

# The vegetation of the southern Langeberg, Cape Province. 1. The plant communities of the Boosmansbos Wilderness Area

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## ABSTRACT

An analysis of the fynbos shrublands and forests of the Boosmansbos Wilderness Area, southern Langeberg, Cape Province, South Africa, is presented. Data were collected at 119 sites in mature fynbos vegetation (>10 years old) and at five sites in patches of Afromontane Forest. Emphasis was placed on the fynbos shrublands and sample sites were subjectively located along a transect from south to north across the Langeberg range in the study area. This south to north orientation follows a complex gradient of changes in aspect, slope, geology, soil form and climate. Data were initially analysed using TWINSPAN and the resulting classification refined using Braun-Blanquet procedures. One forest subassociation and 12 fynbos communities were identified and described. A proposed hierarchical classification of the fynbos communities is presented.

## UITTREKSEL

'n Analise van die fynbos en woude van die Boosmansbos Wildernisgebied, suidelike Langeberge, Kaapprovinsie, Suid-Afrika, word aangebied. Data is van 119 monsterpersele in volwasse fynbosplantegroei (>10 jaar oud) en vyf monsterpersele in Afro-montane woude versamel. Klem is op die fynbosstruikveld gelê en monsterpersele is subjektief langs 'n transek van suid na noord oor die Langeberge in die studiegebied uitgelê. Die suid tot noord oriëntasie volg 'n komplekse gradiënt van veranderings in aspek, helling, geologie, grondform en klimaat. Data is aanvanklik d.m.v TWINSPAN ontleed en die resultaat met behulp van Braun-Blanquet-prosedures verfyn. Een woudsubassosiasie en 12 fynbosgemeenskappe is geïdentifiseer en beskryf. 'n Hiërgiesse klassifikasie van die fynbosgemeenskappe word voorgestel.

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## INTRODUCTION

The position of the Langeberg on the west-east axis of the Cape Fold Belt places it between the mountains of the southwestern Cape and those of the southern Cape (Figure 1). It therefore forms an important highland phytogeographical link between the montane floras of these respective regions.

The southern Langeberg is defined as the Langeberg Range between Kogmanskloof and the Gouritz River. The description and classification of the plant communities of the Boosmansbos Wilderness Area presented in this paper form part of a broad-scale phytosociological study of the southern Langeberg.

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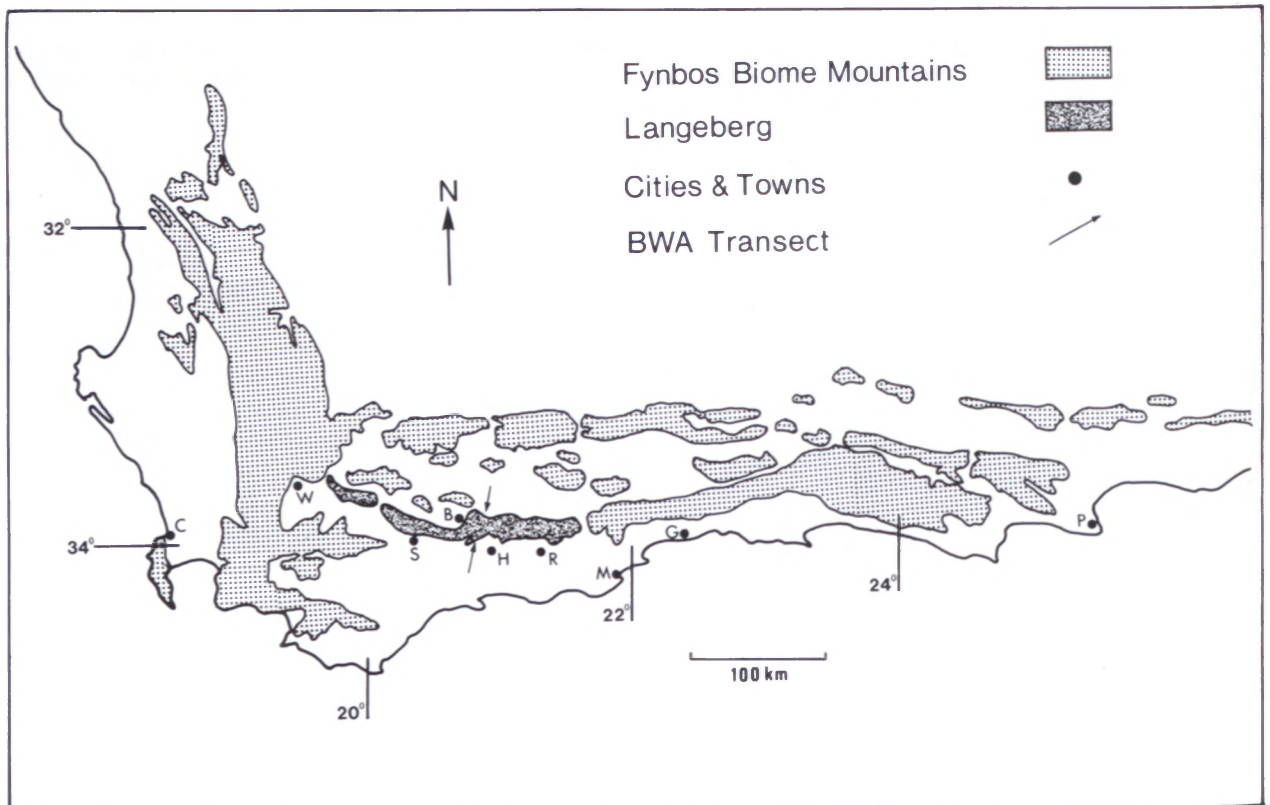


FIGURE 1.—Map of the mountains of the Fynbos Biome showing the position of the Langeberg and the location of the Boosmansbos Wilderness Area (BWA): B, Barrydale; C, Cape Town; G, George; H, Heidelberg; M, Mossel Bay; P, Port Elizabeth; R, Riversdale; S, Swellendam and W, Worcester.

Separate papers cover the description and classification of the vegetation of two other similar transects at Swellendam and Bergfontein (near the Gouritz River) (McDonald 1993a & b).

#### STUDY AREA

##### Location

The Boosmansbos Wilderness Area (BWA) near Heidelberg, Cape Province, is more or less centrally situated in the southern Langeberg and extends across its widest part (13 km). The area forms part of the Grootvadersbosch State Forest and was proclaimed a wilderness area in 1978. The mountain catchments are managed for conservation, limited-access recreational hiking and production of potable water. The Duivenhoks River has its origins in these catchments.

The BWA is approximately 14 200 ha in extent. It is bounded on the south side by agricultural land, on the north side by a private nature reserve and on the west and east sides by privately owned mountain land.

An access road, the Barend Koen Road, traverses the area from the lower south slopes, adjoining the farm Goedehoop, to Helderfontein at 1 150 m. The road is used for management and forms part of the hiking trail network in the area. During this study the road and paths gave ready access to the area for sampling purposes.

The transect was arbitrarily delimited through the centre of the BWA, straddling the Barend Koen Road on the south slopes and the path to Witbooisrivier on the north slopes. It does not follow a straight line over the mountain range

but was positioned to cover as much topographical variation and plant community variation as possible. The transect area was approximately 3 000 ha.

##### Physiography

The southern plateau-like footslopes of the Langeberg in the BWA are deeply incised by the Duivenhoks River. At higher elevations, fault valleys such as Vaalrivierkloof, Bobbejaankloof, Platbosrivierkloof and Saagkuilkloof, which feed the Duivenhoks River, are encountered. Saagkuilkloof and Platbosrivierkloof fall within the delimited transect and have north- and south-facing slopes. North of Platbosrivierkloof is Repeater Kop, a high west-east ridge lying approximately between Vaalrivierkloof and Helderfontein. Behind (north of) Repeater Kop is the Helderfontein Valley and north of that a high ridge runs westwards from Grootberg. The Moeras River and Helderfontein Stream start at the watershed behind Repeater Kop. Moeras River drains northwestwards towards Barrydale. Grootberg is the highest peak (1 627 m) in BWA and directly below it is the deep Boosmansbos Valley. The stream from Helderfontein runs through this valley, through a gorge below Noukrans Peak (1 443 m) and Horingberg (1 487 m) to join the Duivenhoks River outside the wilderness area.

North of Grootberg is a series of sandstone ridges with interspersed shallow valleys. There is one main, relatively broad valley with a shallow gradient eastwards towards Brandrivier. North of the valley is Deception Ridge, so named because of its deceptive height. The north slopes of Deception Ridge are steep and rocky, giving way lower down to mesa-like plateaux of gravels and sandstone conglomerate (see below).

## Geology

The Langeberg is one of the west-east trending mountain ranges with northward-verging folds, in the eastern zone of the Cape Fold Belt. It consists mainly of sediments of the Table Mountain Group (Cape Supergroup) and in part, of pre-Cape Malmesbury Group sediments. The range was formed during the Cape orogeny when the rocks of the Cape Supergroup were folded in a single phase, multiple event orogeny of Permian to Late Triassic age (De Villiers 1944; Hälbich *et al.* 1983). The core of folding in the Langeberg is at Tradouw Pass where the massive folding has resulted in what Le Roux (1974) describes as the Langeberg megastructure.

A transect over the Langeberg at any given locality has its own peculiar local geology owing to folding, faulting and consequent positioning of strata and fault valleys. Only one detailed geological study of a section of the Langeberg exists (Le Roux 1974, 1983). Fortuitously this coincides in part with the area proclaimed as BWA and with the vegetation sampling transect chosen for this study.

Five formations of the Table Mountain Group are found in the study area. The Peninsula Formation sandstone makes up the southern slopes from about 400–1 600 m a.s.l. At 1 150 m the Cedarberg Formation is represented by a relatively thin band of shale in the vicinity of Helderfontein. It is deeply incised and eroded at the headwaters of the Moeras and Duivenhoks Rivers.

North of the Cedarberg Formation are the sandstone sediments of the Nardouw Subgroup comprising the Goudini, Rietvlei and Skurweberg Formations. For the purposes of this study, the Nardouw Subgroup is equated with the Peninsula and Cedarberg formations since the finer distinctions are of secondary importance. Nardouw Subgroup sandstone is also found on the south side of the mountain between Tradouws Pass and Grootvadersbosch Forest Station, Ertjiesvleiberg and in a narrow band eastwards from below Horingberg to beyond Palmyra (Le Roux 1974, 1983). However, Nardouw sandstones were not encountered on the south side of the range on the vegetation transect as designated in BWA.

Above Witbooisrivier, on the north side of the transect, high terrace gravels are found (Lenz 1957; Le Roux 1974). These gravels are cemented by a siliceous matrix, forming resistant silcrete caps or duricrusts (Schloms *et al.* 1983) and are remnants of the African Erosion Surface (Partridge & Maud 1987).

Gravels of the Enon Formation are found at the southern extremity of the vegetation transect. Le Roux (1974) described the Enon sediments as 'weakly consolidated gravels and mudstones in alternating strata ... composed of vein quartz, quartzite (derived from the Table Mountain Group), greenish sandstones and shales (apparently from the Bokkeveld Group), as well as conglomerates older than the Enon Formation.'

## Soils

The soils of BWA agree with the general pattern described by Campbell (1983) for southern Cape coastal mountains and the classification follows the system of the Soil

Classification Working Group (SCWG 1991). The soil forms encountered, their positions in the landscape and their relationship to the geological formations are outlined below.

### Oakleaf Form

Soils of this form have an orthic A-horizon over a diagnostic neocutanic B-horizon. The detailed definition of a 'neocutanic' horizon is given by SCWG (1991); briefly it is a horizon derived from recent sediments and other unconsolidated materials. It shows little colour differentiation and weak structural development.

At low altitude (350 m), at the southern extremity of the BWA vegetation transect, Oakleaf Form soils are encountered. These soils result from the weathering of Enon Formation sediments (see above). At one site (Relevé 59) on the Cedarberg Formation shale at Helderfontein, the soil was identified as Oakleaf Form. This soil has formed by weathering of shale in a moist situation as opposed to the formation of a Clovelly Form soil (described below) under slightly drier conditions.

### Cartref and Houwhoek Forms

Cartref and Houwhoek Form soils are found from low (425 m) to high (1 600 m) elevations on south-facing slopes, mainly on parent rock of the Peninsula Formation. The form encountered at any position in the landscape is dependent on the land facet (convexity or concavity), its steepness and consequent drainage. The Houwhoek Form soils display weak ferrihumic character in the B-horizon and are very close to the more common Cartref Form soils with lithocutanic B-horizons, showing no podzolization.

### Champagne Form

Champagne Form soils are found at sites where drainage is impeded and where deep accumulation of organic matter has occurred. This soil form is typically found at 'seeps' where Restionaceae form dense, matted peat-like deposits. On some of the high peaks (e.g. Grootberg, 1 627 m) and ridges (Repeater Kop, 1 506 m) Champagne Form soils are found on south aspects, on steep slopes. The slopes have a mean gradient of 30° and organic material has accumulated to an average depth of 700 mm. Podzolization may occur in the parent rock beneath, but this would presumably have little influence on the vegetation which is rooted in the humus.

### Mispah Form

At sites where bedrock is close to the surface and where soil development is poor (due to a combination of excessive drainage, high insolation, low organic matter accumulation), Mispah Form soils with shallow orthic A-horizons over hardrock are found. This form is found on the high-altitude north-facing slopes of Repeater Kop ridge, Grootberg and on the terraced gravel-conglomerates above Witbooisrivier.

### Glenrosa Form

Soils of the Glenrosa Form are also found on the north aspect of the ridges and peaks of BWA but on the middle

to lower slopes. Here the form is diagnosed by presence of Orthic A and Lithocutanic B-horizons. This form typically occurs on the well-drained terraced ridges of the Nardouw Subgroup strata north of Grootberg.

### Clovelly Form

Clovelly Form soils are found at three different localities in BWA. These soils with a Yellow-Brown Apedal B diagnostic horizon below an Orthic A-horizon have mainly but not exclusively resulted from accumulation of transported material. The exception is on the Cedarberg Formation shaleband near Helderfontein where the *in situ* shale, with its fine-grained matrix has weathered to Clovelly Form soils.

The south-facing slope of the ridge west of Grootberg is a debris slope of Nardouw Subgroup sandstone. These slopes which lie above the contact with the Cedarberg Formation and which are moderately well-drained, exhibit Clovelly Form soils (Relevé 64).

In the eastward-trending intermontane valley north of Grootberg, deposits of material eroded from Nardouw Subgroup sandstones have given rise to well-developed Clovelly Form soils. These soils are well drained and in one pit examined (Relevé 130) pieces of reworked ferricrete were found at 700 mm depth. On Deception Ridge (north-most ridge on the transect), the south-facing terraced slopes have a mixture of Clovelly and Glenrosa Forms depending on the presence or absence of apedal and lithocutanic B-horizons respectively.

### Climate

Local climate of the Boosmansbos Wilderness Area is poorly documented. A rainfall recording station is situated at Grootvadersbosch Forest Station (Strawberry Hill), however, this inadequately reflects rainfall as it occurs and changes in the montane environment along the BWA transect. The limited data available at best reflect low-altitude conditions on the south slopes. Fuggle (1981) warns of the dangers of interpolation between climatic stations. However, since no climate measurements were made during this study, limited available data from Weather Bureau records (Strawberry Hill 025/599) and Fuggle (1981) are used to obtain at least seasonal trends in climate. Mean annual precipitation estimates were obtained from isohyet maps prepared by Dent *et al.* (1987).

### Wind

In summer the prevailing winds from the southeast and southwest influence the Boosmansbos Wilderness Area the most. The onshore, moisture-laden southeast winds are trapped by the Langeberg and orographic rain occurs. During the winter the winds blow primarily from the northwest and southwest also bringing rain following cold fronts. Berg winds occur in winter heralding the approach of cold fronts (Fuggle & Ashton 1979; Fuggle 1981; Heydorn & Tinley 1980; Tyson 1964, 1969).

### Temperature

Temperature data for the study area are non-existent. This situation is commonly found since few weather stations are situated in the Cape mountains (Bond 1981; Fuggle & Ashton 1979; Fuggle 1981). Temperatures in

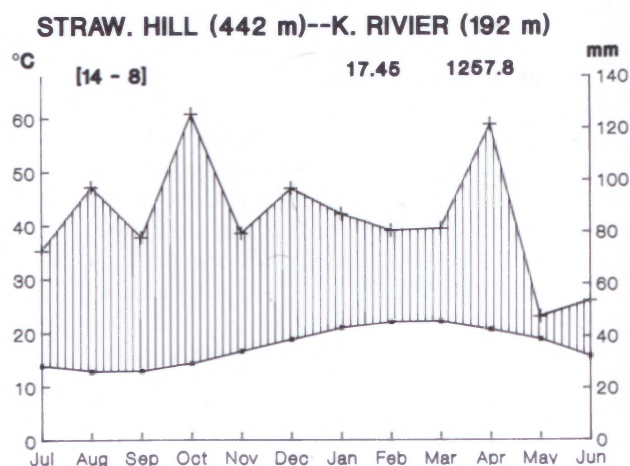


FIGURE 2.— Walter-Lieth climate diagram representing the climate on the southern slopes of the Boosmansbos Wilderness Area. Rainfall data from Strawberry Hill (Grootvadersbosch Forest Station) and temperature data from the nearest station at Karringmelksrivier, near Heidelberg.

mountain areas vary considerably from place to place; therefore it is only possible to make generalized statements about the effect of latitude and altitude on temperature (Fuggle 1981.)

The nearest reliable temperature data are from Karringmelksrivier (192 m a.s.l.) near Heidelberg, well away from the BWA. However, these data are used to give general trends in seasonal temperature variation. In Figure 2 they are combined with rainfall data from Strawberry Hill to give an approximation of the climate of the southern slopes of the BWA.

### Precipitation

Precipitation in the BWA occurs mostly as rain. However, fog or mist from low stratus cloud plays a considerable, but unmeasured, role in contributing to total precipitation. Snowfalls occur in September, October and occasionally November.

As for other climatic parameters, rainfall is not measured on a regular basis in the study area. It is clear from observation that topography and aspect significantly affect rainfall distribution. Interpolated data from Dent *et al.* (1987) show that the lower south slopes of the study area receive approximately 600 mm mean annual precipitation. With an increase in altitude this value increases to almost 1 300 mm on the high peaks. The largest part of the study area receives 1 000 mm precipitation on average each year. With a decrease in altitude on the north slopes, bordering the Little Karoo, a steep gradient exists, with the lower slopes receiving less than 300 mm mean annual precipitation (nearby Barrydale receives 276 mm p.a.; Fuggle 1981).

The seasonal distribution of rainfall on the south aspects of the study area are reflected in the data from Strawberry Hill weather station, and on the lower north slopes by data from Klein Doornrivier, Figure 3. No month is without rain but most rain falls in spring and autumn. Rainfall results from post-frontal anticyclonic (onshore) air movement over the subcontinent from August to November. In the autumn months of March, April and May rainfall results from the progression of cold fronts along the

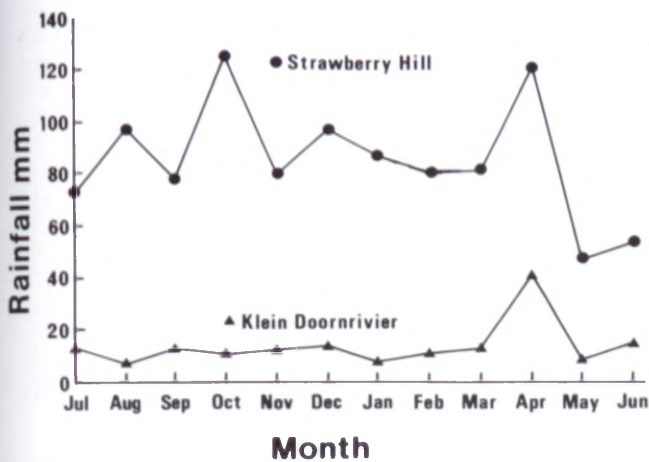


FIGURE 3. — Mean monthly rainfall at Strawberry Hill (1978–1990) and Klein Doornrivier (1982–1990) located at the lower south and north extremes of the Boosmansbos sample transect respectively. Rainfall peaks occur in spring (October) and autumn (April) at Strawberry Hill and in autumn at Klein Doornrivier.

southern coast. Occasional cut-off lows occur which may result in extensive rains (Van Heerden & Hurry 1987), affecting rainfall over the Langeberg as well.

#### Solar radiation

No measured data are available for incoming solar radiation on the slopes of the Langeberg. However, estimates of incoming radiation will be obtained from the RADSLOPE model (Schulze & Lambson, unpublished) and presented in a later paper (McDonald, unpublished).

Bond (1981) calculated potential radiation for a range of slopes and aspects for 33° 30' south latitude using Swift's (1976) algorithm. Incoming radiation in summer was shown to be similar on all slopes and aspects, whereas in winter steep north slopes receive the highest and steep south slopes the lowest radiation. This is true for the Langeberg, and since the range lies between 33° 30' and 34° South, Bond's results could safely be extrapolated here. Similar to the Outeniqua Mountains and the Swartberg, the Langeberg is also often capped with cloud, further limiting incoming radiation, particularly on the high-elevation south slopes.

#### METHODS

Methods employed in sampling the vegetation of Boosmansbos Wilderness Area follow those of McDonald (1983, 1988) where rectangular plots of 5 × 10 (50 m<sup>2</sup>) were used to sample fynbos shrublands; 5 × 10 m plots are commonly used in surveys of fynbos (e.g. Boucher 1978; Bond 1981; Campbell 1985; Boucher 1987). The long axis of each plot was oriented parallel with the contour, with the plot being subdivided into 10 equal-sized subplots to facilitate data recording.

In Afromontane forests circular plots with a radius of 11.3 m (≈ 400 m<sup>2</sup>) were used to collect both floristic and structural data (Geldenhuys *et al.* 1988; Knight 1989).

Only permanently recognizable species were recorded. Geophytes such as *Bobartia* spp. were recorded and included in the analyses. In general 'ephemeral' geophytes and annuals encountered were noted but not used in the analyses. The Braun-Blanquet (BB) cover-abundance scale was applied as shown in Tables 1 & 2. The midpoint of

the BB values given as percentage cover is as follows: 5 = 87.5%; 4 = 62.5%; 3 = 37.5%; 2 = 15.0%; 1 = 2.5%; + = 0.1%; R = value ignored (Mueller-Dombois & Ellenberg 1974; Werger 1974). A border zone of 1.5 m from the perimeter of each plot was searched for any species not found in the marked plot. Species occurring outside the plot are represented by 'O' in the phytosociological tables. Structural data were collected where the strata and their respective cover (BB scale) were recorded at each sample site. The structural characters of stems (e.g. woody, herbaceous) and leaves (e.g. simple, cupressoid, sclerophyllous, leptophyllous) were also evaluated using the BB scale.

TWINSPAN (Hill 1979) was used for initial analysis of the floristic data. The classification was then refined further by sorting the phytosociological tables with the aid of PCTables (Boucher unpublished).

Boosmansbos Wilderness Area is the only area of the Langeberg for which 1:20 000 colour aerial photography is available (Job 824). It was therefore possible to stratify the study area, identify major land type/vegetation units and predetermine general location of plot positions in these units prior to fieldwork. Precise positions of sample plots were subjectively determined with plots placed in stands of mature fynbos (>10 years old).

Floristic composition of communities was compared using diagnostic or character species of each community as the main criteria. Those communities that were not immediately obviously equivalent were subjectively judged on the basis of character species, taxonomic relatedness or morphological similarity e.g. *Berzelia lanuginosa* found in the southwestern Cape versus *B. intermedia* found on the Langeberg, in similar habitats. These relationships do not reflect strict 'synonymy' but serve as a guide for future synthesis of communities found in fynbos vegetation.

#### VEGETATION

Boosmansbos Wilderness Area is named after the well-preserved Afromontane Forest patch in the deep ravine below Grootberg Peak. There are a number of other smaller patches of forest below Repeater Kop as well. These forest patches represent one vegetation type of limited extent in the study area. Shrubby fynbos covers the greater proportion of BWA and is described in greater detail.

Muir (1929) recognised three major categories of fynbos in the Langeberg: 1, The Succession of Bare Rock Surfaces and Cliffs; 2, The Sclerophyllous Vegetation of the Langeberg; and 3, The Langeberg Forest and Mountain Streams. In the present study emphasis is placed on the Sclerophyllous Vegetation which Muir subdivided into (a) Heath, (b) Macchia (c) (Vegetation of ...) Upper Southern Slopes and Summit and (d) (Vegetation of ...) Northern Slopes and Base.

The fynbos communities are described in the order of the proposed classification. Each community is given a species-binomial name which has no syntaxonomic hierarchical rank (McDonald 1988). The communities are placed in context in the Fynbos Biome (see Rutherford & Westfall 1986) by attempting to relate them to communities described by other workers; based on both floristic and structural similarities. The structural formation of each

Table 1. A phytosociological table of the *Erica hispidula* Shrubland Communities south of Grootberg, Boosmansbos Wilderness Area, Langeberg

|   | Community  |                                     |             |          |           |                   |           |                     |         |
|---|--|-------------------------------------|-------------|----------|-----------|-------------------|-----------|---------------------|---------|
|   | 1  |                                     |             |          |           |                   |           |                     |         |
|   | 1.1  |                                     |             |          | 1.2       |                   |           |                     |         |
|   | 1.2.1  |                                     | 1.2.2       |          | 1.2.3     |                   | 1.2.4     |                     |         |
|   |  |                                     |             |          | 1.2.4.1   |                   | 1.2.4.2   | 1.2.4.3             | 1.2.4.2 |
|   |  |                                     |             |          | 1.2.4.2.1 |                   | 1.2.4.2.2 |                     |         |
|   | A  | B                                   | C           | D        | E         | F                 | G         | H                   | I       |
| Relevé number   | x  | 1*                                  | 1*          | x        | x         | x                 | x         | x                   | 1       |
|   | *66778992*23333366778889992*6678*855556* 1688*   |                                     |             |          |           | 1111*11112222777* |           | 123337889*223366792 |         |
|   | *59089563*11346701470360120*2311*867894*13847*36890126*458905678356*457720599254*392867234 |                                     |             |          |           |                   |           |                     |         |
| Altitude (m)  | .11111111.11111111   | 11111111.1111.111111. 1 1.          |             |          |           |                   |           | .111111 1.111111111 |         |
|   | .24412406.01211044610132451.2212.312112.33233.56643444.578877665566.586812100133.011022135 |                                     |             |          |           |                   |           |                     |         |
|   | .89691660.58231633187341585.9384.021751.98193.13253278.160510474077.187511999581.995485804 |                                     |             |          |           |                   |           |                     |         |
|   | .64362066.29842739286612448.5402.389389.61963.84575728.828361012006.841329270188.758200935 |                                     |             |          |           |                   |           |                     |         |
| Aspect (°)  | .12122122.11123222222211   | 1.1111.21 222.32 23.22121222.212111 | 11321.33 33 | 3 . 12   |           |                   |           |                     |         |
|   | .81842921.92402621061135498.6492.258521.09152.76705098.090288887103.3325362 9951.1511 1411 |                                     |             |          |           |                   |           |                     |         |
|   | .80030055.050505050250000.5005.000000.00050.0500000.500500500005.000500050355.050050557    |                                     |             |          |           |                   |           |                     |         |
| Differential species of <i>Erica hispidula</i> -- <i>Spatalla nubicola</i> Shrublands (1.1)       |  |                                     |             |          |           |                   |           |                     |         |
| <i>Spatalla nubicola</i> Rourke   | .12 203 2.   |                                     | .           | .        | .         | .                 | .         | .                   | .       |
| <i>Helichrysum capense</i> Hilliard   | .1++R R+0.   |                                     | .           | .        | .         | .                 | .         | .                   | .       |
| Species common to Communities 1.1 & 1.2.1   |  |                                     |             |          |           |                   |           |                     |         |
| <i>Anthochortus crinalis</i> (Mast.) Linder   | .33312345.2 +  | 114 + 1351                          | .           | .        | .         | .                 | .         | .                   | .       |
| <i>Erica conferta</i> Andr.   | .1++++ +.  | + ++ +RR2 2.0                       | .           | .        | .         | .                 | .         | .                   | .       |
| <i>Platycaulos anceps</i> (Mast.) Linder  | .4354532 .1  | + 253 3                             | .           | .        | .         | .                 | .         | +                   | .       |
| <i>Brunia alopecuroides</i> Thunb.  | .4 43424 .   | 3 0 1.                              | .           | .        | .         | .                 | .         | .                   | .       |
| <i>Leucadendron spissifolium</i> (Salisb. ex Knight)  | .+10 +1  | 11 2.                               | .0          | .        | .         | .                 | .         | .                   | .       |
| <i>Hippia integrifolia</i> Less.  | .1 + 2+.   | + + + 1.                            | .           | +        | .         | .                 | .         | .                   | .       |
| <i>Erica cordata</i> Andr.  | . 0+ 3.2   | 02 1 3.                             | .           | .        | .         | .                 | .         | .                   | .       |
| <i>Erica regerminans</i> L.   | . 3 21 .   | 2 2 .                               | .           | .        | .         | .                 | +         | .                   | .       |
| <i>Hermas capitata</i> L.f.   | .+R .  | R .                                 | .           | .        | .         | .                 | .         | .                   | .       |
| <i>Erica granulatifolia</i> H.A. Baker  | . 1.   | 0 0.                                | .           | .        | .         | .                 | .         | .                   | .       |
| <i>Erica dianthifolia</i> Salisb.   | .0 .   | 0 + .                               | .           | .        | .         | .                 | .         | +                   | .       |
| Differential species of <i>Restio inconspicuus</i> -- <i>Protea grandiceps</i> Shrublands (1.2.2) |  |                                     |             |          |           |                   |           |                     |         |
| <i>Protea grandiceps</i> Tratt.   | .  | .                                   | ++          | .2300.1  | .         | .                 | .         | .                   | .       |
| Differential species of <i>Restio inconspicuus</i> -- <i>Protea aurea</i> Shrublands (1.2.3)      |  |                                     |             |          |           |                   |           |                     |         |
| <i>Protea aurea</i> (Burm. f.) Rourke subsp. aurea  | .  | .                                   | .           | .333231. | 1.        | .                 | .         | .                   | .       |



Table 1. Cont. ...

Relevé number \* 1\* \* \* \* \* \* \* \* 1  
 \*66778992\*2333366778889992\*6678\*855556\* 1688\* 1111\*111122222777\* 123337889\*223366792  
 \*59089563\*11346701470360120\*2311\*867894\*13847\*36890126\*458905678356\*457720599254\*392867234

| Species common to Communities 1.2.4, 1.2.4.1, 1.2.4.2.1, 1.2.4.2.2, 1.2.4.3 |    |   |   |   |   |   |   |   |   |   |
|---|----|---|---|---|---|---|---|---|---|---|
| <i>Hypodiscus aristatus</i> (Thunb.) Krauss                                 | .  | . | . | . | . | . | . | . | . | + 121. 1+1+2 2.+0+ + 212 . +212 1 331.311031413 |
| <i>Metalasia muricata</i> (L.) D. Don                                       | .  | . | . | . | . | . | . | . | . | R+ 2.1++ +0++. 0 +00 .+ 11 . 2 1                |
| <i>Psoralea pinnata</i> L.  | .  | . | . | . | . | . | . | . | . | ++ . . 0 11211 11.12 12 .+ 0                    |
| <i>Ficinia trichodes</i> (Schrad.) Benth. & Hook. f.                        | .  | . | . | . | . | . | . | . | . | + + + + . 0 .+30 .                              |
| <i>Laurophyllus capensis</i> Thunb.   | .0 | . | + | . | . | . | . | . | . | + . . +01 + .+ 0 .                              |
| <i>Aristea major</i> Andrews  | .  | . | . | . | . | . | . | . | . | 0 . +1+ . .1 + .                                |
| <i>Diospyros glabra</i> (L.) de Winter                                      | .  | . | . | . | . | R | . | . | . | .+ . . .++ R.                                   |
| <i>Lanaria lanata</i> (L.) Dur. & Schinz                                    | .  | . | . | . | . | . | . | . | . | 2 . 1 + . . . + .                               |
| <i>Lightfootia tenella</i> Lodd.  | .  | . | . | . | . | . | . | . | . | R .+ . . .R R .                                 |
| <i>Stoebe saxatilis</i> Levyns  | .  | . | . | . | . | . | . | . | . | 0 . . . . . 1 0                                 |
| <i>Tetraria ustulata</i> (L.) C.B. Cl.                                      | .  | . | . | . | . | . | . | . | . | . . . . . . 22+                                 |
| <i>Hypodiscus argenteus</i> (Thunb.) Mast.                                  | .  | . | . | . | . | . | . | . | . | 1+ . . . . . 2 .                                |
| <i>Indigofera langebergensis</i> L. Bol.                                    | .  | . | . | . | . | . | . | . | . | + + . . . . . 1 .                               |

| Species common to Communities 1.2.1, 1.2.2, 1.2.3, 1.2.4, 1.2.4.1, 1.2.4.2.1, 1.2.4.2.2, 1.2.4.3 |     |   |   |   |   |   |   |   |   |   |
|--|-----|---|---|---|---|---|---|---|---|---|
| <i>Restio inconspicuus</i> Esterhuysen   | .   | . | . | . | . | . | . | . | . | +21+31+ 1112 1 .1+1. 11+ .2++11.2++11+++ .+1 1111112 .12111242421+ . 113 +112 |
| <i>Tetraria cuspidata</i> (Rottb.) C.B. Cl.  | .   | . | . | . | . | . | . | . | . | +232+12 1++ + .2 11.+11+2 .++1+1.31+21221.22+4 21++ .22 +21221+ +.1+111113    |
| <i>Ehrharta dura</i> Nees ex Trin.   | .   | . | . | . | . | . | . | . | . | +1222141 +234 .2121.1 411.1 +. + .+++ + . . + +12 +2 +.3122 +2                |
| <i>Erica melanthera</i> L.   | .   | . | . | . | . | . | . | . | . | 0+ 32 1 . 0. 32 .1+ 1+.52+55453.30 0+11+111+.3 31 ++3 1 .+ 1+ 2               |
| <i>Bobartia macrospatha</i> Bak. subsp. <i>macrospatha</i>                                       | . 0 | . | . | . | . | . | . | . | . | 1 +++ 11 .R+ . + 0 .2+ .+11+ 1+. +++++ 1+.1+ + + + + .+1+ + +                 |
| <i>Merxmüllera rufa</i> (Nees) Conert  | .   | . | . | . | . | . | . | . | . | ++ . . .11++ .322 2 .12 ++.10+1 1+. + +11+ .+1++ +++ . +                      |
| <i>Tetraria brevicaulis</i> C.B. Cl.   | . 0 | . | . | . | . | . | . | . | . | ++ 0++ +++ . . . . . 1++ + +. 1+ ++1 + .R1+++ 1 + 1. ++ +                     |
| <i>Widdringtonia nodiflora</i> (L.) Powrie   | . + | . | . | . | . | . | . | . | . | 2 R 1 13+ 2. 1 .20111 . . . . . 0+2+22+++ 11. 01 . R                          |
| <i>Ursinia trifida</i> (Thunb.) W.E. Br.   | .   | . | . | . | . | . | . | . | . | ++ 0 + + . R. . R .+++R + +. 0+ R . + 0+01 + +.1+ + +                         |
| <i>Tetraria fasciata</i> (Rottb.) C.B. Cl.   | .   | . | . | . | . | . | . | . | . | 2 3 . + . .32 +1. 1 4. 2 + .2 +22 2 + .3+ + 3 2+                              |
| <i>Cyclopia sessiliflora</i> Eckl. & Zeyh.   | .   | . | . | . | . | . | . | . | . | 1 1 1 11 .10+ .1+ ++.++ . . . . . 01 1+ R+ . + . 1 1                          |
| <i>Drosera aliciae</i> Hamet   | .0  | . | . | . | . | . | . | . | . | R RO+ + R+R . R . . . . R+0 .R 0 + R + . + .0 +R                              |
| <i>Edmondia sesamoides</i> (L.) Hilliard   | .   | . | . | . | . | . | . | . | . | 0 + + . + . . . . . +++++ +.R++ + + + .R + + . +0                             |
| <i>Schizaea pectinata</i> (L.) Sw.   | .   | . | . | . | . | . | . | . | . | . RR+. R R.++ . + 00 . R+ . + + 1 . R   |
| <i>Corymbium glabrum</i> L. var. <i>glabrum</i>  | .   | . | . | . | . | . | . | . | . | + + + + . . . . . 2 . +R +++ . . . + . 1R +                                   |
| <i>Erica bracteolaris</i> Lam.   | .   | . | . | . | . | . | . | . | . | + + + + + 0 . . . . . + + + . R . . . . .                                     |
| <i>Tetraria compressa</i> Turill   | .   | . | . | . | . | . | . | . | . | + +1 + . .+1 . ++ . 1+ . 1 21 11 1+ . . . . .                                 |
| <i>Gnidia oppositifolia</i> L.   | . + | . | . | . | . | . | . | . | . | + + + + + . . . . . . R + . . . . .   |
| <i>Pteridium aquilinum</i> (L.) Kuhn   | .   | . | . | . | . | . | . | . | . | 1 . . . . . . +1 . 0 12. . . . .  |
| <i>Gleichenia polypodioides</i> (L.) J.E. Sm.  | .   | . | . | . | . | . | . | . | . | + 1. .+ . . . . . . . . . 0 + +.  |
| <i>Struthiola eckloniana</i> Meisn.  | .   | . | . | . | . | . | . | . | . | . . . . . . . . . . . + . .   |
| <i>Tetraria burmanii</i> (Schrad.) C.B. Cl.  | .   | . | . | . | . | . | . | . | . | . . . . . . . . . . . . . . .   |
| <i>Ficinia filiformis</i> (Lam.) Schrad.   | .   | . | . | . | . | . | . | . | . | 1 . . . . . .R .+ + + . . . R .++ R.  |
| <i>Stoebe cinerea</i> (L.) Thunb.  | .   | . | . | . | . | . | . | . | . | + . . 1.1 . . . . . R . +0 . + +  |
| <i>Indigofera sarmentosa</i> L.  | . R | R | . | . | . | . | . | . | . | . . . . . ++ R . . . ++ .+ R +.   |
| <i>Helichrysum felinum</i> (Thunb.) Less.  | .   | . | . | . | . | . | . | . | . | + . . . . + . 0. + . R+ ++ . 0 . +  |
| <i>Amphithalea axillaris</i> R. Granby   | .   | . | . | . | . | . | . | . | . | + + + + . . . . . 0 . 0 0 . . . . .   |
| <i>Chondropetalum mucronatum</i> (Nees) Pillans  | .   | . | . | . | . | . | . | . | . | 5 0 . . . . . . . . . 1 0. 0 +  |
| <i>Pentameris macrocalycina</i> (Steud.) Schweickerdt  | .   | . | . | . | . | . | . | . | . | 3 3 . + . . . . . . . . . 1 +. +  |
| <i>Platycaulos acutus</i> Esterhuysen  | .   | . | . | . | . | . | . | . | . | . . . . . . . . . . . + . . ++  |
| <i>Osteospermum corymbosum</i> L.  | .   | . | . | . | . | . | . | . | . | . 0. . . . + . . . . . + . . ++   |
| <i>Merxmüllera stricta</i> (Schrad.) Conert  | .   | . | . | . | . | . | . | . | . | . . . . . 1. . . . . +1 . . 41  |
| <i>Staberoha cernua</i> (L.f.) Dur. & Schinz   | .   | . | . | . | . | . | . | . | . | . . . . . + . 3 + . . . . . + . +   |
| <i>Erica cubica</i> L.   | .   | . | . | . | . | . | . | . | . | 1 . . . . . . . . . 0 + . . . . . 1   |
| <i>Elegia asperiflora</i> (Nees) Kunth   | .   | . | . | . | . | . | . | . | . | . 3 . . . . . . . . . . . + 1 . +   |
| <i>Pentaschistis malouinensis</i> (Steud.) Clayton   | .   | . | . | . | . | . | . | . | . | 1 . . . . . . . . . . . + + . 1   |
| <i>Ficinia monticola</i> Kunth   | .   | . | . | . | . | . | . | . | . | + . . . . . . . . . . . + . +   |



Table 1. Cont. ...

Relevé number \* 1\* 1\* \* \* \* \* \* \* \* 1  
 \*66778992\*23333366778889992\*6678\*855556\* 1688\* 1111\*111122222777\* 123337889\*22336679 2  
 \*59089563\*11346701470360120\*2311\*867894\*13847\*36890126\*458905678356\*45772059254\*39286723 4

| Widespread species common to all Communities               |           |       |          |         |       |                 |           |                   |                    |              |         |                          |                 |              |
|--|-----------|-------|----------|---------|-------|-----------------|-----------|-------------------|--------------------|--------------|---------|--------------------------|-----------------|--------------|
| <i>Erica hispida</i> L.                                    | .         | ++    | ++       | 5+23120 | 04441 | 1+              | .4413.1   | + +5.1++43.223313 | 1.355444345352.412 | 2+2312       | +.1+131 | 1                        |                 |              |
| <i>Elegia juncea</i> L.                                    | .1+++     | +++   | 1+++11+1 | 112+    | 22    | +++2.1121+2.++2 | +.11      | ++0.12+1+         | +2                 | 21.1+++0     | + +     | 1.11+ 121++              |                 |              |
| <i>Chrysithrix capensis</i> L.                             | .+2       | +1    | +++++++1 | +22     | .     | +. + .          | +.1++     | +++1.1++          | 1+                 | +1           | .1++    | ++11++ +.++111 + +       |                 |              |
| <i>Pentaschistis colorata</i> (Steud.) Stapf               | .2+++     | R++   | .21      | 43312   | + 1   | +1              | .1        | 1.+ +3.+          | 23                 | +. +2+       | ++1     | + .++ +1 22+0 0. 222 111 |                 |              |
| <i>Tetraria flexuosa</i> (Thunb.) C.B. Cl.                 | .1        | +     | 1++++    | 131     | 1     | .414.           | .         | 3                 | 4.                 | 41+++1       | .2      | +1 1 10.5+4+2++1         | 1.1. 11+ 13     |              |
| <i>Thamnochortus cinereus</i> Linder                       | .0        |       | 0.       | 11      | 1+    | ++ + +1         | ++++.     | +. +.1            | +++111             | 1+           | ++      | 1                        | ++ 0+01. 1+ + + |              |
| <i>Clusia alaternoides</i> L.                              | .         |       | +        | 1++1++  | +++   | +.11.           | ++211.1+1 | +. +              | ++.                | ++           | +       | R                        | 1+              | 1++11++1     |
| <i>Ehrharta setacea</i> Nees ex Trin. subsp. scabra        | ++0+      | .     | +        | 1       | +     | .               | .         | 1                 | .3+12              | 10+.32+++11+ | 1+      | .23++1                   | +               | 1.11 +1+11   |
| <i>Blaeria coccinea</i> Klotzsch                           | ++113+22. | 124++ | +2+      | 1123++  | +1+   | +++1+           | +         | .                 | .                  | 01           | .       | .                        | 2               | .2 +41++     |
| <i>Protea cynaroides</i> (L.) L.                           | .20       | +     | .1       | 1+      | ++    | 1+              | +++0      | +.0               | +                  | .            | .       | 1                        | 11              | 0. 00 .+ 0 + |
| <i>Epischoenus cf. adnatus</i> Levyns                      | ++1       | +     | .        | 12      | 212   | +               | +         | .                 | .                  | 4            | 2+      | .                        | .               | .            |
| <i>Othonna quinqueidentata</i> Thunb.                      | ++1+      | 1     | .        | 1+      | +     | 1               | +         | .                 | .                  | +            | +       | .                        | .               | .            |
| <i>Blechnum tabulare</i> (Thunb.) Kuhn                     | .1        |       |          | 0+      | 3.    | .               | .         | .                 | .                  | 1++          | +       | +                        | 1.              | R            |
| <i>Thesium carinatum</i> A. DC.                            | ++        | 1     | .        | +       | +++   | .               | .         | .                 | .                  | .            | .       | .                        | .               | ++           |
| <i>Penaea cneorum</i> Meerb. subsp. ruscifolia Dahlg.      | .1        |       |          | +       | .     | .               | .1        | +                 | 1.                 | 1212220      | .42+2+3 | +1                       | 1.              | R2 1+ .3 1 3 |
| <i>Tetraria thermalis</i> (L.) C.B. Cl.                    | .1        |       |          |         | +     | .               | .         | .                 | +                  | .            | 1+      | .                        | 1+              | 1 + .        |
| <i>Hermas ciliata</i> L.f.                                 | .R        | .     | +        | +++     | +     | .               | .         | .                 | .                  | R            | R       | .                        | .               | .            |
| <i>Syncarpha eximia</i> (L.) B. Nord.                      | .0        | 0     | .        |         | +     | .               | .         | .                 | .                  | R            | .       | .                        | R               | +            |
| <i>Indigofera concava</i> Harv.                            | +         | +     | .        | +       | .     | .               | .         | .                 | .                  | ++           | .       | +                        | .               | .            |
| <i>Lobelia pubescens</i> Dryand ex. Ait. var. rotundifolia | .R        | .R    | +        | +       | .     | .               | .         | .                 | .                  | R            | .       | .                        | .               | .            |
| <i>Senecio ilicifolius</i> (L.) Thunb.                     | .0        |       |          | +       | +     | .               | .0        | .                 | .                  | .            | 0       | .                        | .               | .            |
| <i>Myrica kraussiana</i> Buching ex Meisn.                 | .         | +     | .        | +       | 1.    | .               | .         | +                 | .                  | .            | .       | .                        | .               | .            |

community is given following the system for the Fynbos Biome proposed by Campbell *et al.* (1981).

Riparian communities were not sampled because they form narrow ribbons along streams, and are restricted to the streambanks. Typical dominants found in the non-forest riparian communities are: *Brachylaena neriifolia*, *Cunonia capensis*, *Elegia capensis*, *Empleurum unicapsulare*, *Laurophyllus capensis*, *Rapanea melanophloeos*, *Todea barbara* and *Virgilia oroboides*.

**Afromontane Forest**

The forest patches in the BWA are typical Afromontane Forest. They are found in deep secluded gorges which are cool and moist. These forests are floristically all of one type, based on tree species composition. The Boosmansbos Forest tends to be much wetter than the other patches sampled, shown by the high cover-abundance of *Cyathea capensis* which favours such conditions. An apparently drier-phase forest patch (Relevé 122) is characterized by *Plectranthus fruticosus*. However, this observation is at variance with that of Muir (1929) who presented an early general account of the 'Langeberg Forest' at Riversdale. He maintained that *P. fruticosus* is strongly moisture demanding. McKenzie (1978) gives detailed descriptions of the Boosmansbos forests which he classified as the *Cunonia capensis*-*Platylophus trifolius* Subassociation. A number of 'variations' were distinguished within the Subassociation according to relative wetness and dryness. No additional information was recorded or change in the classification proposed based on the five 400 m<sup>2</sup> plots sampled in the present study. Structurally the forests are classified as Wet High Forest (w-HF) following Geldenhuys (1983). The canopy height varies from 20-30 m and the species recorded, with synoptic Braun-Blanquet values in parentheses, are as follows:

Trees: *Cunonia capensis* (5), *Halleria lucida* (4), *Hartogiella schinoides* (2), *Ilex mitis* (2), *Kiggelaria africana* (1), *Maytenus acuminata* (3), *Ocotea bullata* (4), *Olinia ventosa* (1), *Platylophus trifolius* (4), *Podocarpus latifolius* (2), *Pterocelastrus rostratus* (5), *Rapanea melanophloeos* (5), *Virgilia oroboides* (3).

Shrubs: *Diospyros whyteana* (1), *Plectranthus fruticosus* (1).

Ferns: *Asplenium adiantum-nigrum* (2), *Blechnum giganteum* (5), *B. punctulatum* (2), *B. tabulare* (2), *Cyathea capensis* (5), *Hymenophyllum tunbridgense* (2), *Rumohra adiantiformis* (1), *Todea barbara* (2).

Climbers: *Myrsiphyllum scandens* (3).

Herbs: *Epischoenus adnatus* (2), *Galium undulatum* (1), *Osmitopsis osmitoides* (1), *Peperomia retusa* var. *retusa* (1), *Schoenoxiphium lanceum* (5).

Epiphytes: *Elaphoglossum angustatum* (3), *Microsorium ensiforme* (4).

Geophytes: *Oxalis purpurea* (4).

**Fynbos**

The cool south slopes of the southern Langeberg are covered with physiognomically uniform plant communities over large areas. The slopes are moist and may be likened to an extensive seepage zone. Apart from Muir's (1929) classification the vegetation has been variously referred to as: Wet Sclerophyll Bush (Adamson 1938); Hygrophilous Macchia or Fynbos (Phillips 1931; Taylor 1978); False Macchia (Veld Type 70) by Acocks (1988); Wet Mountain Fynbos (Moll *et al.* 1984) and Wet Ericaceous Fynbos (Campbell 1985). The apparent uniformity is deceptive, however, with close examination showing that the vegetation can be subdivided on species composition into the eight shrubland communities described under 'A' below.



The most striking feature of the fynbos of the BWA is the clear division between the vegetation of the southern and northern sides of the mountain. *Erica hispidula*, a common dominant on the south slopes, is almost completely absent on the north slopes. Although a number of other species transgress the south-north boundary, for example *Leucadendron eucalyptifolium*, it is clear that a definite floristic distinction can be made between the shrublands on the south and north sides of the mountain. This distinction is reflected in the treatment of the data from the respective areas in separate syntaxonomic tables (Tables 1 & 2), where a hierarchical arrangement of communities is also presented.

Using the default options, TWINSpan clearly separated the mesic to dry shrublands north of Grootberg from the largely mesic to wet shrublands of the catchments south of Grootberg at Level 1. This is reflected in the treatment of the relevés in two separate phytosociological tables (Tables 1 & 2). Relevés 41 and 48, however, were included in Table 2, contrary to the TWINSpan classification.

In the mesic to wet *Erica hispidula* Shrublands, TWINSpan separates those relevés (except relevés 31, 33, 34, 36 & 37) which correspond with the *Erica hispidula*–*Spatalla nubicola* and the *Restio inconspicuus*–*Anthochortus crinalis* Shrublands in the BB classification from the remaining relevés which constitute the *Erica hispidula*–*Restio inconspicuus* Shrublands, at Level 2. Correlations between the two classifications from TWINSpan levels 3–6 are not good but show general similarities. Nine communities are identified using the BB classification method, whereas TWINSpan separates the relevés into 15 groups.

In the mesic to dry shrublands the distinction between the *Cannomois parviflora*–*Leucadendron eucalyptifolium* Shrublands and the *C. parviflora*–*Passerina obtusifolia* Shrublands (see below and Table 2) correlates directly with the separation indicated by the TWINSpan classification at Level 2. Correlation at lower levels (3–6) is not good. The BB classification results in four communities being identified, with further subdivision into 13 groups, as indicated by TWINSpan, considered to be too fine.

### 1. *Erica hispidula* Shrublands

Typical of the shrublands of the moist south-facing slopes of the southern Langeberg is the ubiquitous shrub *Erica hispidula*. This species is characteristic of much of the mesic to wet ericaceous fynbos of the mountains of the southwestern and southern Cape (Boucher 1978; Kruger 1979; Bond 1981; McDonald 1988), and is therefore used as a descriptor for these shrublands.

In BWA *E. hispidula* is widespread and links the south-slope shrublands floristically across physiognomic boundaries, with *Restio inconspicuus* playing a subordinate role. *R. inconspicuus* is absent only from the *Erica hispidula*–*Spatalla nubicola* Community, a feature attributed to the dense, waterlogged, humic substrate. *R. inconspicuus* in turn, however, links all the communities falling under the *Erica hispidula*–*Restio inconspicuus* Shrublands in the classification. These shrublands are equivalent to the Heathland, Mixed Sclerophyllous Scrub and Broad-sclerophyllous Scrub communities of Kruger (1979).

#### 1.1 *Erica hispidula*–*Spatalla nubicola* Shrublands (A)

Differential species: *Spatalla nubicola*, *Helichrysum capense*.

Dominant species: *Anthochortus crinalis*, *Brunia alopecuroides*, *Platycaulos anceps*.

Structural formation: Closed Restioid with Mid-high Mid-dense Shrubland Overstorey.

Relationships: *Brunia alopecuroides*–*Restio bifidus* Community (Kruger 1974); Subcommunity E2 of the *Erica*–*Penaea* Community (Glyphis *et al.* 1978); *Restio*–*Hypolaena* Subcommunity (H & I) (Laidler *et al.* 1978); Ericoid-Restioid Zone Fynbos (Taylor 1978); Low Narrow-sclerophyllous Heathland (Kruger 1979); *Simocheilus carneus*–*Restio anceps* Community (Bond 1981); Wet Mountain Fynbos (Moll *et al.* 1984); Ruitersberg Wet Ericaceous Fynbos (Campbell 1985); *Erica hispidula*–*Brunia alopecuroides* Shrublands (McDonald 1993a).

This community (Figure 4) is found on the steep, cool, moist southerly slopes of the BWA, mostly at altitudes above 1 200 m. The community is found in the 'mist zone' where low stratus cloud commonly occurs around the high ridges and peaks. Annual precipitation is estimated at 1 200 mm and insolation is generally low. There is a consequent accumulation of organic material. Champagne Form soils with a strongly acid organic horizon (pH 2.9 in 0.01 mol/l CaCl<sub>2</sub>) as deep as 700 mm in some cases, form the substrate of this community.

These shrublands were sampled mainly on the south side of the ridge of Repeater Kop (Relevés 65, 69, 70, 78, 95 & 96), on Grootberg Summit (Relevé 123) and on the southwest side of the high ridge between Grootberg and Horingberg (Relevé 89).

*Spatalla nubicola* (Proteaceae) is endemic to this community whereas *Helichrysum capense*, the second differential species has a wider distribution, being found at other localities in the Langeberg. Presence of at least one of these species is necessary to determine this community. The dominant species *Brunia alopecuroides* gives these shrublands their characteristic 'brunioid' appearance. The *B. alopecuroides* shrubs seldom exceed 1.2 m in height and their closed canopy provides dense shade for the understorey restioid and ericoid elements. *Anthochortus crinalis* and *Platycaulos anceps* (Restionaceae) dominate the dense understorey stratum. Grasses are conspicuously lacking and are only represented by *Ehrharta setacea* subsp. *scabra*, a rare endemic in the fynbos biome (Gibbs Russell *et al.* 1990), in some stands.

A population of the rare *Spatalla colorata* was found in this community on the summit of Repeater Kop in close proximity to an undescribed endemic *Erica* species. These species apparently favour moist, high-altitude habitats with highly leached soils.

#### 1.2 *Erica hispidula*–*Restio inconspicuus* Shrublands

This community comprises all the shrublands apart from the *Erica hispidula*–*Spatalla nubicola* Shrublands. *Restio inconspicuus* and several prominent species, namely



FIGURE 4.—*Erica hispidula*–*Spatalla nubicola* Shrublands on high altitude, steep south-facing slopes. Note the shrubby endemic *S. nubicola* next to the range rod.

*Tetraria cuspidata*, *Ehrharta dura*, *Erica melanthera* and others (see Table 1) are not found in the latter community. The soils on which the *Erica hispidula*–*Restio inconspicuus* Shrublands occur are generally either more freely drained, with less accumulation of organic material, or are derived from non-sandstone substrates.

#### 1.2.1 *Restio inconspicuus*–*Anthochortus crinalis* Shrublands (B)

Differential species: none.

Dominant species: *Anthochortus crinalis*, *Erica hispidula*, *Ehrharta dura* and *Platycaulos anceps*.

Structural formation: Closed Graminoid Shrubland. Relationships: *Brunia alopecuroides*–*Restio bifidus* Community (Kruger (1974); Subcommunity E2 of the *Erica*–*Penaea* Community (Glyphis *et al.* 1978); *Restio*–*Hypolaena* Subcommunity (H & I) (Laidler *et al.* 1978); Ericoid–Restioid Zone Fynbos (Taylor 1978); Low Narrow-sclerophyllous Heathland (Kruger 1979);

*Simocheilus carneus*–*Restio anceps* Community (Bond 1981); Wet Mountain Fynbos (Moll *et al.* 1984); Ruitersberg Wet Ericaceous Fynbos (Campbell 1985); *Erica hispidula*–*Brunia alopecuroides* Shrublands (McDonald 1993a).

This community (Figure 5) has no differential species but shares many species with the *Erica hispidula*–*Spatalla nubicola* Shrublands (see Table 1); is characterized by absence of *Spatalla nubicola* and *Helichrysum capense*; and is found at altitudes higher than 1 000 m on east-, southeast-, south- and southwest-facing slopes. Sample quadrats were located at five general localities; on the upper south-facing slopes above Saagkuilkloof (Relevés 21 & 74), on the lower south- and southwest-facing slopes of Repeater Kop above Platbosrivierkloof (Relevés 34, 36, 37, 77, 80, 83, 120), on the south-facing slopes of the ridge west of Grootberg Peak (Relevés 60, 61 & 86), on the slopes southeast of Grootberg Peak overlooking Boosmansbos (Relevés 90 & 91) and on the east-facing slopes overlooking Boosmansbos (Relevés 31 & 33).



FIGURE 5.—*Restio inconspicuus*–*Anthochortus crinalis* Shrublands at altitudes above 1 000 m on southerly slopes.

Rainfall is between 1 000 and 1 200 mm annually, depending on altitude and aspect and the *Restio inconspicuus*–*Anthochortus crinalis* Shrublands are found mainly on highly leached Cartref Form soils (see SCWG 1991; Campbell 1983). Two samples (Relevé 90 & 91) were located on Champagne Form soils and show strong floristic affinity with the *Erica hispidula*–*Spatalla nubicola* Shrublands. However, these stands lack the differential species of the latter community.

Shrubs and graminoids are co-dominant, with the shrubs not exceeding 1 m. *Widdringtonia nodiflora* is present in some stands and is emergent up to 2 m. *Erica hispidula* and *Ehrharta dura* dominate with *Anthochortus crinalis* and *Platycaulos anceps* less conspicuous, forming part of the graminoid component.

A number of relevés (31, 36 & 92) do not have any of the differential species of the *Restio inconspicuus*–*Anthochortus crinalis* Community. They are regarded as samples from depauperate stands and are included here on the basis of dominant species and geographical position on the sample transect and in the landscape.

#### 1.2.2 *Restio inconspicuus*–*Protea grandiceps* Shrubland (C)

Differential species: *Protea grandiceps*.

Dominant species: *Erica hispidula*, *Tetraria flexuosa*, *Tetraria bromoides*.

Structural formation: Closed Graminoid Shrubland.

Relationships: *Tetraria bromoides*–*Erica plukenetii* Community (Kruger 1974); *Protea*–*Tetraria* Dry Short Fynbos (Boucher 1978); Wet Mountain Fynbos (Moll *et al.* 1984); Boesmansbos Azonal Restioid Fynbos (Campbell 1985); *Pentaschistis malouinensis*–*Tetraria bromoides* Shrubland (McDonald 1993a).

This community (Figure 6) is localized on the south-facing lower to mid-slopes of the ridge west of Grootberg, overlooking the Helderfontein Valley, at 1 180–1 295 m altitude. This locality lies more or less on the contact between the Cedarberg Formation and the Nardouw Subgroup. The soils are mainly Cartref Form, where

sandstone is the parent rock (Relevés 62, 63 & 71) and Clovelly Form, where shale is the parent rock (Relevé 81).

Mean annual precipitation at this locality is 1 000–1 100 mm and the soils are well drained but slightly more nutrient-rich than soils derived from Peninsula Formation sandstone (G.N. Schafer pers. comm.). The poleward aspect permits lower insolation, and *P. grandiceps* apparently favours the cooler slopes and richer soils.

This community is structurally similar to those of most other parts of the high-altitude slopes. *E. hispidula* dominates the shrub component with *P. grandiceps* having notable cover-abundance in only two of the four plots sampled (Relevés 62 & 63). Sedges such as *Tetraria flexuosa* and *Tetraria bromoides* dominate the herbaceous component. Close affinity exists between the *Restio inconspicuus*–*Protea grandiceps* Shrubland and the *Restio inconspicuus*–*Protea aurea* Shrubland, with these two communities sharing species not common to other communities (see Table 1).

#### 1.2.3 *Restio inconspicuus*–*Protea aurea* subsp. *aurea* Shrublands (D)

Differential species: *Protea aurea* subsp. *aurea*.

Dominant species: *Protea aurea* subsp. *aurea*.

Structural formation: Mid-high to Tall Proteoid Shrubland with a Closed Graminoid Shrubland Understorey.

Relationships: *Tetraria bromoides*–*Erica plukenetii* Community (Kruger 1974); *Protea*–*Tetraria* Dry Short Fynbos (Boucher 1978); *Protea aurea*–*Pteridium aquilinum* Community (Bond 1981); Wet Mountain Fynbos (Moll *et al.* 1984); Boesmansbos Azonal Restioid Fynbos (Campbell 1985); *Pentaschistis malouinensis*–*Tetraria bromoides* Shrubland (McDonald 1993a).

In BWA this community (Figure 7) occurs at altitudes above 1 100 m on the Cedarberg shaleband, near Helderfontein. The shales of the Cedarberg Formation weather to produce fine-grained, clay-rich yellow-brown Clovelly Form soils, and *Protea aurea* is found almost exclusively on these soils. This correlation is found throughout the



FIGURE 6. — *Restio inconspicuus*–*Protea grandiceps* Shrubland localized on the south-facing slopes west of Grootberg.



FIGURE 7.—*Restio inconspicuus*–*Protea aurea* subsp. *aurea* Shrublands found on the Cedarberg Formation shale near Helderfontein.

Langeberg, regardless of the altitude at which the shale-band is exposed. *P. aurea* can therefore be used as a marker indicating the exposure of the Cedarberg Formation in the highly folded strata of the Langeberg.

Sample plots were located between Helderfontein and Boosmansbos (Relevés 56, 57, 58 & 59) on northeast-, southeast- and southwest-facing slopes. Two plots (Relevés 64 & 88) were also located on the lower south- and southwest-facing slopes of the ridge west of Grootberg, above the watershed between the Helderfontein and Moeras River Valleys. Relevé 88 represents a transitional situation between Communities 2.2 and 2.3 but since *P. aurea* has a relatively high BB value (3), and since the soil is Clovelly Form, it is included in the *Restio inconspicuus*–*Protea aurea* Shrublands.

#### 1.2.4 *Restio inconspicuus*–*Hypodiscus aristatus* Shrublands 'Typicum' (I)

Differential species: none.

Dominant species: *H. aristatus*, *R. inconspicuus*, *Ehrharta dura*.

Structural formation: Closed Graminoid Shrubland.

Relationships: *Tetaria thermalis*–*Hypodiscus aristatus* Community (Kruger 1974); Mixed ericoid and restioid fynbos of the xeric slopes (Boucher 1978); *Leptocarpus membranaceus*–*Hypodiscus aristatus* Community (McKenzie *et al.* 1977); Subcommunities B & C of the *Erica*–*Penaea* Community (Glyphis *et al.* 1978); *Tetaria thermalis* Bergpalmietveld (Taylor 1978); Low ericoid open-heath or open graminoid-heath (Kruger 1979); *Erica viridescens*–*Hypodiscus aristatus* Community (Bond 1981); Mesic Mountain Fynbos (Moll *et al.* 1984); Nuweberg Mesic Ericaceous Fynbos (Campbell 1985); *Erica hispidula*–*Hypodiscus aristatus* Shrublands (McDonald 1993a).

The relevés grouped here (23, 29, 32, 38, 66, 67, 72, 93, 124) represent the 'typicum' of the *Restio inconspicuus*–*Hypodiscus aristatus* Shrublands (Figure 8). This 'typicum' or 'background community' has no floristic

elements which allow subdivision into lower-ranking communities; as such it is regarded as depauperate.

These shrublands occur on shallow (0.1–0.15 m), well-drained and highly leached Cartref and Houwhoek Form soils at altitudes from 1 000–1 500 m. Parent rock is mainly Peninsula Formation sandstone with Nardouw Subgroup sandstone found in plots 92 and 124. Aspect is generally north- and northwest-facing, with two exceptions, plots 29 and 30 which face south and southeast. Surface rock cover ranges between five and 75 %; boulders were found in all plots and exposed bedrock in more than 50%. Although rainfall probably exceeds 1 000 mm per annum, high insolation coupled with good drainage is most likely the reason for the depauperate nature and low stature of the community.

Shrubs such as *Erica hispidula* and *Penaea cneorum* subsp. *ruscifolia* are emergent up to 1.2 m but grasses (*Ehrharta dura*, *Pentaschistis colorata*), restios (*Hypodiscus aristatus*, *Restio inconspicuus*) and sedges (*Tetaria* spp.) dominate the low stratum (<0.5 m). Although strongly similar structurally and in species composition to the *Restio inconspicuus*–*Anthochortus crinalis* Shrublands, the *Restio inconspicuus*–*Hypodiscus aristatus* Shrublands have *Hypodiscus aristatus* dominant, whereas it is absent from the former community. Apparently north versus south aspects and relative wetness-dryness account for the change in species dominance and consequent distinction between these two communities.

#### 1.2.4.1 *Hypodiscus aristatus*–*Leucadendron eucalyptifolium* Shrublands (E)

Differential species: none.

Dominant species: *Leucadendron eucalyptifolium*.

Structural formation: Mid-high to Tall, Mid-dense to Closed Proteoid Shrublands.

Relationships: *Berzelia*–*Leucadendron* Moist Tall Fynbos (Boucher 1978); Mixed Sclerophyllous Scrub (Kruger 1979); *Protea neriifolia*–*Leucadendron eucalyptifolium*–*Erica triceps* Community (Bond 1981); Mesic Mountain



FIGURE 8.—*Restio inconspicuus*—*Hypodiscus aristatus* Shrublands found on shallow, well-drained, highly leached sandstone soils at altitudes from 1 000–1 500 m.

Fynbos (Moll *et al.* 1984); Robinson Mesic Proteoid Fynbos (Campbell 1985).

*Leucadendron eucalyptifolium* is a tall proteoid shrub ubiquitous on the Langeberg. It is found at localities on south and north sides of the range. In the BWA, *L. eucalyptifolium* occurs in the Mesic Proteoid Fynbos north of Grootberg as well as at the southern end of the sample transect, on the shaleband at Helderfontein and at the head of the Moeras River Valley. Where *L. eucalyptifolium* occurs with *Protea aurea* it is found on Clovelly Form soils but in the community described here (Figure 9) the soils are either of Oakleaf or Cartref Forms.

*L. eucalyptifolium* shrubs up to 2.5 m high dominate the community and it is the only species found in all relevés. Relevés 1 and 13 show marked floristic affinities with the *Restio inconspicuus*—*Protea aurea* Shrublands, whereas the remaining three relevés do not. This is

attributed to the nature of this community to transgress soil types.

Plots 1, 13 and 84 were situated in localized stands of the *Hypodiscus aristatus*—*Leucadendron eucalyptifolium* Shrublands on Oakleaf Form soils derived from conglomerates of the Enon Formation, detailed above. The soils are loamy with pH 4.3 (in 0.01 mol/l CaCl<sub>2</sub>) in the A-horizon increasing to pH 5.3 in the B-horizon. Aspect is west to southwest at altitudes of just less than 400 m. Mean annual precipitation at these sites is estimated at 800–900 mm.

In contrast, plots 68 and 87 were located in extensive stands of the community at altitudes 1 200–1 340 m on slopes with a northwesterly aspect. Parent rock is Peninsula Formation sandstone with Cartref Form soils. These soils are somewhat more leached and acid (pH 3.2 in 0.01 mol/l CaCl<sub>2</sub>) in the A- and E-horizons than the loamy



FIGURE 9.—*Hypodiscus aristatus*—*Leucadendron eucalyptifolium* Shrublands on a northwest-facing slope on sandstone soil west of Helderfontein.



FIGURE 10.—A dense stand of the *Berzelia intermedia*–*Erica melanthera* Shrublands on the lower south slopes of BWA.

Oakleaf Form soils. Mean annual precipitation is estimated at 1 000 mm.

#### 1.2.4.2 *Hypodiscus aristatus*–*Berzelia intermedia* Shrublands

The *Hypodiscus aristatus*–*Berzelia intermedia* Shrublands comprise two communities, the *Berzelia intermedia*–*Erica melanthera* Shrublands and the *Berzelia intermedia*–*Erica blenna* Shrublands. These shrublands occur at altitudes not higher than 875 m (330–860 m) on the south slopes of the BWA, and give these slopes their characteristic ericoid-brunioid (fine-leaved) appearance. The parent rock is Peninsula Formation sandstone throughout. *Berzelia intermedia* is conspicuously present throughout these shrublands.

##### 1.2.4.2.1 *Berzelia intermedia*–*Erica melanthera* Shrublands (F)

Differential species: *Lobelia coronopifolia*, *Pentaschistis* sp.

Dominant species: *Erica hispidula*, *Erica melanthera*, *Hypodiscus aristatus*, *Penaea cneorum* subsp. *ruscifolia*, *Tetraria cuspidata*.

Structural formation: structure of this community varies between a Low Closed Ericoid Shrubland and a Closed Graminoid Shrubland depending on the density and cover of the shrub component.

Relationships: Fynbos of the ericoid–restioid zone (Taylor 1978); Low Ericoid Heathland (Kruger 1979); *Erica arachnoidea*–*Pentameris dregeana* Community (Outeniqua Mountains) and the *Erica petraea*–*Erica nervata* and *Protea punctata*–*Erica melanthera*, *E. andraei* Communities (Swartberg) (Bond 1981); Mesic Ericaceous Fynbos (Moll *et al.*); Landdros Mesic Ericaceous Fynbos (Campbell 1985).

The dominant species, *Erica melanthera* is characteristic of this community (Figure 10). Dense stands of this erica are visible from a long distance, flowering on the lower slopes of the Langeberg in spring (Muir 1929; McDonald pers. obs.). Since the *Hypodiscus aristatus*–*Erica melan-*

*thera* Shrublands are poorly defined by inconspicuous differential species and because *Erica melanthera* is easily identified, it was chosen for the naming of this community. *Erica hispidula* is less dominant than *Erica melanthera* but is nevertheless well represented, as is *Penaea cneorum* subsp. *ruscifolia*. The dominant graminoids are *Hypodiscus aristatus* (Restionaceae), *Tetraria cuspidata* (Cyperaceae) and *Ehrharta setaceae* subsp. *scabra* (Poaceae). Together with other restios, sedges and grasses such as *Pentaschistis* spp. they constitute the co-dominant graminoid component.

The altitude at which these shrublands are found ranges from 330–625 m with a mean of 490 m. The soils are shallow (100–150 mm), acid (pH 3.2 in 0.01 mol/l CaCl<sub>2</sub>, A-horizon) Cartref Form throughout the community. Mean annual precipitation is estimated at 900–1 000 mm. Typically these shrublands occur on gentle slopes with a mean gradient of 10° (5°–21°) with extremely variable amounts of exposed rock (0–75% cover).

##### 1.2.4.2.2 *Berzelia intermedia*–*Erica blenna* var. *blenna* Shrublands (G)

Differential species: none.

Dominant species: *Berzelia intermedia*, *Erica blenna* var. *blenna*, *Erica hispidula*, *Psoralea pinnata*, *Widdringtonia nodiflora*.

Structural formation: the community is classified as a Low to Mid-high Closed Shrubland with a Mid-dense to Closed Graminoid Understorey.

Relationships: *Berzelia lanuginosa*–*Osmitopsis asteriscoides* Community (Werger *et al.* 1972); *Erica*–*Osmitopsis* Seepage Fynbos and *Chondropetalum*–*Berzelia* Upper Hygric Fynbos (Boucher 1978); Hygrophilous Fynbos (Taylor 1978); Variation I of the *Restio*–*Hypolaena* Subcommunity (Laidler *et al.* 1978); Mixed Sclerophyllous Scrub (Kruger 1979); *Berzelia*–*Osmitopsis* Seepage Fynbos on permanent seeps (Taylor 1984); Wet Mountain Fynbos (Moll *et al.* 1984); Keurbos Wet Ericaceous Fynbos (Campbell 1985); *Berzelia lanuginosa*–*Merxmullera cincta* Tall Closed Shrubland (McDonald 1988); *Erica hispidula*–*Berzelia intermedia* Shrublands (McDonald 1993a).



As noted above, *Berzelia intermedia* is characteristic of the *Hypodiscus aristatus*–*Berzelia intermedia* Shrublands (1.2.4.2). It is most dominant in the *Berzelia intermedia*–*Erica blenna* Shrublands (Figure 11). *Erica hispidula* also attains its highest degree of dominance in this community. *Erica melanthera* is present but much less evident than in the *Berzelia intermedia*–*Erica melanthera* Shrublands. *Widdringtonia nodiflora* is a conspicuous emergent shrub (up to 4 m) in most stands, whereas it is almost totally absent from the latter community. *E. blenna* var. *blenna* is endemic to the Langeberg and is restricted to the Swellendam–Heidelberg part of the range. It is used in the name of the *Berzelia intermedia*–*Erica blenna* Shrublands because it has its strongest expression here and the community is otherwise poorly defined. *Psoralea pinnata* is also found commonly here but it has a wider tolerance, occurring in other communities as well (Table 1). Two other species of particular note which occur in this community are the rare Langeberg endemics *Linconia alopecuroides* L. (Bruniaceae) and *Carpacoce gigantea* Puff (Rubiaceae).

This community is also found on highly leached, low pH, shallow (< 300 mm) soils of Cartref and Houwhoek Forms. Rock cover is mostly 2% or less except in plots 18 (10%) and 76 (25%). The slopes where these shrublands are located vary in aspect from east- to south-facing; one sample plot (73) was located on a west-north-west-facing slope. The mean gradient of the slopes is 19° (10°–33°). Altitudinal range of the community is from 500–850 m with a mean of 670 m. The *Berzelia intermedia*–*Erica blenna* Shrublands thus occupy the zone of higher, steeper slopes than the *Berzelia intermedia*–*Erica melanthera* Shrublands but occur below the zone occupied by the *Restio inconspicuus*–*Anthochortus crinalis* Shrublands (1.2.1) and *Restio inconspicuus*–*Hypodiscus aristatus* Shrublands (1.2.4). Mean annual precipitation is estimated at 1 000–1 100 mm.

Structurally the *Berzelia intermedia*–*Erica blenna* Shrublands are variable. In general the upper shrub stratum does not exceed 1.5 m in height. The exceptions are where *Berzelia intermedia* is dominant and reaches 2.5–3.0 m in height with a high projected canopy cover (Relevés 26 &

76) or where *Widdringtonia nodiflora* reaches 3–4 m and exceeds 10% projected canopy cover (Relevés 20 & 25).

#### 1.2.4.3 *Hypodiscus aristatus*–*Erica versicolor* Shrublands (H)

Differential species: *Erica versicolor*, *Centella virgata* and *Tetraria involucrata*.

Dominant species: *Erica versicolor*, *Erica hispidula*, *Erica melanthera*, *Hypodiscus aristatus* and *Tetraria flexuosa*.

Structural formation: Closed Graminoid Shrubland or a Closed Herbland with a Mid-high Mid-dense Ericoid Shrubland Overstorey.

Relationships: Mesic Mountain Fynbos (Moll *et al.* 1984); *Hypodiscus aristatus*–*Erica versicolor* Shrublands (McDonald 1993a).

This community (Figure 12) is typically found on rocky sandstone outcrops on northwest-, north- and northeast-facing slopes, but on the south side of the range (i.e. south of Grootberg).

Soil development on the rocky outcrops where the *Hypodiscus aristatus*–*Erica versicolor* Community is found is poor, consisting of accumulations of sand and organic material in shallow (100 mm deep) pockets amongst the rocks. These lithosols are therefore regarded as poorly developed Mispah Form soils.

*Erica versicolor* has the habit of favouring almost any well-drained rocky situation and the *Hypodiscus aristatus*–*Erica versicolor* Shrubland Community is usually interspersed amongst other more uniformly distributed communities, forming a mosaic with the latter from low to high altitudes (400–1 200 m). The community is characterized as much by presence of *Erica versicolor* as by marked absence of a number of widely distributed species, e.g. *Cyclopia sessiliflora*, *Drosera aliciae*, *Tetraria compressa* and *Gnidia oppositifolia*, which prefer habitats where the soils are deeper and less readily drained.

The stature of *Erica versicolor* ranges from low (<1 m) to mid-high (1–2 m) and therefore the structural form



FIGURE 11.—*Berzelia intermedia*–*Erica blenna* Shrublands which occur on highly leached acid sandstone soils at altitudes from 1 000–1 100 m mainly on wet south-facing slopes.



FIGURE 12. — *Hypodiscus aristatus*–*Erica versicolor* Shrublands found on rocky sandstone outcrops on the south side of the Langeberg in BWA.

of the *Hypodiscus aristatus*–*Erica versicolor* Community varies between the two forms stated above.

## 2. *Cannomois parviflora* Shrublands

Species with distribution common to all plant communities and with high cover-abundance are not a feature of the vegetation on the north slopes of the Langeberg in the Boosmansbos Wilderness Area. Broad-scale characterization of the plant communities occurring in this area is therefore not simple. *Cannomois parviflora* has been chosen as the 'base' species equivalent to *Erica hispidula* on the south slopes, since it is readily identifiable and found in all the communities in question (Table 2). Campbell (1985) notes that *Cannomois parviflora* (his *Elegia parviflora*) is common as a dominant in Mesic Restioid Fynbos and is also a feature of Dry Restioid Fynbos and Dry Proteoid Fynbos. This supports the use of this species in the nomenclature of the shrublands described here.

The *Cannomois parviflora* Shrublands are found on soils derived exclusively from sandstone of the Nardouw Subgroup. The communities described may or may not reflect the respective geological formations within the Nardouw Subgroup but distinctions in geological formation were not recorded and correlations between plant communities and geological formations are therefore not possible here. Four communities are identified and described, two as subdivisions of the *Cannomois parviflora*–*Leucadendron eucalyptifolium* Shrublands and two as subdivisions of the *Cannomois parviflora*–*Passerina obtusifolia* Shrublands.

### 2.1 *Cannomois parviflora*–*Leucadendron eucalyptifolium* Shrublands

Northeast of Grootberg is a shallow intermontane valley forming part of the catchment of Brandrivier. There are also a number of east-trending rocky ridges, the highest of which is named Deception Ridge in this study. Altitude diminishes eastwards towards Brandrivier. The valley has a mesic to dry climate compared with the wet south slopes and the arid north slopes adjacent to the Little Karoo.

The soils are mainly accumulations of well-drained sand resulting in Clovelly Form soils. The ridges have a somewhat more xeric climate with shallow well-drained lithosols usually of Glenrosa Form.

This community is found in the above-mentioned intermontane valley and on the ridges but not on the arid north-facing slopes of Deception Ridge. They are locally extensive and are divided into two communities, the *Leucadendron eucalyptifolium*–*Protea lorifolia* Shrublands and the *Leucadendron eucalyptifolium*–*Staberoha cernua* Shrublands which are characterized by high cover-abundance of *Leucadendron eucalyptifolium*, *Protea repens* and *Tetraparia bromoides*. The presence of *Leucadendron eucalyptifolium* indicates a close relationship between these shrublands and the *Hypodiscus aristatus*–*Leucadendron eucalyptifolium* Shrublands (1.2.4.1) described above. Their overall species composition and habitat differ, however, and they are therefore treated as separate communities. The tall shrub *Protea eximia* occurs sporadically throughout the *Cannomois parviflora*–*Leucadendron eucalyptifolium* Shrublands and as a dominant in the *Leucadendron eucalyptifolium*–*Staberoha cernua* Shrublands described below.

The *Leucadendron eucalyptifolium*–*Protea lorifolia* Shrublands are found on the rocky ridges north of Grootberg, forming a mosaic with the *Leucadendron eucalyptifolium*–*Staberoha cernua* Shrublands which occur in bottomland situations. Physiognomically the former community differs very little from the latter. Both have a Mid-dense to Closed Graminoid stratum with Mid-high to Tall, Open to Mid-dense to Proteoid Shrub Overstorey. It is therefore difficult to distinguish these communities on the basis of structure.

#### 2.1.1 *Leucadendron eucalyptifolium*–*Protea lorifolia* Shrublands (J)

Differential species: *Agathosma cerefolium*, *Erica versicolor*, *Indigofera pappi*, *Lightfootia tenella*, *Metalasia gnaphalodes*, *Protea lorifolia*, *Stoebe aethiopica*, *Stoebe saxatilis*, *Ursinia nudicaulis*.



FIGURE 13. — *Leucadendron eucalyptifolium*–*Protea lorifolia* Shrublands found on the ridges north of Grootberg, showing the proteoid shrub overstorey with *P. lorifolia* in the left foreground.

Dominant species: *L. eucalyptifolium*, *Elegia filacea*, *Protea repens*, *Tetraria bromoides*, *Thoracosperma galpinii*.

Structural formation: Mid-dense to Closed Graminoid Shrubland with a Mid-high to Tall, Open to Mid-dense Proteoid Shrubland Overstorey.

Relationships: Proteoid Zone Fynbos (Taylor 1978); Broad-sclerophyllous Scrub or Open-scrub (Kruger 1979); *Elegia galpinii*–*Metalasia pulcherrima* Community (Outeniqua Mountains) and *Protea repens*–*Protea lorifolia*–*Hypodiscus striatus* Community (Swartberg) (Bond (1981); Mesic Mountain Fynbos (Moll *et al.* 1984); Thomas Dry Proteoid Fynbos (Campbell 1985).

This community (Figure 13) is found on the ridges north of Grootberg. It is best expressed on Deception Ridge where there are terraces of shallow sandy loam Clovelly Form soil (Relevés 24, 52, 53, 55, 97, 98, 99, 100) and more poorly expressed where Glenrosa Form soils occur (Relevés 47, 49, 102, 113).

Mean annual precipitation is estimated at 600–700 mm. The general aspect is northeasterly but varies at local sites from north through east to south. Although most sites are well exposed and in many respects equivalent, local site aspect apparently plays some role in determining the distribution of the community. This is currently being investigated (McDonald, unpublished).

This community is structurally variable. The lowest stratum is always dominant, with sedges, restios and ericoid shrubs in more or less equal proportions. The upper stratum consists mainly of proteoid shrubs. The broad-leaved *P. lorifolia* is particularly characteristic and apart from some transgression into the *Leucadendron eucalyptifolium*–*Staberoha cernua* Shrubland (see Table 2), the dominant *Protea repens* could be viewed as characteristic of this community as well.

The presence of *Erica versicolor* in the *Leucadendron eucalyptifolium*–*Protea lorifolia* Shrublands indicates some affinity between this community and the *Hypodiscus aristatus*–*Erica versicolor* Shrublands described above. However, *E. versicolor* tends to be a ubiquitous on rocky outcrops if the moisture régime is high enough and the limited presence of the species in this community is thought to indicate the limit of its range on the south-north gradient. *Erica barrydalensis* H. Bol., a rare endemic species, with similar rocky habitat preferences to *E. versicolor*, was recorded on Deception Ridge (McDonald & Oliver 1987) and may replace *E. versicolor* since it apparently tolerates xeric conditions more readily.

#### 2.1.2 *Leucadendron eucalyptifolium*–*Staberoha cernua* Shrublands (K)

Differential species: *Cyphia zeyheriana*, *Erica cerinthoides*, *Helichrysum rotundifolium*, *Lachnaea penicillata*, *Staberoha cernua*.

Dominant species: *Leucadendron eucalyptifolium*, *Protea eximia*, *Tetraria bromoides*, *Elegia filacea*.

Structural formation: Mid-dense to Closed Graminoid Shrubland with a Mid-high to Tall, Open to Mid-dense Proteoid Shrubland Overstorey.

Relationships: as for 2.1.1 above.

The differential species of this community (Figure 14) are not well-represented. It could be argued therefore that distinction between the *Leucadendron eucalyptifolium*–*Protea lorifolia* Shrublands and the *Leucadendron eucalyptifolium*–*Staberoha cernua* Shrublands is tenuous. However, the proteoid stratum of the latter community is dominated by *Protea eximia* and *Leucadendron eucalyptifolium* with *Protea repens* almost absent. In the *Leucadendron eucalyptifolium*–*Protea lorifolia* Shrublands, the opposite is true with *P. eximia* poorly represented and *L. eucalyptifolium* and *Protea repens* co-dominant. Absence of a number of species such as *Anomalanthus* sp., *Ficinia lacineata*, *Hypodiscus argenteus*, *Hypodiscus striatus*, *Phylla mairei*, *Relhania calycina* subsp. *apiculata* and *Stoebe microphylla* from the *Leucadendron eucalyptifolium*–*Staberoha cernua* Shrubland reinforces the distinction as well (see Table 2).

Structurally the *Leucadendron eucalyptifolium*–*Staberoha cernua* Shrublands are similar to the *Leucadendron eucalyptifolium*–*Protea lorifolia* Shrublands. The lower stratum is marginally more graminoid and the upper proteoid stratum more uniformly mid-dense. Other distinctions are negligible.

The *Leucadendron eucalyptifolium*–*Staberoha cernua* Shrublands are found mainly in bottomland situations with south- and southeast-facing aspects. One sample (Relevé 48) was on a 30° slope but mostly the community occurs



FIGURE 14. — *Leucadendron euca-lyptifolium*–*Staberoha cernua* Shrublands in bottomland situations. Note the dense graminoid understorey with *Protea eximia* dominant in the proteoid shrub stratum.

where there is little or no relief apart from a shallow gradient eastwards towards Brandrivier. The soils have resulted from accumulation of sand and are all distinctly yellow and of the Clovelly Form. A typical pH 4.6 increasing to pH 4.8 (in 0.01 mol/l CaCl<sub>2</sub>) was measured for samples from the A- and B-horizons respectively of soil at Relevé 105.

#### 2.2. *Cannomois parviflora*–*Passerina obtusifolia* Shrublands

This community is found on the exposed north-facing slopes of Deception Ridge below an altitude of 1 000 m and on the mesa-like sandstone plateaux above the contact with the Bokkeveld Formation shales of the Little Karoo. This is the most arid aspect of the transect, with high incoming radiation and rainfall ranging between 300–600 mm p.a. Two communities are described, the first being the *Cannomois parviflora*–*Passerina obtusifolia* 'Typicum' and the second the *Passerina obtusifolia*–*Leucospermum calligerum* Shrublands.

*Passerina obtusifolia* is a widespread species found on sandstone soils on the dry aspects of the mountains from Clanwilliam Division in the west to Grahamstown in the east (Thoday 1924). Occurrence of this species on the lower north slopes of the Langeberg clearly places the *Cannomois parviflora*–*Passerina obtusifolia* Shrublands within the context of Dry Mountain Fynbos (Moll *et al.* 1984).

The species shared between the two communities show definite affinities with Karroid vegetation; succulents in the genera *Adromischus*, *Crassula*, *Machairophyllum* and *Ruschia* indicate the transition from fynbos to Succulent Karoo. The endemic *Leucospermum erubescens* is found in these shrublands but was not encountered in any of the sample plots. Its distribution appears to be erratic on the north slopes of the Langeberg from Witbooisrivier to Garcia's Pass.

#### 2.2.1 *Passerina obtusifolia*–*Leucospermum calligerum* Shrublands (L)

Differential species: *Elytropappus cyathiformis*, *Leucospermum calligerum*, *Lobostemon decorus*, *Muraltia heisteria*, *Paranomus spathulatus*, *Serruria balanocephala*, *Thamnochortus karooica*, *Thesium subnudum*.

Dominant species: *Leucospermum calligerum*, *Metalsia densa*, *Passerina obtusifolia*, *Pentaschistis eriostoma*, *Serruria balanocephala*.

Structural formation: Mid-high Mid-dense Graminoid Shrublands.

Relationships: Arid Fynbos (Taylor 1978); Arid Fynbos (Kruger 1979); *Phyllica axillaris*–*Felicia filifolia* Community (Outeniqua Mountains) and *Passerina obtusifolia*–*Felicia filifolia*–*Pentaschistis eriostoma* Community (Swartberg) (Bond 1981); Dry Mountain Fynbos (Moll *et al.* 1984); Sebrafontein Dry Asteraceous Fynbos (Campbell 1985).

This community (Figure 15) is found on the lower north-facing slopes above Witbooisrivier at altitudes from 485–745 m. The habitat is not much different from that of the *Cannomois parviflora*–*Passerina obtusifolia* 'Typicum' except that the mean gradient of the sample sites is 8° (6°–22°). With this difference in mean gradient, changes in drainage and other subtle factors may account for the development of this community.

*Leucospermum calligerum* is a widely distributed proteoid species on the arid aspect of the fynbos of the northwestern and western mountains (Lokenberg and Gifberg) and on the dry north slopes of the Langeberg to the Gouritz River in the east (Rourke 1972). It therefore links this community with the widely distributed Arid Fynbos (*sensu* Taylor 1978; Kruger 1979), Dry Mountain Fynbos (Moll *et al.* 1984) or Dry Asteraceous Fynbos (Campbell 1985). At a local scale, however, endemic species such as *Paranomus spathulatus* and *Serruria balanocephala* Rourke ined., characterize the Dry Moun-

tain Fynbos of the north slopes of the Langeberg; a more refined definition of this community may be possible with more extensive sampling.

### 2.2.2 *Cannomois parviflora*–*Passerina obtusifolia* Shrublands 'Typicum' (M)

Differential species: none.

Dominant species: *Hypodiscus striatus*, *Passerina obtusifolia*, *Pentastichis eriostoma*.

Structural formation: Open Graminoid Shrubland with ericoid shrubs emergent to 2 m.

Relationships: As for 2.2.1 above and *Leucadendron eucalyptifolium*–*Hypodiscus argenteus* Shrubland (McDonald 1993a) in part.

Four relevés, 45, 46, 50 & 51, represent this community. The first two sample plots were located on the lower north slopes above Klein Witbooisrivier at 594 m a.s.l. The soils are of Mispah Form reflecting poor soil development. Relevés 50 & 51 are at 792 and 914 m a.s.l. respectively on the rocky north-facing slopes of Deception Ridge. The soils at these sites are classified as Glenrosa Form. The mean gradient of the sites is 24° and rock cover is not less than 95% at any of the sites.

All the species in the *Cannomois parviflora*–*Passerina obtusifolia* Shrublands are shared with other communities. The xeric conditions at the above sites limit the survival of many plant species and the community consequently lacks species requiring more favourable conditions.

## DISCUSSION AND CONCLUSIONS

Much debate has surrounded the classification of the fynbos vegetation of the Cape Floristic Region. Various methods have been used in attempts to classify the floristically complex vegetation into ecologically meaningful yet 'practical' units interpretable by scientist and manager alike.

Two approaches to the classification of the fynbos of mountain ecosystems in the Cape have been used since

the early 1970's: (i) the floristic approach and (ii) the structural approach. The floristic approach has been based mainly on the methodology of the Zürich-Montpellier school of phytosociology (Mueller-Dombois & Ellenberg 1974; Werger 1974). However, one of the problems facing phytosociologists in the fynbos of the Cape mountains is the great diversity of habitats and attendant high diversity of plant taxa (Werger *et al.* 1972). Floristic techniques have demanded high skills in identifying plants in the field, for example according to Bond (1981), 'high species turnover along geographic gradients places high demands on the ecologist's ability in field taxonomy for limited returns in ecological understanding. ... This reduces the generality and usefulness of a formal phytosociological approach to parochial studies in small areas.' Campbell (1986a & b) affirmed Bond's statement and severely criticised floristic techniques. However, despite this major area of difficulty the mosaic of small, localized studies that have been done have been useful in generating an overall picture of at least the broad fynbos communities present in the Cape mountains.

On the Langeberg, Muir's (1929) early descriptions, Taylor's (1955) documentation of Grootvadersbosch Forest, McKenzie's (1978) study of the forests and Campbell's (1983, 1985, 1986a) structural classification were the only studies of the vegetation prior to the present study. Campbell (*loc. cit.*) placed 21 samples in BWA on his 'Langeberg Transect' which he classified into six subseries (i) Azonal and (ii) Mesic Restioid Fynbos, (iii) Mesic and (iv) Wet Ericaceous Fynbos and (v) Mesic and (vi) Dry Proteoid Fynbos; 12 types were described. However, although Campbell's (1985) classification provides a comprehensive typology of Cape mountain vegetation (Cowling & Holmes 1992) it lacks floristic information found in phytosociological studies, which Bond *et al.* (1992) and Cowling *et al.* (1992) found appropriate for testing ecological and phytogeographical hypotheses. The application of the Braun-Blanquet method in this study was time-consuming but ultimately yielded an acceptable classification of the fynbos plant communities of the BWA. The classification is ecologically meaningful and easily interpretable if the user is familiar with the character species which form only a small proportion of the diverse



FIGURE 15.—*Passerina obtusifolia*–*Leucospermum calligerum* Shrublands on the dry lower north-facing slopes at Witbooisrivier, bordering the Little Karoo.

flora. The floristic data assembled in this study also provide a basis not only for description and hierarchical classification of fynbos plant communities but also for biogeographical studies.

The fynbos of mountain catchments of the southern Langeberg accords with Taylor's (1978) broad zonation classification of Cape mountain vegetation. In BWA, however, complex environmental gradients exist from the mesic lower south slopes through a number of fault valleys to wet high-altitude slopes and exposed peaks and ridges and then to the mesic to dry shallow valleys and ridges and very dry, exposed north slopes. This has profound local effects on the distribution of vegetation associations.

Correlation between environment and plant communities enhances the descriptive and predictive value of any phytosociological classification (Campbell 1983; McDonald 1987; Deall *et al.* 1989). Such correlations have necessarily been superficially described in this paper. Therefore, attempts to explain the gradients underlying the distribution of the communities described here will be presented in a later paper (McDonald, unpublished) where data from two additional sample transects will be available.

In attempting to show relationships between the communities described in this paper and those described by other workers in Mountain Fynbos, difficulty was experienced in equating one community with another. This is due to high geographic turnover (gamma diversity) of species in roughly similar montane habitats (Cowling & Holmes 1992). The relationships of communities shown in this paper are open to modification as greater understanding of the composition and functioning of communities is gained. As the synthesis of fynbos proceeds, the recognition of regional associations of limited extent or geographical races of an association may have to be recognized (Werger *et al.* 1972; Cowling & Holmes 1992) to overcome the problems of equivalence between communities. For instance this may ultimately result in the recognition of southwestern Cape, southern Cape and southeastern Cape zones of the Fynbos Biome.

The vegetation of the BWA was almost completely burned in a summer wildfire in February 1988, subsequent to the sampling of relevés reported on here. After three years (April 1991), apart from the predominance of 'fire-ephemerals' such as *Ursinia trifida* which dominate over large parts of the south slopes, the communities of BWA as described here are identifiable. As succession proceeds it is predicted that the robustness of the floristic classification will become even more evident as the fire ephemerals disappear and the perennial shrublands reach their mature expression.

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