 22.xi.1948, Koch & van Son, (1♀ 1♂ TMSA); Port Nolloth, (29.17S 16.51E), v.(19)53, C.Koch, (2♀ 1♂ TMSA); Port Nolloth Dunes, 29.14S 16.57E, 4.x.1976, E-Y:1257, hand-collected, on dunes, Endrödy-Younga, (2♂ TMSA); Port Nolloth, (29.17S 16.51E), 2.x.1981, V.B. Whitehead, (1♂ SAMC); Port Nolloth, (29.17S 16.51E), 27.xi.1986, C.H.Scholtz, (1♀ UPSA); Port Nolloth, McDougall's Bay, 29.17S 16.52E, 27.xi.1986, C.H. Scholtz, (6♀ 14♂ UPSA); Port Nolloth, 4km S, McDougall's Bay, 29.17S 16.53E, 29.ix.1994, Scholtz, Chown, Klok, (1♂ UPSA); **Quaggafontein**, 30.13S 17.33E, 28.viii.1977, E-Y:1352, hand-collected, at night, Endrödy-Younga, (1♀ 4♂ TMSA); Quaggafontein, 30.13S 17.33E, 29.viii.1977, E-Y:1353, hand-collected, day, Endrödy-Younga, (22♀ 15♂ TMSA); Quaggafontein, 30.13S 17.33E, 29.viii.1977, E-Y:1356, ground traps, with faeces bait, 60 days, Endrödy-Younga, (2♂ TMSA); Quaggafontein, 30.13S 17.33E, 29.viii.1977, E-Y:1356a, ground traps, with meat bait, 60 days, Endrödy-Younga, (10♀ 2♂ TMSA); Quaggafontein, 30.13S 17.33E, 29.viii.1977, E-Y:1356b, ground traps, with meat bait, 60 days, Endrödy-Younga, (4♀ 2♂ TMSA); Quaggafontein, 30.13S 17.33E, 29.viii.1977, E-Y:1357, hand-collected, at night, Endrödy-Younga, (1♀ TMSA); Quaggafontein, 30.13S 17.33E, 29.viii.1977, E-Y:1354, groundtraps 60 days, Endrödy-Younga, (1♀ TMSA); **Rooidam farm**, 31.04S 17.48E, 25.viii.1979, E-Y:1599, hand-collected, sandy hill, Endrödy-Younga, (1♀ TMSA); Rooidam farm, 31.04S 17.48E, 26.viii.1979, E-Y:1602, yellow sand, day, Endrödy-Younga, (3♀ 15♂ TMSA); Rooidam farm, 31.04S 17.48E, 26.viii.1979, E-Y:1603, yellow sand, night, Endrödy-Younga, (2♀ 1♂ TMSA); Rooidam farm, 31.04S 17.48E, 20.ix.1994, E-Y:3026, ground & light, Endrödy-Younga & Bellamy, (4x TMSA); Rooidam farm, 31.04S 17.48E, 21.ix.1994, E-Y:3027E, ground traps with faeces bait for 5 days, Endrödy-Younga, (19x TMSA); Rooidam Farm, 31.04S 17.48E, 21.ix.1994, E-Y:3027G, ground traps for 5 days, Endrödy-Younga & Bellamy, (3x TMSA); Rooidam Farm N, 31.02S 17.46E, 21.ix.1994, E-Y:3028E, ground traps with faeces bait for 5 days, Endrödy-Younga, (3♀ 1♂ TMSA); Rooidam Farm, 31.04S 17.48E, 26.ix.1994, E-Y:3046, white vegetated dunes, Endrödy & Bellamy, (3♀ 6♂ TMSA); **Rondawel Farm**, 30.47S 17.50E, 4.ix.1977, E-Y:1381, hand-collected, Endrödy-Younga, (1♀ TMSA); **Soutpan**, 20km E, 31.15S 17.32E, (in sea, try 18.32E) 31.vii.1989, cattle grid on road, E-Y:2631, Endrödy & Klim., (2♂ TMSA); Soutpan, 10km E, 31.15S 17.59E, 13.ix.1987, in cattle grid, E-Y:2493, Endrödy-Younga, (4♀ 2♂ TMSA); **Thong-**

**Gys Dunes**, 29.32S 17.14E, 23-25.ix.1988, J.Irish, E.Marais, (4♂ SMWN); **Tities Baai**, 3km NW, 31.10S 17.46E, 28.viii.1979, hand-collected, E-Y:1614, Endrödy-Younga, (2♂ TMSA); **Wallekraal**, (30.22.05S 17.37.05E), Namaqualand, SAM, x.1950, (9♀ 11♂ SAMC), (3♀ 4♂ UPSA) *idem*, but NMBH 3682 (1♀ 1♂ BMSA.); **Witduin**, 29.52S 17.25E, 23.ix.1988, J.Irish, E.Marais, (3♀ 1♂ SMWN); **Strandfontein farm**, 30.33S 17.22E, 3.ix.1977, E-Y:1374, hand-collected, dunes, day, Endrödy-Younga, (3♂ TMSA); **Strandfontein farm**, 30.33S 17.22E, 3.ix.1977, E-Y:1376, groundtraps, with banana bait, 56 days, Endrödy-Younga, (3♂ TMSA); No label data, (9x SAMC), (1x SANC).

All material below, unless otherwise specified, was collected by J. du G. Harrison, and is listed in chronological order by site number: **S.Afr: Namaqualand**, Koingnaas, Somnaas 474, 30°08'49S 17°14'36E, 16.vii.1996, site 2, active white dunes, interdune slack, (2♀ 2♂ 1p SANC); Port Nolloth, McDougall's Bay, 29°17'17S 16°52'56E, 18.vii.1996, site 3, coastal hummocks, white sand, (1♀ 1♂ 3eth. TMSA); Port Nolloth, McDougall's Bay, 29°17'36S 16°53'59E, 18.vii.1996, site 4, coastal hummocks, white sand, (1♂ TMSA); S.Afr: Namaqualand, Strand Fontein 499, 30°33'S 17°25'E, 20.vii.1996, site 6, Bitter River Dunes, interdune slack, (2♀ 2p SANC); Roode Heuvel 502, 30°44'57S 17°34'24E, 21.vii.1996, site 9, red sand; (1♂ 1p SANC); Buffels River Complex, Oubeep 173, 29°21'55S 16°57'32E, 22.vii.1996, site 13, coastal hummocks, white sand, (3p SANC); Stryd Rivier 188, 29°34'28S 17°16'49E, 24.vii.1996, site 15, firm red sand, Buffels River, (1p SANC); Stryd Rivier 188, 29°33'46S 17°17'02E, 24.vii.1996, site 16, red sand, Buffels River, (1p SANC); Stryd Rivier 188, 29°33'46S 17°17'02E, 26.vii.1996, site 19, red sand, Buffels River, (1♂ SANC); Stryd Rivier 188, 29°33'37S 17°16'55E, 27.vii.1996, site 20, red sand nr. Buffels River, (2♀ 1p SANC); Roode Vley 189, 29°34'01S 17°15'42E, 27.vii.1996, site 21, blowout, red sand, vegetated dune, (12♀ 4♂ UPSA) (2p SANC); Klein Duin 154, 29°13'01S 16°57'45E, 29.vii.1996, site 22, white sand, vegetated dune, (3p SANC); Klein Duin 154, 29°13'04S 16°57'54E, 29.vii.1996, site 26, white sand dunes, vegetated slack, (1♀ 2♂ TMSA) (1p SANC); Kleinsee, Sand Kop 322, 29°39'54S 17°09'12E, 30.vii.1996, site 29, vegetated dune, blowout, red sand, (2p SANC); Kleinsee, Honde Vlei 325, 29°45'25S 17°13'11E, 7.viii.1996, site 32, vegetated dune, yellow sand, (2♀ 2♂ SAMC) (1p SANC); Roode Vley 189, 29°34'01S 17°15'42E, 9.viii.1996, Harrison & Scholtz, site 21/36, blowout, red sand, vegetated dune, (1♀ SAMC); Port Nolloth, Klein Duin 154, 29°12'46S 16°56'35E, 11.viii.1996, Harrison & Scholtz, site 38, white sand, dune periphery, (5p SANC); Port Nolloth, Klein Duin 154, 29°12'44S 16°56'17E, 11.viii.1996, Harrison & Scholtz, site 39, white sand, dune periphery, (1p SANC); Elands Klip 333, 29°57'45S 17°11'19E, 12.viii.1996, Harrison & Scholtz, site 40, DeBeers Game Farm, vegetated dune, yellow sand, (2♂ 2p SANC); near Koingnaas, 30°02'41S 17°12'44E, 12.viii.1996, Harrison & Scholtz, site 41, DeBeers Game Farm, vegetated dune, white sand, (1♀ SAMC); near Wallekraal, Avontuur 488, 30°23'47S 17°25'21E, 13.viii.1996, Harrison & Scholtz, site 42, red sand, (1♀ 3p SANC); Strand Fontein 499, 30°33'45S 17°26'25E, 13.viii.1996, Harrison & Scholtz, site 43/44, Bitter River dunes, white sand, (3♀ 3♂ ZMHB), (4p SANC); Strand Fontein 499, 30°34'08S 17°27'21E, 13.viii.1996, Harrison & Scholtz, site 45, Klipheuwel House,

drowned, (1♀ SAMC); Dermbergdraai, 504, 30°46'S 17°41'E 14.viii.1996, Harrison & Scholtz, site 49, Groen R. bank RHS, red sand, (2p SANC); De Klipheuvel 435, 30°39'43S 17°38'45E, 15.viii.1996, Harrison & Scholtz, site 52, sand plain Fynbos, red sand, (1♂ 1p SANC); De Klipheuvel 435, 30°38'47S 17°37'40E, 15.viii.1996, Harrison & Scholtz, site 53, red sand, (12♀ 2♂ SMWN); Soutfontein, 435, 30°36'54S 17°35'41E, 15.viii.1996, Harrison & Scholtz, site 54, Bitter River Bed, (1♂ SANC); Strand Fontein 499, 30°31'13S 17°31'30E, 15.viii.1996, Harrison & Scholtz, site 57, red sand, (2♀ 1♂ BMSA); Sand Kop 322, 29°39'55S 17°10'34E, 19.viii.1996, site 62/113, vegetated dune, red sand, (1♂ BMSA); Avontuur 488, nr. Hondeklipbaai, 30°20'11S 17°21'27E, 27.viii.1996, site 68, vegetated dunes, yellow sand, (1p SANC); Strand Fontein 499, Klipheuvel House, 30°34'08S 17°27'21E, 28.viii.1996, site 69, (1♀ SANC); Strand Fontein 499, Bitter R. Dunes, 30°33'01S 17°26'21E, 28.viii.1996, site 71, interdune slack, white/red sand, (1♀ 1♂ UPSA); Strand Fontein 499, Bitter R. Dunes, 30°33'37S 17°26'14E, 28.viii.1996, site 72, interdune slack, white/red sand, (2♂ MNHN); Strand Fontein 499, Bitter R. Dunes, 30°32'28S 17°26'18E, 29.viii.1996, site 75, interdune slack, white/red sand, (4♀ 8♂ SAMC), (4p SANC); Strand Fontein 499, Bitter R. Dunes, 30°32'S 17°26'E, 29.viii.1996, site 77, dune slope, firm white sand, (1♀ BMNH); Driekop 500, 30°36'34S 17°27'41E, 30.viii.1996, site 78, vegetated old dune, yellow sand, (3p SANC); Driekop 500, 30°35'29S 17°31'03E, 30.viii.1996, site 79, vegetated old dune, yellow sand, (1p SANC); Driekop 500, 30°35'09S 17°31'06E, 30.viii.1996, site 80, Bitter River Bank, yellow sand, (5p SANC); Sandkraal exit gate, Soutfontein to Baievllei Rd., 30.viii.1996, site 81, yellow sand, (1p SANC); Zand Kraal 434, 30°33'S 17°45'E, 3.ix.1996, site 83, Bruinkop, yellow firm sand, (1♂ SANC); Strand Fontein 499, 30°32'42S 17°30'30E, 4.ix.1996, site 87, yellow sand, undulating plain, (1♂ SANC); Kleinsee, Sand Kop 322, 29°39'55S 17°10'34E, 28-30.x.1996, Harrison & Scholtz, site 113, vegetated dune, red sand, (10♀ 55♂ 6p UPSA); Kleinsee, Sand Kop 322, 29°40'16S 17°08'05E, 28.x.1996, Harrison & Scholtz, site 114, firm yellow, sand plain, (6♂ SAMC), (2p SANC); Stryd Rivier 188, 29°34'09S 17°17'00E, 31.x.-1.xi.1996, Harrison & Scholtz, site 115, red sand & gravel, (3♀ 2♂ SANC); *idem*, but 9.x.1997, Harrison & Davis, (1x UPSA); Stryd Rivier 188, 29°32'52S 17°14'57E, 9.xi.1996, site 119, vegetated dune, red sand, (6eth. TMSA); Stryd Rivier 188, 29°31'29S 17°14'23E, 9.xi.1996, site 120, vegetated dune & blowout, red sand, (1♀ 4♂ SMWN); Kourootje 316, near Komaggas, 29°46'44S 17°22'22E, 10.xi.1996, site 121, Sandplain Fynbos, vegt. dune Y/R sand, (1♂ 16eth. TMSA); Rooivlei 327, near Kleinsee, 29°48'58S 17°08'31E, 19.xi.1996, site 124, vegetated dune, yellow sand, (2♂ BMSA); Zonnekwa 328, near Kleinsee, 29°50'48S 17°13'08E, 20.xi.1996, site 126, large vegt. dune, yellow sand, (1♀ 2♂ BMNH); Zonnekwa 328, near Kleinsee, 29°50'56S 17°13'23E, 20.xi.1996, site 127, vegetated dune, yellow sand, (1p SANC); Zonnekwa 328, near Kleinsee, 29°51'08S 17°13'59E, 20.xi.1996, site 128, interdune slack, firm W/R sand, (3♀ 8♂ BMSA); Samsons Bak 330, near Kleinsee, 29°54'38S 17°13'47E, 20.xi.1996, site 129, interdune slack, firm W/R sand; (1♀ SANC); Samsons Bak 330, near Kleinsee, 29°55'22S 17°13'34E, 20.xi.1996, site 130, firm yellow sand, near vegt. dune, (2♀ SAMC); Elands Klip 333, near Kleinsee, 29°56'40S 17°13'46E, 21.xi.1996, site 131, soft yellow sand, (1♀ SAMC); Heidons 335, near Kleinsee, 29°58'44S 17°16'31E, 21.xi.1996, site 132,

plain behind dunes, yellow sand, (10♀ 4♂ UPSA) (14eth. TMSA); Heidons 335, near Kleinsee, 29°59'45S 17°17'21E, 21.xi.1996, site 133, plain behind dunes, yellow sand, (1♀ 1♂ 1p SANC); Heidons 335, near Kleinsee, 30°01'16S 17°17'50E, 21.xi.1996, site 134, plain behind dunes, yellow sand, (2♀ BMNH); Heidons 335, near Kleinsee, 30°02'47S 17°17'42E, 21.xi.1996, site 135, plain behind dunes, yellow sand, (1♀ 2♂ SANC); Heidons 335, Heidons, 30°03'58S 17°17'35E, 21.xi.1996, site 136, vegetated dune, yellow sand, (1♀ 1♂ SAMC); Zoutpan 471, near Koingnaas, 30°05'51S 17°19'05E, 21.xi.1996, site 137, Sandplain Fynbos, yellow sand, near vegt. dune, (1♂ BMSA); Zoutpan 471, near Koingnaas, 30°06'35S 17°20'12E, 21.xi.1996, site 138, red sand plain, (2♂ SANC); Koingnaas 475, 30°13'20S 17°18'46E, 22.xi.1996, site 141, Swartlintjies R. Bank, yellow sand, (1♂ 6x eth. TMSA); Zwart Lintjies R. 484, nr. Koingnaas, 30°15'41S 17°19'11E, 22.xi.1996, site 142, yellow sand, (3♀ SMWN); Zwart Lintjies R. 484, nr. Koingnaas, 30°16'59S 17°19'23E, 22.xi.1996, site 143, coastal plain nr. Y. vegt. D., biocrust, (1♀ SANC); Avontuur 488, nr. Hondeklipbaai, 30°19'50S 17°19'57E, 22.xi.1996, site 144, coastal plain nr. Yellow Vegt. Dunes, (1♀ 1♂ MNHN); Avontuur 488, nr. Hondeklipbaai, 30°20'03S 17°21'03E, 22.xi.1996, site 145, vegetated dune, yellow sand, (1♀ 3♂ ZMHB); Avontuur 488, nr. Hondeklipbaai, 30°20'18S 17°21'53E, 22.xi.1996, site 146, vegetated dune, yellow sand, (1♀ 2♂ SANC); Avontuur 488, nr. Wallekraal, 30°23'49S 17°25'21E, 22.xi.1996, site 147, firm red sand, (8♂ BMNH); Kanoep 491, nr. Swartfontein, 30°24'47S 17°25'03E, 22.xi.1996, site 148, firm red sand, (1♂ 1p SANC); Kanoep 491, nr. Swartfontein, 30°26'00S 17°25'10E, 22.xi.1996, site 149, yellow/red sand, (1♂ BMSA); Kanoep 491, nr. Swartfontein, 30°26'41S 17°25'41E, 22.xi.1996, site 150, Spoeg R. Bed, white sand banks, (2♀ 2♂ SMWN); Kanoep 491, near Swartfontein, 30°28'22S 17°26'37E, 23-24.xi.1996, site 151, Bitter R. Dunes, dune periphery, white sand, (18p SANC); Kanoep 491, near Swartfontein, 30°28'14S 17°26'23E, 23-24.xi.1996, site 151a, Bitter R. Dunes, interdune slack, white/red sand, (2♀ 11♂ BMNH), (3♀ 11♂ SANC); Strand Fontein 499, Bitter R. Dunes S., 30°32'19S 17°26'29E, 26.xi.1996, site 154, interdune slack, red/white sand, (4♀ 5♂ BMNH); Strand Fontein 499, Bitter R. Dunes S., 30°33'57S 17°26'37E, 26-27.xi.1996, site 155, dune periphery, soft white sand, (1♀ 1♂ BMNH); Strand Fontein 499, Bitter R. dunes S., 30°35'20S 17°26'44E, 1.xii.1996, site 156, dune periphery, white sand, (1♀ ZMHB); Driekop 500, 30°36'28S 17°27'53E, 1.xii.1996, site 157, coastal plain, yellow sand, (1♀ 1♂ ZMNB); Driekop 500, 30°36'15S 17°28'26E, 1.xii.1996, site 158, coastal plain, yellow sand, (8♀ 2♂ SANC); Driekop 500, 30°35'54S 17°29'16E, 1.xii.1996, site 159, vegetated dune, yellow sand, (1♀ 2♂ BMSA); De Klipheuvel 435, 30°35'S 17°33'E, 1.xii.1996, site 160, sand, (1♂ SMWN); De Klipheuvel 435, near Soutfontein, 30°38'43S 17°35'33E, 1.xii.1996, site 161, Sandplain Fynbos, yellow sand near vegetated dunes, (1♀ 1♂ SAMC); De Klipheuvel 435, near Soutfontein, 30°40'25S 17°34'55E, 1.xii.1996, site 162, Sandplain Fynbos, yellow sand near vegetated dunes, (5♂ UPSA); Kwaas 501, 30°42'38S 17°34'36E, 1.xii.1996, site 164, Sandplain Fynbos, yellow sand, (2♂ SANC); Kwaas 501, 30°43'29S 17°34'21E, 1.xii.1996, site 165, Sandplain Fynbos, yellow sand, (4♂ TMSA); Klip Kuil 547, near Groenrivier, 30°46'04S 17°34'59E, 1.xii.1996, site 166, yellow sand, (2♂ TMSA); Groen River, Roode Heuvel 502, 30°45'24S 17°38'24E, 4.xii.1996, site 168, Groen

River Bank, red sand, (1♂ SANC); Rondabel 542, 30°47'59S 17°46'39E, 4.xii.1996, site 169, Groen River Bank, red sand, (2♀ 2♂ SANC); Rondabel 542, 30°49'01S 17°46'07E, 4.xii.1996, site 170a, firm red sand, (3♂ 4p SANC); Branduin 543, 30°49'51S 17°45'36E, 4.xii.1996, site 171, dead in mud, firm red sand, (3♀ 1♂ BMSA), (11p SANC); De Dam 541, 30°51'14S 17°45'13E, 4.xii.1996, site 172, red sand plain, (1♀ 4♂ SAMC); De Dam 541, 30°52'06S 17°45'24E, 4.xii.1996, site 173, dead in mud, firm yellow sand, (3♀ 6♂ BMNH), (3♀ 4♂ SMWN), (10p SANC); De Witflacte 551, near Hardevlei, 30°52'50S 17°45'50E, 4.xii.1996, site 174, vegetated dune, firm/soft yellow sand, (2♀ 5♂ UPSA) (11p SANC); Varsfontein 554, near Kotzesrus, 30°56'57S 17°50'04E, 5.xii.1996, site 175, Brak River Bank, red/yellow sand, (1♀ 1♂ 1p SANC); Wit Water 557, near Kotzesrus, 31°01'03S 17°47'04E, 5.xii.1996, site 176, Brak River Bank, firm sand, (1♀ SAMC); Wit Water 557, near Kotzesrus, 31°01'18S 17°46'33E, 5.xii.1996, site 177, Brak River, yellow sand bank, (2♂ 9p SANC); Strandfontein 559, near Waterval, 31°01'46S 17°45'44E, 5.xii.1996, site 178, Brak River Bank, (1♂ BMNH); Wit Water 557, near Rooidam, 31°02'29S 17°46'46E, 5.xii.1996, site 179, vegetated dune, yellow sand, (1♀ 4♂ 8p SANC); Strandfontein 559, near Waterval, 31°03'15S 17°45'07E, 5.xii.1996, site 180, Brak River Bank, red sand, (2♂ TMSA); Tities Baai 560, near Brak R. mouth, 31°06'54S 17°44'28E, 5.xii.1996, site 181, firm yellow sand, near sea, (2♀ 3♂ BMNH); **S.Afr: Vredendal District**, Graafwater, Farm 156, 31°22'12S 17°59'54E, 6.xii.1996, site 185, red sand plain, (2♂ SANC); Graafwater, Farm 156, 31°22'38S 18°01'23E, 6.xii.1996, site 186, firm Y. sand plain, nr. vegt. dunes, (2♀ 1♂ SANC); Elsie Erasmus Kloof 158, 31°24'46S 18°02'30E, 7-8.xii.1996, site 188, vegt. 'old' dune, yellow sand, (1♀ 9♂ SANC); Elsie Erasmus Kloof 158, Skaapvlei, 31°28'47S 18°04'08E, 8.xii.1996 site 190, firm red sand, (1♂ SANC); Kommandokraal, on Farm 624, near Koekenaap, 31°29'02S 18°10'08E, 10.xii.1996, site 193, vegetated dune, yellow sand, (8♀ 1♂ SANC); **S.Afr: Namaqualand**, Kourootje 316, nr. Komaggas, 29.46.51S 17.22.55E, 9.x.1997, Harrison & Davis, site 220, vegetated dune, yellow sand, (1p UPSA), Koingnaas 475, 30.11.45S 17.18.17E, 10.x.1997, Harrison & Davis, site 221, (1x UPSA).

Specimens from the following localities may be incorrectly labelled because they are outside the species' established range: **SOUTH AFRICA: Anenous**, (Anenous Pass, Steinkopf), (29°14'S 17°40'E), 25.ix.(19)25, leg. name?, donation Natal Museum, NM 9025, (1♀ 3♂ BMSA); **Garies**, (30°30'S 18°00'E), Namaland, Schlechler, (1♂ SANC).

***Scarabaeus (Pachysoma) gariëpinus*** (Ferreira, 1953)

(Figures 7, 23, 41, 62)

*Pachysoma gariëpinus* Ferreira, 1953a: 23; Ferreira 1961: 24; Ferreira, 1969: 21; Holm and Scholtz, 1979: 231. Holotype: Namaqualand, Holgat. (1♂ TMSA).

*Scarabaeus gariëpinus* (Ferreira): Mostert and Holm, 1982: 275.

**Diagnosis.** Clypeus bidentate, but vestigial outer clypeal teeth sometimes present; genal and clypeal edges serrate (figure 23); protibia not dimorphic with simple protibial spurs

(figure 41); band of indument on elytral and pronotal outer edges; metatarsal claws shorter than last tarsal segment; genitalia illustrated in figures 62a,b.

*Distribution, habitat and conservation.* *S. (P.) gariepinus* is distributed on either side of the Orange River (figure 7). The southern most extent of *S. (P.) gariepinus* distribution in South Africa coincides with the Buffels River (29°33'S 17°24'E), while *S. (P.) gariepinus* occurs to Agub Mountain (26°59'S 15°58'E) in Namibia. The preferred habitat of *S. (P.) gariepinus* is firm consolidated sand of dunes, river banks and inland flats. No specimens were collected (by JDUGH) from dunes south of the Orange River, but only from inland sandy flats, river banks and the bases of sandblown outcrops. North of the Orange River *S. (P.) gariepinus* appears to have a closer association with dunes. Northern populations of *S. (P.) gariepinus* occur within the Namib-Naukluft Park.

*Comments on locality data.* Specimens from Brandvlei, Kakamas, and the Groen River Mouth all occur outside the established distribution range of *S. (P.) gariepinus*, and are probably incorrectly labelled specimens. However, the Kakamas record could be evidence that *S. (P.) gariepinus* can move inland along the Orange River.

*Morphological variation.* The following attributes of *S. (P.) gariepinus* vary within and between localities: size; elytral sculpture; indument; and size of the mesepisternal protuberance. The Namaqualand populations (south of Orange River) are characterised by smaller body size and red indument, while the Namibian populations are generally larger in body size with their indument stained white to grey. Specimens from Rosh Pinah (27°53'S 16°50'E) have very white indument and smooth elytra lacking distinct interstriae and granules. However, their genitalia conform to the typical *S. (P.) gariepinus* form.

A distinct mesepisternal protuberance (MEP), previously not mentioned by other authors, was noticed in specimens of *S. (P.) gariepinus* from Namibia. To determine if the MEP differentiated *S. (P.) gariepinus* into one species on either side of the Orange River it was examined in all available material. The MEP varies within and between populations and sexes. It appears larger in males and especially large males while smaller in females. It varies from virtually no expression in the Namaqualand populations to being well defined in the Namibian populations. For example, it is slightly expressed in some males but no females in populations close to the Buffels River, (e.g. Wolfberg). It becomes markedly more defined in *S. (P.) gariepinus* populations near Port Nolloth, while Hohenfels (Namibia) populations have it well expressed. The MEP clearly suggests a cline from south to north and supports the variation seen within *S. (P.) gariepinus* as attributable to one species. Further support for the continuity of the Namaqualand and Namibian populations is provided by male genitalia and elytral sculpture.

*Biology.* Holm and Scholtz (1979) observed *S. (P.) gariepinus* collecting *Oryx gazella* pellets that they dragged forward one at a time to their burrows. Mostert and Holm (1982) reported that 'When fresh horse droppings were presented to *Scarabaeus gariepinus* specimens in their natural surroundings, they would cut out a ball about 20 mm in diameter and roll it backwards in the same way as do the fully winged *Scarabaeus* species'. This exact

experiment was repeated in Namaqualand but *S. (P.) gariepinus* only showed interest in the horse dung when it was dry. Only then would they break off a small piece of dry dung using their protibia and clypeus and drag it with their hind legs to their preconstructed burrow. Of the 17 nests excavated by JDUGH; nine contained only dry dung pellets; three contained only detritus; while five contained both pellets and detritus. This suggests that *S. (P.) gariepinus* is predominately a dry pellet feeder.

*S. (P.) gariepinus* were successfully bred in captivity and three larvae were obtained. Larval observations and comments concur with *S. (P.) striatus* above.

*Comments.* *S. (P.) gariepinus* superficially resemble *S. (P.) striatus* females, but the two species are easily separated as *S. (P.) striatus* has a hook on the posterior lateral pronotal edge that is absent in *S. (P.) gariepinus*.

*Types.* Ferreira (1953a), designated a holotype (♂), allotype (♀) and 55 unsexed paratypes in her description of *Pachysoma gariepinum*. These types were deposited as follows: holotype, allotype and 51 paratypes in the TMSA collection; three paratypes in the UPSA collection; and one paratype in the CPMM collection. The three UPSA paratypes have subsequently been deposited in the TMSA, while no material from the CPMM collection in Mozambique was borrowed by Holm and Scholtz (1979) or in this revision. Holm and Scholtz (1979) noted that the holotype and most of the paratypes could be traced in the TMSA collection, although not labelled as such. Fortunately, Ferreira (1953a) listed the respective numbers of specimens from each locality, except the Holgat locality. However, via subtraction twelve paratypes were from Holgat. The allotype was not labelled, and since there are ten females from Holgat it becomes untraceable.

To add to the confusion of the type series, two separate series from Holgat dated 23.xi.(19)48 and 2.ix.1950 exist. Only the 1948 date is recorded in Ferreira's (1953a) description, although some of the specimens from 1950 also bear Ferreira's paratype labels. As these specimens (i.e. Holgat 1950) were not published as types, they are invalid. I have taken the opportunity of having all available type material together to label traced paratypes. These labels are printed on yellow card copying Ferreira's format and spelling verbatim. None of Ferreira's (1953a) original labels were removed. Thus, of the original 55 paratypes, 46 are traced and labelled as such.

*Type material examined* (Σ47 spec. [50], 20♀ 28♂, 14♂ diss.). **SOUTH AFRICA:** HOLOTYPE ♂, *Pachysoma gariepinus* Ferreira: Holgat, (28.56S 16.47E), NW C.P., 23.xi.(19)48, Koch & V. Son, / Tipo *Pachysoma gariepinus* 1951 M.C.Ferreira (written in red ink on white rectangular card with a black frame), (1♂ TMSA), (Allotype not marked, therefore untraceable). PARATYPES: *idem*, (10♀ 3♂ TMSA); Anenous, (29.14S 17.40E), 15.xi.1933, G. v. Son, (9♂ TMSA), *idem*, but / VII, 950 /, (1♂ TMSA); Brandkaross, (written in pencil, possibly from Gaerdes collection), (28.28S 16.40E), (1♀ 1♂ TMSA), *idem*, but / NMBH3685 / 203 /, (1♂ BMSA); 12m S of Grootderm, (ca. 28.37.05S 16.37.05E), (Groot Derm 10), 11.ix.1950, G.van Son, C.Koch, (1♀ TMSA); Oograbies, (29.13S 17.08E), L. Namaquald., 30.viii.(19)50, C.Koch, G. van Son, (3♀

5♂ TMSA); Oograbies, (29.13S 17.08E), (written in black ink), (1♀ 1♂ TMSA); Oograbies, (29.13S 17.08E), (written in black ink), (1♂ TMSA); Pt Nolloth, (29.17S 16.51E), Warden, S. / *Pachysoma gariepinus* Fer. 1951, M.C.Ferreira (written on white paper in black ink, black border around rectangle), (1♀ TMSA); Pt. Nolloth. C.C., (29.17S 16.51E), R.M.Lightfoot, Pt. Nolloth. C.C. / *Pachysoma marginatum* / *Pachysoma gariepinus* Fer. 1951, M.C.Ferreira (written on white paper in black ink, black border around rectangle), (1♀ TMSA); Pt Nolloth, (29.17S 16.51E), 1885, (1♀ SAMC). NAMIBIA: Namib, sens. Eberlanz, (1♀ 2♂ TMSA); *idem*, but Eberelanz (1♂ TMSA); Oranjemund, SWA, (28.33S 16.37E), 21. 6 or 8.(19)42, (1♂ TMSA).

*Additional material examined* (Σ453 specs. [16], 188♀ 235♂, 11♂ diss., 13uns., 17eth., 20p.).

**SOUTH AFRICA:** Northern Cape; Namaqualand, **Brandkaross**, (28.28S 16.40E), v.1953, Dr. C.Koch, NMBH 3685, (1♂ BMSA); Brandkaross, Richtersveld, (28.28S 16.40E), 9.ix.(19)50, C.Koch, G.van Son, (Not published paratype, see Ferreira 1953 pub. and specimens totals, acc: J.Harrison 1999), (1♂ TMSA); Richtersveld, Brandkaross Farm, 28.30S 16.39E, 24.viii.1989, E-Y:2667, sandblown hill, night, Endrödy & Klimaszew., (1♀ TMSA); Richtersveld, Brandkaross, 3km SE, 28.30S 16.42E, 30.ix.1991, E-Y:2815, sandy valley, hand-collected, Endrödy-Younga, (2♀ 8♂ TMSA); Richtersveld, Brandkaross, Oranje, 3km SW, 28.30S 16.39E, 4.viii.1989, E-Y:2629, sandblown hill, day, Endrödy & Klimaszew., (3♂ TMSA); Richtersveld, Brandkaross, Oranje, 3km SW, 28.30S 16.39E, 2.viii.1989, E-Y:2625, sandy hill, night, Endrödy & Klimaszew., (1♂ TMSA); **Buffels River Valley**, 29.35S 17.17E, 3.x.1976, hand-collected, Endrödy-Younga, E-Y:1252, (1♀ TMSA); **Grasvlakte**, 28.56S 17.02E, 8.ix.1987, red dunes day, Endrödy-Younga, E-Y:2483, (1♀ TMSA); **Grootmis**, 20km E, (ca. 29.37.05S 17.07.05E), 4.x.1972, H.D.Brown, E.Koster, A.Prinsloo, (2♀ 5♂ SANC); **Holgat**, (28.56S 16.47E), L. Namaquald., 2.ix.1950, C.Koch, G.van Son, (Not published paratype, see Ferreira 1953 pub. and specimens totals, acc: J.Harrison 1999), (6♀ 3♂ TMSA); Holgat, 18km E, 28.56S 16.58E, 5.ix.1987, red dunes, day, Endrödy-Younga, E-Y:2476, (1♂ TMSA); **Jakkalsputs**, SE2816Db, (28.37.05S 16.52.05E), 19,21.xi.1975, H31996, (3♀ 3♂ SMWN); Jakkalsputs, 28.42S 16.54E, 350m, 15-16.ix.1985, A.V.Evans, C.L.Bellamy, (5♀ 5♂ UPSA); Jakkalsputs, 28.38S 16.54E, (16.54E and not 18.54E as on label), 9-11.ix.1982, S.Louw, NMBH 8473, (2♀ 2♂ BMSA); **Port Nolloth**, (29.17S 16.51E), 1885, (1♀ SAMC); Port Nolloth, 36mls E, (ca. 29.15S 17.32E at base of Anenous pass), viii.1925, O.Hughes, 1791, Donation Natal Museum, NMBH 9025, (2♀ BMSA); Port Nolloth, 22-23km SE, 29.19S 17.06E, 150m, 15.ix.1984, C.L.Bellamy, (1x UPSA); Port Nolloth, 22km E, (ca. 29.18S 17.12E), 31.viii.1986, A.V.Evans, (5♀ 9♂ UPSA); **Steenbok** 165, nr. Sononderberg, 29.22S 17.10E, 250m, 1.ix.1986, A.Evans, C. Bellamy, (2♂ UPSA); **Witpütz**, (Witputs 27.36S 16.41E), 21.2.(19)63 / Gaerdes (typed) / H25895 / (1♂ SMWN); **Wolfberg**, (probably ca. 29.37S 17.25E), Cape, ix.1989, C.R.Owen, (3x COCS), (2♀ 3♂ DNSM).

Specimens collected by J.duG.Harrison in chronological order: **S.Afr: Namaqualand, Stryd Rivier** 188, 29°34'28S 17°16'49E, 24.vii.1996, J.duG.Harrison, site 15, firm red sand, Buffels River, (2p SANC); **Dikgat** 195, 29°34'46S 17°14'04E, 26.vii.1996, J.duG.Harrison, site

18, red sand, Buffels River, (1♀ SAMC); Stryd Rivier 188, 29°34'09S 17°17'00E, 9.viii.1996, Harrison & Scholtz, site 35, firm red sand plain, (1♀ SAMC); **Wolfberg 187**, 29°32'17S 17°23'23E, 25.viii.1996, J.duG.Harrison, site 63, Buffels R. Bank, coarse sand, (1♀ SAMC); **Gemsbok Vlei 158**, 29°19'14S 17°10'46E, 25.viii.1996, J.duG.Harrison, site 65, flat red sand plain, (4eth. TMSA), (15p SANC); **Drooge Kraal 180**, 29°27'S 17°17'E, 5.ix.1996, J.duG.Harrison, site 88, red sand plain, (1♀ TMSA); Drooge Kraal 180, 29°27'21S 17°15'23E, 5.ix.1996, J.duG.Harrison, site 89, red sand plain, (2♂ TMSA); near Beauvallon, **Groot Derm 10**, 28°31'12S 16°39'49E, 25.x.1996, J.duG.Harrison, site 105, 'waaisand', (1♀ TMSA); **Farm 600, Holgat R.**, 28°41'26S 16°57'43E, 26.x.1996, J.duG.Harrison, site 107, coarse red sand, (3♀ 2♂ BMNH), (3♀ 2♂ ZMHB), (3♀ 2♂ SMWN), (13eth. TMSA), (2p SANC); Farm 600, Holgat R., 28°41'42S 16°57'29E, 26.x.1996, J.duG.Harrison, site 107a, coarse red sand, (1♀ TMSA); Farm 600, Holgat R., 28°41'36S 16°57'02E, 26.x.1996, J.duG.Harrison, site 108, vegetated dunes, red sand, (2♀ 3♂ SAMC); **Farm 600, Kuboes to Lekkersing road**, 28°43'26S 16°59'50E, 26.x.1996, J.duG.Harrison, site 109, vegetated red sand, (1♀ SANC); Farm 600, Kuboes to Lekkersing road, 28°52'47S 17°00'53E, 26.x.1996, J.duG.Harrison, site 110, vegt. loam near yellow sand rise, (2♀ 1♂ SANC); **Farm 600, Geel Pan**, 28°53'06S 17°00'54E, 26.x.1996, J.duG.Harrison, site 111, vegetated red sand, (1♂ SANC); Farm 600, Bakenskap, 28°57'11S 17°01'59E, 26.x.1996, J.duG.Harrison, site 112, vegetated dune, red sand, (1♀ 1♂ SANC); Stryd Rivier 188, 29°34'09S 17°17'00E, 31.x.-1.xi.1996, Harrison & Scholtz, site 115, red sand & gravel, (19♀ 11♂ UPSA), (1p SANC); **Bontekoe 197**, 29°33'34S 17°19'44E, 4.xi.1996, J.duG.Harrison, site 116, Buffels R. Valley, coarse river sand, (2♀ 2♂ SANC); **Staan Hoek 198**, 29°31'34S 17°22'09E, 9.xi.1996, J.duG.Harrison, site 118, Buffels R. Valley, red river sand, (1♀ 1♂ SANC); **Nuttabooi 199**, Langhoogte to Komaggas Rd., 29°33'47S 17°24'25E, 9.x.1997, Harrison & Davis, site 219, Buffels R. Valley, red river sand, (1x UPSA).

**NAMIBIA:** **Agub Mt.**, 26.59S 15.58E, Diamond Area 1, 12-13.viii.1983, J.Irish, E.Griffin, H56627, (2♂ SMWN); 22mls W Udabib, **Aurusberg W**, (27.39S 16.19E), 20.xi.1962, H.D.Brown, W.Fürst, (1♂ TMSA) (Udabib: cannot trace); Aurusberge, (=Aurus Mts.), Diamond Area 1, (27.39S 16.19E), 22.x.1974, H.D.Brown, (1♂ SANC); Aurus Dunes nr. Aurusvlei, 27.40S 16.12E, 23.iv.1988, R.Oberprieler, (3♀ 6♂ SANC); **Bogenfels**, 20km E, 27.35S 15.35E, 25.vii.1981, sandy gravelly flat, Endrödy-Younga, E-Y:1799, (1♀ TMSA); **Chamias**, 45km S, SE2816Aa, (28.07.05S 16.07.05E), vii.1978, Izak Bruwer, UP, (1♂ SANC); **Daberas Dunes**, (28.13S 16.45E), Gt. Namaqualand, v.1953, C.Koch, (2♂ TMSA); **Diamond Area 1**, 27.52S 16.30E, 17.viii.1983, J.Irish, E.Griffin, H56715, (1♂ SMWN); Diamond Area 1 at 28.02S 15.52E, 16-29.ix.1994, E.Marais, Pres. pitf. traps (2♀ 2♂ SMWN); **Hohenfels** 15mls E Oranjemund, (ca. 28.37.05S 16.37.05E), 19.xi.1962, H.D.Brown & W.Fürst, (3♀ 1♂ TMSA); Hohenfels, 28.30.05S 16.37.00E, 01-07.xi.1994, Scholtz, Chown & Klok, (15♀ 26♂ UPSA), (5x BMNH), (2♀ 2♂ ZMHB); **Kegelberg**, Diamond Area 1, 27.37S 16.23E, 27.ix.1994, E.Marais, (3♀ SMWN); **Klinghardtberge**, Spitzkuppe Süd, Diamond Area 1, (27.20S 15.45E), 9.x.1974, H.D.Brown, (1♀ 7♂ SANC); Klinghardtberge, 10km SE, SE2715Bd3, (27.22.05S 15.52.05E), vii.1982, E.Holm, (1♂ TMSA), (1♀ 5♂ UPSA); SE of Klinghardtberge, SE2715Db2, (27.37.05S

15.52.05E), vii.1982, E.Holm, (1x TMSA); NE of Klinghardtberge, SE2715Bb2, (27.07.05S 15.52.05E), i.1983, E.Holm, (2♀ TMSA); Klinghardt Mt., (27.20S 15.45E), 22.x.1977, V.B.Whitehead, (2♂ SAMC); Klinghardt Mt., (27.20S 15.45E), 1977, J.Boomker, (1♀ 1♂ TMSA), (1♀ SANC); Klinghardt Mts., at 27.20S 15.45E, Diamond Area 1, 3-6.ix.1980, S.Louw, M-L.Penrith, H42441, (5♀ 4♂ SMWN); Klinghardt Mt., 27.18S 15.41E, Diamond Area 1, 29-30.vii.1981, M-L.Penrith, H43463, (1♀ SMWN); Klinghardt Mt., 27.18S 15.42E, 29.vii.1981, sandy valley, day, Endrödy-Younga, E-Y:1808, (2♀ 2♂ TMSA); Klinghardt Mt., at 27.21S 15.42E, Diamond Area 1, 2-4.x.1982, M-L. Penrith, J.Irish, H54956, (2♀ 10♂ SMWN); Klinghardt Mt., W at 27.24S 15.38E, Diamond Area 1, 1-4.x.1982, M-L.Penrith, J.Irish, H54886, (1♂ SMWN); Klinghardt Mt., 27.18S 15.42E, 21.viii.1989, sandy ground, day, Endrödy & Klimaszew., E-Y:2659, (9♀ 11♂ TMSA); Klinghardt Mt., 27.18S 15.42E, 21.viii.1989, ground traps 3 days, Endrödy & Klimaszew., E-Y:2677b, (1♂ TMSA); **Mac Millian's Pass**, 9mls NE Rosh Pinah, (ca. 27.51S 16.52E), 24.ix.1968, H.D.Brown, (1♂ TMSA); **Manganese Mine**, Richtersveld, 28.40S 16.48E, 10.x.1976, hand-collected, Endrödy-Younga, E-Y:1270, (1♀ 1♂ TMSA); **Namaskluft 88**, Lüderitz at 27.55S 16.53E, 31.viii.1989, S.Louw, ex Mesems, NMBH28069, (1♂ BMSA); **Nieu-Tsaus**, Lüderitz District, 26.59S 16.16E, 16.viii.1990, E.Marais, C.Roberts, (1♀ SMWN); **Obib Dunes**, 28.00S 16.39E, 17.ix.1973, hand-collected, dune, night, Endrödy-Younga, E-Y:116, (1♂ TMSA); Obib Dunes, 28.00S 16.39E, 18.ix.1973, on dunes, diurnal, Endrödy-Younga, E-Y:117, (7♀ 3♂ TMSA); Obib Mt. Camp, 27.59S 16.33E, 19.ix.1973, on flowers, Endrödy-Younga, E-Y:123, (2♀ 4♂ TMSA); Obib Dunes, 28.11S 16.36E, 20.ix.1973, faeces trap, day, Endrödy-Younga, E-Y:128, (6♀ 3♂ TMSA); Obib Dunes, 28.11S 16.36E, 20.ix.1973, around camp, Endrödy-Younga, E-Y:129, (1♀ TMSA); Obib Dunes E at 28.02S 16.37E, Lüderitz, 16-20.ix.1973, H14397, (1♀ SMWN); Obib Mts/Dunes, SE2816Ba, (28.07.05S 16.37.05E), Diamond Area 1, 28-30.x.1977, Coll. S.Louw, M-L.Penrith, H35117, (2♀ 2♂ SMWN); Obib Dunes, West edge, (ca. 28.06S 16.15E), 8.ix.1980, on dunes, Whitehead, (2♂ SAMC); Obib Dunes, Lüderitz at 27.59S 16.37E, 3.ix.1991, R.Archer, NMBH28116, (3♀ 5♂ BMSA), *idem*, but Obibwasser (1♂ BMSA); **Oranjemund**, 10km NE, Lüderitz, SE2816Da, (ca. 28.37.05S 16.37.05E), 19.ix.1973, H14546, (1x SMWN); Oranjemund, 10km N, (ca. 28.22.05S 16.22.05E), vii.1978, E.Holm, (2♂ SANC); Oranjemund, SE2816Cb, (28.37.05S 16.22.05E), vii.1979, J.A.Irish, UP, (1♀ SANC); NE of Oranjemund, SE2816Cb2, (28.37.05S 16.22.05E), vii.1982, E.Holm, (2♀ 1♂ TMSA), (1♂ UPSA); Oranjemund, 28.32S 16.37E, 28.vii.1981, sandy hills, day, Endrödy-Younga, E-Y:1805, (4♀ 1♂ TMSA); Oranjemund, 28.33S 16.37E, Diamond Area 1, 27-28.vii.1981, M-L.Penrith, H43524, (1♂ SMWN); Oranjemund, (28.33S 16.37E), i.1991, N.Larsen, (1♂ SAMC); Oranjemund, Diamond Area 1, 28.34S 16.27E, 15.ix.1994, E.Marais, dung traps, (6♀ 2♂ SMWN); **Rechtersveld**, (ambiguous), SWA, 1922, G.E. Smith, 1799, Donation Natal Museum, NMBH9025, (2♀ BMSA); **Rosh Pinah**, 22mls N, (ca. 27.40S 16.42E), Lüderitz Dist., 21.ix.1968, H.D.Brown, (1♂ TMSA); Rosh Pinah, 27.53S 16.50E, 14.ix.1973, hand-collected on ground, Endrödy-Younga, E-Y:103, (1♀ TMSA); Rosh Pinah, 27.53S 16.50E, 15.ix.1973, E-Y:110, hand-collected around camp, Endrödy-Younga, (1♂ TMSA); Rosh Pinah, 28.04S 16.59E, 15.ix.1973, hand-collected, Endrödy-Younga, E-Y:110,

(2♂ TMSA); Rosh Pinah, 27.53S 16.50E, 22.ix.1973, faeces traps, Endrödy-Younga, E-Y:139, (2♂ TMSA); Rosh Pinah, **Namaskluft**, (27.53S 16.50E), 17.xi.1975, SAM, V.B.Whitehead, (1♂ SAMC), *idem*, but 14.xi.1975, (1♀ SAMC); Rosh Pinah, Lüderitz, 27.56S 16.45E, 2.ix.1989, S.Louw, under plants, NMBH 27944, (2♂ BMSA); Rosh Pinah, (south of landing strip), Lüderitz, 27.57S 16.45E, 1.ix.1989, S.Louw, NMBH 31079, (1♂ BMSA); Rosh Pinah, 10km NW, Lüderitz District, 27.54S 16.42E, 13.viii.1990, C.Roberts, E.Marais, (1♀ 4♂ SMWN); Rosh Pinah, 2km ESE, Lüderitz District, 27.58S 16.47E, 13.viii.1990, E.Marais, C.Roberts, (1♂ SMWN); Rosh Pinah, 7.6km E, (*ca.* 27.58S 16.51E), 11.viii.1992, C.R.Owen, (1♀ COCS); **Roter Kamm**, 27.46S 16.18E, 24.iv.1988, R.Oberprieler, (1♀ 2♂ SANC); Roter Kamm, Diamond Area 1, Lüderitz District, 27.46S 16.18E, 25-30.vi.1989, C.S.Roberts, (2♀ 4♂ SMWN); **Sargdeckel**, Klinghardt Mts., SE2715Bc, (27.22.05S 15.37.05E), Diamond Area I, 22-25.x.1977, Coll. M-L. Penrith, S.Louw, H34992, (3♀ 2♂ SMWN); Sargdeckel, Klinghardt Mts., 27.24S 15.41E, Diamond Area I, 1-2.x.1982, M-L. Penrith, J.Irish, H54903, (3♀ 8♂ SMWN); **Skilpadberg**, Diamond Area 1, 28.27S 16.40E, 14.xi.1992, Huns Exp. '92, (1♀ SMWN); Skilpadberg, Diamond Area 1, 28.25S 16.39E, 18.ix.1994, E.Marais, at light, (1♀ SMWN); **Uguchab Riv.**, Diamond Area 1, 27.37S 16.10E, 14-15.viii.1983, J.Irish, E.Griffin, H56680, (2♀ 1♂ SMWN); Uguchab River nr. Aurusberg, 27.32S 16.11E, 22.iv.1988, R.Oberprieler, (1x SANC); Between **Zebrafontein & Obib**, (*ca.* 27.52.05S 16.52.05E), Gt. Namaquald., v.1953, C.Koch, (1♀ TMSA).

Specimens from the following localities may be incorrectly labelled because they are outside the species' established range: SOUTH AFRICA: **Brandvlei**, (30.13S 17.29E Brandvlei Farm), (30.28S 20.30E, Calvinia), (Brandsevlei, 29.525S 18.52E, Gamoep), viii.1937, (1♂ TMSA); **Groenrivermond**, (30.50S 17.36E), 30.x.1972, H.D.Brown, E.Koster, A.Prinsloo, (2♂ SANC); **Kakamas**, (28.52.05S 20.37.05E), 1992, R.O.C., (2♀ USSA).

### ***Scarabaeus (Pachysoma) bennigseni*** (Felsche, 1907)

(Figures 8, 24, 42, 63)

*Pachysoma bennigseni* Felsche, 1907: 274; Péringuey, 1908: 556; Gillet, 1911a: 6; Ferreira, 1953a: 35; Ferreira 1961: 22; Ferreira, 1966: 59; Ferreira, 1969: 20; Holm and Scholtz, 1979: 235. [Holotype]: Orange River [1x SMTD].

*Pachysoma granulatum* Ferreira, 1953b: 2; Ferreira 1961: 23; Ferreira, 1966: 59; Ferreira, 1969: 20. Holotype: Namtib (1♂ TMSA).

*Scarabaeus bennigseni* (Felsche): Mostert and Holm, 1982: 275.

**Diagnosis.** Clypeus quadridentate, outer clypeal teeth reduced in size and deflexed outwards; genae serrated and discontinuous from clypeus (figure 24); protibia hardly sexually dimorphic, protibial spurs sinusoidal in males and straight in females (figure 42); small (length 23 mm; width 14.24 mm), black; elytra granular to smooth, markedly flat and deeply striate; metatarsal claws equal in length to last tarsal segment.

*Distribution, habitat and conservation* Coastal species occurring from just south of the Orange River (i.e. Holgat River mouth) to Spencer Bay north of Lüderitz (figure 8). The northern population is conserved within the Namib-Naukluft Park, but the central and southern populations occur within Diamond Area 1 and Alexkor mining property, respectively. Preferred habitats include coastal sand dunes and sand flats on unstable to compacted sand.

*Comments on locality data.* The Dassiefontein / Sneekop locality record on the escarpment near Kamieskroon is very unlikely (figure 8). This locality falls well out of the confirmed range of *S. (P.) bennigseni* and is a record that is both further inland and at a higher elevation than expected for this coastal sand plain to sand dune species. The genitalia of this single male are typical of *S. (P.) bennigseni*.

*Morphological variation.* *S. (P.) bennigseni* occurs on both sides of the Orange River, which is a potential barrier between the two populations. Examination of external features and male genitalia reveals no evidence that these allopatric populations represent separate species. South of the Orange River *S. (P.) bennigseni* has smoother elytra and specimens are larger, while north of the river they are smaller but with well-defined elytral interstriae and distinct granular elytral sculpture. Within populations the elytral sculpture varies only slightly, unlike *S. (P.) gariepinus* and *S. (P.) striatus*. This minor morphological difference is clinal and consistent with that seen throughout *S. (Pachysoma)* species.

*Biology.* According to Holm and Scholtz (1979) foraging and tunnelling are very similar to *S. (P.) gariepinus*. A single nest was excavated by JDUGH at Jam Pan that contained a mixture of detritus and dung pellets. The larvae are unknown.

*Comments.* *S. (P.) bennigseni* superficially resembles *S. (P.) denticollis* (black form), but lacks dimorphic protibia.

*Types.* Although Felsche (1907) records only a single length (20 mm) in his description of *Pachysoma bennigseni* he lists two collections (Collection Felsche and Collection Bennigsen) in which material is deposited, which suggests more than a single type specimen. Holm and Scholtz (1979) examined the holotype from Oranjevluss (Orange River) in the SMTD collection.

Ferreira (1953b) described *Pachysoma granulatum* and subsequently (Ferreira 1966) synonymised it with *Pachysoma bennigseni*. Holm and Scholtz (1979) only mention the holotype, allotype and four paratypes for *P. granulatum*. The type series of *P. granulatum* comprised 29 specimens (Ferreira 1953b). Twenty-six types are in the TMSA collection, while the remaining three are reputed to be in the BMNH and CPMM collections. There are two sets of specimens from the type locality (i.e. Daberas dunes) which could create confusion in the future (see type and additional material examined). The type series (9♀ 17♂) is labelled with handwritten locality labels while the second series (9♀ 11♂) has printed labels.

*Type material examined* ( $\Sigma$ 26 specs. [7], 9♀ 17♂, 1♂ diss.). **NAMIBIA:** HOLOTYPE ♂, *Pachysoma granulatum* Ferreira: S. Great Namaq., Daberas dunes, (28.13S 16.45E), v.1953, C.Koch (written on faded white card) / (male genitalia point mounted) / Holotype, *Pachysoma granulatum* ♂, M.C.Ferreira, 1953 (written on white card) / Holotypus, *Pachysoma granulatum*,

M.C.Ferreira sp.n. (Endrödy-Younga label), (1♂ TMSA); Allotype ♀, *idem*, but / Allotype (sic) *Pachysoma granulatum* ♀, M.C.Ferreira, 1953 (written on white card) / Allotypus, *Pachysoma granulatum*, M.C.Ferreira sp. n. (Endrödy-Younga label), (1♀ TMSA). PARATYPES: *idem*, but Paratipo (red ink) *Pachysoma granulatum*, M.C.Ferreira (written on white card, all the paratypes are labelled by both Ferreira and Endrödy-Younga), (8♀ 16♂ TMSA); [2 BMNH]; {1 CPMM}.

*Additional material examined* ( $\Sigma$ 137 specs. [24], 49♀ 87♂, 4♂ diss., 1uns.). **SOUTH AFRICA:** Northern Cape; Namaqualand, **Alexander Bay**, 10km S, SE2816Ca, (28.37.05S 16.07.05E), vii.1978, E.Holm, (1♀ UPSA); Alexander Bay, Jam Pan, State L. 1, 28.38.59S 16.32.14E, 24.x.1996, J.duG.Harrison, site 103, periphery of pan, white sand, (1♀ SAMC); **Boegoeberg-South**, 28.46S 16.53E, 28.ix.1988, E.Marais, J.Irish, (1♀ 2♂ SMWN); Richtersveld, **Holgat Mouth**, 28.58S 16.43E, 1.ix.1976, E-Y:1199, hand-collected fr. hummocks, Endrödy-Younga, (1♂ TMSA).

**NAMIBIA:** **Agate Beach**, Lüderitz, (26.36S 15.10E), 19.i.1973, M.K.Jensen, extensive dune field with much *Stipagrostis sabulicola*, (1♂ TMSA), (1♂ SMWN); **Agub Mt.**, 26.59S 15.58E, Diamond Area 1, 12-13.viii.1983, J.Irish, E.Griffin, H56628, (1♀ 7♂ SMWN); **Blueberge**, 2km E, 26.07S 14.58E, 18.i.1974, E-Y:297, on and between dunes, day, Endrödy-Younga, (2♂ TMSA); **Boegoeberg**, 27.54S 15.56E, Diamond Area I, 20-21.viii.1983, J.Irish, E.Griffin, H56778, (2♂ SMWN); **Daberas dunes**, (28.13S 16.45E), Gt. Namaqualand, v.1953, C.Koch, (labels printed in black onto white card, 19 labels in one font, 1 label in a larger font, not part of the original type series of *Pachysoma granulatum*), (9♀ 11♂ TMSA), btw. Rooi Lepel-Daberas Dunes, (ca. 28.07S 16.37.05E = Rooilepel, Oranjemund; 28.15S 16.38E = Rooilepel, Obib), Gt. Namaqualand, v.1953, C.Koch, (2♂ TMSA) Daberas Gate, 8km E, 28.33S 16.30E, Diamond Area I, 26-27.x.1980, C.G.Coetsee, H42554, (1♀ SMWN); Lüderitz Dist., **Eccles dunes**, 27.55S 16.38E, 18.ix.1997, compacted sand, Marais & Kirk-Spriggs, (1♀ 3♂ SMWN); SE of **Klinghardtberge**, SE2715Db2, (ca. 27.33.53S 15.55.58E), vii.1982, E.Holm, (9♂ TMSA), (4♂ UPSA); **Obib Dunes**, West Edge, (ca. 28.07.05S 16.22.05E), 8.ix.1980, on dunes, Whitehead, (2♂ SAMC); Obib Dunes, W at 28.03S 16.28E, Diamond Area 1, 7-9.ix.1980, S.Louw, M-L. Penrith, H42503, (2♀ 3♂ SMWN); Obib Dunes, 28.10S 16.41E, Diamond Area 1, 19.viii.1983, J.Irish, H56755, (1♀ 1♂ SMWN); Obib Mts/Dunes, SE2816BA, (28.07.05S 16.37.05E), Diamond Area 1, 28-30.x.1977, Coll. M-L. Penrith, S.Louw, H35118, Ala 5 gg 161, (1♂ SMWN); **Oranjemund**, SE2816Cb2, (28.37.05S 16.22.05E), vii.1982, E.Holm, (4♀ 6♂ UPSA), *idem*, but NE of Oranjemund, (1♂ UPSA); SE of Oranjemund, SE2715Db2, (27.37.05S 15.52.05E), vii.1982, E.Holm, (1x UPSA); Oranjemund, 10km N, SE2816Ad, (28.22.05S 16.22.05E), vii.1978, E.Holm, (1♀ 2♂ SANC), (1♂ UPSA), (1♀ 1♂ TMSA); Oranjemund, SE2816CB, (28.37.05S 16.22.05E), vii.1978, Izak Bruwer, UP, (1♀ SAMC); Oranjemund Dunes, Diamond Area 1, 28.32S 16.27E, 16.ix.1994, E.Marais, (1♀ 2♂ SMWN); **Rietvlei**, SE2816Dc, (ca. 28.52.05S 16.37.05E [in sea]), xi.1978, J.A.Irish, (1♂ SANC); **Rooiduine nr Obibberge**, 28.07S 16.37E, 25.iv.1988, R.Oberprieler, (3♂ SANC), (1♀ UPSA); **Roter Kamm**, 27.46S 16.18E, 24.iv.1988, R.Oberprieler, (3♀ 3♂ SANC); **Saddle Hill**, (ca. 25.53S 14.56E),

i.1966, (1♂ TMSA); **Saddle Hill North**, 25.48S 14.54E, Diamond Area 2, 7.xii.1989, E.Griffin, on dunes, (2♀ SMWN); **Skerpioenkop**, Diamond Area 1, 27.46S 16.30E, 26.ix.1994, E.Marais, (8♀ 4♂ SMWN), (1♀ 1♂ BMNH), (1♀ 1♂ ZMHB); **Spencer Bay Water**, 25.47S 14.54E, 14.i.1974, E-Y:285, hand-collected, day, Endrödy-Younga, (7♀ 8♂ TMSA); **Uguchab Riv.**, 27.37S 16.10E, Diamond Area 1, 14-15.viii.1983, J.Irish, E.Griffin, H56681, (1♂ SMWN).

Additional material listed in Holm and Scholtz (1979): **Buchberg**, (Boegoeberg), Lüderitz, SE2715Dd, 27.52.05S 15.52.05E, 1972, C.J.C. (SMWN); **Spencer Bay**, Noordhoek, Brakvlei, SE2514Dd, (25.52.05S 14.52.05E), 17.i.1973, (UPSA); Oranjemund, Lüderitz, SE2816Cb, (28.37.05S 16.22.05E), 25-27.xi.1972, (SMWN).

A single specimen from the following locality may be incorrectly labelled because it occurs outside the species' established range: SOUTH AFRICA: Namaqualand, **Dassiefontein & Sneekop**, 30.09S 17.59E, 20-22.ix.1988, J.Irish, E.Marais, (1♂ SMWN).

***Scarabaeus (Pachysoma) schinzi*** (Fairmaire, 1888)

(Figures 9, 25, 43, 64)

*Pachysoma schinzi* Fairmaire, 1888: 178; Péringuey 1902: 80; Felsche 1907: 273; Gillet 1911a: 6; Ferreira 1953a: 26; Ferreira 1961: 24; Ferreira 1966: 59; Ferreira 1969: 21; Holm and Scholtz 1979: 235. [Holotype]: No locality [1♂ MNHN].

*Scarabaeus schinzi* (Fairmaire): Mostert and Holm, 1982: 275.

**Diagnosis.** Sexual dimorphism of head marked (figure 25a,b), males with bifid clypeal horns (figure 25b); protibia serrated between and proximal to protibial teeth (figure 43a,b), distance between second and third protibial teeth (especially in male) greater than between other protibial teeth; elytra smooth, with no sub-elytral ridge; metatarsal claws shorter than last tarsal segment.

**Distribution, habitat and conservation** Confined to the gravel plains around Aus on the Huib-Hoch Plateau (figure 9). *S. (P.) schinzi* has a very restricted distribution and its conservation status is unknown. *S. (P.) schinzi* is not contained within any conservation area.

**Comments on locality data.** The Tinkasfläche specimens collected by Gaerdes occur well out of the confirmed distribution range of *S. (P.) schinzi*. Irish (1995) examined Gaerdes original diaries and verified that Gaerdes confused the name's Tinkasfläche (22°53'S 15°23'E) with Tiras Plains (26°08'S 16°38'E) before about 1967. The Tiras Plains (to the north of Aus) are well within the expected distribution of *S. (P.) schinzi*.

**Morphological variation.** Size of the clypeal horns varies slightly, but the shape is consistent within the species.

**Biology.** Biology unknown. Louw (label data) collected *S. (P.) schinzi* under plants, and according to Owen (pers. comm.) *S. (P.) schinzi* feeds on vegetation (presumably fallen flower petals and detritus).

During September of 1950 Koch and van Son collected 88 females and 70 males of *S. (P.) schinzi* from Aus. This represents the longest series ever collected for any *S. (Pachysoma)* species and forms 84% of available material for *S. (P.) schinzi*. Subsequently only 10 females and 21 males have been collected. Possible reasons for this apparent lack of material since 1950 might include the following: (1) an artifact of collectors' activities and objectives; (2) the unpredictable activity period of *S. (P.) schinzi* a consequence of unpredictable rainfall near Aus; (3) habitat modification around Aus.

The ratio between females and males (1.25♀:1♂) suggests the Aus population sampled in 1950 was at an early stage in their breeding cycle. All 158 specimens collected are mature individuals (no tenerals are present) and the protibial and clypeal wear on some specimens suggests that this sample represented only mature adults most probably of at least one to two years (seasons) old. The small numbers of subsequently collected *S. (P.) schinzi*, could be the result of the large sample taken in 1950. Especially as the restricted distribution range (figure 2d) and low vagility of *S. (P.) schinzi* reduces the potential for recolonization. If this is the case, future coleopterists should refrain from over collecting any local population of *S. (Pachysoma)*. The larvae are unknown.

*Comments.* Rare in collections, probably due to their limited distribution and an activity period linked to unpredictable rainfall (but also see biology). *S. (P.) schinzi* straddles the boundaries between the Desert, Nama-Karoo and Succulent Karoo Biomes (Rutherford and Westfall 1994) on the Huib-Hoch Plateau.

*Types.* Fairmaire (1888) described only the male of *Pachysoma schinzi*, a single body length (29 mm) suggests one specimen was examined from 'Namaqua-Land'. Felsche (1907) noted the differences between the sexes and described the female of *P. schinzi*.

*Type material.* **NAMIBIA:** [HOLOTYPE ♂], *Pachysoma schinzi* Fairmaire: Namaqua-Land, [1♂ MNHN]. Holm and Scholtz (1979) suspect the holotype comes from the vicinity of Aus.

*Additional material examined* ( $\Sigma$ 189 specs. [192], 98♀ 91♂, 5♂ diss.). **NAMIBIA: Augustvelde** 42, Lüderitz Distr., 26.38S 16.18E, 13-30.ix.1994, E.Marais, Pres. pitf. traps, (1♀ 2♂ SMWN); **Aus**, Gt. Namaqualand, (26.41S 16.16E), 17.ix.1950, C.Koch, G.van Son, (3♀ 3♂ UPSA), (76♀ 55♂ TMSA), (2♀ 1♂ SAMC), *idem*, but NM3676, (7♀ 10♂ BMSA), (1♂ TMSA); Aus, (26.41S 16.16E), S.W. Prot., Dr. Knobel, (1♂ SAMC); Aus, 6-12km W, (26.38S 16.13E to 26.38S 16.11E), 4.ii.1974, Davis & Kirsten, DRU1409, (2♀ 2♂ SANC) (1♂ SAMC); Aus, 5km NE, 26.37.05S 16.07.05E, 4.ii.(19)74, Davis & Kirsten, DRU1410, (1♀ 1♂ SANC); Aus, (26.41S 16.16E), 30.ix.1987, C.R.Owen, (2♀ 2♂ BMNH); South Inland, Aus 20-30km E, 26°37'S 16°28'E, 18.ix.1987, E-Y:2504, ground and stones, Endrödy-Younga, (1♀ 3♂ TMSA); **Lüderitz**, 5km N of Aus, 26.37S 16.19E, 12.viii.1997, Kirk-Spriggs & Marais, dung trap sample, (1♂ SMWN); **Plateau Farm**, 22mls E Aus, (26.37S 16.35E), 14-17.i.1972 / Southern African Exp., BM 1972-1, (2♀ BMNH); **Rosh Pinah**, 155km on Aus Rd., Lüderitz, 26.40S 16.18E, 30.viii.1989, S.Louw, under plants, NMBH27927, (1♀ NMBH); **Kubub 15**, Lüderitz Distr.,

26.42S 16.16E, 13-30.ix.1994, E.Marais, Pres. pitf. traps, (6♂ SMWN); **Tinkasfläche**, (= **Tiras plains**, ca. 26.07.05S 16.37.05E), 25.XI.(19)62 / compared to type of *P.valeflorae* Ferreira, clypeal horns further apart, longer, Holm and Scholtz 1979, (1♂ TMSA). Tinkasfläche, (= Tiras plains, ca. 26.07.05S 16.37.05E), 25.XI.(19)62 / Gaerdes (typed) / H25892, (1♂ SMWN). Irish (1995), using Gaerdes diary verified the confusion by Gaerdes between the names Tinkasfläche (SE2215Cd) and Tiras Plains (SE2616Ba) prior to about 1967.

***Scarabaeus (Pachysoma) valeflorae*** (Ferreira, 1953)

(Figures 9, 26, 44, 65)

*Pachysoma valeflorae* Ferreira, 1953a: 28; Ferreira 1961: 24; Ferreira, 1966: 59; Ferreira, 1969:22; Holm and Scholtz, 1979: 235 (subjective synonym of *Pachysoma schinzi* Fairmaire). Holotype: Haalenberg, Namibia (1♂ TMSA).

*Diagnosis.* Sexual dimorphism of the head marked between sexes (figures 26a,b); male has two clypeal horns, anterior edges of genae produced into distinct point (figures 26a,b); no serrations between or proximal to protibial teeth (figures 44a,b); small and slightly built in comparison to *S. (P.) schinzi*.

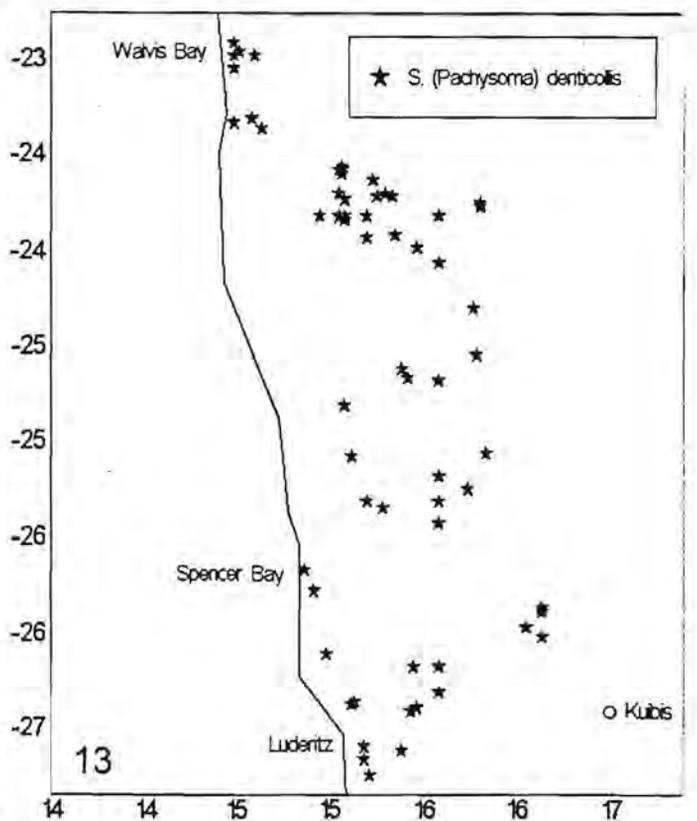
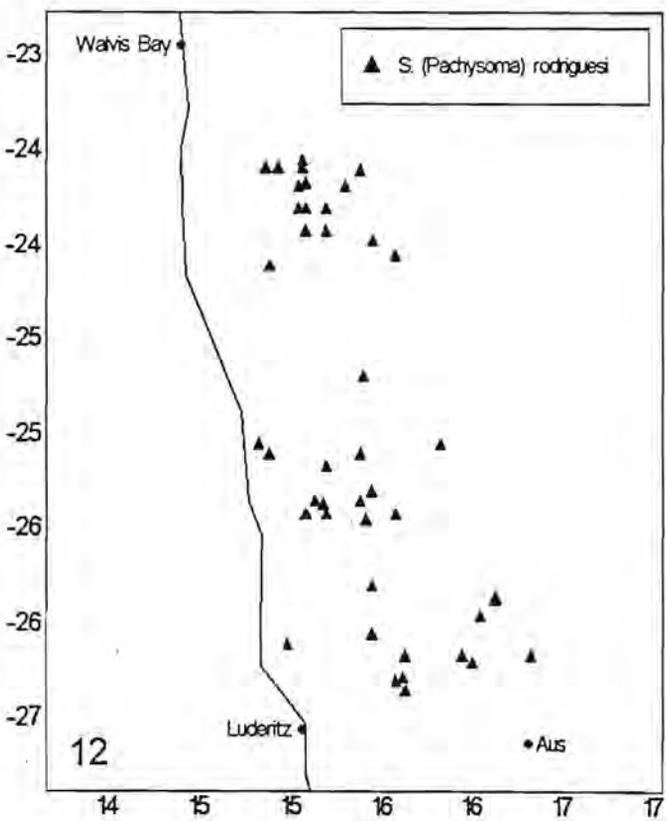
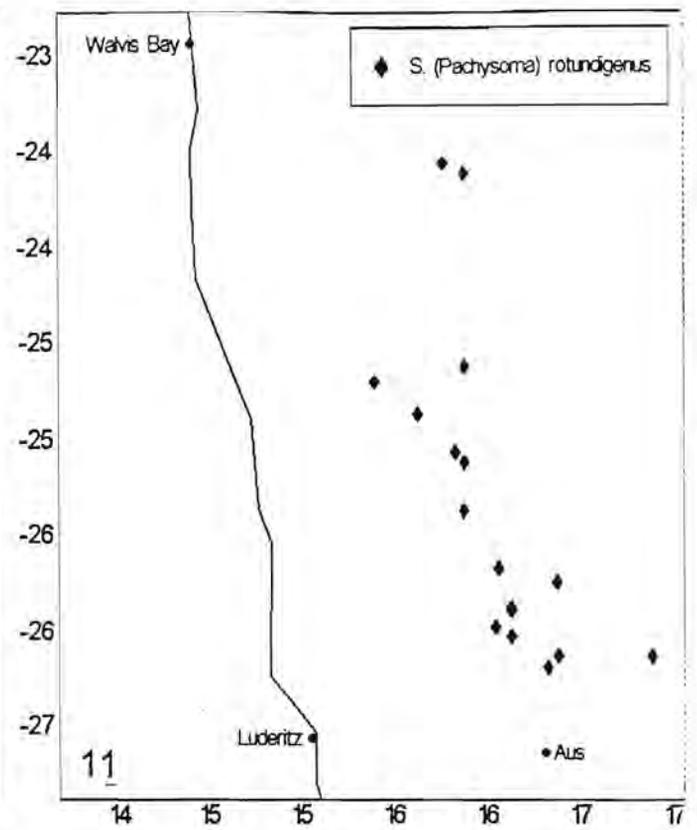
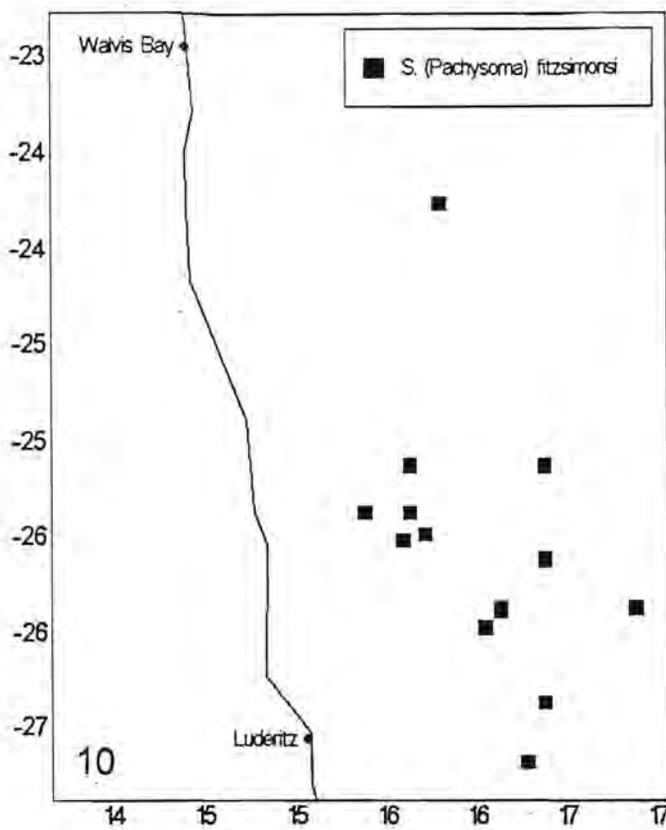
*Distribution, habitat and conservation.* *S. (P.) valeflorae* occurs at the boundary between the Desert and Succulent Karoo Biome on the coastal plain (figure 9), (Rutherford and Westfall 1994). It is probably restricted to the sand dunes between Elizabeth Bay and Grasplatz (see figure 4 in Endrödy-Younga 1986). Its conservation status is unknown.

*Comments on locality data.* Refer to *S. (P.) schinzi* for a discussion on the Gaerdes Tinkasfläche locality.

*Morphological variation.* The holotype is the largest specimen among the limited material examined. *S. (P.) valeflorae* is smaller and slighter than *S. (P.) schinzi*. Sizes of the male clypeal horns differ slightly in the five males examined, but the diagnostic shape is consistent.

*Biology.* Biology unknown.

*Comments.* Ferreira (1953a) based her description of *Pachysoma valeflorae* on the male holotype. Holm and Scholtz (1979) examined two male specimens of *S. (P.) valeflorae* from Haalenberg and Rotkop. The third male specimen, labelled Tinkasfläche, which Holm and Scholtz (1979) attributed to *S. (P.) valeflorae* represents a confusing locality record (see comments on locality data for *S. (P.) schinzi* above), but can now be placed close to Aus at Tiras Plains (26°07'S 16°37'E). Based on the available material, Holm and Scholtz (1979) synonymised *S. (P.) valeflorae* with *S. (P.) schinzi* stating that, with material from Rotkopf and Tinkasfläche now available, *S. (P.) valeflorae* is obviously the western extreme of a cline. A very limited amount of new material, (i.e. the first known female and three males) conform with typical *S. (P.) valeflorae*. *S. (P.) valeflorae* can be distinguishing from *S. (P.) schinzi* by the following characters: (1) the shape and size of the clypeus, anterior edges of genae produced into distinct points (figures 26a,b); (2) males, equal spacing between the second and third



FIGS. 10-13. Distribution of *Scarabaeus (Pachysoma)* species in Namibia. Questioned locality records or range extensions are shown by an open circle. (10) *S. (P.) fitzsimonsi*; (11) *S. (P.) rotundigenus*; (12) *S. (P.) rodriguesi*; (13) *S. (P.) denticollis*.

protibial teeth (figure 44b); (3) no serrations between or proximal to the protibial teeth (figures 44a,b); (4) a localized coastal distribution (figure 9); (5) small body size (the holotype is the largest specimen available); (6) smooth elytra; (7) and stouter, shorter aedeagi (figures 65a,b,c).

The final word on the status of *S. (P.) valeflorae* will only be possible when material from near Tsaukaib and Garub is collected (that is if *S. (P.) valeflorae* occurs at these sites?). This area is either the transition zone between the two species, or an ecological barrier of unsuitable or very marginal habitats. *S. (P.) valeflorae* is very close to *S. (P.) schinzi*, and potentially could be considered a subspecies of *S. (P.) schinzi*. This was obviously evident to Ferreira who considered the name *Pachysoma similis* (unpublished) before choosing *Pachysoma valeflorae* instead. Based on the limited available material, I find no evidence for a clinal gradation in morphology between *S. (P.) valeflorae* and *S. (P.) schinzi* and subsequently reinstate *S. (P.) valeflorae* to specific level.

*Types.* *Pachysoma valeflorae* was described from a single male specimen, currently in the TMSA collection. Koch and van Son collected the holotype on the 23.ix.1950, but a few days previously (17.ix.1950) they had collected the 158 *S. (P.) schinzi* from Aus.

*Type material examined* (1♂ diss.). **NAMIBIA:** HOLOTYPE ♂, *Pachysoma valeflorae* Ferreira: 10m W of Haalenberg, (26.37.05S 15.22.05E), Gt. Namaqualand, 23.ix.1950, Koch & van Son / Holotypus ♂, *Pachysoma similis* (sic) det.M.C. Ferreira, 1951 / Holotypus, *Pachysoma valeflorae* sp.n. M.C.Ferreira (Endrödy-Younga label), (1♂ TMSA).

*Additional material examined* (Σ5 specs. [1], 1♀ 4♂, 3♂ diss.). **NAMIBIA: Diamond Area 1**, 26.51S 15.40E, 11.viii.1983, J.Irish, H56792, (1♀ SMWN); **Rotkop**, (26.43S 15.23E), 10.x.1995, C.R.Owen (2♂ SMWN), (1♂ TMSA); Rotkop, 22mls E of Lüderitz, (26.37.05S 15.22.05E), 22.xi.1929 / S.W.Africa, R.E.Turner, Brit. Mus. 1930-113, (damaged teneral), (1♂ BMNH).

### ***Scarabaeus (Pachysoma) fitzsimonsi* (Ferreira, 1953)**

(Figures 10, 27, 45, 66)

*Pachysoma fitzsimonsi* Ferreira, 1953a: 20; Ferreira 1961: 22; Ferreira 1966: 58; Ferreira 1969: 21; Holm and Scholtz 1979: 234. Holotype: Namtib, Namibia (1♂ TMSA).

*Scarabaeus fitzsimonsi* (Ferreira): Mostert and Holm, 1982: 275.

*Diagnosis.* Clypeus quadridentate, outer clypeal teeth reduced in size (figure 27); protibia hardly dimorphic with simple protibial spurs (figure 45); sub-elytral ridge usually present but faint; inner metatarsal claws slightly shorter than outer metatarsal claw; metatarsal claws shorter than last tarsal segment; male genitalia in figures 66a,b.

*Distribution, habitat and conservation.* This species occurs east of the central dune area (figure 10), on the sandy flats of the pro-Namib (Holm and Scholtz 1979). *S. (P.) fitzsimonsi* occurs within the Namib-Naukluft Park.

*Comments on locality data.* The single record from the far east of the Namib Desert (23°53'S 16°07'E), is a considerable range extension northwards for the distribution of *S. fitzsimonsi*. Suspicion of a new species was unconfirmed as the single male matches *S. (P.) fitzsimonsi* in all aspects, including the faint sub-elytral ridge and genitalia typical of the species. This locality record requires confirmation.

*Morphological variation.* Two females, one each from Haibvlakte and Numabis Pan have no sub-elytral ridge, a character used by Holm and Scholtz (1979) to separate *S. rotundigenus* from *S. (P.) fitzsimonsi*. A male from Haibvlakte does, however, have a sub-elytral ridge and genitalia typical of *S. fitzsimonsi*. This suggests, possible dimorphism in expression of the sub-elytral ridge, but no other *S. (P.) fitzsimonsi* females examined confirm this possibility.

*Biology.* The biology of *S. (P.) fitzsimonsi* is unknown. However, based on the hind leg morphology their foraging behaviour and food choice should not differ from that of *S. (P.) rodriguesi* (dung pellets) or *S. (P.) denticollis* (dung pellets and detritus). The short metatarsal claws of *S. (P.) fitzsimonsi* suggest pellet feeding rather than detritus feeding and adaptation to a firm substrate rather than soft dune sand (see Koch 1961, 1962a,b, 1969, Lawrence 1969, Newlands 1972, Endrödy-Younga 1982a, and Henschel 1997 for evidence of this morphological change in other taxa). *S. (P.) fitzsimonsi* is thus probably predominately a dry pellet feeder. Evidence to support this claim comes from Davis (pers. comm.) who recalls finding sheep pellets in the burrows when he excavated the Weissenborn specimens. The larvae are unknown.

*Comments.* Easily confused with *S. (P.) rotundigenus* but *S. (P.) fitzsimonsi* is distinguished by having simple protibia in both sexes, short metatarsal claws, and apical insertion of the mesotarsi and metatarsi on the tibia. The sub-elytral ridge in *S. fitzsimonsi* cannot be used as the only character to distinguish between these two species (see morphological variation).

*Types.* All the types are in the TMSA collection. The holotype and allotype have no date on their locality label, but the paratypes are dated 17.ix.1950.

*Type material examined* ( $\Sigma 4$  specs. [4], 2♀ 2♂, 2♂diss.). **NAMIBIA:** HOLOTYPE ♂, *Pachysoma fitzsimonsi* Ferreira: Namtib, 70m NW of Aus, (ca. 25.52.05S 16.52.05E), Gt. Namaqualand, (no date), C.Koch, G.van Son / Holotipo *Pachysoma FitzSimonsi*, ♂, M.C.Ferreira, 1951 (written by Ferreira in red ink on white card, surrounded by a black rectangular border) / Holotypus *Pachysoma fitzsimonsi*, M.C.Ferreira sp.n. (written by Endrödy-Younga onto TMSA Ferreira label), (aedeagus and pygidium on a separate pin), (1♂ TMSA); *idem*, but /Alotipo *Pachysoma FitzSimonsi*, ♀, M.C.Ferreira, 1951 / Allolotypus *Pachysoma fitzsimonsi*, M.C.Ferreira sp.n., (1♀ TMSA). PARATYPES: Aus, Gt. Namaqualand, (26.41S 16.16E), 17.ix.1950, C.Koch, G.van Son / Para-Tipo *Pachysoma FitzSimonsi*, M.C.Ferreira, (1♀ 1♂ TMSA).

*Additional material examined* ( $\Sigma$ 26 specs. [29], 11♀ 15♂, 5♂ diss.). **NAMIBIA: Aus**, 30km N to **Helmeringhausen**, SE2616Ad, (ca. 26.22.05S 16.22.05E), 7.x.1979, E. Holm & C.H. Scholtz, (1♀ UPSA); **Haibvlakte**, 25.29S 15.42E, Diamond Area 2, 5-6.iv.1986, J.Irish, H65260, (1♀ 1♂ SMWN); **Kanaän 104**, SE2516Cc, (ca. 25.52.05S 16.07.05E), Lüderitz, 22-27.vi.1976, S.Louw, M-L. Penrith, H32992, plains, grass & dunes, (3♀ 4♂ SMWN), (1♀ TMSA); Kanaän 104, 25.53S 16.07E, Lüderitz, 15-21.x.1976, S.Louw, M-L. Penrith, H33338, (2♀ 1♂ SMWN); Farm **Namtib**, 112km NW Aus via Farm Neisip, (ca. 25.52.05S 16.07.05E), 5.ii.1974, Davis & Kirsten, DRU1413, (1♀ 1♂ SANC); Namtib Dunes, 25.58S 16.02E, 2.viii.1981, E-Y:1818, night, veget. dunes, Endrödy-Younga, (1♀ TMSA); **Numabis Pan**, 25.31S 15.35E, Diamond Area 2, 7.iv.1986, J.Irish, H65359 (1♀ SMWN); **Uri Hauchab**, (ca. 25.22.05S 15.22.05E), 4.vii.1976, (1♂ UPSA); Farm **Weissenborn**, SWA, 100km NW Aus via Farm Neisip, (ca. 25.07.05S 16.22.05E), 5.ii.1974, Davis & Kirsten, DRU1411, (2♂ UPSA), (3♂ SANC), (1♂ SAMC).

Additional localities listed in Holm and Scholtz (1979): **Awasi Dunes E**, (ca. 25.07.05S 15.37.05E), Lüderitz, 29-30.i.1974, (SMWN); **N-Awasib**, (ca. 25.22.05S 15.37.05E), 4.vii.1976, Dept. Entomology, Univ. Pretoria (UPSA); **Farm Spesbona**, 184 km N Aus via Farm Neisip, (ca. 25.37.05S 16.22.05E), 5.xi.1974, Davis & Kirsten, (SANC).

A single specimen from the following locality may be incorrectly labelled because it occurs outside the species' established range. **NAMIBIA: Namib Desert**, far east, 23.46S 15.47E, Praetorius, 9.ii.1981, 10h30, 1DV, south breeze, high fog, C5477, (1♂ SMWN).

### ***Scarabaeus (Pachysoma) rotundigenus*** (Felsche, 1907)

(Figures 11, 28, 46, 67)

*Pachysoma rotundigena* Felsche, 1907: 273; Péringuey 1908: 555; Gillet 1911a: 6; Holm and Scholtz 1979: 236. [Holotype]: Sinclair, S.W.A. [1x SMTD].

*Neopachysoma rotundigena* (Felsche): Ferreira, 1953a: 43; Ferreira 1961: 25; Ferreira 1966: 60; Ferreira 1969: 25; Zunino 1977: 15.

*Scarabaeus rotundigenus* (Felsche): Mostert and Holm, 1982: 275.

*Diagnosis.* Clypeus quadridentate, outer clypeal teeth reduced in size; genae rounded and finely serrated (figure 29); protibia dimorphic, protibial spurs bifid in both sexes (figure 46); elytra smooth and shiny with no sub-elytral ridge; tarsal insertion sub-apical; metatarsal claws longer than last two tarsal segments; male genitalia as in figures 67a,b.

*Distribution, habitat and conservation.* This species occurs in the vegetated marginal inland dunes of the southern Namib dune area (Holm and Scholtz 1979), (figure 11). The very long tarsal claws and enlarged tibial setal brushes suggest *S. (P.) rotundigenus* is adapted to soft dune sand. Conserved within the Namib-Naukluft Park.

*Comments on locality data.* The three specimens from the SE corner of the Namib-Naukluft Park extend the known distribution for *S. (P.) rotundigenus* northwards (figure 11). Collected independently these specimens probably reflect real occurrence rather than

incorrectly labelled specimens. The most northerly record of *S. (P.) fitzsimonsi* is from near this locality. As *S. (P.) fitzsimonsi* and *S. (P.) rotundigenus* occur close to one another in the south, these overlapping range extensions corroborate these new records.

*Morphological variation.* The three (2♀ 1♂) most northerly specimens (SE of Namib-Naukluft Park) match in all morphological attributes, including male genitalia to that of *S. (P.) rotundigenus*.

*Biology.* Biology unknown. However, they occur in vegetated dunes where detritus readily accumulates around the base of plants. This habitat and their long metatarsal claws suggest a detritus feeding diet. The larvae are unknown.

*Comments.* Easily confused with *S. (P.) fitzsimonsi*, but differentiated by the absence of a sub-elytral ridge, sub-apical insertion of the tarsi on the tibia, and long metatarsal claws.

*Types.* A body length of 26 mm is given by Felsche (1907) in the description of *Pachysoma rotundigena*, suggesting that he only examined one specimen. However, two collections (Collection Felsche and Collection Bennigsen, Berlin) are listed as having material, suggesting more than one specimen was examined (Felsche 1907).

*Type material* (>?2 spec.). **NAMIBIA:** [HOLOTYPE], **Sinclair**, (25.44S 16.22E), D.S.W. Afrika, [1x SMTD].

*Additional material examined* ( $\Sigma$ 50 specs. [33], 19♀ 31♂, 4♂diss.). **NAMIBIA:** Namib plain, 70mls N **Aus**, (ambiguous), 1.v.1972, L.& O. Prozesky, (1♂ TMSA); E **Awasi**, SE2515Bb1, (ca. 25.03.53S 15.48.53E), 11.vii.1976, UP, (1♀ UPSA), (1♀ SAMC); **Excelsior 59**, Lüderitz, SE2616Ab, (ca. 26.07.05S 16.22.05E), 1-4.vii.1979, S.Louw, M-L. Penrith, H39170, (1♀ 2♂ SMWN); SW of **Helmeringhausen**, SE2616Ab3, (ca. 26.10.58S 16.18.53E), vii.1978, E.Holm, (1♀ 1♂ UPSA), (2♀ 3♂ SANC); **Kanaän**, SE2516Cc, (25.52.05S 16.07.05E), 19-20.i.1985, UP Ent. Dept., (2♂ UPSA); Kanaän 104, 25.53S 16.07E, Lüderitz, 15-21.x.1976, S.Louw, M-L. Penrith, H33338, (1♀ SMWN); Kanaän 104, SE2516Cc, (ca. 25.53S 16.07E), Lüderitz, 25.iv.-2.v.1977, M-L. Penrith, S.Louw, H34749, (4♂ SMWN), (1♂ UPSA); Kanaän 104, SE2516Cc, (ca. 25.53S 16.07E), Lüderitz, 22-27.vi.1976, S.Louw, M-L. Penrith, H32992, (2♀ 9♂ SMWN); Farm Kanaän, 25.53S 16.07E, 7.v.1977, E-Y:1323, hand-collected on dunes, S.Mothlasedi, (1♀ 2♂ TMSA); **Namtib Dunes**, 25.58S 16.02E, 8.viii.1989, E-Y:2640, dunes, day, Endrödy & Klimaszew., (1♂ TMSA); Namtib Dunes, 25.58S 16.02E, 2.viii.1981, E-Y:1817, sandflat, day, Endrödy-Younga, (1♀ TMSA); Namtib, 70mls NW of Aus, SE2516Cc, (ca. 25.52.05S 16.07.05E), Gt. Namaqualand, C.Koch, G. van Son, (2♀ TMSA); **Sossusvlei**, (24.42S 15.23E), x.1965, W.D.Haacke, (1♀ UPSA), (1♂ TMSA); Sossusvlei, (24.42S 15.23E), 7.iv.1996, D.Wellmann, 2nd Yr. Coll., (1♀ UPSA); **Tiras Dunes**, 26.01S 16.07E, Lüderitz District, 8.iv.1986, J.Irish, (1♀ SMWN); Farm **Vergenoeg**, 25.40S 16.03E, 28.iii.1986, E.Holm & E.Marais, (1♀ 2♂ UPSA); **Wolwedans 144**, Maltahöhe Distr., SE2515Bb, (ca. 25.07.05S 15.52.05E), i.1990, Z.Cooper, (1♂ SMWN).

Additional localities listed in Holm and Scholtz (1979); **Gorrasis 99**, Lüderitz, SE2515Bd, (ca. 25.22.05S 15.52.05E), 25-31.i.1974, (SMWN); **Kanaän 104**, Lüderitz, SE2516Cc, (ca. 25.53S 16.07E), 6-7.x.1972, (SMWN); **Koichab East**, SE2616Bb, (ca. 26.07.05S 16.52.05E), vii.1978, Dept.Ento. (UPSA); **Sesriem 137**, Maltahöhe, SE2415Dc, (ca. 24.52.05S 15.37.05E), 5-6.IV.1972, (SMWN); Sesriem Dunes, SE2415Db, (ca. 24.37.05S 15.52.05E), 5.v.1972, I.O.Prozesky, (TMSA).

Specimens from the following localities may be incorrectly labelled because they are outside the species' established range: NAMIBIA; SE corner of Namib Desert Park, nr. **Knamhoek Farm**, SE2315Db, (ca. 23.37.05S 15.52.05E), 860m, 15.ii.1974, L.Lyneborg, vegetated, moving dunes / Zool. Museum DK Copenhagen / (1♀ UPSA); **Namib Park**, SE corner, 23.34S 15.45E, 26.xi.1974, E-Y:496b, groundtraps for 105 days, with ferm. banana bait, Endrödy-Younga, (1♀ 1♂ TMSA).

***Scarabaeus (Pachysoma) rodriguessi*** (Ferreira, 1953)

(Figures 12, 29, 47, 68)

*Neopachysoma rodriguessi* Ferreira, 1953a: 44; Ferreira 1961: 25; Ferreira 1966: 60; Ferreira 1969: 25; Zunino 1977: 15. Holotype: Namtib, Namibia (1♂ TMSA).

*Pachysoma rodriguessi* (Ferreira): Holm and Scholtz 1979: 237.

*Scarabaeus rodriguessi* (Ferreira): Mostert and Holm 1982: 275.

*Diagnosis.* Head with prominent tubercle on frons (figure 29); protibia sexually dimorphic, spurs strongly bifid (figures 47a,b); posterior pronotal margins with sharp points on either side; large, shiny and reddish black in colour; metatarsal claws long; male genitalia illustrated in figures 68a,b.

*Distribution, habitat and conservation.* Restricted to the central Namib dune area (figure 12). Their morphology reflects adaptation to ultrapsammophilous conditions of the central dune sea. *S. (P.) rodriguessi* is contained within the Namib-Naukluft Park.

*Comments on locality data.* Holm and Scholtz (1979) mentioned the curious record along the Buffels River. They noted that the single female collected, did not differ significantly from the northern population, except in having the tubercle on the frons reduced. The size of the tubercle on the frons varies within and between sexes from the same population and thus does not constitute a population specific character. Recent extensive field work along the Buffels River yielded no *S. (P.) rodriguessi* and confirms the suspicion by Holm and Scholtz (1979) that this specimen is incorrectly labelled.

*Morphological variation.* The size of the protuberance on the frons varies in both the 13 females and in the 11 males in the material of *S. (P.) rodriguessi* from 20 miles south of Gobabeb.

*Biology.* Holm (1970) and Holm and Scholtz (1979), give detailed accounts of the biology of *S. (P.) rodriguessi*. To summarize, the species collects *Oryx* and hare pellets that are

dragged forward to their preconstructed burrows, but no use of detritus is mentioned. *S. (P.) rodriguessi* has been observed mating above ground in the afternoon (Holm and Scholtz 1979). The larvae are unknown.

*Comments.* *S. (P.) rodriguessi* is an unmistakable large central Namib species, with only very large specimens of *S. (P.) hippocrates* and *S. (P.) glentoni* matching it in size.

*Types.* Ferreira (1953a) described *Pachysoma rodriguessi* from five specimens, four of which she deposited in the TMSA collection and one paratype in the CPMM collection. All the types are currently in the TMSA collection. The date is omitted from the printed locality labels, while the holotype has a separate label with the date (26.ix.1953) on it. Ferreira (1953a) records the date of collection of the type series as the 26.ix.1950. Considering the description of *P. rodriguessi* was published in 1953, I suspect the date of collection was the 26.ix.1950, rather than 26.ix.1953 as recorded on the holotype.

*Type material examined* ( $\Sigma$ 5 specs. [5], 1♀ 4♂, 3♂diss.). **NAMIBIA:** HOLOTYPE ♂, *Neopachysoma rodriguessi* Ferreira: Namtib, 70m NW of Aus, (ca. 25.58S 16.02E), Gt. Namaquald., C.Koch, G.van Son / 26.ix.1953 (written in pencil on faded white paper) / Holotipo *Neopachysoma Rodriguessi* M.Cornita Ferreira, 1950 (written in red ink on white card, with a black border around the label) / Holotypus *Neopachysoma rodriguessi* M.C.Ferreira sp.n. (written by Endrödy-Younga on TMSA Ferreira label), (1♂ TMSA); (aedeagus of the holotype is point mounted on a separate pin, but labelled *idem*); ALLOTYPE ♀, *idem*, but Alotipo (sic) *Neopachysoma Rodriguessi* M.Cornita Ferreira, 1950 (written in red ink on white card, with a black border around the label) / Allotypus *Neopachysoma rodriguessi* M.C.Ferreira sp.n. (written by Endrödy-Younga on TMSA Ferreira label), (1♀ TMSA). PARATYPES: *idem*, but Paratipo (sic) *Neopachysoma Rodriguessi* M.Cornita Ferreira, 1950 (written in red ink on white card, with a black border around the label) / Paratypus *Neopachysoma rodriguessi* M.C.Ferreira sp.n. (written by Endrödy-Younga on TMSA Ferreira label), (3♂ TMSA).

*Additional material examined* ( $\Sigma$ 93 specs. [37], 44♀ 49♂, 3♂diss). **NAMIBIA:** **Aus**, 46km NW, (ca. 26.11S 15.37E), 18.ix.1996, C.R.Owen, (2♂ COCS), (1♂ TMSA); **E. Awasib**, SE2515Bb1, (25.03.53S 15.48.53E), 11.vii.1976, U.P., (1♂ UPSA), (1♂ SANC); **N. Awasib**, 2515Bc3, (25.25.58S 15.33.53E), 4.vii.1976, UP, (1♂ UPSA), (1♂ SANC); **Awasib Sand Dunes**, (25.25.58S 15.33.53E), southern Namib, 15.v.1969, H.D.Brown, (3♀ SANC), *idem*, but NMBH3684, (1♂ BMSA); **Blueberg**, 2km E, 26.07S 14.58E, 18.i.1974, E-Y:297, on and between dunes day, Endrödy-Younga, (2♂ TMSA); **Diamond Area 2**, 25.28S 15.24E, 23.v.1983, J.Irish, H57740, (1♂ SMWN); **St. Francis Bay**, SE2514Bb1, (25.03.53S 14.48.53S), 8.vii.1976, UP, (1♀ SANC); **Guinasibberg**, SE2515Ab, (25.07.05S 15.22.05E), 17.i.1985, UP, (1♀ UPSA); **W. Guinasibberg**, SE2515Ad2, (25.18.53S 15.25.58E), 6.vii.1976, UP, (1p UPSA); **Gobabeb**, 10mls S of, (ca. 23.42S 15.02E), iii.1968, E.Holm, (3♀ 2♂ TMSA); **Gobabeb**, 20mls S of, (ca. 23.49S 15.02E), vi.1967, E.Holm, (13♀ 11♂ TMSA); **Gobabeb**, (23.34S 15.03E), ii.1977, R.Tilson, (1♂ SMWN); **S. Gobabeb**, SE2315Ca3, (23.40.58S 15.03.53E), 14.vii.1976,

UP, (1♂ UPSA); Gobabeb, 23.34S 15.03E, 22.viii.1982, E-Y:1919, hand-collected, dune valley, day, Endrödy-Younga, (1♂ TMSA); nr. **Harus**, (25.23S 15.10E), southern Namib, 10.v.1969, H.D.Brown, (1♀ TMSA); nr. **Harus Mts**, (25.23S 15.10E), southern Namib, 9.v.1969, H.D.Brown, NMBH3683, (1♂ BMSA); SW of **Helmeringhausen**, SE2616Ab3, (26.10.58S 16.18.53E), vii.1978, E.Holm, (2p UPSA); Farm **Kanaan**, 25.53S 16.07E, 7.v.1977, E-Y:1323, hand-collected on dunes, S.Mothlasedi, (1♂ TMSA); **Koichab**, SE2615Bc1, (26.18.53S 15.33.53E), vii.1982, E.Holm, (2♂ UPSA); **Koichab**, SE2615Bb4, (26.10.58S 15.55.58E), vii.1982, E.Holm, (1♀ UPSA); **Koichab Pan**, (26.18S 15.36E), vii.1978, E.Holm, (2♂ UPSA); Namib Desert, SWA, (2♀ 1♂ TMSA); **Namib-Expedition**, SE2315Cc3, (23.55.58S 15.03.53E), i.1977, Holm, Kirsten & Scholtz, (1♀ UPSA); **Namib-Expedition**, SE2515Aa4, (25.10.58S 15.10.58E), i.1977, Holm, Kirsten & Scholtz, (1♀ SANC); **Namib-Expedition**, SE2515Ac4, (25.25.58S 15.10.58E), i.1977, Holm, Kirsten & Scholtz, (1♀ SANC); **Namib-Expedition**, SE2515Cd2, (25.48.53S 15.25.58E), i.1977, Holm, Kirsten & Scholtz, (1♀ SANC); **Namtib Dunes**, 35mls E, Neisip, (ca. 26.13S 15.59E), Aus Dist., 1.v.1972, L. & O.Prozesky, (2♂ TMSA); **Namtib Dunes**, 25.58S 16.02E, 8.viii.1989, E-Y:2640, dunes, day, Endrödy-Younga, (1♀ TMSA); **Namtib Dunes**, 25.58S 16.02E, 2.viii.1981, E-Y:1817, sand flat, day, Endrödy-Younga, (1♂ TMSA); **Natab**, 10mls E, (ca. 23.36S 16.16E), Central Namib, 28.iv.1969, H.D.Brown, (3♂ TMSA); **Natab**, 15mls E, (ca. 23.36S 14.51E), Central Namib, 28.iv.1969, H.D.Brown, (1♀ TMSA); **Natab**, 23.36S 15.03E, 6.xi.1976, W.J.Hamilton, C1221, (1♀ SMWN); **Sossusvlei**, (24.42S 15.23E), x.1965, W.D.Haacke, (1♀ TMSA); **Tsondab**, SE2415Ba1, (24.03.53S 15.33.53E), 11.vii.1975, // day, dune foot // (1♀ UPSA); **NE Tsondab Plains**, SE2315Cc2, (23.48.53S 15.10.58E), 15.vii.1976, UP, (1♀ UPSA), (3♀ SANC); **SE Tsondab Plains**, SE2315Cc4, (23.55.58S 15.10.58E), 15.vii.1976, UP, (1♂ UPSA), (2♂ SANC), (1♂ SAMC); **Tsondab Plains**, N fringe, 15mls S of **Natab**, (ca. 23.42S 15.17E), 20.iv.1969, M.Pond, (2♀ 2♂ SMWN), *idem*, but 10:00-17:30, (1♀ SMWN), *idem*, but C2896, (1♂ SMWN); **Tsondab Vlei**, 23.59S 15.26E, 13.i.1975, E-Y:542B, ground baited faeces traps, 1 day, Endrödy-Younga, (1♀ TMSA); **N Uri-Hauchab**, SE2515Ac3, (25.25.58S 15.03.53E), 6.vii.1972, UP, (1♀ UPSA); **Ururas**, 90km SSE, SE2414Bb, (24.07.05S 14.52.05E), 14.x.1979, Holm & Scholtz, (1♂ UPSA); SE2615Ab2, (26.03.53S 15.25.58E), 8.vii.1980, UP, (1♂ UPSA).

Additional locality data from Holm and Scholtz (1979); **Awasi**, 9km W, SE2515Ad, (ca. 25.22.05S 15.22.05E), 8.vi.1969, (SMWN); Dunes nr. **Harus**, SE2515Ac, (ca. 25.22.05S 15.07.05E), Lüderitz, 9.v.1969, (SMWN); **Harusberg**, SE2515Ac, (ca. 25.22.05S 15.07.05E), v.1969, (SMWN); **Homeb** 10mls ESE Gobabeb, SE2315Cb, (ca. 23.37.05S 15.22.05E), 23-25.i.1972, (BMNH); **Koichab Pan**, SE2615Bc, (ca. 26.22.05S 15.37.05E), 20.i.1966, (SMWN); **Koichab West**, SE2615Bc, (ca. 26.22.05S 15.37.05E), vii.1978, E.Holm, (UPSA); **Lüderitz**, SE2514Bb, (ca. 25.07.05S 14.52.05E), 17.ix.1971, (SMWN); **Sossusvlei**, Lüderitz, SE2413Cb, (ca. 24.37.05S 13.22.05E), 6.iv.1974, W. Wendt, H. Roth, (SMWN); **N Tsondab Plains**, SE2315Cc1, (ca. 23.48.53S 15.03.53E), 14.vii.1976, (UPSA).

A single specimen from the following locality may be incorrectly labelled because it is outside the species' established range: SOUTH AFRICA; Northern Cape, Namaqualand;

Buffelsriver Valley, 29.35S 17.14E, 31.viii.1976, E-Y:1197B, groundtraps for 33 days, Endrödy-Younga, (1♀ TMSA).

***Scarabaeus (Pachysoma) denticollis* (Péringuey, 1888)**

(Figures 13, 30, 48, 69)

*Pachysoma denticolle* Péringuey, 1888: 93; Péringuey, 1902: 77; Gillet, 1911a: 6; Holm and Scholtz, 1979: 239. Lectotype: Walfish Bay, Namibia (1♂ SAMC).

*Neopachysoma denticolle* (Ferreira), 1953a: 37; Ferreira 1961: 25; Ferreira, 1966: 60; Ferreira, 1969: 25; Zunino, 1977: 15; Holm and Scholtz, 1979: 239; Mostert and Holm, 1982: 277.

*Neopachysoma penrithae* Zunino, 1977: 15; Holm and Scholtz, 1979: 239. Holotype: Lüderitz, Namibia (1♀ SMWN).

*Scarabaeus denticollis penrithae* (Zunino): Mostert and Holm, 1982: 277.

**Diagnosis.** Clypeus quadridentate, outer clypeal teeth smaller than medial teeth; genae finely serrated (figure 30); protibia sexually dimorphic, protibial spurs bifid in males simple in females (figures 48a,b); elytra orange to black, deeply striate, striae smooth to granular; metatarsal claw longer than last tarsal segment; male genitalia as in figures 69a,b.

**Distribution, habitat and conservation.** Restricted to the coastal and inland dunes of the central Namib (figure 13), and conserved within the Namib-Naukluft Park. Holm (1970) suggests they prefer semi-stable sand and dune streets.

**Comments on locality data.** The Mata Mata locality (Kalahari Gemsbok National Park), is without doubt due to a labelling error. The Kuibis record also occurs out of the established distribution range for *S. (P.) denticollis*.

**Morphological variation.** Refer to comments on *S. (P.) denticollis penrithae*.

**Biology.** *S. (P.) denticollis* feeds mainly on hare and *Oryx* dung which are dragged as single pellets to their preconstructed burrows. They are also reported to collect dead insects, mice and chameleon droppings and vegetable matter (grass blades, *Monsonia* sp. leaves etc.) (Holm 1970, Holm and Scholtz 1979). Here the forage is picked up with the hind legs and held against the underside of the abdomen (Holm and Scholtz 1979), while the beetle runs on the front four legs.

**Comments.** Zunino's (1977) description of *Neopachysoma penrithae* is based on two females from the southern Namib. Holm and Scholtz (1979) noted it was difficult to evaluate the characters proposed by Zunino due to the lack of material, but suggested three possibilities to account for the morphological differences: (1) the southern extreme of a cline; (2) a subspecies; (3) hybrids between *S. (P.) denticollis* and *S. (P.) bennigseni*. They however choose to synonymise *S. penrithae* with *S. (P.) denticollis*. Having examined 22 additional specimens of *S. penrithae*, from three localities, Mostert and Holm (1982) concluded it had become 'fairly certain that *S. penrithae* Zunino is a subspecies of *denticolle* Péringuey, with a very limited distribution (parapatric with the typical form) in the triangle between Kolmanskop, Lüderitzbucht

and Spencer Bay' (see figure 4d). Mostert and Holm (1982) also mention that 'specimens collected on scattered dunes between Kolmanskop and Koichab pan were clearly intermediate between *penrithae* and *denticolle* in all the diagnostic characters given by Zunino (1977)'. This suggests a cline rather than a distinct subspecies. Unfortunately, Mostert and Holm (1982) did not examine any black specimens from the north of *S. (P.) denticollis* distribution (Walvis Bay), nor was *S. (P.) denticollis penrithae* included in their key.

Zunino (1977) used the following differences to separate *S. (P.) denticollis* from *S. penrithae*: (1) shape of the median clypeal teeth, (2) elytral sculpture; (3) colouration of elytra; (4) size of the epipleura and pseudo-epipleura.

To assess the validity of retaining *S. (P.) denticollis penrithae* as a subspecies these characters were investigated in the 211 available specimens. The following was found: there is no consistent significant difference in the size or shape of the median clypeal teeth between the northern and southern populations of *S. (P.) denticollis*, the holotype of *S. penrithae* represents an individual where the outer two clypeal teeth are deflexed outwardly more than usual in southern specimens; granular elytral interstriae define the southern population more reliably than elytral colour. However, although most series of *S. (P.) denticollis penrithae* exhibit this character, it is variably expressed within and between the southern populations. For example, in the seven individuals from SE2615Ad4 (26°26'S 15°26'E), elytral sculpture varies in expression and is not as marked as in the six individuals from 30km N of Lüderitz (26°22'S 15°07'E); both the northern (Walvis Bay at 22°58'S 14°30'E) and southern populations (Lüderitz at 26°36'S 15°10'E) of *S. (P.) denticollis* have elytras that range in colour from completely black to a dark orange. The presence of black *S. (P.) denticollis* at both ends of the species distribution, but absent in the centre of its range has not been reported previously (see Holm and Kirsten 1979). Specimens with one black and one orange elytron further substantiate the variability of elytral colour. The disjunct occurrence of individuals with black elytra indicates that its use as a diagnostic character has no standing and should be avoided. Zunino (1977) however, used the black elytra of *S. penrithae* as a diagnostic feature for the species; the epipleura and pseudo-epipleura are broader in the southern populations, but do not constitute grounds for erecting a subspecies. The large female holotype has particularly wide elytra, and consequently large epipleura and pseudo-epipleura; while no substantial difference was found in the male genitalia between the northern and southern samples examined.

To retain *S. (P.) denticollis penrithae* as a subspecies would necessitate the description of two additional subspecies to account for the central Namib and northern Namib populations. *S. penrithae* represents the southern morphological variation within *S. (P.) denticollis*, which is no greater than that expressed in the central (small, always orange) and northern (medium sized, black to orange with smooth interstriae) populations. *S. (P.) denticollis penrithae* is thus regarded as synonymous with *S. (P.) denticollis*.

*Types.* Péringuey's (1888) description of *Pachysoma denticolle* gives no range for size, and mentions a single locality (Walvis Bay) and collector (Mr P. Nightingale), which suggests he probably based his description on a single specimen (see Péringuey's description of

*Pachysoma marginatum* under *S. (P.) striatus* above for the opposite situation). However, Péringuey's type label is on a male labelled 'Ganab C.Wilmer', while the Walfish specimen lacks a type label. This situation led Holm and Scholtz (1979) to designate the Walfish specimen as lectotype, although the Ganab specimen bears the type label.

Péringuey is renowned for inconsistently or not labelling type specimens (see Cochrane 1995 for a discussion). Reexamination of all available evidence suggests that the lectotype (Walfish) designated by Holm and Scholtz (1979) is in fact the original holotype. Evidence for this includes the following: (1) of all potential type material examined, only the Walfish specimen is dated [Dec. (18)85] before the publication date (1888) of the species. The Ganab specimen bearing the type labels is dated 2.(18)89, which excludes it as a possible type; (2) Péringuey (1902) includes four diagrams (plate 7, figures 31-34) of *Pachysoma* aedeagi. *P. denticolle*, *P. marginatum*, *P. hippocrates* and *P. aesculapius* are illustrated, which comprise the only illustrations in Péringuey's papers (1888, 1902, 1908) of *Pachysoma* genitalia. The only dissected *Pachysoma* aedeagi attributable to Péringuey in the SAMC collection (Péringuey Collection) includes only the above four species all labelled in his handwriting. These separately mounted genitalia were probably used for the above illustrations, but can they be matched to specimens?; (3) the potential type specimens include one male from Walfish Bay (1♂) and a pair from Ganab (1♂ 1♀). The only specimen previously dissected and lacking its genitalia is the Walfish Bay specimen (lectotype). Thus, the aedeagus labelled *P. denticolle* by Péringuey is probably from this Walfish specimen; (4) Péringuey (1902) in his 'Catalogue of the Coleoptera of South Africa' provides a new description for *P. denticolle* (the 1888 and 1902 descriptions are strikingly different). In which he mentions the female of *P. denticolle* for the first time, gives a range in body length (16-17mm; width 11mm) and records the distribution as Damaraland. The pair labelled Ganab, Damaraland was probably used for the second description, and possibly this is when Péringuey labelled the Ganab male as type.

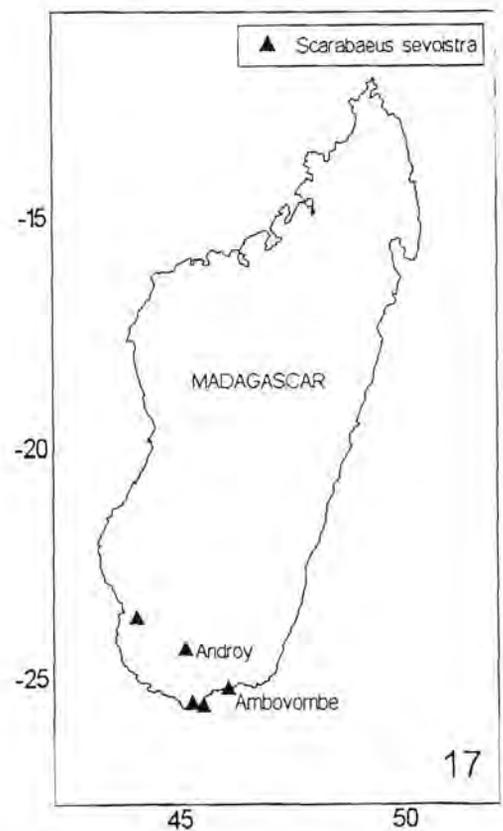
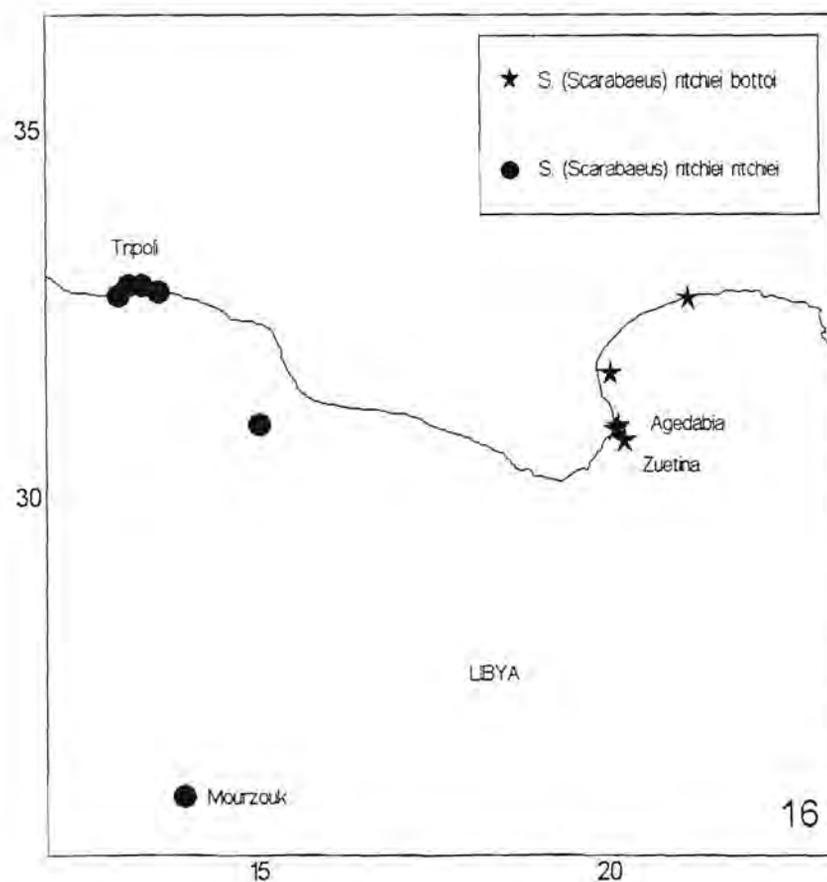
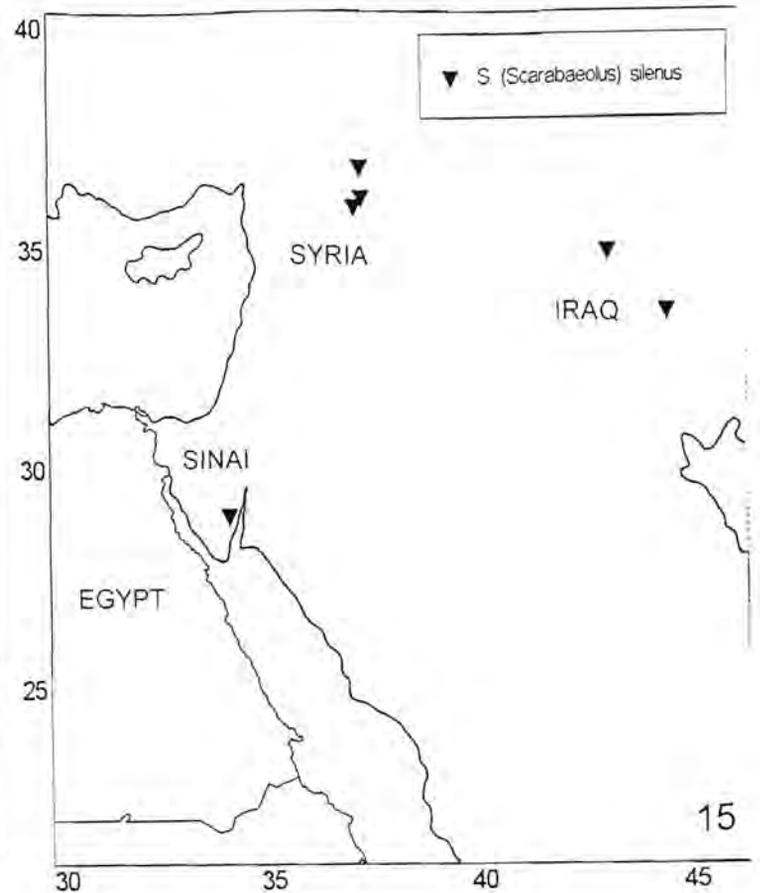
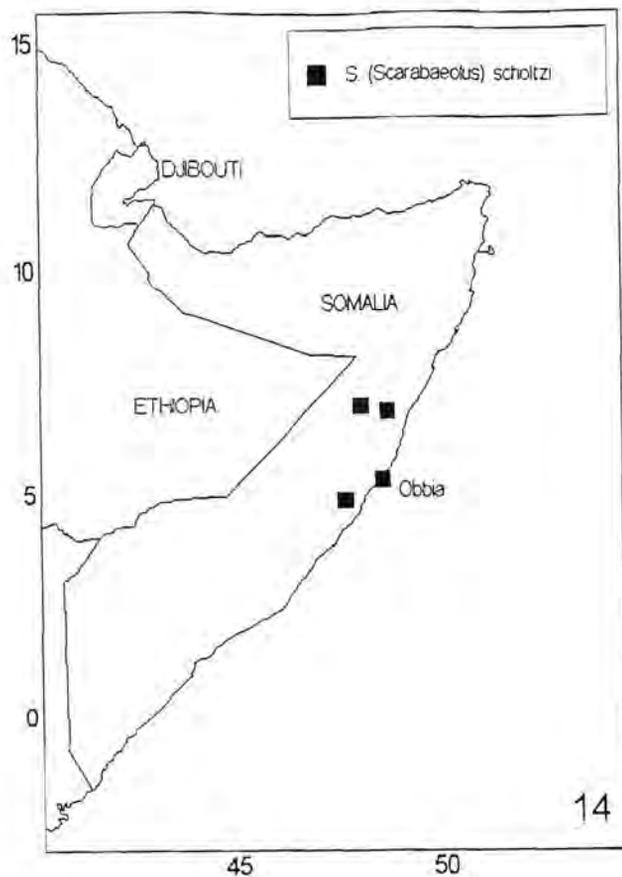
This evidence substantiates the choice by Holm and Scholtz (1979) of the Walfish Bay Nightingale specimen as lectotype, but suggests that the Walfish Bay Nightingale specimen is probably the original holotype of *Pachysoma denticolle*. Short of submitting a query to the Zoological Commission, I retain the original lectotype designation, but designate the aedeagus as a paralectotype.

*Type material examined* ( $\Sigma$ 2 spec. [2], 1♀ 1♂, 1♂diss.). **NAMIBIA:** LECTOTYPE ♂, *Pachysoma denticolle* Péringuey designated by Holm and Scholtz 1979: Walfish B, (22.58S 14.30E), Dec. (18)85 (date hard to see) // Nightingale //, / *Pachysoma denticolle*, LP (written in black ink by Péringuey on faded white card) / *Pachysoma denticolle* Péringuey Lectotype, Holm and Scholtz, 1978, (1♂ SAMC); PARALECTOTYPE ♂, *Pachysoma denticolle* Péringuey designated here: (aedeagus mounted with a brass minuten on white card) / *Pachysoma denticolle* LP (1♂ aedeagus SAMC). HOLOTYPE ♀, *Neopachysoma penrithae* Zunino: Lüderitz, SE 2615 Ca, 19 Oct 1970 / H5483 / Holotypus, *Neopachysoma penrithae* mihi, M.Zunino 1977 / (female genital

slide labelled) *Neopachysoma penrithae* Zunino, Holotypus, (1♀ SMWN). Paratype: Suid. Namib / H2889, {1♀ MZTI}.

*Additional material examined* (Σ209 specs. [78], 85♀ 105♂, 8♂diss., 19uns., 1p.). **NAMIBIA:**  
**Agate Beach**, (26.36S 15.10E), Lüderitz, 19.i.1973, extensive dune field with much *Stipagrostis sabulicola*, M.K.Jensen, (1♂ UPSA); Agate Beach, Lüderitz, SE2615Ca2, (ca. 26.33.53S 15.10.58), vii.1978, E.Holm, (1x UPSA); **Awasi Dunes E** at 25.15S 15.43E, Lüderitz, 29-30.i.1974, H17188, Zunnio genital slide, (1♀ UPSA); N Awasi, SE2515Bc3, (ca. 25.25.58S 15.33.53E), 4.vii.1976, UP, (1♀ 1♂ UPSA), (1♀ SANC); E Awasi, SE2515Bb1, (ca. 25.03.53S 15.48.53E), 11.vii.1976, UP, (1♂ UPSA), (3♂ SANC), (1♀ SAMC); **Blueberge**, 2km inland, 26.07S 14.58E, 18.i.1974, hand-collected, E-Y:297, Endrödy-Younga, (1 TMSA); Damaral., **Ganab**, (23.06S 15.29E), 2.(18)89., // C.Wilmer //, / *Pachysoma denticollis* (sic) type ♂ L P / Type (printed in black onto red card), (1♂ SAMC); (*idem*, but female, with no C.Wilmer on reverse of label, label illegible without other legible label), (1♀ SAMC); **Gobabeb**, (23.34S 15.03E), 408m, 17.iv.1967, (2♀ 2♂ TMSA); Gobabeb, 2mls S., (ca. 23.35S 15.02E), 8.iv.1967, Holm, (1♂ TMSA); Gobabeb, 10mls S, (ca. 23.42S 15.02E), iii.1968, E.Holm, (1♀ TMSA); Gobabeb, 20mls S, (ca. 23.49S 15.02E), vi.1967, E.Holm, (1♀ 2♂ TMSA); Gobabeb, 15km S., 23.44S 15.04E, Diamond Area 2, 14-15.v.1984, J.Irish, H.Liessner, H60772, (1♀ 1♂ SWWN); Namib-Naukluft Park, dunes near Gobabeb, 23.34S 15.03E, iii.1983, R.Oberprieler, (2♂ SANC); **SE Guinasibberg**, SE2515Bc1, (ca. 25.18.53S 15.33.53E), 4.vii.1976, UP, (1♀ UPSA), (2♀ SANC); N Guinasibberg, SE2515Ba3, (ca. 25.10.58S 15.33.53E), 5.vii.1976, UP, (3♀ UPSA), (2♀ 1♂ SANC), (1♀ SAMC); **Homeb**, 2mls upstream Kuiseb W bank, (ca. 23.38.05S 15.13.00E), x.1967, W.J.Hamilton, (includes dung pellet, the size of beetles abdomen), (1♀ TMSA); Namib between Lüderitz & **Hottentotsbay**, (ca. 26.23S 15.06E), 10.i.1974, E-Y:274, hand-collected, Endrödy-Younga, (1♂ UPSA); Farm **Kanaän**, 25.53S 16.07E, 7.v.1977, hand-collected on dunes, E-Y:1323, S.Mothlasedi, (1♀ TMSA); Kanaän, 25.52S 16.07E, 2.iv.1976, M.K.Seely, well vegetated red dunes, C1241, (1♂ SMWN); Kanaän 104, SE2516Cc, (25.52S 16.07E), Lüderitz, 22-27.vi.1976, S.Louw, M-L. Penrith, H32993, (14♀ 9♂ SMWN), (2 UPSA); Kanaän 104, SE2516Cc, (25.52S 16.07E), Lüderitz, 25.iv-2.v.1977, M-L. Penrith, S.Louw, H34748, (1♀ 2♂ SMWN); **Koichab Pan**, SE2615Ba3, (ca. 26.10.58S 15.33.53E), vii.1978, E.Holm, UP, (2♂ UPSA), (1♂ SANC); Koichab, SE2615Bc1, (ca. 26.18.53S 15.33.53E), vii.1982, E.Holm, (1♀ 1♂ UPSA); **Kolmanskop**, 6km SE, 26.45S 12.15E, 5.viii.1989, shifting dunes, day, Endrödy-Younga & Klim., (orange to black), (7 TMSA); **Kolmanskop**, SE2615Cb, (26.37.05S 15.22.05E), 6.x.1979, E.Holm, C.H.Scholtz, (2 UPSA); **Lüderitz**, 30km N, SE2615Ac, (26.22.05S 15.07.05E), 5.x.1979, E.Holm, C.H.Scholtz, (dark form), (2♀ 1♂ UPSA), (3♂ SANC); Lüderitz, SE2615Ca4, (26.40.58S 15.10.58E), 16.vii.1975, UP, (1♂ UPSA); **Namib Desert**, 25.05.05S 15.06.00E, (v.v. of SE on label), 20.vii.1976, *S.sabilicola* covered sandy street, M.K.Seely, C1234, (1♂ SMWN); Namib Desert, 23.45S 15.47E, 8.ii.1981, far east census, 11:30hrs, slipface pit traps, Osberg, C5250, (1♀ SMWN); Namib Desert, 23.46S 15.47E, far east, 29.v.1981, morning middune, Praetorius, C5429, (1♂ SMWN); Namib, 1948,

(probably Gaerdes coll.), (1♀ 1♂ TMSA); Namib Desert, **Noctivaga**, 23.43S 15.14E, 22.vi.1981, middune, moderate N wind, clear, 12h25, Praetorius, C5514, (1♀ SMWN); Namib Desert, **Miss Cluckies Fley**, 23.43S 15.19E, 25.v.1981, middune, 16h30, Praetorius, C5501, (1♀ SMWN); (Namib Desert), far east, 23.46S 15.47E, 17.iv.1982, 11h00, midslope, Hamilton, C5711, (1♂ SMWN); **Namib Exped.**, SE2415Cc1, (24.48.53S 15.03.53E), i.1977, Holm, Kirsten & Scholtz, (1♂ UPSA); Namib Exped., SE2615Ab4, (26.10.58S 15.25.58E), i.1977, Holm, Kirsten & Scholtz, (dead faded specimen), (1♂ UPSA); **Namtib Dunes**, 25.58S 16.02E, 8.viii.1989, E-Y:2640, dunes, day, Endrödy-Younga & Klim., (3♀ 1♂ TMSA); Namtib, 70mls NW of Aus, (SE2516Dd), (ca. 25.52.05S 16.52.05E), Gt. Namaqualand, C.Koch & van Son, 26.ix.1953, (4♀ 11♂ TMSA); **Natab**, 23.36S 15.03E, 10.xii.1976, L.W.Powrie, C1237, (1♀ SMWN); Natab, 23.35S 15.03E, 25.viii.1976, M.K.Seely, C1236, (1♀ SMWN); Dunes S of **Rechenberg**, 30mls NE Lüderitz, (ca. 26.24S 15.27E), ix.1963, W.D.Haacke, (1♀ 2♂ TMSA); **Sandwich Bay**, SE2314Bc1, (ca. 23.18.53S 14.33.53E), 7.vii.1975, day, beach, UP, (1♂ UPSA); Sandwich Harbour, (23.20S 14.28E), 28.xii.(19)62, W.Criess, (all black), (4♀ 1♂ TMSA), (1♀ SANC); **Sesriem Dunes**, (24.33S 15.46E), 5.v.1972, Prozesky, (1♀ 2♂ TMSA); **Sossusvlei**, SE2415Cb, (24.37.05S 15.22.05E), 4.vii.1978, L.A.Wessels, (3♂ UPSA), (1♀ SANC); Sossusvlei, SE2415Da3, (24.40.58S 15.33.53E), 14.vii.1975, UP // night, dune //, (1♂ SANC); Sossusvlei, 24.40S 15.24E, 14.viii.1989, E-Y:2649, dunes, day, Endrödy-Younga & Klim., (2♀ 2♂ 6 TMSA); Sossusvlei, Namib-Naukluft Park, 24.18S 15.45E, 7.xii.1992, M.Pusch, (1♀ SMWN); **Spencerbay**, N-hook, 25.40S 14.51E, 11.i.1974, hand-collected, day, E-Y:278, Endrödy-Younga, (1 TMSA); **Spencer Bay Water**, 25.47S 14.54E, 14.i.1974, hand-collected on dunes, E-Y:286, Endrödy-Younga, (1♀ TMSA); **Tiras Dunes**, 26.01S 16.07E, Lüderitz District, 8.iv.1986, J.Irish, (1♀ 1♂ SMWN); **Tsondab Plains**, N fringe, 15mls S of Natab, (ca. 23.42S 15.17E), 20.iv.1969, M.Pond, (1♀ 6♂ SMWN); Tsondab Flats, 23.55S 15.20E, 8.vii.1975, M.K.Seely, C1238, (1♂ SMWN); Tsondab Flats, 23.55S 15.20E, 8.vii.1975, M.K.Seely, C1239, (1♂ SMWN); Tsondab Flats, 23.50S 15.04E, Diamond Area 2, 15.v.1984, J.Irish, H.Liessner, H61048, (1♀ SMWN); Tsondab, SE2315Dc1, (23.48.53S 15.33.53E), 12.vii.1975, day, dune, UP, (1♀ UPSA); Tsondab, SE2415Ba1, (24.03.53S 15.33.53E), 11.vii.1975, day, dune foot, UP, (1p UPSA); SE Tsondab Plains, SE2315Cc4, (23.55.58S 15.10.58E), 15.vii.1976, UP, (1♀ 1♂ UPSA); N Tsondab Plains, SE2315Cc1, (23.48.53S 15.03.53E), 14.vii.1976, UP, (1♀ 1♂ UPSA), (1♂ SANC); NE Tsondab Plains, SE2315Cc2, (23.48.53S 15.10.58), 15.vii.1976, UP, (1♀ 1♂ UPSA), (1♀ 3♂ SANC); W Tsondab Plains, SE2314Dd2, (23.48.53S 14.55.58E), 15.vii.1976, UP, (1♀ SANC); Tsondabvlei, Namib-Naukluft Park, at 23.59S 15.27E, 2-26.viii.1989, dunes, day, S.Louw, NMBH 27864, (1♀ BMSA); **Uri Hauchab**, 25.21S 15.16E, 21.vii.1976, M.K.Seely, C1235, (1♂ SMWN); N Uri Hauchab, SE2515Ac2, (25.18.53S 15.10.58E), 6.vii.1976, UP, (2♂ UPSA), (2♂ SANC); **Walvisch. B.**, (22.58S 14.30E), J.Drury, (19)08, (1♂ SAMC); Walvisbai, 8km S of town, 22.59S 14.35E, 19.xi.1974, E-Y: 487, sandy flat, Endrödy-Younga, (orange to black), (2♀ 11♂ TMSA); Walvis Bay, 22.55S 14.28E, 8.iv.1981, S.Braine, (black), (1 SANC); **Wortel**, 23.03S 14.28E, 8.i.1977,



FIGURES 14-17. Distribution of flightless *Scarabaeus* (*Scarabaeolus*) and *Scarabaeus* (*Scarabaeus*) species in Africa, the Middle East and Madagascar. (14) *S. (Scarabaeolus) scholtzi* in Somalia; (15) *S. (Scarabaeolus) silenus* in Sinai, Syria, and Iraq; (16) *S. (Scarabaeus) ritchei* in Libya; (17) *S. (Scarabaeus) sevoistra* in Madagascar. See figure 2 for distribution of *S. (Scarabaeus) cancer* in Angola.



separated by incision between genae and clypeus; aedeagus symmetrical; only recorded from Somalia . . . . . **S. (*Scarabaeolus*) *scholtzi*** Mostert & Holm

\*Key modified from Mostert and Holm (1982).

***Scarabaeus* (*Scarabaeolus*) *scholtzi*** Mostert and Holm, 1982  
(Figures 14, 31, 49, 70)

*Scarabaeus* (*Scarabaeolus*) *scholtzi* Mostert and Holm, 1982: 276.

*Mnematium scholtzi* (Mostert and Holm, 1982): Carpaneto and Piattella, 1988: 269.

*Diagnosis.* Clypeus quadridentate, outer clypeal teeth half size of medial teeth, medial teeth separated by broad 'U' shaped gap; genal and clypeal edges unserrated, and separated by an incision at genal-clypeal suture (figure 31); protibia quadridentate, serrations between and proximal to teeth (figure 49); elytra fused, humeral callus absent, no sub-elytral rim, small elytral rim, elytral striae very faint; second mesotibial spur, vestigial which places this species in subgenus *Scarabaeolus* (Mostert and Scholtz 1986); metatarsal claws, shorter than last tarsal segment; aedeagus symmetrical (figure 70a,b).

*Distribution and habitat.* Endemic to the coastal plains of Somalia (figure 14), occurring in what is also known as the Somali-Chalbi Desert (Costa 1995). Koch (1961) includes a photograph by C.F. Hemming (who collected the type series of *S. (Scarabaeolus) scholtzi*) of Somalian dunes, east of Berbera. This picture possibly depicts likely habitat for *S. (Scarabaeolus) scholtzi*.

*Morphology.* The head of *S. (Scarabaeolus) scholtzi* resembles that of *Sceliages* species in shape. The mesocoxae of *S. (Scarabaeolus) scholtzi* are completely contiguous as with all *Pachysoma* species, but unlike *Pachysoma* the mesosternal ridge is still present as a distinct hump.

*Biology.* The mouthparts of *S. (Scarabaeolus) scholtzi* do not appear to be adapted for feeding on dry dung or detritus as in *S. (Pachysoma)* species. The epipharynx of *S. (Scarabaeolus) scholtzi* and *Sceliages brittoni* are strikingly similar in morphology. Towards the end of the wet season on the Namaqualand coast, dead millipedes became abundant in certain sandy areas. As *Sceliages brittoni* feeds mainly on dead millipedes, perhaps *S. (Scarabaeolus) scholtzi* has a similar diet which could account for the convergence in epipharyngeal morphology. It seems possible that dead millipedes could be an abundant, localized, but short lived food resource for a flightless beetle?

*Comments.* Dr Charles Koch visited Somalia in 1958 and collected an abdomen with elytra of a flightless Scarabaeini. Ferreira (1966) examined this abdomen and suggested without reasons that it came from a *Pachysoma* species. Holm and Scholtz (1979) were unable

to find this elytron in the TMSA collection and queried how Ferreira (1966) determined it to be a *Pachysoma* rather than a *Mnematum*. Mostert and Holm (1982) were also unable to trace this elytron, but mentioned that it probably belonged to *S. (Scarabaeolus) scholtzi*. The abdomen was discovered in the BMSA collection (which curates some of Ferreira's collection). It consists now of two complete elytra and all the abdominal sternite. Although labelled from Somalia, the specimen was puzzling because the head and thorax were that of *S. (Scarabaeus) ritchiei*. However, due to the distinct mesosternal ridge, and a protuberance on the outer edge of the last abdominal sternite, characters which are absent in *S. (Scarabaeus) ritchiei*, the abdomen was determined to be that of *S. (Scarabaeolus) scholtzi*. Further examination revealed that the *S. (Scarabaeus) ritchiei* pronotum and head were glued to the *S. (Scarabaeolus) scholtzi* abdomen, suggesting a previous mismatch. The parts of the two species have been separated and the *S. (Scarabaeolus) scholtzi* abdomen deposited in the TMSA collection.

*Types.* Mostert and Holm (1982) record 13 type specimens, but only 11 were traced. The BMNH and UPSA collections are listed by Mostert and Holm (1982) as having two paratypes each, while only one paratype was found in each of these collections.

*Type material examined* ( $\Sigma$ 11 uns. specs., 1 $\sigma$  diss.). **SOMALIA:** HOLOTYPE  $\sigma$ ; NE. Afr. Somali Rep, 52 km NE El Den, (04.53N 47.38E), coastal plain / 28.10.1971, Hemming T 238 / Holotype, *Scarabaeus scholtzi* Mostert & Holm 1982, (1 $\sigma$  TMSA). PARATYPES: *idem*, but Paratype, *Scarabaeus scholtzi* Mostert & Holm 1982, (1x BMNH), (6x TMSA), (1x UPSA); Somali Rep., 90 km N. Obbia on Geriban road, (06.53N 48.38E) / T 240 2.xi.1971, C.F. Hemming / Paratype, *Scarabaeus scholtzi* Mostert & Holm 1982, (2x TMSA).

*Additional material examined* (1x abdomen). **SOMALIA:** Obbia, (Hoby), (05.21.05N 48.31.32E), SOMALIA, Mudugh., (Mudug, Gobolka), (07.00N 48.00E), viii.1958, C. Koch, (1x abdomen TMSA).

### ***Scarabaeus (Scarabaeolus) silenus* (Gray, 1832)**

(Figures 15, 32, 50, 71)

*Mnematum silenus* Gray, 1832: 40; Felsche 1907: 275; Balthasar 1935: 27; Balthasar 1963: 141; Ferreira 1969: 28.

*Mnematum silenus* (Gray): Reitter 1894: 183.

*Scarabaeus rotundipennis* Holdhaus, 1919: 54.

*Mnematum rotundipenne* (Holdhaus): Balthasar 1935: 28; Balthasar 1963: 141; Ferreira 1969: 28.

*Pachysoma rotundipenne* (Holdhaus): Holm and Scholtz 1979: 226.

*Pachysoma silenus* (Gray): Holm and Scholtz 1979: 227.

*Scarabaeus (Scarabaeolus) silenus* (Gray): Mostert and Holm, 1982: 277.

*Diagnosis.* Clypeus quadridentate, teeth pointed and almost equal in size, separated by equal gap, genal anterior apex produced into distinct tooth (figure 32); protibia quadridentate, serrations between and proximal to teeth, proximal serrations' coarse; spurs simple, males with inner edge of protibia serrated (figure 50); Sub-elytral rim present, small elytral rim, striae very faint, humeral callus absent; metatarsal claws about half length of last tarsal segment; mesocoxae semi-contiguous (> 1.5 mm), with prominent depression between mesocoxae, anterior to which is prominent mesosternal ridge; male genitalia simple (figures 71a,b).

*Distribution.* Recorded from the Sinai Peninsula, Aleppo in Syria, Anah and Baghdad in Iraq to Saudi Arabia (figure 15). Probably associated with the Tigris and Euphrates Rivers in Iraq, which extend into Syria as the Al Furat River.

*Morphology.* The vestigial second mesotibial spur, which places this species in the subgenus *Scarabaeolus*, is very hard to see. Some specimens of *S. (Scarabaeolus) silenus* examined had lost (open socket visible) their vestigial spur, the spur is however present in the species.

*Biology.* Unknown. The mouthpart morphology appears intermediate between that of wet dung feeding *Scarabaeus* and dry dung feeding *Pachysoma*, which suggests a mixed diet of both wet and dry food.

*Comments.* The inclusion of this species in the subgenus *Scarabaeolus* (*sensu* Mostert and Holm 1982, Balthasar 1965), requires further investigation.

No difference was found between *S. silenus* (distribution centred on the Sinai Peninsula and Saudi Arabia) and its synonym *S. rotundipenne* (distribution centred on Iraq and Syria).

*Types.* Balthasar (1963) was unable to locate the holotype. Mostert and Holm (1982) examined the holotype, which is housed in the SMTD collection.

*Type material examined* (1 uns. spec.). **SYNTYPE, ARABIA:** *Silenus* Ol.\* Arab. Ol. (written onto faded yellow card) / 8889 / (1x ZMHB).

*Additional material examined* ( $\Sigma$ 8 uns. specs.). **EGYPT:** Egypt; S.W. Sinai, 10.1.1948, (29.00N 34.00E), H.Field / H.Field B.M. 1954-393 / (6x BMNH), (1x TMSA); **IRAQ:** Persia / 71.30 / (1x BMNH).

*Published locality data* (in italics). **IRAQ:** *Ana* (Anah), 34.28N 41.56E; *Baghdad*, 33.20.19N 44.23.38E, *Baghdad*, (Muhafazat), 34.00N 43.46E. **SYRIA:** *Aleppo*, (Halab, Muhafazat), 36.00N 37.00E, (Halab), 36.12N 37.10E; *Nahye* (Bayi), untraced.

### ***Scarabaeus (Scarabaeus) ritchiei*** (MacLeay, 1821)

(Figures 16, 33, 51, 72)

*Mnematium ritchiei* MacLeay, 1821: 506; Reiche 1841: 212; Reiche 1842: 93; Reitter 1894: 183; Ferreira 1961:26; Balthasar 1963: 138. Holotype: Mourzouk (1 BMNH).

*Scarabaeus (Mnematium) ritchiei* (MacLeay): Bedel 1892: 282.

*Mnematium ritchiei ritchiei* MacLeay: Gridelli 1930: 324; Zunino 1984: 96.

*Mnematium ritchiei bottoi* Gridelli, 1930: 324; Zunino 1984: 96.

*Pachysoma ritchiei* (MacLeay): Holm and Scholtz, 1979: 226.

*Scarabaeus (Scarabaeus) ritchiei* (MacLeay): Mostert and Holm, 1982: 275.

*Diagnosis.* Clypeus quadridentate, clypeal teeth pointed and separated by 'U' shaped depression; posterior edge of genae without pointed flange, genae unserrated, but produced into an extra tooth on anterior edge (figure 33); protibia quadridentate, serrations between and proximal to teeth, spurs simple (figure 51); sub-elytral ridge and rim small, elytral striae vary from faint to distinct between specimens, humeral calli absent; metatarsal claws shorter than last tarsal segment (LTS), and approximately equal to width of LTS; male genitalia simple (figure 72a,b).

*Distribution and habitat.* Coastal vegetated sand dunes (Balthasar 1963) in Libya (figure 16).

*Comments on locality data.* The type locality for *Mnematium ritchiei*, i.e. Mourzouk (Murzuq or Marzuq) when compared to most of the coastal locality records, is far inland (figure 16). The distribution maps of Balthasar (1963) and Mostert and Holm (1982) do not show this clearly. The town Murzuq is close to the 'Sahara Murzuq', which are presumably inland sand dunes. There are no locality records joining the two subspecific populations of *S. (Scarabaeus) ritchiei*, but one would expect their distributions to have been continuous at some previous time along the coastline.

*Morphological variation.* Gridelli (1930) described the subspecies *Mnematium ritchiei bottoi*, which has a Cyrenacian distribution (figure 16). Schatzmayr (1937) synonymised it with *M. ritchiei*. Zunino (1984), using male genitalia and differential reduction of the hind wings recognised the two subspecies as valid. Because only specimens from Tripoli (31°00'N 15°00'E) were examined, no comment can be made on the validity of *S. (Scarabaeus) ritchiei bottoi*. However, from experience with coastal *S. (Pachysoma)* species one would expect a degree of clinal variation across the geographic range of flightless *S. (Scarabaeus) ritchiei*.

*Biology.* Biology unknown. Various authors have assumed that *S. (Scarabaeus) ritchiei* rolls ball like flying *Scarabaeus* (e.g. Balthasar 1963). The mouthpart morphology appears intermediate between that of wet dung feeding *S. (Scarabaeus)* and dry dung feeding *S. (Pachysoma)*, which suggests a mixed diet of both wet and dry food.

*Comments.* The size of the mesosternal ridge and hind wing buds (see Zunino 1984) suggests that *S. (Scarabaeus) ritchiei* have not been flightless for as long as *S. (Pachysoma)* species. There is no marked setal development, a typical adaptation for dealing with soft dune sand.

*Types.* *Mnematium ritchiei* was described from a single specimen that is now in the BMNH collection ('The only specimen known of this interesting insect is now in the British

Museum...'. MacLeay 1821). MacLeay (1821) includes the following data about the specimen, 'Mourzouk, October 1819, D.Ritchie', but this is not on the label itself.

*Type material examined* (1♂). LECTOTYPE ♂, *Mnematium ritchiei*, MacLeay: Vigor's Type ('Vigor's' written, 'Type' typed, on white disk surrounded by a red circle) / *Ritchii* ML / (written, on now faded white paper) / Babary. (not traced), Capt. Lyon. (typed) / 59.57, Vigors Coll. (typed), (1♂ BMNH).

*Additional material examined* ( $\Sigma$ 26 uns. specs., 2♂ diss.). **LIBYA**: Tripoli, Lyb., (31.00N 15.00E), NMBH11654,55,56,57, (4 BMSA); Tripolis, (31.00N 15.00E), 06 (6 UPSA); Tripolis / Coll. C. Felsche Kauf 20, 1918, (1 SMTD); Tripolis, (3 ZMHB); Tripolitaine, (31.00N 15.00E), Envir. de Tripoli, Alluaud...1899 / Nevinson Coll. 1918-14 (6 BMNH), *idem*, but 302, (1 BMNH); Tripolis / Fry Coll. 1905-100, (4 BMNH); Tripoli, (2 BMNH).

*Published locality data*. *Scarabaeus ritchiei ritchiei* (MacLeay), Tripolitan Distribution. **LIBYA**; Mourzouk (Murzuk; Murzuq), 25.55N 13.55E; Pirazzoli (untraced); d'Orbigny (untraced). *Scarabaeus ritchiei bottoi* (Gridelli), Cyrenaican Distribution. **LIBYA**; Sidi Mesri (untraced, but Sidi Kasar, 32.42.42N 21.07.55E; Sidi ben Nur, Sidibennur (Sidi Bu an Nur), 31.41N 20.01E, (Sidi Abu an Nur), 32.48N 13.36E); Zuetina (Az Zuwaytinah), 30.57.15N 20.07.18E, 30.55N 20.05E; Agedabia, (Ajdabiya), 30.45.33N 20.13.23E; En-Ngila, (An Najilah), 32.45N 13.02E; Tagiura, (Tajura), 32.52.54N 13.21.02E.

#### ***Scarabaeus (Scarabaeus) sevoistra* Alluaud, 1902**

(Figures 17, 34, 52, 73)

*Scarabaeus sevoistra* Alluaud, 1902: 250.

*Neateuchus sevoistra* (Alluaud): Gillet, 1911b: 309.

*Neomnematium sevoistra* (Alluaud): Janssens, 1938: 71; Paulian, 1953: 27; Paulian and Lebis, 1960: 13; Ferreira 1961: 26; Mostert and Holm 1982: 275.

*Scarabaeus (Scarabaeus) sevoistra* Alluaud: Mostert and Holm 1982: 275.

*Diagnosis*. Clypeus quadridentate, clypeal teeth pointed, but blunt ended; clypeus and genae punctate-striate; small protuberance on frons (figure 34); protibia quadridentate, and markedly sexually dimorphic; no serrations between or proximal to protibial teeth, male protibia, serrated on inner edge and with prominent inward protuberance distally (figure 52), spurs simple in both sexes; pronotal disc smooth, but impressed with circular punctures; shortest elytral length to pronotal length ratios of any flightless Scarabaeini; very faint sub-elytral ridge, elytral rim and striae faint; no metatarsal claws were available for examination. Paulian (1960) includes a habitus diagram where the mesotarsal claws are shorter than the last tarsal segment, but the metatarsus are not illustrated. Male genitalia illustrated in figures 73a,b.

*Distribution and habitat.* Only recorded from the southwest of Madagascar, in semiarid bush veld (figure 17).

*Comments on locality records.* Mostert and Holm (1982) map *Scarabaeus sevoistra* in the north east of Madagascar. According to the NIMA GEOnet Names Server (Roher 1999) there are 60 Marovato, four Ambovombe, and eight Androy localities in Madagascar. However, Faux Cap (Betany) is used only once in Madagascar, and thus all localities were chosen from the semiarid bush veld of southwestern Madagascar.

*Morphology.* *S. (Scarabaeus) sevoistra* differs from the other flightless Scarabaeini in that the head resembles *Kheper* species. The absence of serrations on the outer edge of the protibia, is another characteristic of *Kheper* species. The mesotarsal claws are typical of *Scarabaeus* species, i.e. two curved claws, but no metatarsal claws were available for examination. A single metatarsal claw would place this species with *Kheper* rather than *Scarabaeus*. Mesocoxae semi-contiguous (0.58 mm; 1♀), and separated by a depression. Mesosternal ridge present, but more reduced than *S. (Scarabaeus) ritchiei*, *S. (Scarabaeolus) silenus* and *S. (Scarabaeolus) scholtzi*.

*Biology.* Foraging and feeding biology unknown. However, the mouthpart morphology suggests wet dung feeding.

*Comments.* *S. (Scarabaeus) sevoistra* is one of three Scarabaeini recorded from Madagascar, the other two species include *Scarabaeus radama* Fairmaire, 1895 which morphologically is a typical flying *Scarabaeus*. While *Madateuchus viettei* Paulian, 1953 which Mostert and Scholtz (1986) synonymised with *Scarabaeus* has characteristics placing it with *Kheper* (three protibial teeth) and *Scarabaeus* (two tarsal claws).

*Types.* Alluaud (1902) described the species from a single specimen (length 22 mm), collected in the Analavondrove region at Androy in February 1901 by Dr J. Decorse. Ferreira (1961) lists the holotype in the MNHN collection.

*Material examined* ( $\Sigma$ 2 specs., 1♀ 1♂). **MADAGASCAR**; Marovato (25.32S 45.16E), Ambovombe Distr. (25.10S 46.05E or 25.12S 46.04E), i.1956, leg. C.Koch, (1♀ TMSA), *idem*, but / Museum Frey München / NMBH11652, (1♂ BMSA). The male specimen is badly damaged, has only one complete protibia and its aedeagus has been lost.

*Published locality data.* **MADAGASCAR**; Type locality, *Androy*, 24.21S 45.07E or 23.41S 44.03E; *Faux Cap* (or *Betany*), 25.34S 45.31E.

### ***Scarabaeus (Scarabaeus) cancer* (Arrow, 1919)**

(Figures 1, 2, 35, 53, 74)

*Mnematium cancer* Arrow, 1919: 433; Boucomont 1925: 116; Ferreira 1961: 26; Balthasar 1963: 139; Ferreira 1969: 28.

*Pachysoma cancer* (Arrow): Holm and Scholtz 1979: 227.

*Scarabaeus cancer* (Arrow): Mostert and Holm 1982: 278.

*Diagnosis.* Clypeus quadridentate, clypeal teeth pointed, (both specimens examined are worn, so shape of apex of clypeal teeth cannot be determined); genae extended laterally, anterior edge produced into a point (also worn), posterior edge coarsely serrate, dorsal surface with scattered setiferous punctures (figure 35); protibia quadridentate, (no sign of serrations between worn protibial teeth), edge irregular below protibial teeth (figure 53); profemur enlarged, spined, procoxae with large spines on anterior edge; spurs simple in both sexes; very faint sub-elytral ridge, elytral rim larger, humeral calli absent, anterior edge of elytra rounded, striae faint; metatarsal claws were absent in both specimens, but Arrow (1919) describes tarsi and claws as 'both pairs of tarsi are rather broad and the claws are minute, short, straight, and not divergent'; mesocoxae contiguous, deep depression separating them; mesosternal ridge absent; male genitalia illustrated in figures 74a,b.

*Distribution and habitat.* Only recorded from the Kwatiri and Longa rivers in Angola (Boucomont 1925), (figures 1,2). Based on the distribution of the other flightless Scarabaeini (figures 1,2), one would expect this species to occur in the coastal dunes north of the Kunene River, i.e. the Mocamedes Desert. The known distribution of *S. (Scarabaeus) cancer* suggests rather an association with inland rivers. Sand bodies near these rivers would be a likely place to look for *S. (Scarabaeus) cancer*.

*Comments on locality data.* When Arrow (1919) described *Mnematium cancer* he remarked, 'A single specimen of the extraordinary insect here represented, bearing no label to record its origin or habitat, was in the collection of the late BG. Nevinson, recently presented to the British Museum by his son. Probably, like its nearest allies, it inhabits the western part of southern Africa, possibly the Bihé district of Angola, from where Mr. Nevinson received other interesting beetles'. As the BMNH collection currently has two specimens, *S. (Scarabaeus) cancer* was obviously collected again as the female does not have a BMNH locality label. Boucomont (1925) records two localities in the Kubango District of Angola, where *S. (Scarabaeus) cancer* was collected. The female in the BMNH possibly comes from this expedition.

*Morphology.* *S. (Scarabaeus) cancer* is hard to place within the Tribe Scarabaeini. The profemora and procoxae suggest it evolved from a *Pachylomerus* like ancestor. The asymmetrical aedeagus and two tarsal claws place it closer to *Scarabaeus*. While the shape of the head is very similar to *S. (Scarabaeus) ritchiei*, *S. (Scarabaeolus) silenus* and the flying *S. (Scarabaeus) multidentatus*, placing it within the *Mnematium / Mnematidium* species group. The degree of morphological change that has occurred since wing loss, is similar to *Pachysoma*, i.e. contiguous mesocoxae, mesosternal ridge absent, fused elytra, rounded anterior elytral edge. The mouthparts of *S. (Scarabaeus) cancer* are closer to *Pachysoma* than to *Mnematium* species. Which could be a result of their geographical proximity and an equal lapse in time since wing loss?

**Biology.** The biology of this species is unknown. However, based on the biology of other Scarabaeini one could expect *S. (Scarabaeus) cancer* to behave and forage like *Pachylomerus femoralis* (see Tribe 1976) or *Scarabaeus catenatus* (see Sato 1997, 1998). Both these flying species have very short mesocoxal distances, which is probably an adaptation or pre-adaptation to a multi-foraging strategy, and enlarged profemora. The mouthpart morphology of *S. (Scarabaeus) cancer* is closest to *S. (Pachysoma)* species, which suggests dry dung feeding or at least both dry and wet feeding. Collected during April and May 1913.

**Comments.** Arrow (1919) refrained from placing *S. (Scarabaeus) cancer* in its own genus, because of the unsatisfactory character of several genera within the Scarabaeini at the time. Holm and Scholtz (1979), suggested that if any species warranted a separate genus *S. (Scarabaeus) cancer* would. Mostert and Holm (1982), discussed *S. (Scarabaeus) cancer* as *incertae sedis* but placed it within *Scarabaeus sensu lato*. The temptation to create a new genus is great, probably because of the large body size and spectacular profemora of *S. (Scarabaeus) cancer*. *S. (Scarabaeus) cancer* warrants a separate genus no more than *S. (Scarabaeus) sevoistra* or *S. (Scarabaeolus) scholtzi* (which are just as unique, but much smaller). Flying species seemingly warranting their own genera includes; *S. galenus*, *S. multidentatus*, and *S. proboscideus*.

Eighty years after the description of *S. (Scarabaeus) cancer*, a well-supported decision on the generic placement of this species can still not be made. Progress has been compounded by the lack of specimens (only two known) and biological information for *S. (Scarabaeus) cancer*. With the advent of molecular biology, molecular data (if ever *S. (Scarabaeus) cancer* is recollected) should be added to the morphological before a decision is made regarding the origin or generic placement of *S. (Scarabaeus) cancer*. As the last known collection of this species was 86 years ago, and the area where they occur is probably mined, this might never be possible.

**Types.** *Mnematium cancer* was described from the single male holotype, housed in the BMNH collection (Arrow 1919).

**Type material examined** (1♂ diss.). HOLOTYPE ♂, **ANGOLA:** (No type locality, but Bihé (Kuito) District at 12.23S 16.56E suspected) / Holotype (white paper disk with a red circle, 'Holotype' typed in black) / Nevinson Coll. 1918-14 / *Mnematium cancer* type Arrow / Aedeagus point mounted / *Mnematium cancer* ♂ Arrow, M.E. Bacchus, det. 1975, Holotype, (1♂ BMNH).

**Additional material examined** (1♀ diss.). **ANGOLA:** (No locality data), / *Mnematium cancer* Arrow, det. R.J.W. Aldridge 1978 / *Pachysoma cancer* (Arrow) det. Holm & Scholtz 1978 / (1♀ BMNH).

**Published locality data.** **ANGOLA:** River Kwatiri (15.50S 20.10E), 1200 m, April 1913; River Longa (15.20S 18.50E), 1200 m, May 1913.

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## Appendix 1a. Checklist of the species of *Scarabaeus* (*Pachysoma*)

***Scarabaeus* (*Pachysoma*) *aesculapius*** Olivier, 1789.

= *Ateuchus barbatus* Thunberg, 1818.

= *Pachysoma validum* Boheman, 1857.

***Scarabaeus* (*Pachysoma*) *bennigseni*** (Felsche, 1907).

= *Pachysoma granulatum* Ferreira, 1953b.

***Scarabaeus* (*Pachysoma*) *denticollis*** (Péringuey, 1888).

= *Neopachysoma penrithae* Zunino, 1977.

***Scarabaeus* (*Pachysoma*) *endroedyi*** Harrison, Scholtz & Chown **sp. n.**

***Scarabaeus* (*Pachysoma*) *fitzsimonsi*** (Ferreira, 1953a).

***Scarabaeus* (*Pachysoma*) *gariepinus*** (Ferreira, 1953a).

***Scarabaeus* (*Pachysoma*) *glentoni*** Harrison, Scholtz & Chown **sp. n.**

***Scarabaeus* (*Pachysoma*) *hippocrates*** (MacLeay, 1821).

= *Pachysoma macleayi* Castelnau, 1840.

= *Pachysoma hessei* Ferreira, 1953a.

***Scarabaeus* (*Pachysoma*) *rodriguesi*** (Ferreira, 1953a).

***Scarabaeus* (*Pachysoma*) *rotundigenus*** (Felsche, 1907).

***Scarabaeus* (*Pachysoma*) *schinzi*** (Fairmaire, 1888).

***Scarabaeus* (*Pachysoma*) *striatus*** (Castelnau, 1840).

= *Pachysoma marginatum* Péringuey, 1888.

= *Irrorhotides fryi* Shipp, 1896.

***Scarabaeus* (*Pachysoma*) *valeflorae*** (Ferreira, 1953a).

## Appendix 1b. Checklist of the species of flightless *Scarabaeus* (*Scarabaeolus*)

***Scarabaeus* (*Scarabaeolus*) *scholtzi*** Mostert and Holm, 1982.

***Scarabaeus* (*Scarabaeolus*) *silenus*** (Gray, 1832).

= *Scarabaeus rotundipennis* Holdhaus, 1919.

## Appendix 1c. Checklist of the species of flightless *Scarabaeus* (*Scarabaeus*)

***Scarabaeus* (*Scarabaeus*) *cancer*** (Arrow 1919).

***Scarabaeus* (*Scarabaeus*) *ritchiei ritchiei*** (MacLeay, 1821).

***Scarabaeus* (*Scarabaeus*) *ritchiei bottoi*** (Gridelli, 1930).

***Scarabaeus* (*Scarabaeus*) *sevoistra*** (Alluaud, 1902).

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