

## CHAPTER 4: RESULTS

In general the vegetation of the area can be referred to as Reed wetland, Dune Thicket/Forest, Limestone fynbos, Dune Asteraceous Fynbos, and a little bit of South and Southwest Coast Renosterveld (Low & Rebelo 1998, Cowling & Richardson 1995).

Six main different habitat types are found in the study area, namely the wetland, limestone hills, shallow limestone plain, deep-soil limestone plain, neutral sand area, undulating dune plain and Renosterveld.

A TWINSPAN analysis of the total floristic data set comprising of 171 relevés revealed two main vegetation types, namely (i) the Inland Plains and Hills and (ii) the Coastal Thicket, Dunes and Strand. To describe these two main vegetation types adequately, two separate phytosociological tables were constructed, Table 2 showing plant communities 1-4 of the Inland Plains and Hills and Table 3 showing plant communities 5-10 of the Coastal Thicket, Dunes and Strand.

### CLASSIFICATION OF THE INLAND PLAINS AND HILLS OF ANDREW'S FIELD AND TSABA-TSABA NATURE RESERVE

Four plant communities were distinguished in the Inland Plains and Hills area of the study area, with the aid of the TWINSPAN program (Hill 1979a), as contained within MEGATAB (Hennekens 1996b). The second community can be subdivided into four sub-communities. The third community can be subdivided into five sub-communities. The classification is as follows:

1. *Phragmites australis* - *Juncus kraussii* short to high closed Reed Wetland community.
2. *Chondropetalum microcarpum* - *Metalasia pungens* low closed ericoid and restioid fynbos community.
  - 2.1. *Adromischus caryophyllaceus* - *Chondropetalum microcarpum* low closed limestone fynbos sub-community.
  - 2.2. *Passerina corymbosa* - *Chondropetalum microcarpum* low to short closed fynbos sub-community.

- 2.3. *Empodium gloriosum* - *Chondropetalum microcarpum* low to short, closed limestone fynbos sub-community.
- 2.4. *Eriocephalus kingesii* - *Chondropetalum microcarpum* low to short, closed fynbos sub-community.
3. *Leucadendron meridianum* - *Protea obtusifolia* low to high limestone fynbos community.
- 3.1. *Amphitalia alba* - *Leucadendron meridianum* tall closed limestone fynbos sub-community.
- 3.2. *Erica abietina* - *Leucadendron meridianum* tall closed limestone fynbos sub-community.
- 3.3. *Ehrharta calycina* - *Leucadendron meridianum* low to short limestone fynbos sub-community.
- 3.4. *Metalsia muricata* - *Leucadendron meridianum* tall closed limestone fynbos sub-community.
- 3.5. *Protea susannae* - *Leucadendron coniferum* high closed fynbos sub-community.
4. *Oedera uniflora* - *Elytropappus rhinocerotus* low closed Renosterveld community.

A diagrammatic presentation of the hierarchical classification and associated environmental interpretation of the plant communities can be seen in Figure 5. The community numbers in Figure 5. correspond with the plant community numbers used in the descriptions in the text.

#### DESCRIPTION OF PLANT COMMUNITIES

1. *Phragmites australis* - *Juncus kraussii* short to high closed Reed Wetland community.

The structure of the community can be described as high, dense reeds (*Phragmites australis*) in and close to the dam, both high *Phragmites australis* and medium high *Juncus kraussii* and some other low shrubs in the area immediately surrounding the dam (Photo 1). The surrounding marshy area contains medium high, dense *Juncus kraussii*, with some low shrubs in between. Height- and plant cover classes of plants are described according to the structural classification of Edwards (1983),

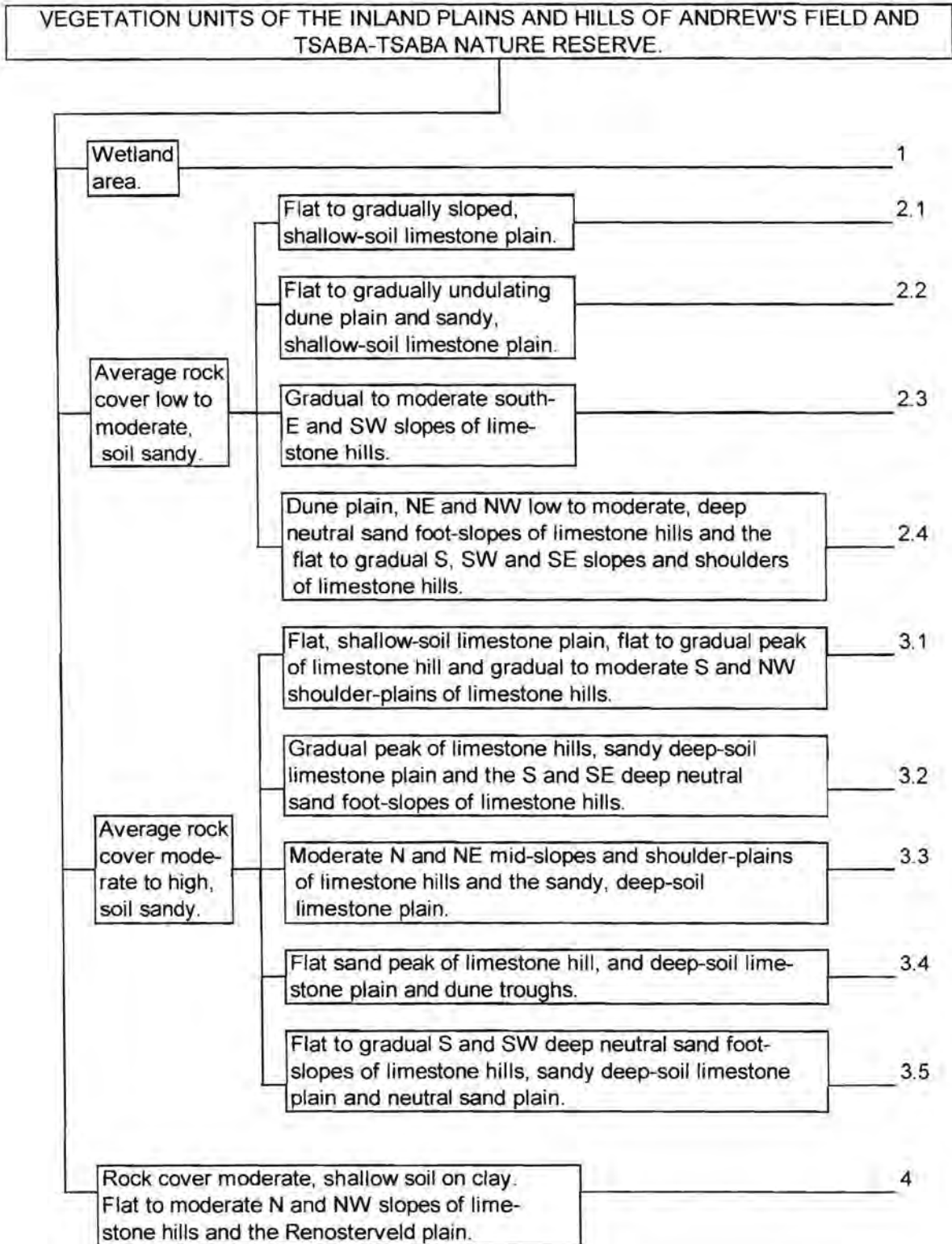


Figure 5. The hierarchical classification and associated environmental characteristics of plant communities of the inland plains and hills.



Photo 1. *Phragmites australis* - *Juncus krausii* reed wetland community, showing a dense stand of *Phragmites australis* in the dam, with *Juncus krausii* and *Plecostachys serpyllifolia* on the periphery.











The community is situated near the corner of the western section of the northern border and western border of Tsaba-Tsaba Nature Reserve. The community is found in the wetland/marsh area, at an altitude of 3 m, and a gradient of 0°. Small, irregular white-gray and orange-brown stones and pebbles, covering 10 % are mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group, and ferricrete, associated with Table mountain stones (Malan *et al.* 1994).

The soil can be described as the Coega form (Macvicar 1991).

The reed *Phragmites australis* and the rush *Juncus kraussii* as well as the shrub *Plecostachys serpyllifolia* are diagnostic for the community (Species Group A, Table 2).

The reed *Phragmites australis* and the rush *Juncus kraussii* (Species Group A, Table 2) are also dominant in the community.

The short shrub stratum shows an average canopy cover of 7% and an average height of 0.6 m. *Phragmites australis* has an average height of 2.5 m and an average canopy cover of 25%. *Juncus kraussii* has an average canopy cover of 40% and an average height of 1 m.

The plant community contains an average of only four species per relevé.

## 2. *Chondropetalum microcarpum* - *Metalasia pungens* low closed ericoid and restioid fynbos community

The structure of the community can be described as varying from predominantly low, closed ericoid and asteraceous shrubs, with low restioids in abundance, with some short shrubs sparsely scattered in the area, to having mostly low to short, closed ericoid and asteraceous shrubs, with some taller shrubs scattered through the area, some tall restios and short restios in abundance.

The community is found in the greatest part of the Andrew's Field section of the study area, (with the exception of a small area at the northern border of Andrew's Field). The community is also found at the western

border of Tsaba-Tsaba Nature Reserve, at the eastern section of the northern borderline of Tsaba-Tsaba, near the corner formed by the western part of the northern borderline and the western borderline of Tsaba-Tsaba. The community is also found in patches in the middle of the entire study area, reaching from the middle of the western borderline of the study area up to near the indented corner formed by the middle section and the eastern section of the northern borderline of Tsaba-Tsaba.

The community is found at an altitude of 3 – 23 m, at a gradient of 0° to 45°, on the shallow-soil limestone plain, undulating dune plain, southern, southeastern and southwestern slopes and shoulders of limestone hills, and on the northeastern and northwestern deep, neutral sand foot-slopes of limestone hills.

Small irregular white-gray pebbles, stones and rocks, and stretches of white-gray rock cover 0-40 %, on the limestone plain, is mostly limestone originating from the Waenhuiskrans formation of the Bredasdorp group. Small irregular white-gray pebbles on the dune plain (cover 0 - 5%) are mostly limestone originating from the Strandveld formation of the Bredasdorp group. Small irregular white-gray pebbles, stones, small rocks and stretches of white-gray rock cover 2-60 % on the limestone hills, is mostly limestone originating from the Waenhuiskrans formation of the Bredasdorp group. The soil of the community can be described as the Coega and Brandvlei forms on the limestone plain, the Namib form on the dune plain and neutral sand, and the Coega and Immerpan forms on the limestone hills (Macvicar 1991).

The diagnostic species for this community (Species Group B, Table 2), include the shrubby *Metalasia pungens*, *Indigofera meyeriana*, *Acmadenia obtusata*, *Agathosma collina*, *Muraltia saturooides* v. *saturooides*, the forb *Lobelia setacea*, the restioid *Calopsis viminea*, and the grasses *Cymbopogon plurinodis* and *Setaria sphacelata* v. *sphacelata* the most prominent.

The restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2) are dominant in the community.

The shrubs *Metalasia pungens*, *Acmadenia obtusata*, *Agathosma collina* (Species Group B, Table 2), *Diosma guthriei* (Species Group C, Table 2), *Disparago anomala*, *Phyllica ericoides* (Species Group M, Table 2), *Morella quercifolia* (Species Group N, Table 2), *Passerina paleacea* (Species Group P, Table 2) and *Passerina galpinii* (Species Group Q, Table 2), and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M, Table 2) are further the most prominent species in the community.

The tall-, short-, and low shrub strata have an average canopy cover of 5%, 13% and 29% respectively, and an average height of 1.5 m, 0.75 m and 0.4 m respectively. The forb stratum has an average canopy cover of 3% and an average height of 0.3 m. The short-, and low restioid strata have an average canopy cover of 4% and 7.5% respectively, and an average height of 0.75 m and 0.4 m respectively. The sedge stratum has an average canopy cover of 1% and an average height of 0.15 m. The short-, and low grass strata have an average canopy cover of 0.5% and 10% respectively, and an average height of 0.5 m and 0.3 m respectively.

An average of 24 species per relevé was recorded for this community.

#### 2.1 *Adromischus caryophyllaceus* - *Chondropetalum microcarpum* low closed limestone fynbos sub-community.

The structure of the sub-community can be described as mostly low, closed ericoid and asteraceous shrubs, with low restioids in abundance. Some short shrubs are also sparsely found in the sub-community.

The sub-community is situated near the corner of the northern and southern border of Tsaba-Tsaba and in patches near the middle of the western borderline of the study area. The sub-community is also found at the southern corner of Andrew's Field, near the corner of the northern and western borderline of Andrew's Field, and at the southeastern boundary of Andrew's Field.

The sub-community occurs at an altitude of 3 – 10 m, at a gradient of 0° to 8°, on the shallow-soil limestone plain. Small, irregular white-gray

pebbles, stones and rocks and stretches of white-gray rock cover 0 - 30 %, are mostly limestone originating from the Waenhuiskrans formation of the Bredasdorp group. The soil of the sub-community can be described as the Coega and Brandvlei forms (Macvicar 1991).

This sub-community is characterized by Species Group C (Table 2) with the most prominent diagnostic species the shrubby *Diosma guthriei*, the succulent forb *Adromischus caryophyllaceus* and the sedge *Ficinia tuncata*.

The shrubs *Metalasia pungens* and *Acmadenia obtusata*, (Species Group B, Table 2), and the restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2) are dominant in the sub-community. The shrubs *Disparago anomala*, *Phyllica ericoides* (Species Group M, Table 2), and *Passerina galpinii* (Species Group Q, Table 2), and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M, Table 2) are prominent in the sub-community.

The sub-community contains an average of 28 species per relevé.

## 2.2 *Passerina corymbosa* - *Chondropetalum microcarpum* low to short closed fynbos sub-community.

The structure of the sub-community can be described as having mostly low to short, closed ericoid and asteraceous shrubs, with some taller shrubs scattered throughout the area, with some tall restios and short restios in abundance (Photo 2).

The sub-community is found in patches at the western border of Tsaba-Tsaba Nature Reserve as well as near the corner formed by the western section of the northern borderline and the western borderline of Tsaba-Tsaba. The sub-community is also found near the middle part of the whole of the study area and near the indented corner formed by the middle section and the eastern section of the northern borderline of Tsaba-Tsaba, as well as near the eastern section of the northern borderline of Tsaba-Tsaba. On the Andrew's Field section of the study



Photo 2. *Passerina corymbosa* - *Chondropetalum microcarpum* sub-community, showing the typical shallow-soil limestone plain vegetation.

area, the sub-community is found on and near the southwestern border of Andrew's Field and near the northern border of Andrew's Field.

This sub-community is found at an altitude of 0 – 12 m, at a gradient of 0° to 26°, on the dune plain and the sandy, shallow-soil limestone plain. Small irregular white-gray pebbles on the dune plain (cover 0 - 5%) are mostly limestone originating from the Strandveld formation of the Bredasdorp group. Small, irregular white-gray pebbles, stones and rocks, and stretches of white-gray rock (cover 7 - 40 %) on the limestone plain, are mostly limestone originating from the Waenhuiskrans formation of the Bredasdorp group. The soil of the sub-community can be described as the Namib form on the dune plains and the Brandvlei form on the limestone plain (Macvicar 1991).

This sub-community is characterized by Species Group D (Table 2) with the most prominent diagnostic species the shrubby *Passerina corymbosa* and *Agathosma dielsiana* and the restioid *Ischyrolepis triflora*.

The shrubs *Metalasia pungens*, *Acmadenia obtusata* (Species Group B, Table 2) *Agathosma collina* (Species Group B, Table 2), *Morella quercifolia* (Species Group N, Table 2) and *Passerina paleacea* (Species Group P, Table 2), and the restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2), are dominant in the sub-community.

The shrubs *Phylica ericoïdes*, *Disparago anomala*, (Species Group M, Table 2), *Otholobium bracteolatum* (Species Group P, Table 2) and *Passerina galpinii* (Species Group Q, Table 2) the restioid *Thamnocortus insignis* (Species Group Q, Table 2), and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M, Table 2), are also prominent in the sub-community.

The sub-community contains an average of 35 species per relevé.

2.3 *Empodium gloriosum* - *Chondropetalum microcarpum* low to short, closed limestone fynbos sub-community.

The structure of the sub-community can be described as having mostly low to short, closed ericoid and asteraceous shrubs, with some taller shrubs scattered throughout the area, some tall restios and short restios in abundance.

The sub-community is situated near the western border of Tsaba-Tsaba Nature Reserve and near the eastern middle part of Tsaba-Tsaba. The sub-community is also found at the center part of Andrew's Field and at the northern borderline of Andrew's Field.

The sub-community is found at an altitude of 3 – 23 m, at a gradient of 0° to 45°, on the southeastern and southwestern slopes of limestone hills. Small irregular white-gray pebbles, stones, small rocks and stretches of white-gray rock cover 2 - 60 %, are mostly limestone originating from the Waenhuiskrans formation of the Bredasdorp group. The soil of the sub-community can be described as the Coega and Immerpan forms (Macvicar 1991). This sub-community is characterized by Species Group E (Table 2) with the most prominent diagnostic species the forb *Empodium gloriosum*.

The shrub *Phyllica ericoides* (Species Group M, Table 2) and restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2) are dominant in the community. The shrubs *Disparago anomala* (Species Group M, Table 2), *Passerina paleacea* (Species Group P, Table 2) the restioid *Thamnocortus insignis* (Species Group Q, Table 2) and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M, Table 2) are also prominent in the sub-community.

The sub-community contains an average of 26 species per relevé.

2.4 *Eriocephalus kingesii* - *Chondropetalum microcarpum* low to short, closed fynbos sub-community.

The structure of the sub-community can be described as having mostly low to short, closed ericoid and asteraceous shrubs, with some taller

shrubs scattered throughout the area, some tall restios and short restios in abundance (Photo 3).

The sub-community is situated near the eastern middle part of Tsaba-Tsaba Nature Reserve, at the middle section of the northern border of Tsaba-Tsaba, in the corner formed by the eastern section of the northern borderline of Tsaba-Tsaba and the coastal southeastern border of Tsaba-Tsaba, as well as at the southern borderline of Tsaba-Tsaba. The sub-community is also found at the western borderline of Andrew's Field, near the center of the northern borderline, as well as at the northern borderline of Andrew's Field.

This sub-community occurs on the southeastern and southwestern slopes of limestone hills, on the dune plain, northeastern and northwestern deep, neutral sand foot-slopes of limestone hills, and the southern, southwestern and southeastern slopes and shoulders of limestone hills.

The sub-community is found at an altitude of 3 – 21 m, at a gradient of 0° to 16°, on the dune plain, northeastern and northwestern deep, neutral sand foot-slopes of limestone hills, and the southern, southwestern and southeastern slopes and shoulders of limestone hills. Small irregular white-gray pebbles, cover 1 - 35% on the neutral sand and limestone hills, are mostly limestone originating from the Waenhuiskrans formation of the Bredasdorp group. The soil of the sub-community can be described as the Namib form on the dune plain and neutral sand, and Immerpan and Coega forms on the limestone hills (Macvicar 1991).

This sub-community is characterized by Species Group F (Table 2) with the most prominent diagnostic species the shrubby *Eriocephalus kingesii*.

The shrubs *Acmadenia obtusata* and *Agathosma collina* (Species Group B, Table 2), *Phyllica ericoides* (Species Group M, Table 2), *Passerina paleacea* (Species Group P, Table 2) the restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2) are dominant in the sub-community.



Photo 3. *Eriocephalus kingesii* - *Chondropetalum microcarpum* sub-community with *Agathosma collina* in flower in the front, and showing the clear transition between the dune plain and the dune vegetation.

The shrubs *Metalasia pungens* (Species Group B, Table 2), *Disparago anomala* (Species Group M, Table 2), *Morella quercifolia* (Species Group N, Table 2) and *Passerina galpinii* (Species Group Q, Table 2), the restioids *Calopsis viminea* (Species Group B, Table 2) and *Thamnocortus insignis* (Species Group Q, Table 2) and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M, Table 2) are also prominent in the sub-community.

The sub-community contains an average of 22 species per relevé.

3. *Leucadendron meridianum* - *Protea obtusifolia* low to high limestone fynbos community.

The structure of the community varies from low, open ericoid dominated fynbos shrubland, with scattered groups of tall to high, closed proteoid dominated shrubs, to tall to high, closed proteoid dominated shrubland fynbos. High restios are found in the community, usually more abundant in the closed proteoid dominated shrubland areas of the community. Low restios are also found quite abundantly throughout the community (Photo 4).

The community is situated from the northern border of Tsaba-Tsaba Nature Reserve (at the corner formed by the northern and western borderlines of Tsaba-Tsaba Nature reserve) up to the middle of the study area, running along the western borderline of Tsaba-Tsaba and reaching up to the southern borderline of Tsaba-Tsaba. The community is also found running along the northern borderline of Tsaba-Tsaba, reaching to the middle section of the northern borderline of Tsaba-Tsaba. The community is also found and at the eastern section of the northern borderline of Tsaba-Tsaba, as well as at the indented corner formed by the middle and eastern part of the northern borderline of Tsaba-Tsaba. The community also occurs at the northern border of Andrew's Field.

The community is found at an altitude of 1 – 31 m, at a gradient of 0° to 16°. The community is found on the shallow -soil limestone plain, deep-soil limestone plain, peak of limestone hills, southern and northwestern shoulder plains of limestone hills, northern and northeastern mid-slopes



Photo 4. *Leucadendron meridianum* - *Protea obtusifolia* community, with (Thatch reed) *Thamnocortus insignis* in front.

and shoulder-plains of limestone hills, on the southern, southeastern and southwestern deep, neutral sand foot-slopes and plain as well as on the dune troughs between dunes.

Large irregular shaped, white-gray rocks, with some smaller stones and pebbles, as well as sheaths of rock, on the limestone hills cover 3 - 65%, and small, irregular white-gray pebbles and stones, on the limestone plains, covers 0 - 7% , are mostly limestone originating from the Waenhuiskrans formation of the Bredasdorp group. The neutral sand and dune trough contains an average of 0% rock cover.

The soil of the community can be described as the Brandvlei form on the shallow-soil limestone plain, the Immerpan form on the deep-soil limestone plain, the Immerpan and Coega forms on the limestone hills, and the Namib form on the neutral sand and dune through areas (Macvicar 1991).

This community is characterised by Species Group G (Table 2) with the most prominent diagnostic species the shrubby *Helichrysum patulum*, the shrubby trees *Leucadendron meridianum* and *Protea obtusifolia*.

The shrubs/trees *Amphitalea alba*, *Leucospermum truncatum*, *Erica longifolia*, *Erica propinqua*, *Stoebe cinerea* and *Aspalathus globulosa* (Species Group I, Table 2), *Protea susannae* (Species Group L, Table 2), the forbs *Dimorphoteca nudicaulis* (Species Group I, Table 2), *Dorotheanthus bellidiformes*, *Gladiolus gracilis*, *Dianthus albens* (Species Group J, Table 2), and the grass *Eragrostis sarmentosa* (Species Group K, Table 2) are common species in the community.

The shrubs *Rhus glauca*, *Euclea racemosa* (Species Group Q, Table 2), and the restioid *Thamnocortus insignis* (Species Group Q, Table 2) are dominant in the community.

The shrubby tree *Protea susannae* (Species Group L, Table 2), the shrubs *Metalasia muricata* (Species Group N, Table 2), *Passerina paleacea* (Species Group P, Table 2), and *Passerina galpinii* (Species Group Q, Table 2), and the restioids *Ischyrolepis eleocharis* and

*Chondropetalum microcarpum* (Species Group N, Table 2) are further prominent species in the community.

The tall-, high-, short-, and low shrub strata have an average canopy cover of 21%, 16%, 11% and 11% respectively, and an average height of 2.5 m, 1.5 m, 0.75 m and 0.4 m respectively. The forb stratum has an average canopy cover of 4% and an average height of 0.3 m. The high-, tall-, short-, and low restioid strata have an average canopy cover of 0.5%, 6%, 2%, and 14% respectively, and an average height of 2.5 m, 1.5 m, 0.75 m and 0.4 m respectively. The sedge stratum has an average canopy cover of 0.7% and an average height of 0.15 m. The short- and low grass strata have an average canopy cover of 1% and 3% respectively, and an average height of 0.5 m and 0.3 m respectively.

An average of 31 species per relevé was recorded in this community.

### 3.1 *Amphitalia alba* - *Leucadendron meridianum* tall closed limestone fynbos sub-community.

The structure of the sub-community can be described as low, open ericoid dominated fynbos shrubland, with scattered groups of tall, closed proteoid dominated shrubs.

The sub-community is situated near the corner of the northern and western border of Tsaba-Tsaba Nature reserve, adjacent to the marsh area. The sub-community is also found at the northwestern inland border, as well as near the middle of the western border of Tsaba-Tsaba Nature reserve.

The sub-community is found at an altitude of 3 – 31 m, at a gradient of 0° to 16°, on the shallow -soil limestone plain, peak of limestone hill, southern and northwestern shoulder plains of limestone hills.

Large irregular shaped, white-gray rocks, with some smaller stones and pebbles, on the limestone hills, and small irregular white-gray pebbles, on the limestone plain, cover 3 - 45%, and are mostly limestone originating from the Waenhuiskrans formation of the Bredasdorp group. The soil of

the sub-community can be described as the Brandvlei form on the limestone plain and the Coega and Immerpan forms on the limestone hills (Macvicar 1991).

This community is characterised by Species Group I (Table 2) with the most prominent diagnostic species the shrubs *Amphitalea alba*, *Leucospermum truncatum*, *Oedera capensis* and *Erica spectabilis*.

The shrubs *Leucadendron meridianum* and *Protea obtusifolia* (Species Group G, Table 2) and the restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2), are dominant in the sub-community.

Furthermore, the shrubs *Helichrysum patulum* (Species Group G, Table 2), *Metalasia calcicola* (Species Group H, Table 2), *Amphitalea alba* (Species Group I, Table 2), *Phyllica ericoides* (Species Group M, Table 2), *Disparago anomala* (Species Group M, Table 2), *Rhus glauca* and *Euclea racemosa* (Species Group Q, Table 2), are also prominent in the sub-community.

The sub-community contains an average of 42 species per relevé.

### 3.2 *Erica abietina* - *Leucadendron meridianum* tall closed limestone fynbos sub-community.

The structure of the sub-community can be described as tall, closed proteoid dominated shrubland fynbos.

The sub-community is found at the northern border of Tsaba-Tsaba Nature reserve, near the marsh area; at the northwestern border, as well as near the middle of Tsaba-Tsaba Nature reserve.

The sub-community is found at an altitude of 3 – 31 m, at a gradient of 0° to 16°, on the peak of limestone hills, deep-soil limestone plain and the southern and southeastern deep, neutral sand foot-slopes of limestone hills. Small irregular white-gray pebbles and stones, on the limestone plain, and large irregular white-gray rocks, with some pebbles and stones,

as well as sheaths of rock on the limestone hills cover 0 - 65%, and are limestone originating from the Waenhuiskrans formation of the Bredasdorp group. The neutral sand area contains an average of 0% rock cover. The soil of the sub- community can be described as the Immerpan form on the limestone plain, the Immerpan and Coega forms on the limestone hills, and the Namib form in the neutral sand area (Macvicar 1991).

This community is characterized by Species Group J (Table 2) with the most prominent diagnostic species the shrubby *Erica abietina* v. *abietina*, *Heterolepis peduncularis* and *Stoebe cinerea*.

The shrubs *Leucadendron meridianum* and *Protea obtusifolia* (Species Group G, Table 2) and the restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2) are dominant in the sub-community. The shrubs *Helichrysum patulum* (Species Group G, Table 2), *Metalasia calcicola* (Species Group H, Table 2), *Phyllica ericoides*, *Disparago anomala* (Species Group M, Table 2), *Metalasia mucicata* (Species Group N, Table 2), *Passerina paleacea* (Species Group P, Table 2), *Rhus glauca* and *Euclea racemosa* (Species Group Q, Table 2) and the restioid *Thamnocortus insignis* (Species Group Q, Table 2) are also prominent in the sub-community.

The sub-community contains an average of 34 species per relevé.

### 3.3 *Ehrharta calycina* - *Leucadendron meridianum* low to short limestone fynbos sub-community.

The structure of the sub-community can be described as low to short, open ericoid dominated fynbos shrubland, with groups of tall to high, closed proteoid dominated shrubs. High and low restios are found quite abundantly in the sub-community (Photo 5).

The sub-community is found in the corner formed by the northern and western borderlines of Tsaba-Tsaba Nature Reserve, in patches from near the middle section of the northern borderline of Tsaba-Tsaba to the middle part of Tsaba-Tsaba. The sub-community also occurs in the



Photo 5. *Ehrharta calycina* - *Leucadendron meridianum* sub-community, showing a typical limestone outcrop with plants growing in potholes.

middle of the whole of the study area (Tsaba-Tsaba and Andrew's Field), near the western borderline of Tsaba-Tsaba, at the eastern part of the northern border of Tsaba-Tsaba, and also at the northern border of Andrew's Field.

The sub-community is found at an altitude of 3 – 21 m, at a gradient of 0° to 16° on the northern and northeastern mid-slopes and shoulder-plains of limestone hills and on the sandy deep-soil limestone plain. Irregular white-gray pebbles, stones and small rocks and stretches of rock, cover 1-10 % on the limestone plain and are mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. Big irregular white-gray rocks, with some pebbles and stones, as well as stretches of rock, covering 0 - 60%, on the limestone hills are mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil of the variant is the Immerplan form on the limestone plain, and the Immerpan and Coega forms on the limestone hills (Macvicar 1991).

This sub-community is characterised by Species Group K (Table 2) with the most prominent diagnostic species the shrub *Cassine peragua* and the grasses *Ehrharta calycina*, *Bromus diandrus* and *Eragrostis sarmentosa*.

The shrubs *Rhus glauca*, *Euclea racemosa* (Species Group Q, Table 2) and *Passerina paleacea* (Species Group P, Table 2), and the restioid *Thamnocortus insignis* (Species Group Q, Table 2) are dominant in the sub-community.

Furthermore the shrubs *Leucandendron meridianum*, *Protea obtusifolia* (Species Group G, Table 2), *Helichrysum patulum* (Species Group G, Table 2), *Metalasia muricata*, *Morella quercifolia* (Species Group N, Table 2), *Otholobium bracteolatum* (Species Group P, Table 2) and *Passerina galpinii* (Species Group Q, Table 2) and the restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2) and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M, Table 2) are also prominent in the sub-community.

The sub-community contains an average of 33 species per relevé.

#### 3.4 *Metalasia muricata* - *Leucadendron meridianum* tall closed limestone fynbos sub-community.

The structure of the sub-community can be described as tall closed proteoid dominated shrubland.

The sub-community is found near the corner formed by the northern and western borderline of Tsaba-Tsaba Nature Reserve, in patches near the middle part of the whole study area (Tsaba-Tsaba and Andrew's Field). The sub-community is also found in patches southeast of the indented corner formed by the middle and eastern part of the borderline of Tsaba-Tsaba, as well as near the southern part of the southeastern border of Tsaba-Tsaba.

The sub-community is found at an altitude of 1 – 14 m, at a gradient of 0° to 8°, on the sandy peak of a limestone hill, and on the deep-soil limestone plain and on dune troughs. Small irregular white-gray pebbles and stones, covering 3% on the limestone hill, are limestone originating from the Waenhuiskrans formation of the Bredasdorp group. There is a rock cover of 0% on the limestone plain and dune through area. The soil of the sub-community can be described as the Namib form in the dune area, the Immerpan form on the limestone plain, and the Immerpan and Coega forms on the limestone hill (Macvicar 1991).

Although no diagnostic species group could be identified, the presence of Species Group G and the absence of Species Groups H-L (Table 2) are characteristic for this sub-community.

The shrub *Metalasia muricata*, and the restioid *Chondropetalum microcarpum* (Species Group N, Table 2) are dominant in the sub-community.

The shrubs *Leucadendron meridianum*, *Protea obtusifolia* (Species Group G, Table 2), *Helichrysum patulum* (Species Group G, Table 2) and *Passerina paleacea* (Species Group P, Table 2) are further prominent species in this sub-community.

The sub-community has an average of only 13 species per relevé.

### 3.5 *Protea susannae* - *Leucadendron coniferum* high closed fynbos sub-community.

The structure of this sub-community can be described as high closed proteoid dominated shrubland (Photo 6).

The sub-community is situated in patches along the northern borderline of Tsaba-Tsaba Nature reserve, adjacent to the marsh area, in the corner of the northern and inland northwestern border of Tsaba-Tsaba, and in patches near the middle of the whole study area.

The sub-community is found at an altitude of 3 – 25 m, at a gradient of 3° to 8°, on the southern and southwestern deep, neutral sand foot-slopes of limestone hills, on sandy deep-soil limestone plain, and on the deep, neutral sand plain. There is a rock cover of 0% in the sub-community. The soil of the sub-community can be described as the Namib form on the neutral sand areas and the Immerpan form on the sandy deep-soil limestone plain (Macvicar 1991).

Species Group L (Table 2) is characteristic for this sub-community and the diagnostic species include the shrubby trees *Protea susannae* and *Leucadendron coniferum*, which is also dominant in this sub-community.

The shrubs *Helichrysum patulum* (Species Group G, Table 2) and *Passerina paleacea* (Species Group P, Table 2) and the restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2) are prominent in the sub-community.

The sub-community has an average of 24 species per relevé.

### 4. *Oedera uniflora* - *Elytropappus rhinocerotus* low closed Renosterveld community.

The structure of the community can be described as low, closed asteraceous dominated renosterveld shrubland (Photo 7).



Photo 6. *Protea susannae* - *Leucadendron coniferum* sub-community.



Photo 7. *Oedera uniflora* - *Elytropappus rhinocerotus* community.

The community is found in patches near the middle part of the western borderline of the study area, as well as adjacent to the wetland area.

The plant community is found at an altitude of 3° to 18 m, at a gradient of 0 – 13°, on the northern and northwestern slopes of limestone hills, and on the Renosterveld plain. Small, irregular white-gray pebbles and stones cover 1-10%, and are mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil can be described as the Brandvlei form (Macvicar 1991).

The diagnostic species are listed Species Group O (Table 2), which includes shrubs *Elytropappus rhinocerotis* and *Oedera uniflora* and the grass *Andropogon appendiculatus* which are the most dominant diagnostic species, while the shrub *Euchaetis meridionalis* and the forbs *Berkheya coriacea* and *Tritonia deusta* are also diagnostic for the community.

The shrubs *Passerina galpinii* and *Helichrysum teretifolium* (Species Group Q, Table 2) are also prominent in the community.

The tree stratum has an average canopy cover of 6% and an average height of 2.5 m. The high shrub stratum has an average canopy cover of 6% and an average height of 1.5 m, while the medium shrub stratum has an average canopy cover of 7%, and an average height of 0.75 m and the low shrub stratum has an average canopy cover of 32% and an average height of 0.4 m. The high reed-, medium reed- and low reed strata show an average canopy cover of 2%, 0.6% and 4% respectively, and an average height of 1.5 m, 0.75 m, and 0.20 m respectively. The medium grass stratum has an average canopy cover of 17% and an average height of 0.6 m while the low grass stratum has an average canopy cover of 2% and an average height of 0.25 m. The sedges have an average canopy cover of 0.5% and an average height of 0.10 m. The forb stratum has an average canopy cover of 3% and an average height of 0.15 m.

The community has an average of 25 species per relevé.

## CLASSIFICATION OF THE COASTAL THICKET, DUNES AND STRAND OF ANDREW'S FIELD AND TSABA-TSABA NATURE RESERVE:

There can in general be referred to the vegetation of the area as Dune Asteraceous Fynbos, with some Limestone fynbos and Renosterveld (Low & Rebelo 1998, Mustard *et al.* 1997).

Six main different habitat types are found in the study area, namely dune plain, Renosterveld plain, limestone plain, limestone hills, dunes and strand.

Six plant communities can be distinguished (community 5 to 10). Community 5 has six sub-communities, with two variants in both sub-communities 2 and 6. Community 7 has two sub-communities.

The classification of the vegetation is as follows:

5. *Rhus glauca* - *Euclea racemosa* short to tall closed thicket community.
  - 5.1. *Rhus lucida* - *Euclea racemosa* low to short closed thicket sub-community.
    - 5.2. *Pterocelastrus tricuspidatus* - *Euclea racemosa* short to tall closed thicket sub-community.
      - 5.2.1. *Olea exasperata* - *Euclea racemosa* short to high closed thicket variant.
      - 5.2.2. *Carissa bispinosa* - *Euclea racemosa* short to tall closed thicket variant.
    - 5.3. *Acmadenia obtusata* - *Euclea racemosa* short to tall closed thicket sub-community.
    - 5.4. *Helichrysum dasyanthum* - *Euclea racemosa* low to short closed thicket sub-community.
    - 5.5. *Acacia cyclops* - *Euclea racemosa* high to tall closed thicket sub-community.
    - 5.6. *Thamnocortus insignis* - *Euclea racemosa* high to tall closed thicket sub-community.
      - 5.6.1. *Elytropappus rhinocerotus* - *Euclea racemosa* short to tall closed thicket variant.

5.6.2. *Leucadendron coniferum* - *Euclea racemosa* high to tall closed thicket variant.

6. *Chrysanthemoides monilifera* - *Solanum africanum* low closed dune community.

7. *Chrysanthemoides monilifera* - *Ehrharta villosa* var. *maxima* low to short closed dune shrub community.

7.1. *Chrysanthemoides monilifera* - *Rhus crenata* short to high dune shrub sub-community.

7.2. *Chrysanthemoides monilifera* - *Morella cordifolia* low to short closed shrub sub-community.

8. *Ehrharta villosa* var. *maxima* low to high closed dune grassland community.

9. *Ammophila arenaria* low to high closed dune community.

10. *Arctotheca populifolia* - *Thinopyrum distichum* short to low open strand community.

A diagrammatic presentation of the hierarchical classification and associated environmental interpretation of the plant communities can be seen in Figure 6. The community numbers in Figure 6. correspond with the description in the text.

## DESCRIPTION OF PLANT COMMUNITIES

5. *Rhus glauca* - *Euclea racemosa* short to tall closed thicket community.

The structure of the community can be described as scattered groups of closed broad-leaved shrubs throughout the area, consisting of mostly short to tall shrubs, but having high shrubs near the center and lower shrubs near the periphery of a group.

The community is found in a mosaic with communities 2, 4, 6 and sub-community 3.4, as well as near the indented corner formed by the middle and eastern part of the northern borderline of Tsaba-Tsaba Nature Reserve and in patches near the middle part of Tsaba-Tsaba.

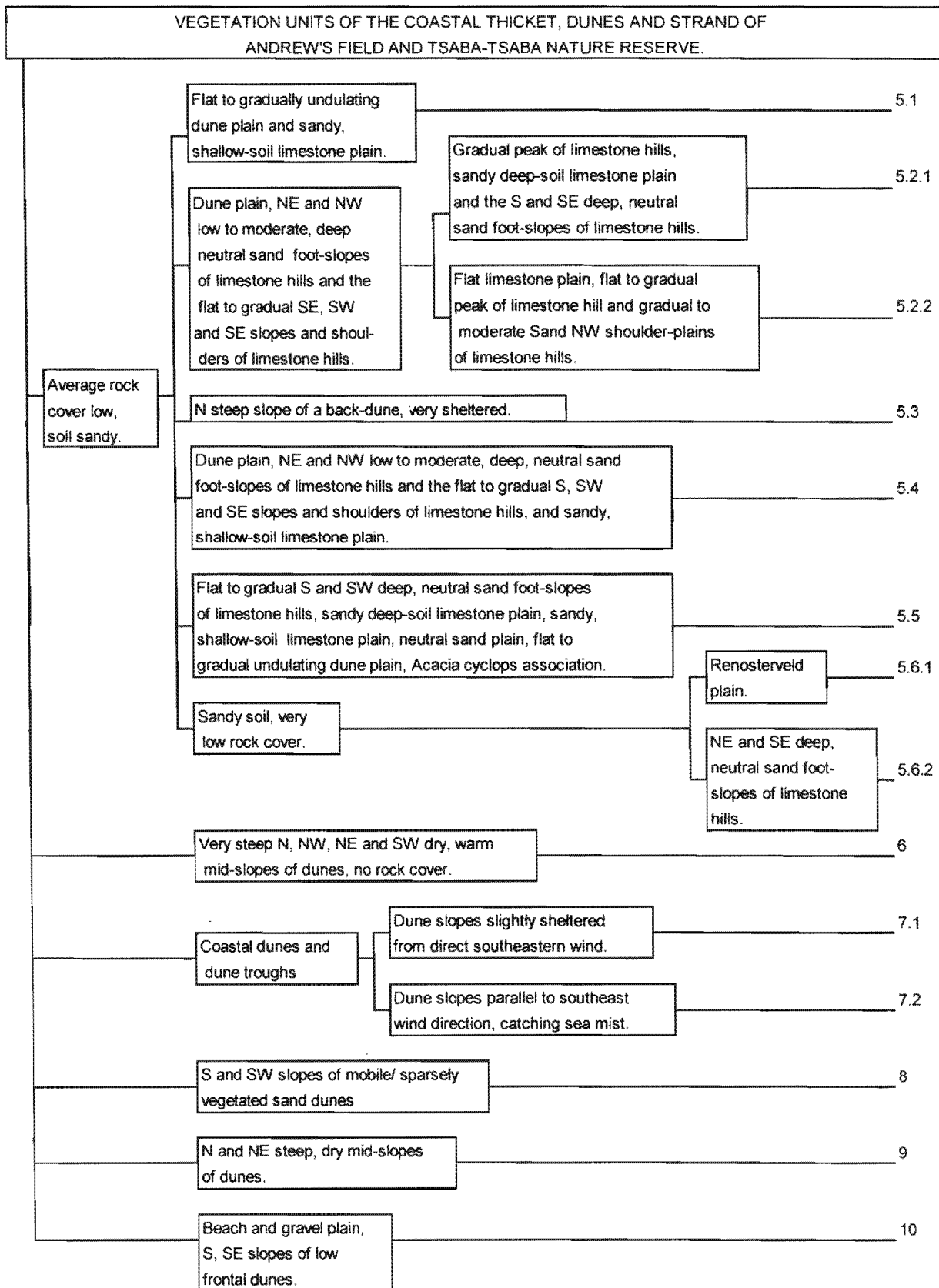


Figure 6. Hierarchical classification and associated environmental characteristics of the coastal thicket, dunes and strand of Andrew's Field and Tsaba-Tsaba nature reserve.









The community is found at an altitude of 0 – 15 m, at a gradient of 0° to 45°, on the dune plain, northern slope of a back-dune, limestone plain, Renosterveld plain, and on the southern, southwestern, southeastern and western slopes and peaks of limestone hills.

The shrubs *Euclea racemosa*, *Rhus glauca* and *Rhus laevigata* (Species Group A, Table 3) are diagnostic and dominant in this community.

The shrubs *Rhus glauca* (Species Group A, Table 3), *Rhus lucida* (Species Group B, Table 3), *Robsonodendron maritimum*, *Pterocelastrus tricuspidatus* (Species Group D, Table 3), *Olea exasperata*, *Osyris compressa*, *Knowltonia vesicatoria* (Species Group E, Table 3), *Carissa bispinosa*, *Sideroxylon inerme*, *Gymnosporia buxifolia* (Species Group F, Table 3), *Acmadenia obtusata* (Species Group G, Table 3), *Protea obtusifolia* (Species Group I, Table 3), *Asparagus capensis*, *Metalasia densa*, *Cassine peragua*, *Passerina paleacea* (Species Group J, Table 3), *Elytropappus rhinocerotus*, *Leucadendron linifolium*, *Helichrysum teretifolium*, *Myrsine africana*, *Oedera uniflora*, *Lycium afrum*, *Rhus laevigata* var. *villosa*, *Asparagus lignosus*, *Euryops hebecarpus* (Species Group K, Table 3), *Eriocephalus kingesii*, *Leucadendron coniferum*, *Anthospermum aetiopicum*, *Viscum capense*, *Protea susannae*, *Agathosma collina*, *Salvia africana-lutea*, *Maytenus procumbens*, *Agathosma serpyllacea*, *Phylica stipularis*, *Trigogyne repens*, *Tephrosia capensis*, *Othonna dentata*, *Indigofera meyeriana*), *Microloma sagittatum* (liane) (Species Group L, Table 3), the forbs *Arctopus echinatus*, *Zalusianskya villosa* (Species Group G, Table 3), *Torilis arvensis* (Species Group J, Table 3), *Limonium scabrum* var. *scabrum*, *Hermannia althaefolia*, *Pelargonium myrrhifolium* (Species Group K, Table 3), the parasitic liane *Cassytha ciliolata*, *Conicosa pugioniformis* subsp. *muirii*, *Wachendorfia paniculata*, *Heliophyla refracta*, *Crassula subulata* var. *subulata*, *Oxalis obtusa*, *Gymnodiscus capillaris*, *Sebaea aurea*, *Cineraria* sp., *Albuca cooperi*, *Babiana montana*, *Euphorbia foliosa*, *Sebaea albens*, *Othonna filicaulis*, *Gazania pectinata* (Species Group L, Table 3), the grasses *Panicum deustum* (Species Group F, Table 3), *Festuca scabra* (Species Group G, Table 3), *Koeleria capensis*, *Tribolium echinatum* (Species Group J, Table 3), the restioids *Ischyrolepis eleocharis* (Species

Group K, Table 3), *Willdenowia glomerata*, and *Elegia stipularis* (Species Group L, Table 3) are all often found in this community.

The shrubs *Otholobium bracteolatum* (Species Group C, Table 3), *Chrysanthemoides monillifera* and *Metalasia muricata* (Species Group R, Table 3) are also prominent in the community.

The tall-, high-, short- and low shrub strata show average canopy covers of 14%, 20%, 28% and 15% respectively, and an average height of 2.5 m, 1.5 m, 0.75 m and 0.4 m respectively. The forb stratum contains an average canopy cover of 3% and an average height of 0.3 m. The short-, and low restioid strata have an average canopy cover of 4% and 7.5% respectively, and an average height of 0.75 m and 0.4 m respectively. The sedge stratum has an average canopy cover of 1% and an average height of 0.15 m. The short-, and low grass strata have an average canopy cover of 0.5% and 10% respectively, and an average height of 0.5 m and 0.3 m respectively.

The community has an average of 13 species per relevé.

#### 5.1 *Rhus lucida* - *Euclea racemosa* low to short closed thicket sub-community.

The structure of the sub-community can be described as scattered groups of low to short closed broad-leaved shrubs.

The sub-community is found in a mosaic distribution pattern with sub-communities 2.1 and 2.2.

The sub-community is found at an altitude of 3 – 10 m, at a gradient of 0° to 16°, on the dune plain and shallow-soil limestone plain. Small irregular white-gray pebbles, covering 1%, are found on the dune plain. Irregular white-gray rocks, stones and pebbles, covering 1%, are found on the limestone plain. The rock on the dune plain is mostly limestone, originating from the Strandveld formation of the Bredasdorp group. The rock on the limestone plain is mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil on the dune

plain can be described as the Namib form, and on the limestone plain the Brandvlei and Coega forms (Macvicar 1991).

*Rhus lucida* (Species Group B, Table 3) is the only diagnostic species for this sub-community.

The shrubs *Euclea racemosa*, *Rhus glauca* and *Rhus laevigata* var. *laevigata* for. *coangoa* (Species Group A, Table 3) are dominant in the community.

The shrubs *Rhus lucida* (Species Group B, Table 3), *Helichrysum dasyanthum* (Species Group H, Table 3), *Passerina paleacea* (Species Group J, Table 3) are also prominent in the sub-community.

The sub-community contains an average of only 4 species per relevé.

*5.2 Pterocelastrus tricuspidatus - Euclea racemosa* short to tall closed thicket sub-community.

The structure of this sub-community can be described as scattered groups of short to tall closed broad-leaved shrubs, with some lower shrubs at the periphery.

The sub-community is found scattered, in a mosaic with sub-communities 2.3 and 2.4.

The sub-community is found at an altitude of 3 – 23 m, at a gradient of 0° to 16°, on the dune plain, northeastern and northwestern deep, neutral sand foot-slopes of limestone hills, and the southern, southwestern and southeastern slopes and shoulders of limestone hills.

Small irregular white-gray pebbles, covering 1%, are found on the dune plain. Irregular white-gray rocks, stones and pebbles covering 1 %, are found on the deep neutral sand and limestone hills. The rock on the dune plain is mostly limestone, originating from the Strandveld formation of the Bredasdorp group. The rock on the limestone hills is mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group.

The soil on the dune plain can be described as the Namib form, and the Immerpan and Coega forms on the limestone hills (Macvicar 1991).

Species Group D (Table 3) is diagnostic for this sub-community, with the shrubby trees *Robsonodendron maritimum* and *Pterocelastrus tricuspidatus* dominant diagnostic species.

The shrubs *Euclea racemosa*, *Rhus glauca* and *Rhus laevigata* var. *laevigata* for. *coangoa* (Species Group A, Table 3), are also dominant, while the shrub and *Otholobium bracteolatum* (Species Group C, Table 3) are prominent in the sub-community.

The sub-community contains an average of 12 species per relevé.

#### 5.2.1. *Olea exasperata* - *Euclea racemosa* short to high closed thicket variant.

The structure of the variant can be described as scattered groups of short to high closed broad-leaved shrubs, with some lower shrubs at the periphery.

The variant is distributed in a mosaic pattern with sub-community 2.4.

The variant is found at an altitude of 3 – 23 m, at a gradient of 0° to 16°, on the dune plain, northeastern and northwestern deep, neutral sand foot-slopes of limestone hills, and the southern, southwestern and southeastern slopes and shoulders of limestone hills. Small irregular white-gray pebbles, covering 1%, are found on the dune plain. Irregular white-gray stones and pebbles, covering 1%, are found on the deep neutral sand and limestone hills. The rock on the dune plain is mostly limestone, originating from the Strandveld formation of the Bredasdorp group. The rock on the neutral sand and limestone hills is mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil on the dune plain and neutral sand foot-slopes can be described as the Namib form, and the Immerpan and Coega forms (Macvicar 1991) on the limestone hill.

Species Group E (Table 3) is diagnostic, with *Olea exasperata* and *Osyris compressa* the most prominent diagnostic species.

The shrubs *Euclea racemosa*, *Rhus glauca* and *Rhus laevigata* var. *laevigata* for. *coangoa* (Species Group A, Table 3), *Robsonodendron maritimum* (Species Group D, Table 3), are dominant in the variant.

The shrub *Pterocelastrus tricuspidatus* (Species Group D, Table 3) is also prominent in the variant.

The variant contains an average of 12 species per relevé.

5.2.2. *Carissa bispinosa* - *Euclea racemosa* short to tall closed thicket variant.

The structure of the variant can be described as scattered groups of short to tall closed broad-leaved shrubs, with some lower shrubs at the periphery (Photos 8 and 9).

The variant is found in a mosaic with sub-community 2.3.

The variant is found at an altitude of 3 – 23 m, at a gradient of 0° to 16°, on the southwestern and southwestern slopes of limestone hills. Irregular white-gray stones, pebbles covering 1 %, are found on the limestone hills, are mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil on the limestone hills can be described as the Immerpan and Coega forms (Macvicar 1991).

Species Group F (Table 3) is diagnostic with the shrubs *Carissa bispinosa* and *Sideroxylon inerme* the most prominent diagnostic species.

The shrubs *Euclea racemosa*, *Rhus glauca* (Species Group A, Table 3), *Robsonodendron maritimum* and *Pterocelastrus tricuspidatus* (Species Group D, Table 3) are dominant in the variant.

The shrubs *Rhus laevigata* var. *laevigata* for. *coangoa* (Species Group A, Table 3), the exotic shrub *Acacia cyclops* (Species Group I, Table 3) and



Photo 8. *Carissa bispinosa* - *Euclea racemosa* variant developed into a small Dune forest.



Photo 9. Showing the inside of the small Dune forest.

*Chrysanthemoides monilifera* (Species Group R, Table 3) are also prominent in the variant.

The variant contains an average of 13 species per relevé.

### 5.3 *Acmadenia obtusata* - *Euclea racemosa* short to tall closed thicket sub-community.

The structure of the sub-community can be described as scattered groups of short to tall closed broad-leaved shrubs, with some lower shrubs at the periphery.

The sub-community is found in a small patch near the center part of the whole of the study area.

The sub-community is found at an altitude of 3 – 6 m, at a gradient of 26° to 45°, on the northern slope of a back-dune. The rock cover in the sub-community is 0%. The soil of the sub-community can be described as the Namib form (Macvicar 1991).

Species Group G (Table 3) is diagnostic for this sub-community with the shrub *Acmadenia obtusata*, the forbs *Arctopus echinatus* and *Zaluzianskya villosa* and the grass *Festuca scabra*, as diagnostic species for the sub-community.

The shrubs *Euclea racemosa* (Species Group A, Table 3), *Otholobium bracteolatum* (Species Group C, Table 3), *Rhus crenata* (Species Group O, Table 3), and *Passerina rigida* (Species Group Q, Table 3), are dominant in the sub-community.

The sub-community has an average of 18 species per relevé.

5.4 *Helichrysum dasyanthum* - *Euclea racemosa* low to short closed thicket sub-community.

The structure of the sub-community can be described as scattered groups of low to short closed broad-leaved shrubs, with some high shrubs at the center. This sub-community is found in a mosaic distribution pattern with sub-communities 2.1, 2.2 and 2.4.

This sub-community is found at an altitude of 3 – 21 m, at a gradient of 0° to 16°, on the dune plain, sandy shallow-soil limestone plain, on the northeastern and northwestern deep neutral sand foot-slopes of limestone hills, southern, southwestern and southeastern slopes and shoulders of limestone hills. Small irregular white-gray pebbles, covering 0 - 1%, are found on the dune plain and neutral sand area. Irregular white-gray stones and pebbles, covering 1%, are found on the limestone hills. The rock on the dune plain is mostly limestone, originating from the Strandveld formation of the Bredasdorp group. The rock on the limestone hills and neutral sand is mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil on the dune plain and neutral sand area can be described as the Namib form and the soil on the limestone hills as the Immerpan and Coega forms (Macvicar 1991).

*Helichrysum dasyanthum* (Species Group H, Table 3) is the only diagnostic species for this sub-community.

The shrubs *Euclea racemosa*, and *Rhus laevigata* var. *laevigata* for. *coangoa* (Species Group A, Table 3), *Otholobium bracteolatum* (Species Group C, Table 3), are dominant in the sub-community.

The shrubs *Rhus glauca* (Species Group A, Table 3), *Pterocelastrus tricuspidatus* (Species Group D, Table 3), *Passerina paleacea* (Species Group J, Table 3), *Chrysanthemoides monilifera* (Species Group R, Table 3), are also prominent in the sub-community.

The sub-community contains an average of only 6 species per relevé.

5.5 *Acacia cyclops* - *Euclea racemosa* high to tall closed thicket sub-community.

The structure of the sub-community can be described as scattered groups of high to tall closed broad-leaved shrubs, with some low to short shrubs at the periphery.

The sub-community is found in a mosaic with sub-communities 2.1 and 3.5.

The sub-community is found at an altitude of 3 – 25 m, at a gradient of 0° to 8°, on the shallow-soil limestone plain, deep-soil limestone plain, southern and southwestern deep neutral sand foot-slopes of limestone hills and on the neutral sand plain. Small irregular white-gray pebbles and stones, covering 1%, are found on the shallow-soil limestone plain and is mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. A rock cover of 0% was found on the neutral sand area and deep-soil limestone plain. The soil on the neutral sand can be described as the Namib form, on the shallow-soil limestone plain as the Brandvlei and Coega forms, and on the deep-soil limestone plain as the Immerpan form (Macvicar 1991).

The exotic *Acacia cyclops*, the shrubby tree *Protea obtusifolia* and the shrub *Passerina galpinii* are the diagnostic species for this sub-community (Species Group I, Table 3),

The shrubs *Euclea racemosa*, and *Rhus laevigata* var. *laevigata* for. *coangoa* (Species Group A, Table 3), and *Metalasia muricata* (Species Group R, Table 3) are dominant in the sub-community.

The shrub *Rhus glauca* (Species Group A, Table 3) is also prominent in the sub-community.

The sub-community contains an average of only 7 species per relevé.

#### 5.6 *Thamnocortus insignis* - *Euclea racemosa* high to tall closed thicket sub-community.

The structure of the sub-community can be described as scattered groups of high to tall closed broad-leaved shrubs, with some low and short shrubs at the periphery. Low forbs and some high, low and short restioids are also present in the sub-community (Photo 10).

The sub-community is found in a mosaic with community 4 as well as near the indented corner formed by the middle and eastern part of the northern borderline of Tsaba-Tsaba Nature Reserve and in patches near the middle part of Tsaba-Tsaba.

The sub-community is found at an altitude of 3 – 20 m, at a gradient of 0° to 16°, on the Renosterveld plain and on the northeastern and southeastern deep neutral sand foot-slopes of limestone hills. Small irregular white-gray pebbles and stones, covering 0 -1%, are found on the neutral sand and Renosterveld plain and is mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil of the neutral sand can be described as the Namib form and as the Brandvlei form on the Renosterveld plain (Macvicar 1991).

Species Group J (Table 3) is diagnostic for this sub-community with the restioid *Thamnocortus insignis* and the shrubs *Helichrysum patulum*,

*Passerina paleacea*, *Metalasia densa* the most prominent diagnostic species.

The shrubs *Euclea racemosa* and *Rhus glauca* (Species Group A, Table 3) and the restioid *Thamnocortus insignis* (Species Group J, Table 3) are dominant in the sub-community.

*The shrubs Olea exasperata* (Species Group E, Table 3), *Chrysanthemoides monilifera* and *Metalasia muricata* (Species Group R, Table 3), are also prominent in the sub-community.

The sub-community contains an average of 27 species per relevé.



Photo 10. *Thamnocortus insignis* - *Euclea racemosa* sub-community, showing the typical vegetation of the sandy, deep-soiled limestone plain, with *Chrysanthemoides monilifera* prominent at the back.

5.6.1 *Elytropappus rhinocerotus* - *Euclea racemosa* short to tall thicket variant.

The structure of the variant can be described as scattered groups of short to tall closed broad-leaved shrubs, with some lower shrubs at the periphery, as well as some high restioids.

The variant is distributed in a mosaic with community 4.

The variant is found at an altitude of 3 m, at a gradient of 0° to 3°, on the Renosterveld plain. Small irregular white-gray pebbles and stones, covering 1%, are found on the Renosterveld plain and is mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil can be described as the Brandvlei form (Macvicar 1991).

The diagnostic species are listed in Species Group K (Table 3), which includes the shrubs *Elytropappus rhinocerotis*, *Leucadendron linifolium*, *Oedera uniflora*, *Lycium afrum*, *Rhus laevigata* var. *villosa*, *Asparagus lignosus*, *Euryops hebecarpus*, and the forbs *Limonium scabrum* var. *scabrum*, *Hermannia althaeifolia* and *Pelargonium myrrhifolium*.

The shrubs *Euclea racemosa* and *Rhus glauca* (Species Group A, Table 3), the restioids *Thamnocortus insignis* (Species Group J, Table 3) are dominant in the variant.

The shrubs *Helichrysum patulum*, *Passerina paleacea* (Species Group J, Table 3), *Elytropappus rhinocerotis*, *Leucadendron linifolium* (Species Group K, Table 3) and *Chrysanthemoides monilifera*, *Metalsia muricata* (Species Group R, Table 3) are also prominent in the variant.

The variant contains an average of 22 species per relevé.

5.6.2 *Leucadendron coniferum* - *Euclea racemosa* high to tall closed thicket variant.

The structure of the variant can be described as scattered groups of high to tall closed broad-leaved shrubs, with some low to short shrubs at the periphery, as well as some high and low restioids in between.

The variant is found at a gradient of 8° to 26°, at an altitude of 3 – 6 m on the northeastern and southeastern deep neutral sand foot-slopes of limestone hills. Small irregular white-gray pebbles and stones, covering 0-1%, are mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil can be described as the Namib form (Macvicar 1991).

A large number of species given in Species Group L (Table 3) are diagnostic for this variant, These include the shrubs *Eriocephalus kingesii*, *Leucadendron coniferum*, *Viscum capense*, *Protea susannae*, *Maytenus procumbens*, *Agathosma serpyllacea*, *Phylica stipularis*, *Trigogyne repens*, *Tephrosia capensis*, *Othonna dentata*, *Microlooma sagittatum* (liane), the parasitic liane *Cassytha ciliolata*, the forbs *Conicosa pugioniformis* subsp. *muirii*, *Wachendorfia paniculata*, *Heliophyla refracta*, *Crassula subulata* var. *subulata*, *Oxalis obtusa*, *Gymnodiscus capillaris*, *Sebaea aurea*, *Cineraria* sp., *Albuca cooperi*, *Babiana montana*, *Euphorbia foliosa*, *Sebaea albens*, *Gazania pectinata* and the the restioids *Cannomois virgata*, and *Elegia stipularis*.

The shrubs *Euclea racemosa* and *Rhus glauca* (Species Group A, Table 3), the restioids *Thamnocortus insignis* (Species Group J, Table 3) are dominant in the variant.

The shrubs *Olea exasperata* (Species Group E, Table 3), *Cassine peragua* (Species Group J, Table 3), *Protea susannae*, *Agathosma collina*, *Salvia-africana lutea*, *Maytenus procumbens*, *Agathosma serpyllacea*, *Phylica stipularis* (Species Group L, Table 3), *Solanum africanum* (Species Group M, Table 3), *Chrysanthemoides minilifera* (Species Group R, Table 3) and the restioid *Chondopetalum microcarpum* (Species Group L, Table 3) are also prominent in the variant.

The variant is rich in species and contains an average of 43 species per relevé.

6. *Chrysanthemoides monilifera* - *Solanum africanum* low closed dune community.

The structure of the community can be described as mostly low prostrate shrubs, with some short, high and tall shrubs also present in the community (Photo 11).

The community is found in a mosaic with communities 7, 8 and 9, in the sparsely vegetated shifting sand dune area (adjacent to the coast). The community is also found in a mosaic with communities 7 and 8, in the densely vegetated sand dune area found at the seashore and deeper inland, adjacent to the shifting sand dune area.

The community is situated at an altitude of 1 – 21 m, at a gradient of 26° to >45°. The community is found on the dryer (exposed to less moisture from sea, and more sunlight, than the eastern, southeastern and southern slopes, as the sea lies southeast of the coastal part of the study area) northern, northwestern, northeastern and southwestern mid-slopes of coastal dunes. A rock cover of 0% is found in the community.

The low shrub *Solanum africanum* (Species Group M, Table 3) is not only diagnostic but also dominant in the community.

The shrub *Chrysanthemoides monilifera* (Species Group R, Table 3) is also prominent in the community.

The tall-, high-, short- and low shrub strata show an average canopy cover of 6%, 5%, 5% and 51% respectively, and an average height of 2.5 m, 1.5 m, 0.75 m and 0.15 m respectively. The forb stratum contains an average canopy cover of 1% and an average height of 0.3 m. The short grass stratum has an average canopy cover of 0.6%, and an average height of 0.75 m.

The community contains an average of only 4 species per relevé.



Photo 11. *Chrysanthemoides monilifera* - *Solanum africanum* community.

7. *Chrysanthemoides monilifera* - *Ehrharta villosa* var. *maxima* low to short closed shrub dune community.

The structure of the community can be described as low to short shrubs, with some short, high and tall shrubs also present, as well as some low forbs, and low and short grass (Photo 12).

The community is found in a mosaic with communities 6, 8 and 9 in the sparsely vegetated shifting sand dune area adjacent to the coast. The community is also found in a mosaic with communities 6 and 8 in the dense vegetated sand dune area found at the seashore and deeper inland, adjacent to the shifting sand dune area.

The community is found at an altitude of 1 – 21 m, at a gradient of 3° to 45°, on coastal dunes and dune troughs (plains between dunes). A rock cover of 0% is found in the community.

The shrubs *Stoebe cinerea* and the grass *Ehrharta villosa* var. *maxima* (Species Group N, Table 3), are diagnostic for the community.

The shrub *Chrysanthemoides monilifera* (Species Group R, Table 3) is dominant in the community.

The shrubs *Solanum africanum* (Species Group M, Table 3), *Stoebe cinerea* (Species Group N, Table 3), *Morella cordifolia* (Species Group P, Table 3),

*Passerina rigida* (Species Group Q, Table 3) and *Metasia muricata* (Species Group R, Table 3) are prominent in the community.

The tall-, high-, short- and low shrub strata show an average canopy cover of 6%, 10%, 29% and 16% respectively, and an average height of 2.5 m, 1.5 m, 0.75 m and 0.3 m respectively. The forb stratum contains an average canopy cover of 2% and an average height of 0.3 m. The short restioid stratum has an average canopy cover of 0.3%, and an average height of 0.2 m. The sedge stratum contains an average canopy cover of 0.5%, and an average height of 0.15 m. The high-, short-, and



Photo 12. *Chrysanthemoides monilifera* - *Ehrharta villosa* var. *maxima* , showing a typical example of the sparsely-vegetated dune area, with *Chrysanthemoides monilifera* in the front, and *Passerina rigida* at the top of the dune.

low grass strata have an average canopy cover of 0.5%, 2% and 2% respectively, and an average height of 1.5 m, 0.75 m, 0.3 m respectively.

The community has an average of 10 species per relevé.

#### 7.1 *Chrysanthemoides monilifera* - *Rhus crenata* short to high shrub dune sub-community.

The structure of the sub-community can be described as short to high shrubs, with some short and tall shrubs also present, as well as some low forbs, low restios, low sedges, and low, short and high grass.

The sub-community is found in a mosaic with communities 6, 8 and 9 in the sparsely vegetated shifting sand dune area, adjacent to the coast.

The sub-community is found at an altitude of 0 – 21 m, at a gradient of 8° to 45°, on the very steep (26° - 45°) northern, northeastern, northwestern and southern slopes and moderate (8° - 16°) peaks of coastal dunes and on the gradual to moderate (3° - 16°) dune troughs. A rock cover of 0% is found in the sub-community. It can in general be said that the sub-community is found in areas that are at least slightly sheltered from the southeastern wind, carrying salt spray, either because of slope direction, or because of the presence of other nearby dunes.

The shrubs *Rhus crenata* (Species Group O, Table 3), is the only diagnostic species.

*Passerina rigida* (Species Group Q, Table 3), *Chrysanthemoides monilifera* (Species Group R, Table 3), *Metalasia muricata* (Species Group R, Table 3), are dominant in the sub-community.

The shrubs *Solanum africanum* (Species Group M, Table 3), *Stoebe cinerea* (Species Group N, Table 3), *Morella cordifolia* (Species Group P, Table 3), and the grass *Ehrharta villosa* var. *maxima* (Species Group N, Table 3) are also prominent in the sub-community.

The sub-community contains an average of 12 species per relevé.

## 7.2 *Chrysanthemoides monilifera* - *Morella cordifolia* low to short closed shrub dune sub-community.

The structure of the sub-community can be described as low to short shrubs, with some high and tall shrubs, as well as some low forbs, low restios, low sedges, and low, short and high grass (Photo 13).

The sub-community is found in a mosaic with communities 6 and 8 in the dense vegetated sand dune area found at the seashore and deeper inland, adjacent to the shifting sand dune area.

The sub-community is found at an altitude of 1 – 21 m, at a gradient of 0° to 45°, on the steep to very steep (16 - >45°) southern, southwestern, northern and northeastern mid-slopes, moderate (8 - 16°) peaks of coastal dunes, and on the gradual (3 - 8°) dune troughs. A rock cover of 0% is found in the sub-community. The sub-community is mostly exposed to sea mist, and can in general be found almost parallel to the direction of the southeastern sea wind. The dune troughs on which part of the sub-community occurs, are in general much larger, more exposed, open areas, than those on which sub-community 7.1 occurs. The leaf structure and orientation of the most dominant plant species found in the sub-community (*Morella cordifolia*), is such that it enhances the ability of the plant to catch moisture, originating from seaside coming mist.

The shrubs *Morella cordifolia*, *Lessertia frutescens* (Species Group P, Table 3), are dominant diagnostic species, and *Chrysanthemoides monilifera* (Species Group R, Table 3) is also dominant in the sub-community.

The shrubs *Stoebe cinerea* (Species Group N, Table 3), *Passerina rigida* (Species Group Q, Table 3), and *Metalasia muricata* (Species Group R, Table 3), and the grass *Ehrharta villosa* var. *maxima* (Species Group N, Table 3) are also prominent in the sub-community.

The sub-community contains an average of 11 species per relevé.



Photo 13. *Chrysanthemoides monilifera* - *Morella cordifolia* sub-community with *Morella cordifolia* dominant, and showing a typical example of the densely vegetated dune area.

8. *Ehrharta villosa* var. *maxima* low to high closed dune grassland community.

The structure of the community can be described as low to high closed dune grassland.

The community is found in a mosaic with communities 6, 7 and 9. in the sparsely vegetated, shifting sand dune area adjacent to the coast, in a mosaic with communities 6 and 7, in the densely vegetated sand dune area found at the seashore and deeper inland, adjacent to the shifting sand dune area, and also in a mosaic with community 10 in the coastal strand area, adjacent to the sea.

The community is found at an altitude of 3 – 21 m, at a gradient of 16° to 45°, on the southern and southwestern slopes of coastal dunes. A rock cover of 0% is found in the community. There can in general be said that the community is found on the otherwise not-vegetated or sparsely vegetated sand dunes, or the more mobile shifting sand dunes.

The grass *Ehrharta villosa* var. *maxima* (Species Group N, Table 3) is dominant in the community.

The high-, short-, and low grass strata have an average canopy cover of 3.5%, 25%, and 15% respectively and an average height of 1.5 m, 0.75 m, and 0.3 m respectively.

The community contains an average of only 1 species per relevé.

9. *Ammophila arenaria* low to high closed dune grassland community.

The structure of the community can be described as low to high closed dune grassland (Photo 14).

The community is found in a mosaic with communities: 6, 7 and 8 in the sparsely vegetated shifting sand dune area adjacent to the coast.



Photo 14. *Ammophila arenaria* community, showing the exotic grass species.

The community is found at an altitude of 1 – 21 m, on the northern and northeastern dry, warm, mid-slopes of sand dunes, at a gradient of 16° to 45°. The rock cover is 0%. The soil can be described as the Namib form (Macvicar 1991).

The exotic grass *Ammophila arenaria* (Species Group S, Table 3) is diagnostic and dominant species in the community.

The shrub stratum has an average height of 1m and an average canopy cover of 10%. The grass stratum has an average height of 0.7 m and an average canopy cover of 44%.

The community contains an average of only 3 species per relevé.

10. *Arctotheca populifolia* - *Thinopyrum distichum* short to low open strand community.

The structure of the community can be described as short to low open strand grassveld with low forbs (Photo 15).

The community is situated in the area directly adjacent to the sea.

The community is found at an altitude of 0 – 3 m, at a gradient of 0° to 16°, on the dry beach, gravel plain behind the low frontal dunes, on the southern and southeastern slopes of low frontal dunes along the coastline. The rock cover varies from 0-50%. There is a rock cover of 0% on the beach and dunes and a rock cover of 30-50% on the gravel plain. The rocks on the gravel plain are mostly sandstone and quartzite roll-stones (in all probability deposited, by the sea, during a prior increase in sea level), originating from Table mountain sandstone, and is considered as part of the Bredasdorp group (Malan *et al.* 1994). The soil can be described as the Namib form (Macvicar 1991).

The forb *Arctotheca populifolia* and the grass *Thinopyrum distichum* (Species Group T, Table 3) are diagnostic for and prominent in the community.



Photo 15. *Arctotheca populifolia* - *Thinopyrum distichum* community, showing one of the gravel-plain areas of the community.

The community contains an average of only 2 species per relevé.

### ORDINATION

The distribution of syntaxa along the first (x) and second (y) axes of the DECORANA ordination (Hill 1979b) can be seen in Figure 7, 8 and 9. The vegetation gradient indicated along the x-axis is associated with soil clay / sand content. The vegetation gradient along the y-axis is associated with the degree of exposure to wind. Two distinct groups of communities were distinguished: The first group includes communities 1 to 4, (Figure 7) and are those found on the inland plains and hills of the study area. The second group includes community 5 to 10, (Figure 8), and are those found on the coastal plains, hills, dunes and strand area of the study area. The relation between the two groups of communities can also be seen in Figure 9.

The result supports the classification. The vegetation gradient revealed by the distribution of the plant communities concurs with an environmental gradient on axis 2 where plant communities found on soil with a high clay content occur at the left, and plant communities found on very sandy soil are located to the right of the diagram. The distribution of plant communities also concurs with an environmental gradient on axis 3, where plant communities that are sheltered from the wind, by the presence of *Acacia cyclops* trees, or other environmental conditions (for instance sheltered by dunes all around), shows a gradient of sheltered communities at the bottom, to exposed communities at the top of the diagram.

### CONCLUDING REMARKS

The plant communities (Figure 10), could all be related to specific environmental conditions and are therefore floristically and ecologically distinguishable and interpretable. Plant community variations are closely associated with differences in soil, (soil depth, % clay/sand) as well as exposure to the northwestern (land-side) and southeastern (sea-side) winds, the two dominant wind-types found in the study area.

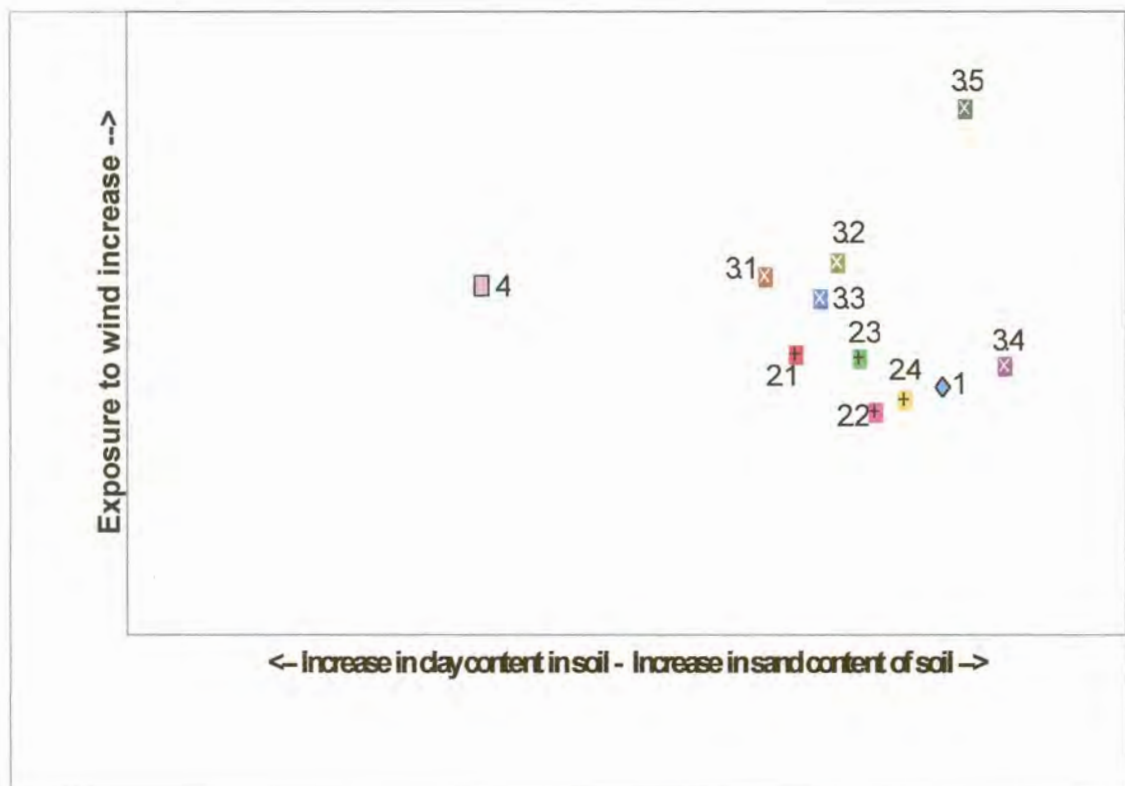


Figure 7. Ordination diagram of the inland plains and hills of Andrew's Field and Tsaba-Tsaba nature reserve, showing the distribution of the plant communities along the x and y axes.

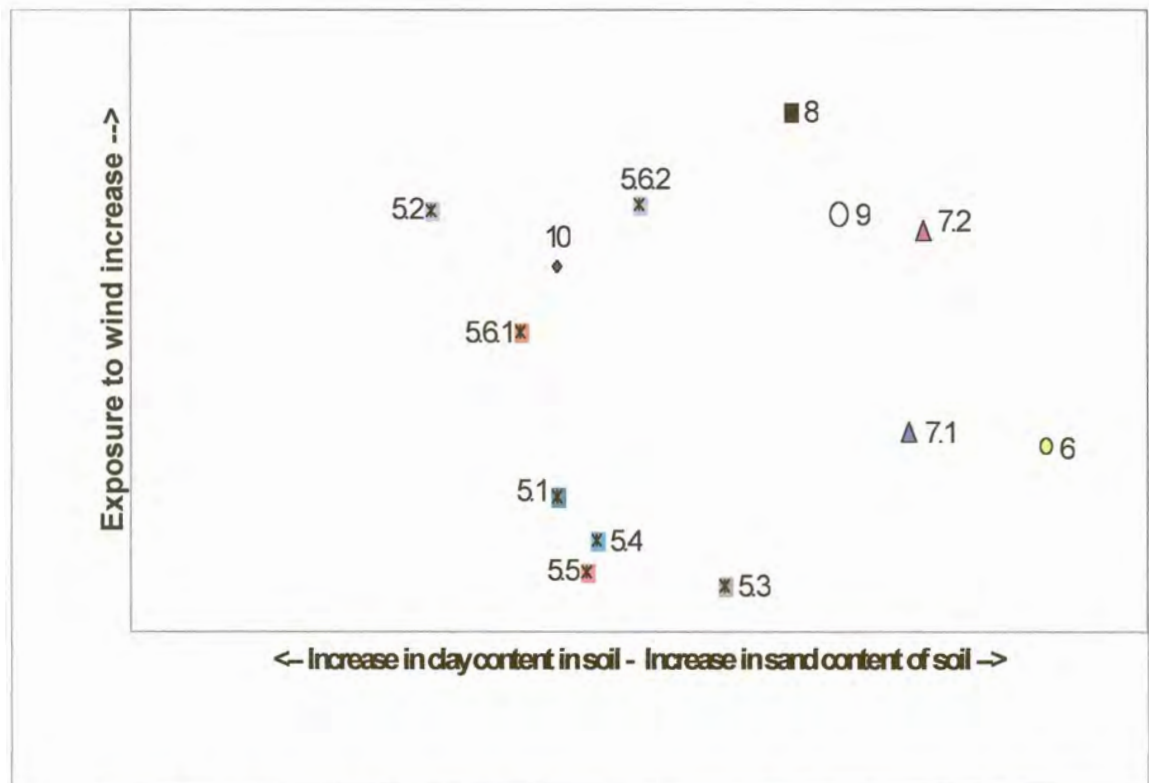


Figure 8. Ordination diagram of the coastal thicket, dunes and strand of Andrew's field and Tsaba-Tsaba Nature reserve, showing the distribution of the plant communities along the x and y axes.

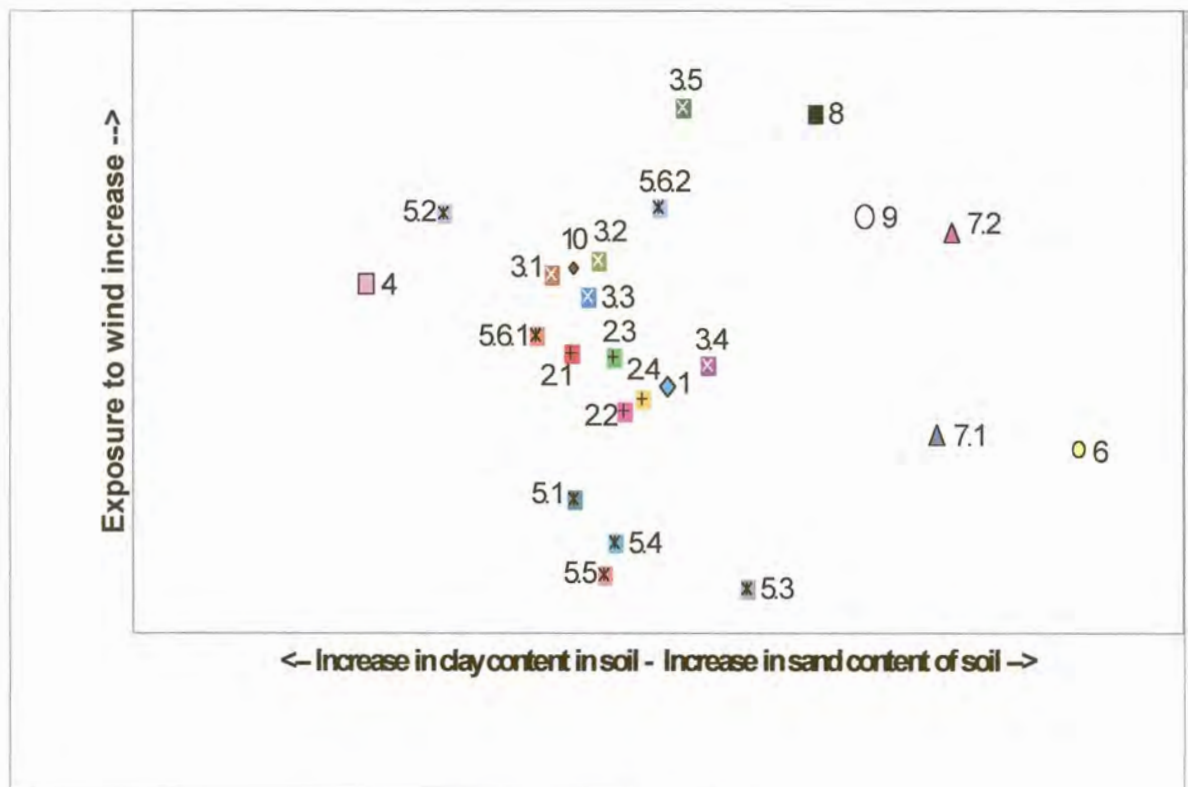
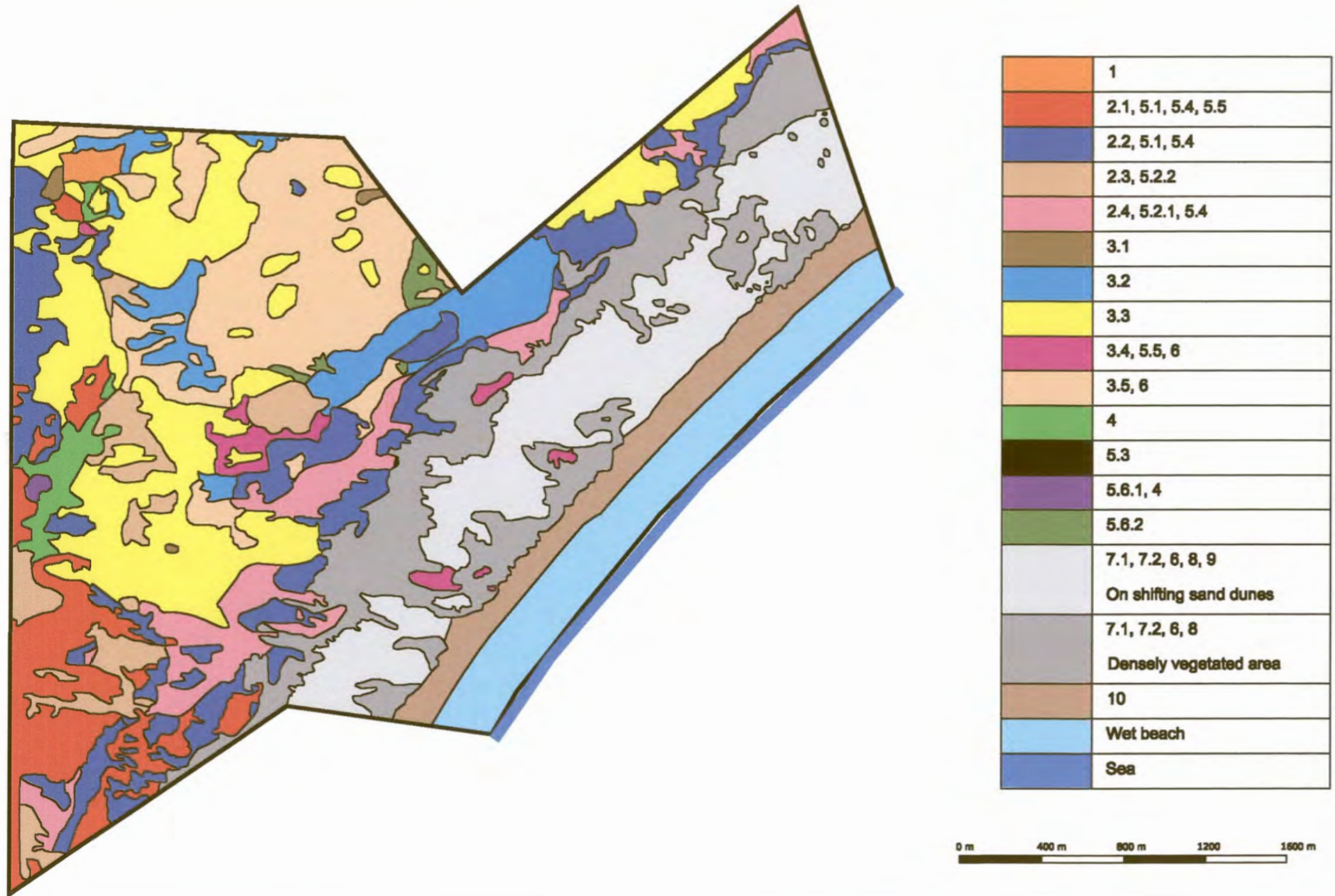


Figure 9. An x-y ordination of the plant communities of Andrew's Field and Tsaba-Tsaba nature reserve, showing the relationship between the inland plains and hills area and the coastal thicket, dunes and strand area.



**Figure 10: Vegetation Map of the Vegetation units within Andrew's Field and Tsaba-Tsaba Nature Reserve compiled from this study**

## KEY TO VEGETATION MAP

1. *Phragmites australis* - *Juncus kraussii* short to high closed reed  
Wetland community.

2.1, 5.1, 5.4, 5.5 - Mosaic of:

2.1 *Adromischus caryophyllaceus* - *Chondropetalum microcarpum*  
low closed limestone fynbos sub-community.

5.1 *Rhus lucida* - *Euclea racemosa* low to short closed thicket sub-  
community.

5.4 *Helichrysum dasyanthum* - *Euclea racemosa* low to short closed  
thicket sub-community.

5.5 *Acacia cyclops* - *Euclea racemosa* high to tall closed thicket sub-  
community.

2.2, 5.1, 5.4 - Mosaic of:

2.2 *Passerina corymbosa* - *Chondropetalum*  
*microcarpum* low to short closed fynbos sub-community.

5.1 *Rhus lucida* - *Euclea racemosa* low to short closed thicket sub-  
community.

5.4 *Helichrysum dasyanthum* - *Euclea racemosa* low to short closed  
thicket sub-community.

2.3, 5.2.2 - Mosaic of:

2.3 *Empodium gloriosum* - *Chondropetalum microcarpum* low to short,  
closed limestone fynbos sub-community.

5.2.2. *Carissa bispinosa* - *Euclea racemosa* short to tall closed thicket  
variant.

2.4, 5.2.1, 5.4 - Mosaic of:

2.4 *Eriocephalus kingesii* - *Chondropetalum microcarpum* low to short,  
closed fynbos sub-community.

5.2.1. *Olea exasperata* - *Euclea racemosa* short to high closed thicket variant.

5.4 *Helichrysum dasyanthum* - *Euclea racemosa* low to short closed thicket sub-community.

3.1 *Amphitalia alba* - *Leucadendron meridianum* tall closed limestone fynbos sub-community.

3.2 *Erica abietina* - *Leucadendron meridianum* tall closed limestone fynbos sub-community.

3.3 *Ehrharta calycina* - *Leucadendron meridianum* low to short limestone fynbos sub-community.

3.4 *Metalasia muricata* - *Leucadendron meridianum* tall closed limestone fynbos sub-community.

3.5, 6 - Mosaic of:

3.5 *Protea susannae* - *Leucadendron coniferum* high closed fynbos sub-community.

6. *Chrysanthemoides monilifera* - *Solanum africanum* low closed dune community.

4. *Oedera uniflora* - *Elytropappus rhinocerotus* low closed Renosterveld community.

5.3 *Acmadenia obtusata* - *Euclea racemosa* short to tall closed thicket sub-community.

5.6.1, 4 - Mosaic of:

5.6.1 *Elytropappus rhinocerotus* - *Euclea racemosa* short to tall closed thicket variant.

4. *Oedera uniflora* - *Elytropappus rhinocerotus* low closed Renosterveld community.

7.1, 7.2, 6, 8, 9 - Sparsely vegetated mosaic of:

7.1 *Chrysanthemoides monilifera* - *Rhus crenata* short to high dune shrub sub-community.

7.2 *Chrysanthemoides monilifera* - *Morella cordifolia* low to short closed shrub sub-community.

6. *Chrysanthemoides monilifera* - *Solanum africanum* low closed dune community.

8. *Ehrharta villosa* var. *maxima* low to high closed dune grassland community.

9. *Ammophila arenaria* low to high closed dune community.

7.1, 7.2, 6, 8 - Densely vegetated mosaic of:

7.1 *Chrysanthemoides monilifera* - *Rhus crenata* short to high dune shrub sub-community.

7.2 *Chrysanthemoides monilifera* - *Morella cordifolia* low to short closed shrub sub-community.

6. *Chrysanthemoides monilifera* - *Solanum africanum* low closed dune community.

8. *Ehrharta villosa* var. *maxima* low to high closed dune grassland community.

10. *Arctotheca populifolia* - *Thinopyrum distichum* short to low open strand community.

REFERENCES:

- COWLING, R.M. & RICHARDSON, D. 1995. *Fynbos: South Africa's Unique floral kingdom*. Fernwood Press, Cape Town.
- EDWARDS, D. 1983. A broad-scale structural classification of vegetation for practical purposes. *Bothalia* 14: 705-712.
- HENNEKENS, S.M. 1996b. *MEGATAB – a visual editor for phytosociological tables*. Giesen & Geurts, Uft, The Netherlands.
- HILL, M.O. 1979a. *TWINSPAN: A Fortran program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes*. Cornell University, New York.
- HILL, M.O. 1979b. *DECORANA: A Fortran program for detrended correspondence analysis and reciprocal averaging*. Cornell University, New York.
- LOW, A.B. & REBELO, A.G. 1998. *Vegetation of South Africa, Lesotho and Swaziland: A companion to the vegetation map of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs & Tourism, Pretoria.
- MACVICAR (ed.) 1991. *Grondklassifikasie - 'n Taksonomiese sisteem vir Suid-Afrika*. Departement van Landbou-Ontwikkeling, Pretoria.
- MALAN, J.A., VILJOEN, J.H.A., SIEGFRIED, H.P. & WICKENS, H. de V. 1994. *Die geologie van die gebied Riversdale*. Staatsdrukker, Pretoria.
- MUSTARD, P., COWLING, R. & ALBERTYN, J. 1997. *Southern Overberg: South African wildflower guide 8*. National Book Printers, Cape Town.