The plant communities of Swartboschkloof, Jonkershoek

D J McDonald

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PREFACE

Interest in the ecology of fynbos ecosystems has gathered considerable momentum over the past 10 years. This interest has been fuelled largely by the Fynbos Biome Project, one of several national scientific programmes within the National Programme for Ecosystem Research, administered by the CSIR. The National Programme is a cooperative undertaking of scientists and scientific institutions in South Africa concerned with research related to environmental problems. It includes research designed to meet local needs as well as projects being undertaken in South Africa as contributions to the international programme of SCOPE (Scientific Committee on Problems of the Environment), the body set up in 1969 by ICSU (International Council of Scientific Unions) to act as a focus of non-governmental international scientific effort in the environmental field. The research of participating universities is financed from a central fund administered by the National Committee for Ecosystem Research and contributed largely by the Department of Environment Affairs.

The Swartboschkloof catchment area in the Jonkershoek State Forest is one of the primary sites identified by the Fynbos Biome Project's steering committee for the study of Mountain Fynbos ecosystems. A study of the regeneration of the fynbos vegetation of the area was completed as an MSc thesis by Phillip van der Merwe in 1966. The study was one of the first of its kind in fynbos and provides valuable information on the regeneration modes of fynbos plants. Other projects that have been completed in the area include climate studies, surveys of the insect faunas, ornithological studies, and studies on the biomass, phenology, photosynthesis and water relations of plants.

The vegetation of the area was last burnt in February 1958 and it is to be burnt again in March 1987 as part of the normal management of such areas. Researchers are now in a position to make basic predictions of what the outcome of a fire in March will be on the ecosystem. The planned burn in Swartboschkloof therefore presents an ideal opportunity for testing a number of hypotheses derived over the past ten years.

Considerable interest has been generated by the opportunity created by the planned burn. Proposals for research on climate, hydrology (water balance, groundwater movements and streamflow) and ecosystem processes such as energy budget, decomposition, nutrients, phenology and growth have already been drawn up. Special attention will also be paid to aspects of the population dynamics of plants and animals. Soil seed stores will be quantified and modes of regeneration determined; population dynamics of herbivorous, granivorous and pollinating animals will be studied.

Much of the information collected during the burn study will be incorporated into a comprehensive ecosystem model currently being developed within the Fynbos Biome Project and operational on the Jonkershoek Forestry Research Centre computer. The model will serve as a basis for collating and synthesizing ecosystem data derived from studies in Swartboschkloof.

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ABSTRACT

Swartboschkloof forms part of the Jonkershoek mountain catchment complex at the headwaters of the Eerste River, Cape Province. It has been selected as a primary study site for the Fynbos Biome Project multi-disciplinary studies of Mountain Fynbos.

Using the Braun-Blanquet phytosociological method, vegetation and environmental data were collected at 201 relevés throughout the study area; 101 of these relevés are correlated with a survey of soils of part of the same area. Sixteen Mesic Mountain Fynbos (Moll et al 1984) communities, classified into three groups, and five forest communities, classified into two groups, have been identified.

A map of the plant communities is presented.

ACKNOWLEDGEMENTS

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Ms E Mantle, FRD, CSIR, undertook the entire typography and Mrs E A Steer assisted in the latter stages of proof reading.

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INTRODUCTION

Swartboschkloof, at Jonkershoek near Stellenbosch, was selected as a site for intensive multi-disciplinary studies of Mesic Mountain Fynbos (sensu Moll et al 1984) within the Fynbos Biome Project (Cowling 1978). The vegetation survey of Swartboschkloof reported on in this document, also forms part of a Master Programme for surveys in Mountain Fynbos. This programme was drawn up to provide the Department of Environment Affairs (Directorate of Forestry) with information concerning the vegetation and floristics of mountain catchments. In addition it forms part of a resource inventory of Mountain Fynbos vegetation, Veld Type 69 (Acocks 1975).

Three studies of the vegetation of Swartboschkloof have previously been carried out (van der Merwe 1966; Werger et al 1972; van Wilgen 1981). Those of van der Merwe (1966) and van Wilgen (1981) were mainly concerned with vegetation response to fire and that of Werger et al (1972) was a phytosociological study. Fry (in preparation) surveyed the soils of Swartboschkloof.

Werger et al (1972) sampled 35 relevés in fynbos and eight relevés in forest vegetation. Their findings are evaluated, taking into consideration that succession had proceeded for 11 years between the time their study was carried out and 1981, when this survey was started. A greater area was covered in this study, than that sampled by Werger et al (1972). Sampling was also more intensive.

The objectives of this study were:

(i) to identify, describe and classify the Cape fynbos and remnant forest communities occurring in Swartboschkloof;

(ii) to map the plant communities of Swartboschkloof;

(iii) to relate the plant communities to the soils of Swartboschkloof;

(iv) to relate the plant communities to selected habitat factors, apart from the edaphic factors, namely climate, altitude, aspect and topography.

THE STUDY AREA

LOCATION

Swartboschkloof is situated in the Jonkershoek Forest Reserve, about 15 kilometres from Stellenbosch (Figure 1). It is 373 hectares in extent and forms part of the greater Jonkershoek catchment in the Hottentots Holland Mountains at 34° 00' South latitude and 18° 57' East longitude. Most of the study area has an equatorial (north-facing) aspect. In 1936 it was proclaimed a nature reserve in terms of the Forest Act (Werger et al 1972). The boundaries of the area selected for this survey do not coincide exactly with the boundaries of the Swartboschkloof-Sosyskloof Nature Reserve but are as follows:

> in the north-east the boundary is a ridge of sandstone cliffs; from the south-east corner to the south-west corner the firebreak forms the southerly boundary; on the west side the boundary is the drainage divide between the Swartboschkloof and Sosyskloof catchments; in the north, Sosyskloof stream forms the boundary; a short firebreak bounds a small section at the base of Swartboschkloof on the north to north-east side (Figure 2).

The area between the Sosyskloof stream and the 'zigzag' firebreak which was sampled by Werger et al (1972) was not included in this study because the vegetation was burnt as recently as 1977 and therefore considered to be immature.

At present Swartboschkloof is managed as part of the whole Jonkershoek mountain catchment complex.

GEOLOGY, GEOMORPHOLOGY AND TOPOGRAPHY

Porphyritic Cape granite underlies the quartzitic sandstones of the Table Mountain Group (TMG) which form the precipitous mountains at Jonkershoek (Taljaard 1949). The granite forms the undulating floor of the Swartboschkloof Valley. The sandstone cliffs do not erode readily. Nevertheless, the debris from these cliffs together with granite boulders

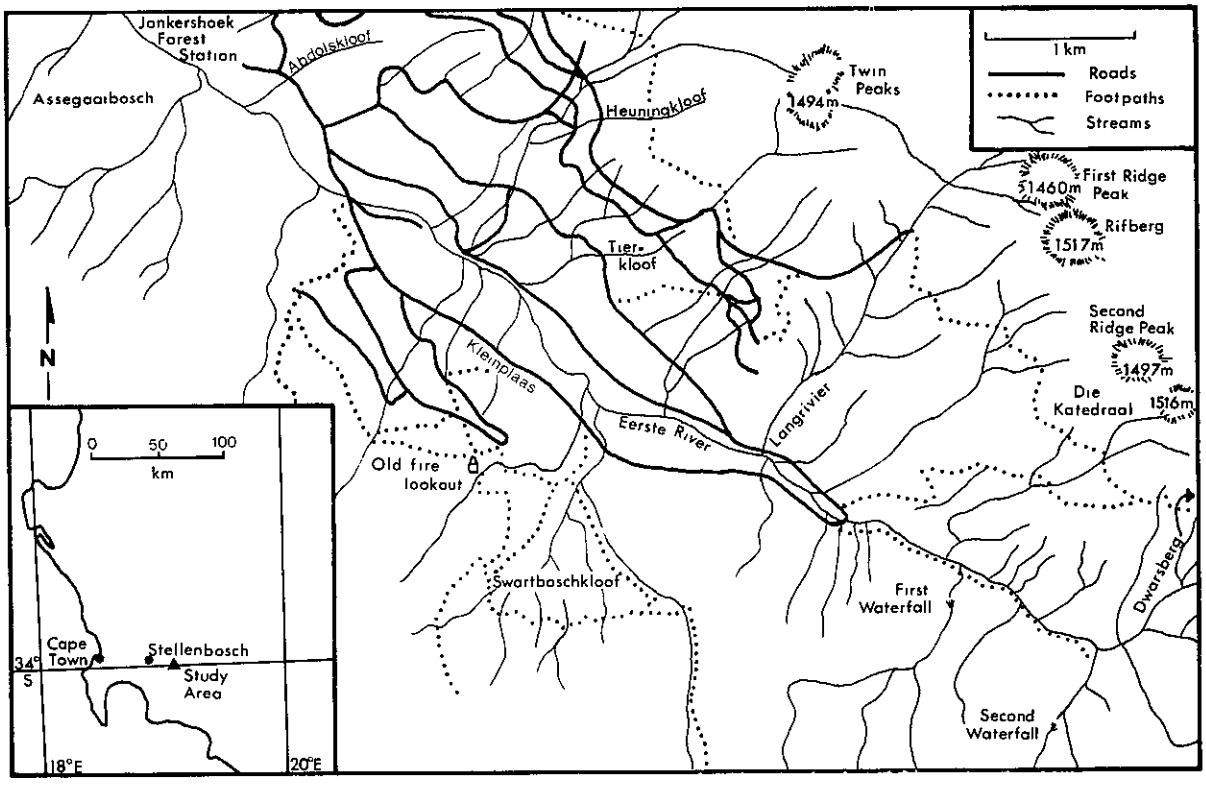

Figure 1. Location of the study area, Swartboschkloof, in the Jonkershoek Forest Reserve (after van Wilgen 1981).

form a colluvial admixture covering most parts of the granite floor. Van der Merwe (1966) notes that the granite is encountered up to about 530 metres altitude, above which sandstone occurs. Fry (in preparation), however, found the granite-sandstone contact to be nearer 700 metres. Granite outcrops occur at only a few places in the valley.

There is some folding of the sandstone cliffs bounding Swartboschkloof but generally this feature is absent. Taljaard (1949) describes the straightness of the Jonkershoek Valley, trending north-west to south-east, and its remarkable cross-sectional asymmetry. He notes that the sandstone is clearly down-faulted on the western side. Beekhuis et al (1944) comment, 'It is not clear what kind of faulting took place, but it is thought that the Jonkershoek fault consists of a number of parallel fault planes'. They note that evidence of this faulting is found at Twin Peaks, Swartboschkloof and in the region of Second Waterfall. Werger et al (1972) say, however, that the Swartboschkloof Valley was formed by a series of secondary faults roughly at right angles to those faults which caused the main Jonkershoek Valley.

Swartboschkloof is a fan-shaped valley ranging from 285 metres to 1 200 metres in altitude. The head of the valley forms the widest part of the 'fan' and it narrows with a decrease in altitude. The slopes range from less than five degrees to 45 degrees with the steep slopes averaging 30 degrees. About two per cent of the area consists of inaccessible, almost vertical cliffs.

Apart from the steep cliffs and colluvial slopes there are also loose boulder screes. These screes consist of sandstone boulders and are on the higher slopes immediately below the steep cliffs. In parts the screes have stabilized and support forest vegetation.

The streams in Swartboschkloof follow the fault lines. The main Swartboschkloof stream, which flows from south-west to north-east, is perennial and well wooded. It is fed by three other seasonal streams. The other major stream, on the east side of the valley, is perennial but is not fed by other streams. It apparently carries less water than the main Swartboschkloof stream and is less wooded. These major streams join at the lower end of the valley before joining the Eerste River. The stream from Sosyskloof drains the area to the west of Swartboschkloof and flows independently into the Eerste River, which runs down the centre of the Jonkershoek Valley (Beekhuis et al 1944; de Villiers et al 1964; van der Merwe 1966; Werger et al 1972; van Wilgen 1981).

SOILS

Fry (in preparation) has classified the soils of Swartboschkloof following the binomial classification for soils in South Africa (MacVicar et al 1977). He has identified 12 forms with 14 series. Fry did not sample the soils of the high steep slopes which are lithosols and probably fall into the Mispah Form. The soils will not be discussed in further detail here.

CLIMATE

Wicht et al (1969) described the climate of Jonkershoek as being 'Etesian of the Mediterranean type'. According to Köppen's (1931) system it would have an average temperature of below 22°C for the warmest month. It conforms to Climate Type IV in Walter and Leith's classification (Werger et al 1972).

During the summer, strong anti-cyclonic winds from the south-east enter the valley over the Dwarsberg (see Figure 1) having originated in high pressure cells between about 25° and 35° South latitude. This air is cold and, as it passes over the Dwarsberg, its temperature drops further causing moisture condensation and creating the renowned south-east cloud like the 'table-cloth' on Table Mountain at Cape Town (Marloth 1904, 1907; Stewart 1904; Nagel 1956, 1962; Kerfoot 1968).

Exceptional rains from the south-east have been recorded when the cooling effect is enough to permit cloud to persist over the valley, when the air is not adiabatically heated and moisture is not re-absorbed into the atmosphere (Wicht et al 1969).

In winter pre-frontal cyclonic winds of the westerly wind system bring moisture-laden air from the north-west into the Jonkershoek Valley where they meet a mountain barrier, resulting in heavy orographic rain. After the passage of a cold front, wind direction changes from north-west to west and south-west. Pressure rises and temperatures fall causing unstable conditions. It is at these times that showers and storms may occur (Wicht et al 1969; Jackson and Tyson 1970; Erasmus 1981).

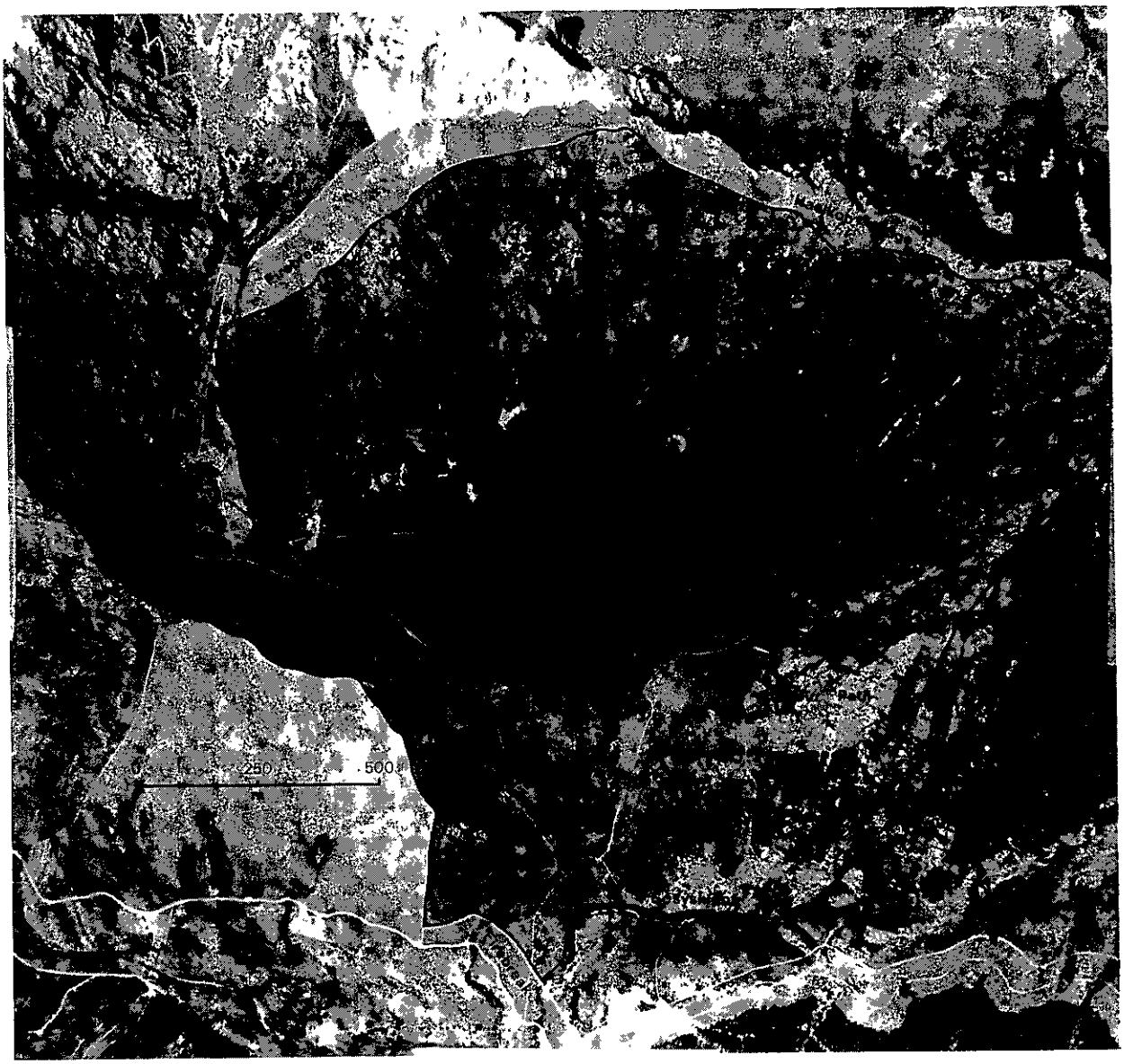

Figure 2. Aerial photograph of Swartboschkloof, showing boundaries of the study area.

METHODS

THE BRAUN-BLANQUET METHOD

The Braun-Blanquet (B-B) phytosociological method (Werger 1974) was used because it has been extensively tested in fynbos and forest vegetation and found to be reliable, repeatable and ecologically sound. It is also applied as a standard procedure in the Vegetation Ecology Section of the Botanical Research Institute.

Rectangular quadrats of five metres by ten metres (50 m^2) were used to sample the fynbos vegetation and quadrats of ten metres by 20 metres (200 m^2) were used to sample the riparian and forest communities. Quadrats of 50 m^2 were used to sample the Halleria elliptica - Brabejum stellatifolium Short Forest as this size was adequate for this community. In the case of boulder scree communities, quadrats of 200 m^2 were used; their shape was dependent on subjective assessment of each stand, since Boucher (1977) states, 'The relevé shapes could possibly have been more flexible, for instance in sampling riparian communities which form narrow bands along streams'. The quadrats were divided, where possible, to give ten equal-sized sub-plots, for systematized data recording. The sub-plots were not nested and therefore the data collected were not suitable for drawing species-area curves or assessing species diversity. Additional species within one metre of the perimeter of the sample quadrat were also recorded.

There were two phases of fieldwork in this survey. During the first phase, 101 of the 114 soil pits sampled by Fry (in preparation) in his soil study of Swartboschkloof were relocated. Vegetation sample plots were placed as close as possible to these soil pits, to enable correlation between the soil series identified (Fry, in preparation) and the vegetation samples. This was done bearing in mind the requirement for sampling homogeneous stands of vegetation. It was, however, not always possible to meet this requirement. The reason for this was that the soil pits themselves were often on boundaries in the soil catena, a feature reflected by the vegetation in some cases.

For the second phase of sampling it was necessary to first examine and interpret 1:5 000 scale black and white and 1:20 000 scale colour aerial photographs. This was done because Fry (in preparation) did not cover the whole of the area, as defined for this study, for his soil survey. In this instance the plots were placed in homogeneous stands in each of the vegetation units delimited on the aerial photos. A further 100 relevés were sampled during the second phase of fieldwork.

Figure 3 (see back cover map pocket) shows the positions of relevés associated with Fry's (in preparation) soil pits, relevés sampled independently of Fry's survey and the positions of relevés sampled by Werger et al (1972).

DATA COLLECTION

Floristic data were gathered by:

(i) recording all permanently recognizable species together with their B-B cover-abundance values;

(ii) collecting those species not immediately recognizable as voucher specimens.

The latter were identified by the author with assistance from the Stellenbosch Botanical Research Unit Herbarium personnel. When ephemeral species, which were not permanently recognizable, such as annuals and geophytes were encountered, they were recorded in parentheses.

Structural data were collected for each relevé by noting total cover (per cent) for each stratum and the dominant species in each stratum.

TABLE PREPARATION

The suite of computer programmes, TABSORT, developed by the Directorate of Forestry at Jonkershoek and modified and expanded by the Botanical Research Institute (Boucher 1977), was used for the sorting of relevé data in this study. The manipulation of data was streamlined by using the CANDE system on the Burroughs B7800 computer of the Department of Agriculture.

Raw data for the Werger et al (1972) survey were made available by one of the co-authors, Mr H C Taylor. These data were encoded for computer manipulation following the procedures outlined above. By keeping the same relevé order as in the final tables of the Werger et al (1972) study and using the order of species from the final tables of this study, it has been possible to prepare B-B tables from the Werger et al (1972) data which are directly comparable with those of this study (McDonald, 1983).

MAP PREPARATION

A photographic enlargement of a black and white photograph of Swartboschkloof was used as the basis for the maps. The photograph was enlarged to give a scale of 1:5 000 from which the maps depicted in Figures 3 and 4 were prepared (see back cover map pocket).

Boundaries of the study area were delineated on the photograph. The positions of all relevés were then plotted together with symbols representing the respective communities into which the relevés were grouped. The positions of 40 relevés of the Werger et al (1972) survey were also plotted, 15 of which fall outside the study area for this survey.

Stereoscopic viewing of 1:20 000 scale colour aerial photographs (Job 794/77, 325 and 326) together with interpretation of the annotated black and white photograph made it possible to draw tentative boundaries of the plant communities on the 1:5 000 scale black and white photograph.

The tentative boundaries of communities were then checked, using the B-B tables to key out communities at points (see Figure 3) where the vegetation was not sampled. Once the field-map (1:5 000 scale photograph with community boundaries) was completed, it was copied to produce the final map of plant communities of Swartboschkloof (see back cover map pocket).

THE VEGETATION

The vegetation of Swartboschkloof has been divided into two main types:

(i) Mesic Mountain Fynbos communities (sensu Moll et al 1984);

(ii) forests and riparian vegetation.

This division is based on physiographic features as well as physiognomic, structural and floristic characteristics. The Mesic Mountain Fynbos (Moll et al 1984) is located in drier situations than forests and riparian vegetation.

The Mesic Mountain Fynbos communities (Moll et al 1984) fit broadly into Taylor's (1978) zonation patterns. Proteoid vegetation occurs mainly on the lower slopes with mixed granite and sandstone soils. On the upper, drier slopes, with shallow sandy soils, plants in the families Restionacae and Cyperaceae dominate. There are also localized perennial seeps where typical hygrophilous communities are found.

The forests are restricted to stream banks of perennial streams and rock screes. These forests are somewhat shorter than those of the southern Cape (McKenzie 1978), probably because of more extreme climatic conditions.

The Halleria elliptica - Brabejum stellatifolium Short Forest grades into high forest vegetation; it is most often found along drainage lines which have seasonal running water where forest vegetation does not develop.

Structural classification of the communities is based on averages of structural data from all relevés within each community. The classification proposed by Edwards (1983) has been applied. In each community description, the number of the relevé considered to be most representative of the community is underlined following Boucher and Shepherd (in press).

Information and data pertaining to the soils were obtained from Fry (in preparation) as well as from personal observation. All other environmental and habitat data presented in the community descriptions were recorded on site.

For the naming of the communities a species-binomial system using two differential species, where possible, is used following Boucher (in preparation). In addition to the species-binomial, a structural name following Edwards (1983) is given for each community. An alternative structural name following the system proposed by Campbell et al (1981) for structural characterization of vegetation in the fynbos biome is also given. Other synonyms for the respective communities extracted from Boucher and McDonald (1982) and from other sources, as indicated, are given as well.

The Mesic Mountain Fynbos (Moll et al 1984) communities are described first, followed by a description of the forest and riparian communities.

MESIC MOUNTAIN FYNBOS COMMUNITIES

Three major Mesic Mountain Fynbos (Moll et al 1984) groupings occur in Swartboschkloof. They are systematically subdivided on the basis of floristic relationships. The term community is used as an abstract term (Shimwell 1971) and does not imply any specific rank.

Erica hispidula - Diospyros glabra Shrubland

The three shrublands grouped together under this category, namely: the Diospyros glabra - Elegia capensis High Closed Shrubland; the Diospyros glabra - Cliffortia odorata High Closed Shrubland; and the Diospyros glabra - Rhus angustifolia Short to Tall Closed Shrubland, include specialized communities and those communities which favour heavier soils of granite or colluvial origin. They are all referred to as hygrophilous communities.

The presence of perennial free water appears, in particular, to override the influence of substrate on the development of the Diospyros glabra - Elegia capensis Shrubland and the Diospyros glabra - Cliffortia odorata Shrubland. In this sense they are regarded as specialized communities together with the Rhus angustifolia - Berzelia lanuginosa and Berzelia lanuginosa - Merxmuellera cincta Shrublands. The latter two communities, however, are apparently more substrate-dependent; they are found in bottomland situations on deep, predominantly sandstone-derived soils.

1. Diospyros glabra - Elegia capensis High Closed Shrubland

Campbell et al (1981) structural equivalent: Tall Mid-dense Shrubland
Map Symbol: A Community area: 4,19 ha
Relevés (3): 148, 150, 151 Age of vegetation in relevés: 9 years
Average number of species per relevé: 20 (13-26)

Differential species: Blechnum punctulatum, Crassula coccinea, Crassula pellucida, Cullumia setosa, Elegia capensis, Hippia pilosa, Lampranthus deltoides, Nemesia acuminata.

Dominant species: Arctotis semipapposa, Blechnum punctulatum, Cullumia setosa, Elegia capensis, Psoralea pinnata.

The Diospyros glabra - Elegia capensis Tall Closed Shrubland is found on slopes at high altitudes (800 metres to 930 metres) with a south-easterly aspect in the south-west quarter of the study area (Figure 3). The slopes have an average gradient of 18 degrees (15 degrees to 21 degrees). The community is restricted to this part of the study area although many species which occur in it are found in seep conditions at lower altitudes, associated with other species which do not occur here.

This community is found on localized wet sites, usually dissected by drainage lines and the soil is usually waterlogged. Fry (in preparation) did not investigate these soils. However, the author noted that they are sandy to loamy with a high organic content. The high organic content is most likely due to the high average litter cover of 88 per cent (75 per cent to 99 per cent) and to local wet conditions. Exposed rock cover is low with an average of six per cent (two per cent to ten per cent) but the substrate is noticeably rocky under the dense vegetation.

The estimated total projected canopy cover of this community is 98 per cent. Three strata can be distinguished. The tallest stratum consists of shrubs, two to three metres high, with an average projected canopy cover of 56 per cent. Elegia capensis and Psoralea pinnata are the dominant shrubs in this stratum. Cliffortia dentata, Cliffortia polygonifolia and Cullumia setosa dominate in the second shrub stratum, which is half-a-metre to two metres high and has an average projected canopy cover of 46 per cent. The third stratum (less than half-a-metre high) consists of herbs and dwarf shrubs. Arctotis semipapposa and Blechnum punctulatum are prominent in this stratum. Projected canopy cover of the low stratum is estimated at 10 per cent on average.

Erica racemosa is found in this community and in the communities found on soils of sandstone origin. It is not found in the communities on heavier soils at lower altitudes. The species was not found often in this study but could indicate specific habitat conditions not detected here but worth further investigation.

2. Diospyros glabra - Cliffortia odorata High Closed Shrubland

Campbell et al (1981) structural equivalent: Low Closed Shrubland
Map symbol: B — Community area: 0,13 ha
Relevés (1): 192 — Age of vegetation in relevés:
Number of species in relevé: 26 — (24 years)

Differential species: Centella eriantha, Cliffortia odorata, Leucadendron salicifolium.

Dominant species: Cliffortia odorata, Leucadendron salicifolium.

This community is characterized on the basis of one relevé which, in strict terms, is not sufficient information to justify its existence as a distinct community. In Swartboschkloof it occurs as a localized stand, too small to sample more extensively, but for the sake of completeness it is described. It has some species which are common to it and to the other hygrophilous communities, namely: Gnidia oppositifolia, Osmitopsis asteriscoides and Psoralea pinnata.

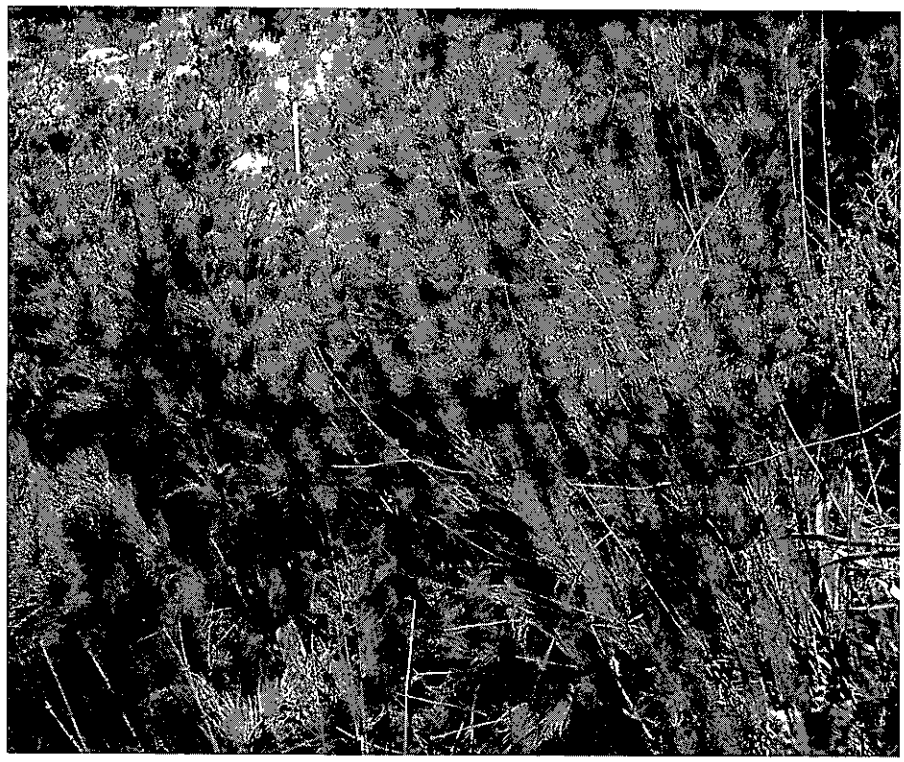

Figure 5. Diospyros glabra - Elegia capensis Tall Closed Shrubland; a seep community found at altitudes from 800 metres to 930 metres in the study area. Survey pole is 2,5 metres tall.

The community was sampled at the top of a stabilized scree slope below cliffs at an altitude of 655 metres. The aspect is north-facing and the slope is steep (34 degrees). Water runs off the cliff above, where the same community is found, falls over the rocks and then percolates through the rock rubble of the scree below. The scree rocks are covered (97 per cent) with a dense growth of prostrate Cliffortia odorata which dominates the lower stratum (less than one metre high). Emergent through this layer are tall to high shrubs such as Leucadendron salicifolium, Osmitopsis asteriscoides and Psoralea pinnata with a projected canopy cover of 24 per cent.

Fry (in preparation) did not sample the soil at this site. However, the soil amongst the rocks is dark in colour and is rich in organic matter. The parent material of the soil here is quartzitic sandstone.

Further sampling of this community, if it were found in other parts of Jonkershoek, would probably indicate its status in the Jonkershoek vegetation as a whole.

This community is similar to the Berzelia lanuginosa - Leucadendron salicifolium community at Jakkalsrivier (Kruger 1974) in that L. salicifolium is a prominent emergent shrub. The Diospyros glabra - Cliffortia odorata Shrubland described here does not have Berzelia lanuginosa present. In Swartboschkloof B. lanuginosa occurs at lower altitudes on deeper soils (see below).

The sites of the Werger et al (1972) relevés 18 and 38 (318 and 338 in Figure 3) were revisited during this survey. They previously recorded L. salicifolium at these sites but none was found when these sites were revisited.

3. Diospyros glabra - Rhus angustifolia Short to Tall Closed Shrubland

This community has four major sub-categories, which have in turn been subdivided. The common factor between the sub-categories is the presence of granite or granite-derived material in the soil. Fry (in preparation) found granite in 82 per cent of the soil profiles related to these shrublands. It is possible that the influence of granite is masked by an overburden of sandstone-derived soil in the remaining 18 per cent of the profiles, for example in the soils where the Rhus angustifolia - Berzelia lanuginosa Shrubland is found. The plant communities could possibly be more sensitive indicators of the presence of granite material than methods of soil analysis used by Fry.

The highest point of the granite-sandstone contact is at about 700 metres. Ten per cent of the relevés representing these shrublands are at altitudes between 680 metres to 700 metres near this contact. The other 90 per cent are mostly situated at lower altitudes (330 metres to 550 metres) where the amount of granite derived material is greater than the amount of sandstone derived material in the soil.

3.1 Rhus angustifolia - Berzelia lanuginosa Short Closed Shrubland

Campbell et al (1981) structural equivalent: Low Closed Shrubland
Map symbol: D
Relevés (3): 9, 10, 12
Community area: 2,5 ha
Age of vegetation in relevés: 27 (19 to 35) years

Differential species: The differential species of this community are shared with the Berzelia lanuginosa - Merxmuellera cincta community variant. They are: Berzelia lanuginosa, Elegia asperiflora, Neesenbeckia punctoria. It is distinguished from the variant by the lack of differential species unique to the variant.

Dominant species: Berzelia lanuginosa, Elegia asperiflora, Tetraria fasciata.

The first major sub-category of the Diospyros glabra - Rhus angustifolia Short to Tall Closed Shrubland, the Rhus angustifolia - Berzelia lanuginosa Short Closed Shrubland, is found in the lower central part of the study area (altitude: 380 metres to 530 metres) and has a north-easterly aspect (Figure 6). Estimated average rock cover is 15 per cent (five to 25 per cent) which is fairly low but considerably more than in the community variant. Average litter cover is 65 per cent (50 per cent to 80 per cent) which is somewhat lower than that in the community variant.

The soils where this community occurs are moist but well drained. Fry (in preparation) classified these soils into three forms and three series: Westleigh Form, Witsand Series (We21); Fernwood Form, Warrington

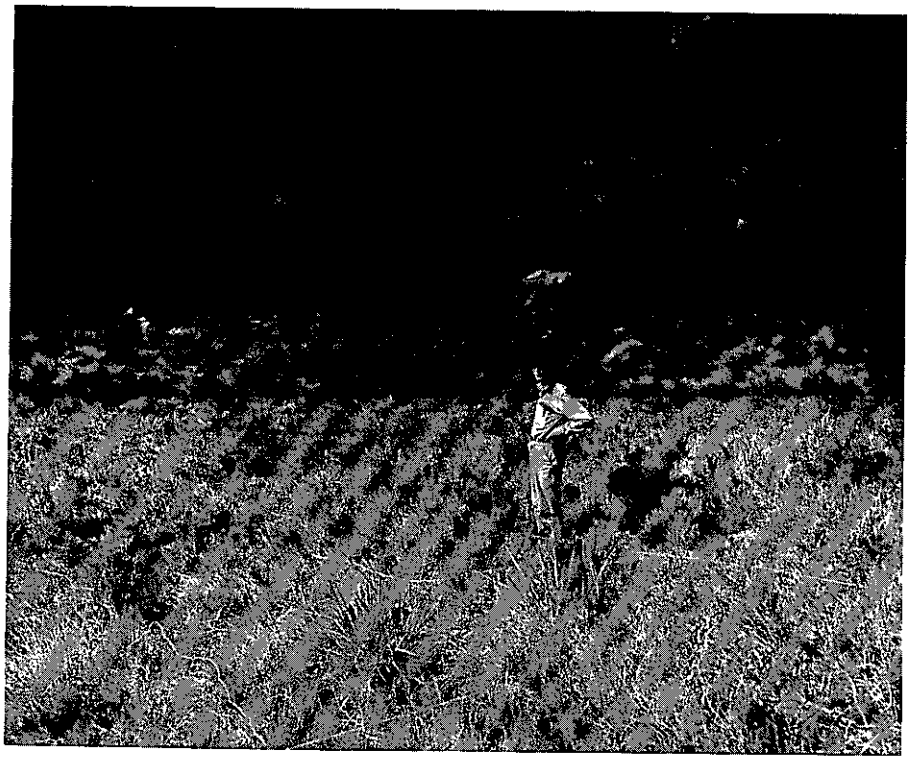

Figure 6. Rhus angustifolia - Berzelia lanuginosa Shrubland in the foreground.

Series (Fw31); and Vilafontes Form, Hudley Series (Vf11). The parent material is sandstone. The Witsand and Warrington Series are described as 'hydromorphic' soils and the Hudley Series is described as a 'pale' soil which is moderately to poorly drained.

This community is characterized by a low stratum, less than half-a-metre high, dominated by sedges, notably Tetraria fasciata. Cover of this stratum ranges between 76 per cent to 95 per cent with an average of 87 per cent. Restios, grasses and other herbaceous species contribute to this layer as well. Berzelia lanuginosa is emergent from the low stratum; it occurs sparsely with an average cover of ten per cent and does not reach more than one metre in height.

It is interesting to note that Osmitopsis asteriscoides, a ubiquitous seep species, is absent from this community, owing to the presence of drier soil conditions. The presence or absence of this species can therefore be used to distinguish this community from the community variant described in 3.1.1 below.

3.1.1 Berzelia lanuginosa - Merxmuellera cincta Tall Closed Shrubland

Campbell et al (1981) structural equivalent: Mid-high Mid-dense Shrubland
Map symbol: C Community area: 1,84 ha
Relevés (4): 99, 101, 102, 158 Age of vegetation in relevés: 24 years
Average number of species per relevé: 21 (13-30)

Differential species: Cunonia capensis, Laurentia arabidea, Merxmuellera cincta, Restio depauperatus.

Dominant species: Berzelia lanuginosa, Merxmuellera cincta, Osmitopsis asteriscoides.

The Berzelia lanuginosa - Merxmuellera cincta Tall Closed Shrubland (Figure 7) is a variant of the Rhus angustifolia - Berzelia lanuginosa Shrubland. It occurs in similar conditions to the latter community and the two communities are found closely associated in the lower central area of Swartboschkloof. It also occurs as a more distinct unit along a drainage line on the slopes above Sosyskloof stream. Here the slope is 34 degrees which is much steeper than the average gradient (nine degrees) in the lower central area. The altitudinal range at which this community was recorded in the study area is 380 metres to 530 metres.

The soil at relevé 158 was not sampled by Fry (in preparation), but it was noted that the soil at the surface was rich in organic material. This is a characteristic shared with the soils of the Fernwood Form, Warrington Series in the lower central area where the same community is found. The amount of accumulated organic material on the soil surface is greater (91 per cent on average) than where the Rhus angustifolia - Berzelia lanuginosa Shrubland occurs. The diagnostic horizon of the soils of the Warrington Series consists of acid, medium grade, wet regic sand. No rocks were found at the soil surface in any of the relevés representing this community variant.

Structurally this community variant differs from the typical community (see 3.1) in that the upper stratum is dominant. This stratum is one to two metres high, has an average projected canopy cover of 60 per cent and is dominated by Berzelia lanuginosa, Merxmuellera cincta, Neesenbeckia punctoria and Osmitopsis asteriscoides. Merxmuellera cincta and Neesenbeckia punctoria grow as large tussocks between which Berzelia lanuginosa and Osmitopsis asteriscoides emerge. The lower stratum (less than one metre high) has an average projected canopy cover of 45 per cent and is dominated by Elegia asperifolia, Erica hispidula and Restio depauperatus.

Evidence suggests that the development of the Berzelia lanuginosa - Merxmuellera cincta Shrubland depends largely on the presence of a high water-table. The development of the more typical Rhus angustifolia - Berzelia lanuginosa Shrubland, on the other hand, does not seem to have this requirement. Any presence and possible influence of granite derivatives in the soils of the Berzelia lanuginosa - Merxmuellera cincta Shrublands is probably overridden by the effect of the waterlogged regic sands. In the areas where these two communities are closely associated they are mapped as a mosaic (Figure 4).

Analysis of the Werger et al (1972) data shows that the community they described as the Berzelia lanuginosa - Osmitopsis asteriscoides Community is the same as the Berzelia lanuginosa - Merxmuellera cincta Shrubland variant of the Rhus angustifolia - Berzelia lanuginosa Short Closed Shrubland.

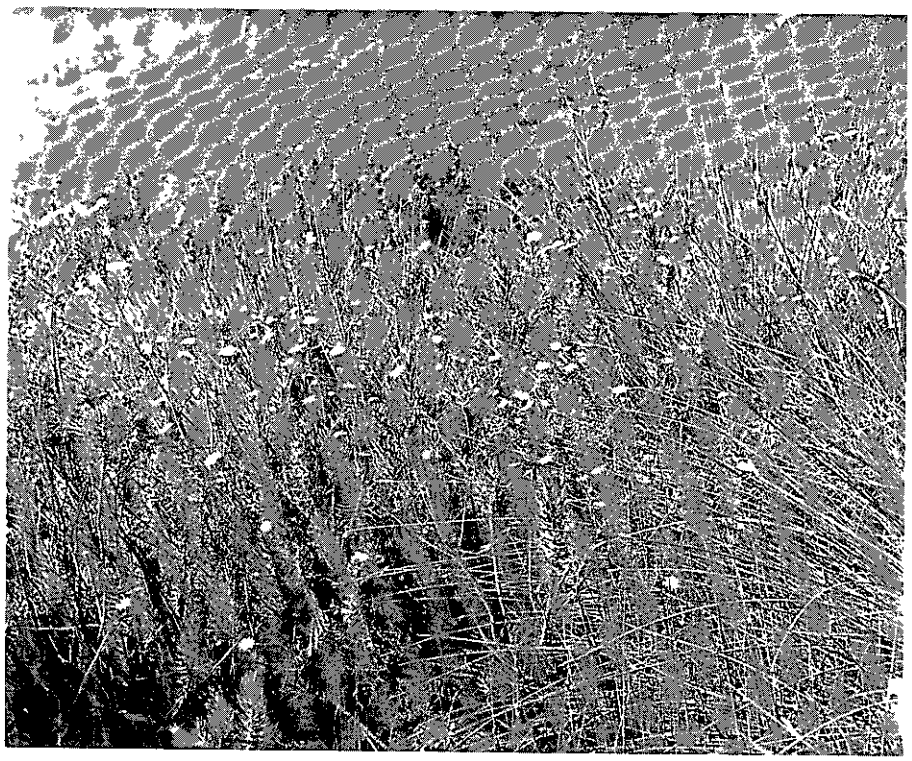

Figure 7. Berzelia lanuginosa - Merxmuellera cincta Tall Closed Shrubland deep sand with accumulated organic material at the surface. The white composite is Osmitopsis asteriscoides.

3.2 Rhus angustifolia - Zantedeschia aethiopica High Closed Shrubland

Campbell et al (1981) structural equivalent: Tall Closed Shrubland
Map Symbol: E Community area: 5,57 ha
Relevés (5): 57, 58, 62, 63, 64 Age of vegetation in relevés: 23 years
Average number of species per relevé: 15 (5-21)

Differential species: The differential species of this community are shared with the Myrsine africana - Olea europaea subspecies africana Shrubland (see 3.3.1). They are, Blechnum australe, Maytenus acuminata, Olea europaea subspecies africana and Zantedeschia aethiopica.

Dominant species: Pteridium aquilinum, Protea neriifolia, Rhus angustifolia

The Rhus angustifolia - Zantedeschia aethiopica High Closed Shrubland is the second major sub-category of the Rhus angustifolia - Berzelia lanuginosa Short Closed Shrubland. It is not subdivided although two structural forms were identified. It occurs in the mid-central part of the study area below the contour path at altitudes ranging from 450 metres to 530 metres. The slope varies from eight degrees to 20 degrees and the aspect from north-north-west, through north to north-north-east. Land facets vary from pediment slopes to waxing slopes depending on the steepness.

Three relevés were situated in stands on soils of the Champagne Form, Champagne Series (Ch 11) and the other two in vegetation on soils of the Nomanci Form, Nomanci Series (No 10) and Magwa Form (Ma 9, undescribed series) respectively (Fry, in preparation). No rocks were found on the soil surface but accumulated litter was in excess of 90 per cent cover on average which is high in relation to the rest of the study area.

Champagne Series soils are dark, peaty soils with a high organic content. The tall form of the Rhus angustifolia - Zantedeschia aethiopica Shrubland is found on these soils. The short stratum (less than one metre high) has the highest projected canopy cover (93 per cent) and is dominated by Pteridium aquilinum and Zantedeschia aethiopica. Rhus angustifolia is emergent from this stratum forming a shrub layer (one to two metres high) with a projected canopy cover of 22 per cent. This form of the community is clearly distinguishable on aerial photographs, and in the field, appearing as a distinct physiognomic entity from the other form.

The second form has a high stratum (two to four metres high) with a projected canopy cover of 70 per cent. Protea neriifolia is the dominant shrub in this stratum. It can also have a tall stratum (one to two metres high) which, if present, is usually dominated by Brunia nodiflora and Cliffortia cuneata. The lowest stratum is a short (less than one metre high), closed (56 per cent projected canopy cover) layer with Pteridium aquilinum dominant. This form of the community occurs on Nomanci and Magwa soil forms (Fry, in preparation).

It may be argued that the 'tall' form of the community is a separate community from the 'high' form, on the basis of physiognomic appearance and structure. However, on the basis of floristic composition, a distinction could not be made between them. These two structural forms are therefore mapped as a single unit on the map of plant communities.

In many respects the Rhus angustifolia - Zantedeschia aethiopica Shrubland is similar to the Rhus angustifolia - Myrsine africana Shrubland. They would be the same were it not for the absence of species such as Asparagus compactus, Myrsine africana and Rhus tomentosa from the former. This is particularly true of the 'high' form described above.

Werger et al (1972) did not sample or describe this community in their study.

It appears that porcupines are intermittent visitors to this shrubland where they root in the peaty soil for the fleshy rhizomes of Zantedeschia aethiopica.

3.3 Rhus angustifolia - Myrsine africana Short to High Closed Shrubland

This shrubland is the third major sub-category of the Diospyros glabra - Rhus angustifolia Short to Tall Closed Shrubland. It has two variants, the Myrsine africana - Olea europaea subspecies africana High Closed Shrubland and the Myrsine africana - Cliffortia dentata Tall Closed Shrubland. All the soils on which these communities occur, except Clovelly Form, Geelhout Series (Cv 11), have granite material in the profile. The influence of granite is apparently greater on the former than on the latter community.

In the soils of the Myrsine africana - Cliffortia dentata Shrubland (except in the Glenrosa Form), sandstone-derived materials are also well represented.

The average altitudes at which these two communities occur differ by over 160 metres. The gradient of slopes where the Myrsine africana - Cliffortia dentata Shrubland occurs average 38 degrees which is almost twice as steep as those on which the Myrsine africana - Olea europaea subspecies africana Shrubland is found. The steeper slopes are also cooler and moister. They have a north-easterly to south-easterly aspect in contrast to the north-easterly to north-westerly aspect where the Myrsine africana - Olea europaea subspecies africana Shrubland occurs.

Floristically the two variants are related by having a number of general (ubiquitous) species in common. More specifically, these shrublands have three species, Asparagus compactus, Psoralea cordata and Tetraria sylvatica which are exclusive to them.

3.3.1 Myrsine africana - Olea europaea subspecies africana High Closed Shrubland

Campbell et al (1981) structural equivalent: Tall Closed Shrubland
Map Symbol: F — Community area: 5,17 ha
Relevés (6): 37, 38, 39, 42, 56, & 96 — Age of vegetation in relevés: 23 years
Average number of species per relevé: 27 (11-38)

Differential species: The differential species of this community are shared with the Rhus angustifolia - Zantedeschia aethiopica, Myrsine africana - Cliffortia dentata and Restio gaudichaudianus - Myrsine africana Shrubland communities. They are as follows: Asparagus compactus, Blechnum australe, Halleria lucida, Hartogiella schinoides, Maytenus acuminata, Myrsine africana, Olea europaea subspecies africana, Oxalis bifida, Psoralea cordata, Psoralea pinnata, Rapanea melanophloeos, Rhus tomentosa, Tetraria sylvatica, Zantedeschia aethiopica.

Dominant species: Cliffortia cuneata, Diospyros glabra, Olea europaea subspecies africana, Protea neriifolia, Pteridium aquilinum, Rhus angustifolia.

The Myrsine africana - Olea europaea subspecies africana High Closed Shrubland community variant is found in the mid-central part of the study area. It does not occur as a single unit but rather as disjunct patches interspersed between other communities (Figure 4). The slopes on which it is found range from ten degrees to 36 degrees (average 22 degrees) and estimated rock cover is low, (five per cent). Relevé 37 is an exception since it has an estimated rock cover of 60 per cent. Estimated litter cover is high with an average of 90 per cent.

The soils of this community are all granite-derived and include the same three forms and series as for the Rhus angustifolia - Zantedeschia aethiopica Shrubland: Champagne Form, Champagne Series (Ch 11), Nomanci Form, Nomanci Series (No 10) and Magwa Form (Ma 9, undescribed series).

The Myrsine africana - Olea europaea subspecies africana Shrubland is characterized by a high stratum (two to six metres high) with an average projected canopy cover of 67 per cent. This stratum is dominated by Olea europaea subspecies africana, Protea neriifolia and Rhus angustifolia. A tall stratum (one to two metres high) with an average projected canopy cover of 25 per cent is found in some stands. It is dominated by Cliffortia cuneata. A short stratum (less than one metre high) with average projected canopy cover of 24 per cent, and dominated by Pteridium aquilinum, is the typical understorey of this community.

Relevé 42 is somewhat anomalous in the Myrsine africana - Olea europaea subspecies africana Shrubland. It is grouped here by virtue of the presence of Myrsine africana and Rhus tomentosa. It is situated on Champagne Series soil and is closely allied to the 'tall' form of the Rhus angustifolia - Zantedeschia aethiopica Shrubland. However, on the basis of floristic relationships relevé 42 is retained as representing the Myrsine africana - Olea europaea subspecies africana Shrubland (Figures 3 and 4).

Werger et al (1972) did not sample this community in their survey.

3.3.2 Myrsine africana - Cliffortia dentata Short Closed Shrubland

Campbell et al (1981) structural equivalent: Low Closed Shrubland
Map symbol: G Community area: 3,24 ha
Relevés (4): 29, 30, 31, 32 Age of vegetation in relevés: 23 years
Average number of species per relevé: 40 (31-54)

Differential species: Cliffortia dentata, Ficinia trichodes, Galium mucroniferum, Pelargonium cf tabulare, Pentaschistis aristidoides, Polyarrhena reflexa, Selago serrata.

Dominant species: Aristea major, Cliffortia cuneata, Pteridium aquilinum.

The Myrsine africana - Cliffortia dentata Short Closed Shrubland is found on cool north-east to south-east facing slopes, in the south-west sector of Swartboschkloof. It ranges in altitude from 680 metres to 700 metres. The slopes are steep varying from 32 degrees to 42 degrees. This is much steeper than the average gradient of the slopes in the catchment.

Four different soil series are found in the four relevés representing this community variant: Hutton Form, Clansthal Series (Hu 24); Glenrosa Form, Glenrosa Series (Gs 15); Clovelly Form, Mossdale Series (Cv 14) and Clovelly Form, Geelhout Series (Cv 11). These relevés are in a geomorphologically active zone: steep slopes below sandstone cliffs off which a large amount of water drains. The land facets represented include waxing slopes and detrital slopes which indicate steepness and active geomorphological processes as well (see Appendix 1).

Estimated rock cover is high (85 per cent to 90 per cent) in two relevés compared with the very low (two per cent) rock cover in the other two relevés. Estimated average litter cover is moderate (55 per cent) and total projected canopy cover averages 88 per cent.

The dominant stratum of the Myrsine africana - Cliffortia dentata Shrubland is a short layer (less than one metre high) with an average projected

canopy cover of 72 per cent. This stratum is dominated by Aristea major, Cliffortia dentata, Erica sphaeroidea and Pteridium aquilinum. In moist situations Cliffortia dentata forms extensive low mats. Above the short stratum is a tall shrub layer with an average projected canopy cover of 35 per cent. It is dominated by Aristea major, Cannomois virgata and Cliffortia cuneata. Cliffortia dentata, Ficinia trichodes and Selago serrata are common to the Diospyros glabra - Elegia capensis Shrubland and the Myrsine africana - Cliffortia dentata Shrubland. This suggests some affinity between these two communities, possibly owing to the moist conditions in which they are found.

The Myrsine africana - Cliffortia dentata Shrubland is confined to the slopes adjacent to and above the path to Haelkop Ridge. This community was not found at other localities and it was not sampled or described by Werger et al (1972).

3.4 Rhus angustifolia - Restio gaudichaudianus High Closed Shrubland

Campbell et al (1981) structural equivalent: Tall Closed Shrubland
Map symbol: I Community area: 18,66 ha
Relevés (18): 60, 61, 68, 71, 72, 73, 77, 78, 79, 81, 82, 83, 88, 92, 95, 97, 98, 195 Age of vegetation in relevés: 23 years
Average number of species per relevé: 31 (20-42)

Differential species: This community has no true differential species. It is characterized on the basis of low occurrence or absence of Hartogiella schinoides, Myrsine africana, Oxalis bifida and Rhus tomentosa.

Dominant species: Aristea major, Merxmuellera stricta, Protea neriifolia, Pteridium aquilinum, Restio gaudichaudianus.

The Rhus angustifolia - Restio gaudichaudianus High Closed Shrubland is the fourth major sub-category of the Diospyros glabra - Rhus angustifolia Short to Tall Closed Shrubland, and in its typical form occurs interspersed with the Rhus angustifolia - Myrsine africana Shrubland (Figure 8) over a large part of the mid-central zone of the study area (390 metres to 550 metres). It is found on a wide variety of soils: Champagne Series (Ch 11), Magwa Form (Ma 9, undescribed series), Nomanci Series (No 10), Tokai Series (Ct 11), Geelhout Series (Cv 11), Mossdale Series (Cv 14) and Glenrosa Series (Gs 15). At elevations between 550 metres and 700 metres, on the central mid-slopes it occurs on a mixture of Nomanci and Glenrosa soil forms.

The aspect where this community occurs varies between north-east to west, but is mainly north-east facing. The gradient of the slopes where it is found varies from fairly shallow, almost level (five degrees) to steep (34 degrees). The various land facets identified in this community include convex-concave slopes, concave-convex slopes, pediment slopes, plain slopes, convex crests, waxing slopes and detrital slopes.

Rock cover is low, with an average of four per cent (zero per cent to 20 per cent). This is one of the lowest rock cover values recorded for the fynbos shrublands on the lower slopes. Other low values were recorded in

the Myrsine africana - Olea europaea subspecies africana Shrubland. Litter cover estimates average 80 per cent which is comparable with that of the Restio gaudichaudianus - Myrsine africana Shrubland. Total projected canopy cover is estimated at 87 per cent.

Protea neriifolia and Protea repens dominate the high shrub layer (two to five metres high) which has an average projected canopy cover of 34 per cent. Following Edwards (1983), this is a moderately closed canopy. Seven of the 18 relevés sampled lacked this stratum.

A tall stratum (one to two metres high) occurs in all but one relevé. It has an average projected canopy cover of 25 per cent and is dominated by Brunia nodiflora, Cannomois virgata, Cliffortia cuneata, Cliffortia ruscifolia, Diospyros glabra, Halleria elliptica and Leucadendron salignum. The short stratum (less than one metre high) has the highest average projected cover (64 per cent). Dominant species are: Aristea major, Cymbopogon marginatus, Merxmuellera stricta, Pteridium aquilinum, Restio gaudichaudianus and Watsonia pyramidata.

Figure 8. Rhus angustifolia - Restio gaudichaudianus High Closed Shrubland. Note the person almost completely obscured by the dense growth of Protea branches.

By more extensive sampling it has been possible to divide the Protea nitida (=P. arborea) - Rhus angustifolia Community (Werger et al 1972) into two separate communities: the Rhus angustifolia - Restio gaudichaudianus Shrubland and the Restio gaudichaudianus - Myrsine africana Shrubland. Werger et al (1972) relevés 4, 5, 6, 23, 36 (304, 305, 306, 323, 336 in Figure 3) represent the Rhus angustifolia - Restio gaudichaudianus Shrubland which is not part of the 'Waboomveld' (sensu Taylor 1963) as suggested by these workers.

3.4.1 Restio gaudichaudianus - Myrsine africana High Closed Shrubland

Campbell et al (1981) structural equivalent: Tall Closed Shrubland
Map Symbol: H
Community area: 10,97 ha
Relevés (15): 1, 2, 4, 7, 8, 59, 66, 69, 70, 74, 75, 76, 80 111, 112
Age of vegetation in relevés: 23 years
Average number of species per relevé: 39 (24-52)

Differential species: This community has no true differential species. It is distinguished from the Rhus angustifolia - Restio gaudichaudianus Shrubland by having marked presence of Hartogiella schinoides, Myrsine africana, Oxalis bifida and Rhus tomentosa.

Dominant species: Cliffortia ruscifolia, Cymbopogon marginatus, Merxmuellera stricta, Protea neriifolia, Protea nitida, Pteridium aquilinum, Restio gaudichaudianus.

The Restio gaudichaudianus - Myrsine africana High Closed Shrubland (Figure 9) is found at altitudes of 330 metres to 500 metres in the lower to mid-central parts of the study area, associated with the Rhus angustifolia - Myrsine africana Shrubland. The soils on which it is found are: Magwa Form (Ma 9, undescribed series), Clovelly Form, Geelhout Series (Cv 11), Oakleaf Form (Oa 34) and Glenrosa Form, Glenrosa Series (Gs 15).

This community occurs mainly on north-east facing slopes which range from level (two degrees) to steep (30 degrees) with an average gradient of nine degrees. The land facets on which it occurs include pediment slopes, pediplains, concave-convex slopes, detrital slopes, plain slopes and convex crests. Drainage is good at all the sites sampled.

There is a wide range in estimated rock cover (one per cent to 75 per cent). The average rock cover is 21 per cent, which is considerably more than for those sites where the Rhus angustifolia - Restio gaudichaudianus Shrubland is found. This could be important because dominance of Protea nitida (waboom) in the Restio gaudichaudianus - Myrsine africana Shrubland appears to be correlated with the amount of exposed rock. The Restio gaudichaudianus - Myrsine africana Community is the only community where Protea nitida is consistently dominant throughout, in contrast to it appearing as a sporadic dominant in a number of other communities.

Estimated total projected canopy cover ranges from 80 per cent to 97 per cent (average 87 per cent) and estimated average litter cover is 78 per cent, which is somewhat higher than the average for the study area.

Three strata are distinguished in this community. The high stratum (two to five metres high) is dominated by Protea nitida, Protea neriifolia and less commonly by Cliffortia ruscifolia and Protea repens. The average projected canopy cover for this stratum is 44 per cent. The tall (one to two metres high) stratum which is dominated by Cliffortia cuneata, Diospyros glabra, Rhus angustifolia, Halleria elliptica and Cliffortia ruscifolia, has an average projected canopy cover of 22 per cent. The short (less than one metre high) stratum has the highest average projected canopy cover (66 per cent). It is dominated by Aristea major, Cymbopogon marginatus, Merxmuellera stricta, Montinia caryophyllacea, Pteridium aquilinum and Restio gaudichaudianus.

This community is referred to by Taylor (1963) as 'Waboomveld' because of the dominance of Protea nitida. Other Protea species are poorly represented in this community. In Swartboschkloof, Waboomveld is best developed on Oakleaf Form (Oa 34) soils (relevés 1, 75, 76 and 111).

As mentioned above the Protea nitida (=P. arborea) - Rhus angustifolia Community of Werger et al (1972) has been separated into two communities in this study. The Werger et al (1972) relevés 1, 2, 3, 41, 42 and 43 (301, 302, 303, 342 and 343 in Figure 2) represent the Restio gaudichaudianus - Myrsine africana Shrubland or 'Waboomveld' in this study.

Figure 9. The Restio gaudichaudianus - Myrsine africana High Closed Shrubland found in the lower to mid-central parts of the study area.

Diospyros glabra - Protea repens Transitional Shrublands

The Diospyros glabra - Protea repens Shrubland consists of those communities which are transitional between the Erica hispidula - Diospyros glabra Shrubland and the Erica hispidula - Restio sieberi Shrubland. There are two groups, the Protea repens - Rhus angustifolia High Closed Shrubland and the Protea repens - Nebelia paleacea High Closed Shrubland. The first group has a typical community with two variants and the second has two variants.

All these communities, except for two relevés on soils derived mainly from granite, occur on sandstone-derived soils. The Protea repens - Rhus angustifolia Shrubland are more akin to the 'pure' communities found on soils of granite and mixed (granite-sandstone) derivation. In contrast, the Protea repens - Nebelia paleacea Shrubland is allied to the 'pure' sandstone associated communities of the Erica hispidula - Restio sieberi Shrubland.

A sharp increase in the occurrence of sandstone favouring species is found in the Protea repens - Nebelia paleacea Shrubland communities compared with the Protea repens - Rhus angustifolia Shrubland communities.

Protea repens has been used in the binomial of the major group because there is no other species considered suitable for this purpose. It may be argued that it is not a suitable species because it has a wide ecological tolerance and is adversely affected by fire. However, Protea repens is a conspicuous, easily identified shrub, which performs best in the transitional communities. These attributes outweigh those not in its favour.

1. Protea repens - Rhus angustifolia High Closed Shrubland

Campbell et al (1981) structural equivalent: Tall Closed Shrubland
Map Symbol: L Community area: 8,6 ha
Relevés (11): 40, 43, 44, 49, 50, 55, 65, 67, 135, 136, 137 Age of vegetation in relevés: 23 years
Average number of species per relevé: 37

Differential species: The species which differentiate this community are shared with a number of other communities. It is characterized by absence of many species of communities associated with granite-derived and mixed soils and increased presence of species associated with sandstone-derived soils.

Dominant species: Bobartia indica, Cliffortia ruscifolia, Protea neriifolia, Protea repens, Restio triticeus.

The Protea repens - Rhus angustifolia High Closed Shrubland in its typical form (Figure 10) has a disjunct distribution in Swartboschkloof, at altitudes ranging from 430 metres to 570 metres. It is found on the ridge in the north-eastern corner but mainly on waxing slopes, plain slopes and detrital slopes in the east central part of the study area. Aspect is northerly to easterly but one relevé faces south-west. The gradient of the slopes range from almost level (four degrees) to steep (32 degrees).

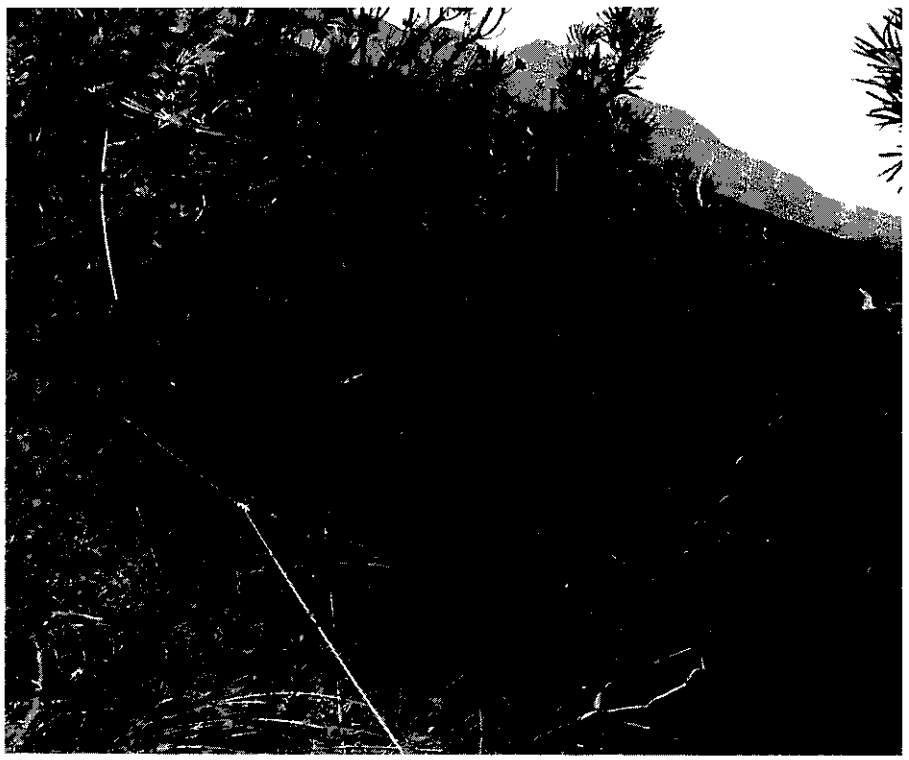

Figure 10. The typical form of the Protea repens - Rhus angustifolia High Closed Shrubland. Height of the survey pole is 2,5 metres.

The soils on which the Protea repens - Rhus angustifolia Shrubland is found are generally sandy, with boulders and gravel, of the Clovelly Form, Geelhout Series (Cv 11). There are two exceptions: relevé 50 is on sandstone-derived soil of the Constantia Form, Tokai Series (Ct 11) and relevé 40 is on Nomanci Series (No 10), which is a humic clay-loam derived from granite. Rock cover varies from low (four per cent) to moderate (50 per cent) with an average of 33 per cent. Estimated litter cover averages 70 per cent but can be as high as 90 per cent.

Four strata have been distinguished in this community. The dominant stratum is the high stratum (two to four metres high) which has an average projected cover of 65 per cent. It is dominated by Protea neriifolia and Protea repens. Below the high stratum is a tall stratum (one to two metres high) which is dominated by Cliffortia ruscifolia and in some cases by Brunia nodiflora. This stratum has an average projected canopy cover of 28 per cent. The third layer is a short shrub stratum (half-a-metre to one metre high) which has an average projected canopy cover of 63 per cent. It is dominated by Restio triticeus. A low stratum (less than half-a-metre) dominated by grasses such as Cymbopogon marginatus and Merxmuellera stricta is found below the short stratum.

In qualitative terms this community is somewhat more open and easier to penetrate than the other Protea dominated shrublands. This makes for easier collection of floristic data and easier assessment of the structure of the community.

1.1 Rhus angustifolia - Restio sieberi Tall Closed Shrubland

Campbell et al (1981) structural equivalent: Mid-high Mid-dense Shrubland
Map symbol: K
Community area: 12,4 ha
Relevés (14): 11, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 27, 33, 36
Age of vegetation in relevés: 23 years (3 relevés), 8 years (11 relevés)
Average number of species per relevé: 38

Differential species: This community is characterized by the presence, absence and relative abundance of species. It has no true differential species since it has many species in common with other communities.

Dominant species: Erica hispidula, Merxmuellera stricta, Restio sieberi, Stoebe plumosa.

This shrubland is found on the west side of the study area (Figure 11), below the cliffs. Relevés 27 and 33 represent stands of this community along the paths to Haelkop Ridge at 741 metres and 580 metres respectively. This is higher than the average altitude (460 metres) of the community. Aspect is mainly east to north-east and the gradient of the slopes ranges from three degrees to 32 degrees with an average of 12 degrees. The land facets on which this community occurs include detrital slopes, waxing slopes, plain slopes and concave-convex slopes.

All the soils on which the Rhus angustifolia - Restio sieberi Shrubland is found are derived from sandstone. They include Vilafontes Form, Hudley Series (Vf 11), Clovelly Form, Geelhout Series (Cv 11) and Constantia Form, Tokai Series (Ct 11). Estimated rock cover ranges from one per cent to 40 per cent with a low average of seven per cent. Litter cover averages 49 per cent (ten per cent to 90 per cent) which is less than that of the Protea dominated communities but comparable with values for litter in the Erica hispidula - Restio sieberi Shrubland communities.

Three strata are found in this Shrubland. The low stratum (less than half-a-metre high) which is dominated by Merxmuellera stricta, Restio sieberi and Stoebe plumosa has marginally less projected canopy cover (48 per cent) than the short stratum. The short stratum (half-a-metre to one metre high) is dominated by Erica hispidula and has a projected canopy cover of 50 per cent. The tall stratum (one metre to two metres high) consists of tall shrubs which are emergent from the short stratum. The tall stratum has a projected canopy cover of 35 per cent and is dominated by Cliffortia cuneata and Erica hispidula. The Erica hispidula in the short and tall strata give this shrubland its characteristic 'ericoid' appearance.

The presence of Restio sieberi in the Rhus angustifolia - Restio sieberi Shrubland with moderate to high cover abundance is significant. It separates this community from the Rhus angustifolia - Restio gaudichaudianus Shrubland because although Restio sieberi and Restio gaudichaudianus are morphologically very similar, they are ecologically mutually exclusive. Restio sieberi favours sandy soils whereas Restio gaudichaudianus favours deeper soils of granite or colluvial derivation.

Restio sieberi is usually found at high altitudes on sandy soils (E Esterhuysen, personal communication). In Swartboschkloof this species is found at lower altitudes in some places, such as in the area where the Rhus angustifolia - Restio sieberi Shrubland mostly occurs. The apparent reason for this is that the sandstone has slumped into the valley on the west side, providing suitable conditions for Restio sieberi to grow at lower altitudes. In only a few instances does the presence of Restio sieberi overlap with that of Restio gaudichaudianus.

Protea repens is absent from the Rhus angustifolia - Restio sieberi Shrubland. This may be due to the habitat not being suitable for this species, although this seems unlikely, or as a result of an accidental fire in September 1973 (Jonkershoek Forestry Research Station Records).

Figure 11. Rhus angustifolia - Restio sieberi Tall Closed Shrubland in the foreground. This part of the study area was burnt in September 1973.

Most of the area occupied by the Rhus angustifolia - Restio sieberi Shrubland was affected by the 1973 fire. It is thus not in a mature state (as shown by the many Protea neriifolia shrubs of about ten years old scattered through the area) and should therefore be interpreted with this in mind. It may be that, given time, it would develop to become structurally, but not floristically, like the Protea repens - Maytenus oleoides Shrubland.

Werger et al (1972) showed their relevé 21 (321 in Figure 2) to be in the Thamnochortus gracilis - Hypodiscus aristatus Community they described. They also considered their relevé 22 (322 in Figure 3) to represent an undersampled community. This study shows that both these relevés represent the Rhus angustifolia - Restio sieberi Shrubland.

1.2 Protea repens - Maytenus oleoides High Closed Shrubland

Campbell et al (1981) structural equivalent: Tall Closed Shrubland
Map Symbol: J Community area: 21,34 ha
Relevés (18): 41, 45, 46, 47, 48, 52, 84, 85, 86, 87, 100, 103, 138, 153, 155, 156, 157, 165
Age of vegetation in relevés: 23 years (11 relevés) 24 years (6 relevés)
Average number of species per relevé: 41 (32-47)

Differential species: This community is characterized by the combination of presence, absence and relative abundance of species. It has no true differential species since it has many species in common with other communities.

Dominant species: Cliffortia ruscifolia, Cymbopogon marginatus, Diospyros glabra, Protea neriifolia, Protea repens, Restio gaudichaudianus, Restio triticeus.

The Protea repens - Maytenus oleoides High Closed Shrubland (Figure 12) has a widespread but scattered distribution through the study area. It occurs as patches within the Protea repens - Nebelia paleacea Shrubland on the lower western slopes as well as adjacent to the Boland Hiking Trail path before it reaches the 'zigzags' up to the contour path. Smaller stands are found alongside and above the stream from Nuwejaarskloof on the south-eastern boundary; below the contour path in the mid-central area; near the granite-sandstone contact on the slopes in the south-westerly sector and adjacent to the firebreak in the north-east corner (Figure 3).

The average altitude at which the Protea repens - Maytenus oleoides Shrubland occurs is 518 metres with a range from 400 metres to 700 metres. The gradients of the slopes average 24 degrees (four degrees to 37 degrees) with aspect varying from south-east through north to north-west. Land facets on which this community is found include the following: waxing slopes, plain slopes, convex-concave slopes, detrital slopes and in one case a convex crest.

Fry (in preparation) classified the soils where this shrubland is found into the following forms and series: Clovelly Form, Geelhout (Cv 11) and Springfield (Cv 24) Series; Fernwood Form, Fernwood Series (Fw 11); Constantia Form, Tokai Series (Ct 11) and Glenrosa Form, Glenrosa Series (Gs 15). There are some exceptions. The classification of the soils at relevés 103, 138, 153, 155, 157 and 165 is either not known or is unclear from Fry's soil map.

Rock cover is estimated to average 31 per cent (two per cent to 65 per cent) and litter cover is moderate, averaging 56 per cent (20 per cent to 95 per cent). Total projected canopy cover of the vegetation has a high average of 86 per cent (65 per cent to 95 per cent).

Figure 12. Protea repens - Maytenus oleoides High Closed Shrubland. Height of survey pole is 2,5 metres.

Structurally this community can be subdivided into three strata. The high stratum (two metres to five metres high), which is not found in all stands of this community, has an estimated projected canopy cover of 55 per cent. This stratum is composed of shrubs and is dominated by Protea neriifolia and Protea repens. A tall shrub stratum (one metre to two metres high) is found below the high stratum. It has an estimated average projected canopy cover of 24 per cent and is dominated by shrubs: Cliffortia cuneata, Cliffortia ruscifolia, Diospyros glabra, Erica hispidula and Protea nitida. The short stratum (less than one metre high) is composed mainly of grasses and restios. It is dominated by Aristea major, Cymbopogon marginatus, Restio gaudichaudianus and Restio triticeus and has an average projected canopy cover of 60 per cent.

Since this is a transitional community closely related to the Restio gaudichaudianus - Myrsine africana Shrubland and Rhus angustifolia - Restio sieberi Shrubland (with species having affinity for sandstone derived soil) it is more or less a 'sink' for those relevés which cannot be unequivocally placed in 'pure' communities. It has stronger affinities to those communities found on heavier soils of granite or mixed derivation. This is indicated by the constant presence of Restio gaudichaudianus.

2. Protea repens - Nebelia paleacea High Closed Shrubland

The Protea repens - Nebelia paleacea Shrubland consists of two community variants: the Nebelia paleacea - Erica sphaeroidea High Closed Shrubland; and the Nebelia paleacea - Restio perplexus High Closed Shrubland. They occur on shallow (less than half-a-metre deep), well-drained, sandstone-derived soils at altitudes between 400 metres and 950 metres. The gradient of slopes where these communities occur ranges from moderately steep to steep (14 degrees to 40 degrees) with an average gradient of 27 degrees. Aspect varies through all bearings except south.

This transitional shrubland is most akin to the 'pure' communities of the Erica hispidula - Restio sieberi Shrubland.

2.1 Nebelia paleacea - Erica sphaeroidea High Closed Shrubland

Campbell et al (1981) structural equivalent: Tall Closed Shrubland
Map symbol: M
Community area: 19,16 ha
Relevés (15): 28, 51, 53, 54, 104, 122, 123, 125, 126, 130, 131, 149, 152, 159, 175
Age of vegetation in relevés:
8 years (2 relevés)
23 years (5 relevés)
24 years (8 relevés)
Average number of species per relevé: 39

Differential species: No true differential species are found here. This community is characterized by the absence of many species found in the previously described communities and presence of species most allied to the Erica hispidula - Restio sieberi Shrubland communities.

Dominant species: Cliffortia cuneata, Cliffortia polygonifolia, Cliffortia ruscifolia, Protea neriifolia, Protea repens and Restio sieberi.

The Nebelia paleacea - Erica sphaeroidea Shrubland community variant is widespread, occurring in small patches at a number of different places in Swartboschkloof. In the north-western sector it is found associated with the Rhus angustifolia - Maytenus oleoides and Restio sieberi - Nebelia paleacea Shrublands. On the eastern slopes it also occurs as part of mosaic with the latter community. In the south-eastern sector it tends to occur as more uniform stands over larger areas (Figure 4). Altitudes at which it is found range from 415 metres to 885 (550 metres on average).

Most of the slopes where this community occurs, range from moderately steep to steep (16 degrees to 18 degrees) with an average gradient of 26 degrees. The land facet classes of these slopes depends on the gradient and they include detrital slopes, waxing slopes, concave-convex and plain slopes.

All the soils on which this community is found are derived from sandstone. They are well-drained and are usually less than half-a-metre deep. Fry (in preparation) classified these soils into the Clovelly Form, Geelhout series (Cv 11) and Fernwood Form, Fernwood Series (Fw 11) as well as a mixture of Clovelly and Glenrosa Forms. Rock cover estimates range from ten per cent to 90 per cent with an average of 45 per cent. This average is almost

twice as high as the general average for rock cover in the study area. Litter cover also has a wide range (ten per cent to 90 per cent) with an average of 57 per cent which is below average for the study area.

Average total projected canopy cover of this Shrubland is 87 per cent. Both floristically and structurally it is mid-way between the Protea repens - Rhus angustifolia and Nebelia paleacea - Restio perplexus Shrubland Communities. It has two structural forms. Sixty per cent of the relevés representing the Nebelia paleacea - Erica sphaeroidea Community do not have shrubs higher than two metres. The remaining 40 per cent (six relevés) have a high stratum (two metres to five metres high) similar to that of the Protea repens - Rhus angustifolia Shrubland.

The first structural form is the 'low closed' form. The low stratum (less than half-a-metre high) is dominant, with an average projected canopy cover of 72 per cent. Dominant species in this stratum are Blaeria dumosa, Restio sieberi and Thamnochortus gracilis. The short stratum (half-a-metre to one metre high) has an average projected canopy cover of 58 per cent and is dominated by Cliffortia polygonifolia, Cliffortia ruscifolia, Erica hispidula and Penaea mucronata. The tall stratum (one metre to two metres high) has an average projected canopy cover of 31 per cent. It is dominated by Brunia nodiflora, Cliffortia cuneata, Cliffortia polygonifolia, Protea nitida and Watsonia pyramidata.

The second form of 'high closed' shrubland is dominated by a high stratum (two metres to five metres high) and has no low stratum. The high stratum is dominated by Cliffortia ruscifolia, Protea neriifolia and Protea repens. It has an average projected canopy cover of 76 per cent. The tall stratum (one metre to two metres high) which has an average projected canopy cover of 16 per cent is dominated by Brunia nodiflora, Cliffortia cuneata, Cliffortia polygonifolia and Penaea mucronata. The short stratum has an average projected canopy cover of 53 per cent and is dominated by Ehrharta racemosa, Pentaschistis colorata and Restio triticeus.

Floristic data collected in this study show that the two structural forms described here, although structurally different, cannot be separated on a floristic basis.

2.2 Nebelia paleacea - Restio perplexus High Closed Shrubland

Campbell et al (1981) structural equivalent: Tall Open Shrubland
Map symbol: N
Community area: 33,29 ha
Relevés (17): 26, 124, 128, 129, 139, 142, 147, 154, 170, 173, 176, 177, 178, 179, 180, 189, 191
Age of vegetation in relevés:
7 years (2 relevés)
9 years (3 relevés)
23 years (1 relevé)
24 years (11 relevés)
Average number of species per relevé: 36 (21-53)

Differential species: No true differential species are found in this community. It lacks presence of many species found in the previously described communities.

Dominant species: Blaeria dumosa, Cliffortia polygonifolia, Erica hispidula, Protea repens, Restio perplexus, Watsonia pyramidata.

This community variant (Figure 13) was sampled at elevations from 485 metres to 924 metres with an average altitude of 757 metres. It occurs mainly in three areas of Swartboschkloof. On the western slopes it is found in patches associated with the Restio sieberi - Nebelia paleacea Shrubland and the Protea repens - Nebelia paleacea Shrubland. In the eastern part it occurs again as part of a mosaic with the latter two communities. In the south-eastern sector at altitudes from 560 metres to 830 metres, it occurs uniformly as pure stands. At relatively high elevations (700 metres to 930 metres) in the south-western sector it is found in rock situations, particularly on the cliffs close to the southern boundary (Figure 4).

It is found on well-drained slopes with gradients averaging 28 degrees (14 degrees to 40 degrees). Aspect varies from south-easterly to north-westerly and land facets include detrital slopes, waxing slopes and concave-convex slopes. Rock cover averages 53 per cent, ranging from low (five per cent) to very high (95 per cent). Estimated litter cover also has a wide range (ten per cent to 80 per cent) with a moderate average of 46 per cent which is almost a third less than the general average (65 per cent) for the study area.

The soils on which this community is found are all derived from sandstone. They are shallow, (half-a-metre to one metre in depth) with an average depth of 0,27 metres. Fry (personal communication) did not sample the soils where relevés 129, 139, 142, 147, 154, 170, 176, 177, 178, 179, 180, 189 and 191 are situated.

The area where relevés 176, 177, 178, 179 and 180 are situated, Fry (in preparation) classified and mapped as a mixed matrix of Clovelly and Glenrosa soil forms. The soil series of relevés 124 and 128 are Vilafontes Form, Hudley Series (Vf 11) and Clovelly Form, Geelhout Series (Cv 11) respectively.

The total projected canopy cover of the Nebelia paleacea - Restio perplexus Shrubland is 89 per cent on average. It can be subdivided into four strata. The high stratum has an average projected canopy cover of 31 per cent and is dominated by Protea neriifolia and Protea repens. It was only encountered in three relevés: 124, 129 and 189. The vegetation sampled at relevé 128 would probably develop a high stratum were it not for apparent severe wind pruning. Protea repens at this site has a high cover abundance score of four but the shrubs do not reach more than one-and-a-half metres in height.

The tall stratum (one metre to two metres) is dominated by Brunia nodiflora, Cliffortia ruscifolia, Cliffortia polygonifolia, Diospyros glabra and Erica hispidula. It has an average projected cover of 33 per cent. The short stratum (half-a-metre to one metre high) has an average projected canopy cover of 67 per cent with Aristea major, Erica hispidula, Hypodiscus albo-aristatus, Restio perplexus and Watsonia pyramidata dominant. The low stratum (less than half-a-metre) has the highest average projected canopy cover of 75 per cent). Dominant species in this stratum are: Blaeria dumosa, Cymbopogon marginatus, Elegia juncea, Pentaschistis colorata, Pentaschistis curvifolia, Restio sieberi and Staberoha cernua.

Relevés 124, 129 and 189 are structurally similar to the 'high closed' form of the Nebelia paleacea - Erica sphaeroidea Shrubland. However, these relevés lack presence of species such as Anthospermum aethiopicum, Asparagus rubicundus, Erica sphaeroidea, Pteridium aquilinum and Rhus angustifolia which would place them in the latter community.

Two relevés (180 and 191) in this community are in the firebreak. The objective of placing relevés in the firebreak was to assess the change in floristic composition of the communities through which the firebreak passes. Relevé 191 is a paired sample with relevé 117. In this case these relevés do not represent the same community since relevé 117 represents the Restio sieberi - Nebelia paleacea Shrubland and relevé 191 represents the Nebelia paleacea - Restio perplexus Shrubland. This could be attributed to the effects of fire on the vegetation samples at relevé 191 or to the absence of these effects at relevé 117. Relevé 180 (in the firebreak) is paired with relevé 179. Both relevés here represent the Restio sieberi - Nebelia paleacea Shrubland which suggests that the fire has not had any noticeable effect on the floristics of the vegetation at relevé 180. These findings are contradictory and suggest that further investigation is necessary to clarify the reason for this contradiction.

Figure 13. Nebelia paleacea - Restio perplexus Low Closed Shrubland. Each section of the survey pole is 0,5 metres; total height is 2,5 metres.

Erica hispidula - Restio sieberi Shrubland

There are two shrubland communities grouped together here: the Restio sieberi - Nebelia paleacea and Restio sieberi - Tetraria involucrata Shrubland. They are found at relatively high altitudes on shallow sandstone derived soils. Restio sieberi has been used as one of the species in the naming of these communities because it prefers sandstone derived soils at higher altitudes (see description of Rhus angustifolia - Restio sieberi Shrubland above).

It would be necessary to sample the vegetation of this type more extensively (outside the study area) to establish its place in the vegetation of Jonkershoek as a whole).

1. Restio sieberi - Nebelia paleacea Tall Closed Shrubland

Campbell et al (1981) structural equivalent: Low Closed Shrubland
Map symbol: P Community area: 41,58 ha
Relevés (22): 24, 25, 34, 90, 91,
105, 106, 117, 118, 119, 120,
121, 127, 133, 134, 140, 141,
143, 144, 145, 146, 185
Average number of species per relevé: 36 (23-58)

Differential species: Berzelia intermedia, Cliffortia exilifolia, Erica coccinea, Leptocarpus membranaceus, Sympieza articulata, Tetraria burmanni.

Dominant species: Erica coccinea, Erica hispidula, Nebelia paleacea, Restio sieberi, Tetraria capillacea.

This shrubland is found mostly on the slopes of the ridges bordering the study area on the west and east sides and in the south-east corner. Below the contour path in the mid-western part it is found in patches associated with the Nebelia paleacea - Restio perplexus Shrubland (Figure 14).

It occurs on a wide variety of land facets which include waxing slopes, detrital slopes, plain slopes, concave-convex slopes, a free face, drainage lines and convex-concave slopes. The land facets depend largely on the steepness of the slopes which range from almost level (four degrees) to steep (37 degrees), with an average of 23 degrees. It was sampled at altitudes from 420 metres to 910 metres (643 metres on average) but may occur at higher elevations on inaccessible cliffs which were not sampled).

Sandstone is the parent material of all the soils on which this community is found. Fry (in preparation) sampled the soils at relevés 24, 25, 34, 90 and 91. These he classified into the Clovelly Form, Geelhout Series (Cv 11) and Constantia Form, Tokai Series (Ct 11). Using Fry's (in preparation) soil map it is possible to classify the soils of relevés 117, 118, 119, 120, 121 and 127 as Clovelly Form, Geelhout Series (Cv 11). Rock cover ranges from low (ten per cent) to very high (90 per cent), with an average of 44 per cent, which is about twice the general average (25 per cent) for the whole study area. Average litter cover is 50 per cent which is 15 per cent less than the general average; in this shrubland litter cover ranges from 15 to 80 per cent.

Three strata can be distinguished in this shrubland. The low stratum (less than half-a-metre high) has the highest projected canopy cover (76 per cent). Dominant species in this stratum include: Elegia juncea, Restio sieberi, Staberoha cernua and Tetraria capillacea. The short stratum (half-a-metre to one metre high) has an average projected canopy cover of 58 per cent and is dominated by Erica hispidula and Nebelia paleacea. A tall stratum (one metre to two metres high) is found in ten relevés (45 per cent of the relevés sampled) and it has an average projected canopy cover of 20 per cent. Dominant species in this stratum are Brunia nodiflora, Cliffortia polygonifolia, Erica coccinea, Nebelia paleacea and Protea neriifolia.

The accidental fire in September 1973 swept through the Restio sieberi - Nebelia paleacea Shrubland on the western slopes of the study area. This could explain the absence of Erica coccinea from this area (relevés 140, 141, 143, 144, 145 and 146 (Figure 2)). Alternatively, the absence of this species from the above-mentioned relevés and relevés 133, 134 and 185 could be due to aspect of soil related factors which are not known. Erica coccinea is an important food plant for the Orange-breasted Sunbird (Nectarinia violacea L.) which feeds on the nectar of the flowers (Rebelo et al 1984).

From this study it is apparent that the Thamnochortus gracilis - Hypodiscus aristatus Community described by Werger et al (1972) represents a broad concept which can now be split into a number of more specific communities. One of these is the Restio sieberi - Nebelia paleacea Shrubland. Six relevés: 17, 19, 20, 24, 25 and 28 (317, 319, 320, 324 and 325 in Figure 3) from the Thamnochortus gracilis - Hypodiscus aristatus Community fall into the Restio sieberi - Nebelia paleacea Shrubland.

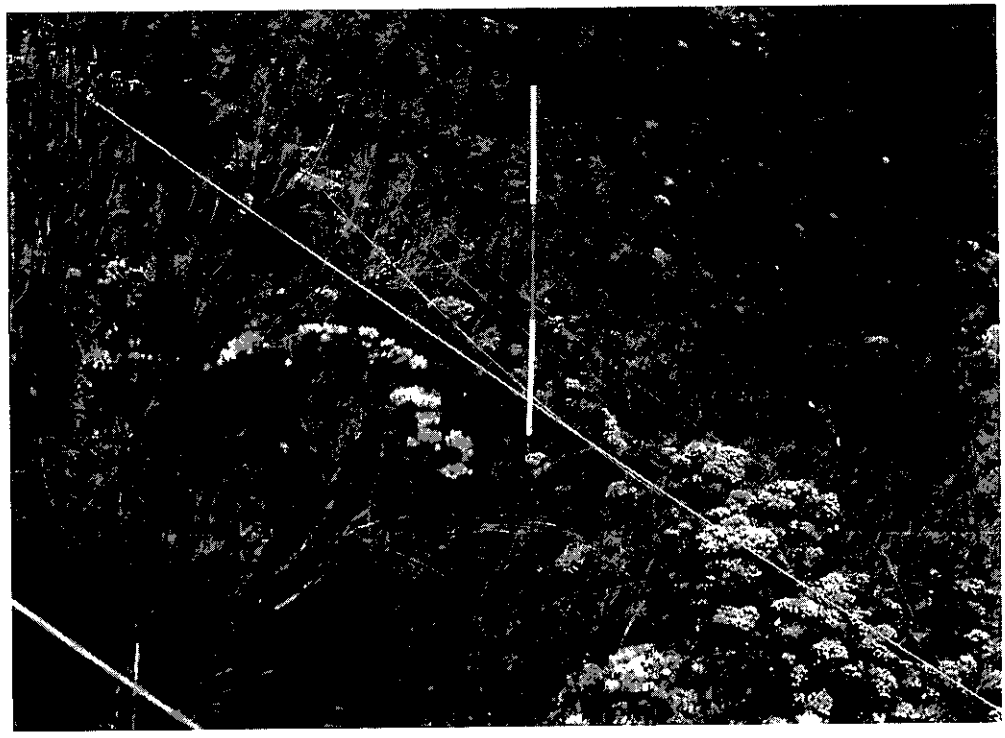

Figure 14. Restio sieberi - Nebelia paleacea Tall Closed Shrubland. The shrub with white flowers is Nebelia paleacea.

2. Restio sieberi - Tetraria involucrata Tall Closed Shrubland

Campbell et al (1981) structural equivalent: Low Closed Shrubland
Map symbol: R
Community area: 30,21 ha
Relevés (13): 132, 168, 169, 171, 172, 174, 181, 182, 184, 186, 187, 188, 190
Age of vegetation in relevés:
7 years (4 relevés)
8 years (1 relevé)
24 years (8 relevés)
Average number of species per relevé: 36 (24-48)

Differential species: Tetraria involucrata.

Dominant species: Cliffortia polygonifolia, Erica hispidula, Hypodiscus albo-aristatus, Restio sieberi, Tetraria involucrata.

This major sub-category of the Erica hispidula - Restio sieberi Shrubland is found at the highest altitudes in the study area, situated between 590 metres and 960 metres, with an average altitude of 840 metres. Four relevés (171, 187, 188 and 190) representing this community are situated in the firebreak on the southern boundary of the study area. They are thus not in the study area as such but were placed in the firebreak as 'paired samples' with relevés 168, 186, 133 and 134 respectively.

The community favours detrital slopes, convex-concave slopes and drainage lines with a north-easterly to westerly aspect. Gradients range from moderately steep to steep (12 degrees to 38 degrees), with an average of 28 degrees. The soils (not investigated by Fry) are sandy with a high percentage of boulders and stones all derived from quartzitic sandstone. These soils are well-drained and shallow; average depth is 20 centimetres. Estimated rock cover ranges from low to very high (two per cent to 85 per cent) with a moderate average of 42 per cent. Litter cover also has a wide range (five per cent to 80 per cent) but has a lower average value (27 per cent).

Two strata are typically found in this community. The tall stratum (one metre to two metres high) has an average projected canopy cover of 11 per cent and is dominated by emergent shrubs such as Cliffortia cuneata, Cliffortia polygonifolia and Penaea mucronata. Below this is a short stratum (less than one metre high) which is dominated by Aristea major, Elegia juncea, Hypodiscus albo-aristatus, Restio sieberi and Watsonia pyramidata. It has an average projected canopy cover of 78 per cent (Figure 15).

In five relevés a high (two metres to two-and-a-half metres) shrub stratum was found. It has an average projected canopy cover of 38 per cent in these relevés, but if taken in the community as a whole it has a much lower projected canopy cover of seven per cent. Dominant shrubs in this stratum are Cliffortia cuneata, Cliffortia polygonifolia and Protea nitida. The high stratum is thought to be typical of the Restio sieberi - Tetraria involucrata Shrubland as a whole.

Once again a contradictory situation is apparent with the 'paired samples'. Relevés 168 and 171 in mature vegetation represent the same community (Restio sieberi - Tetraria involucrata Shrubland) as their respective paired samples, 186 and 187, which are situated in the

firebreak. Conversely, relevés 188 and 190 in the firebreak represent the Restio sieberi - Tetraria involucrata Shrubland, whereas their respective paired relevés represent the Restio sieberi - Nebelia paleacea Shrubland.

It is interesting to note that species such as Erica curvirostris, Hypodiscus aristatus, Pentaschistis curvifolia, Pentaschistis steudeli, Restio cuspidatus and Thamnochortus gracilis are absent or have low presence and low cover abundance scores in the Restio sieberi - Tetraria involucrata Shrubland.

Werger et al (1972) did not sample the high-lying slopes of Swartboschkloof and thus did not characterize the Restio sieberi - Tetraria involucrata Shrubland or a possible equivalent.

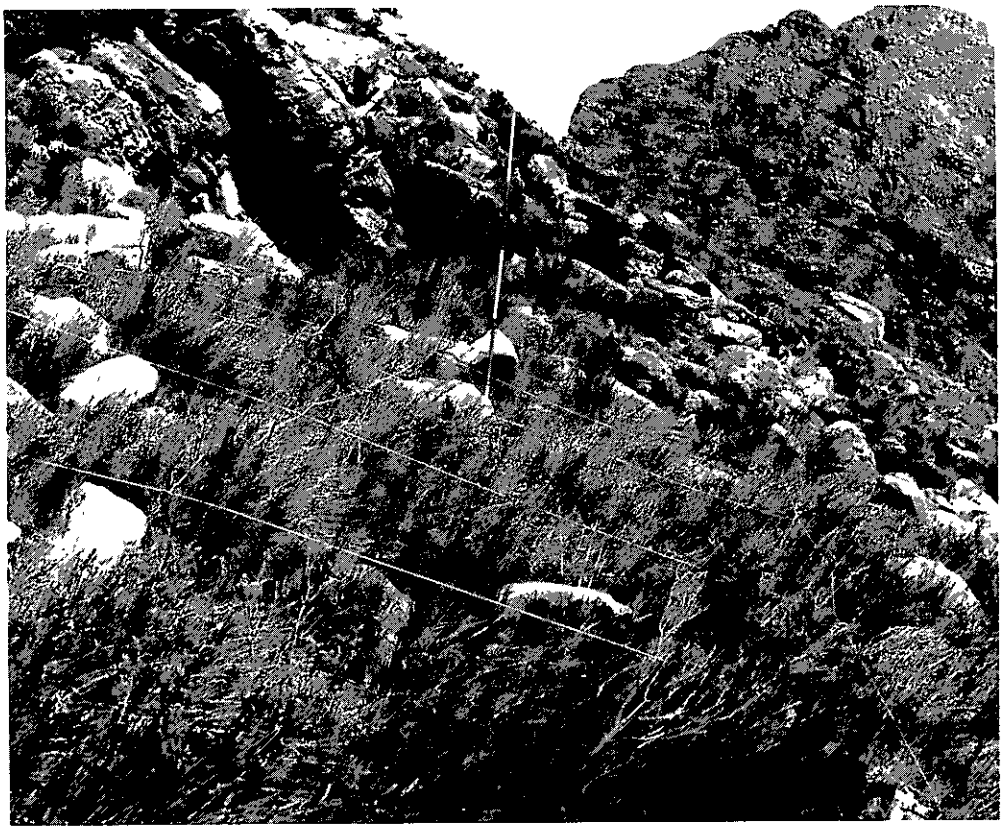

Figure 15. Restio sieberi - Tetraria involucrata Tall Closed Shrubland at high altitudes on rocky terrain. Sections of the survey pole are each half-a-metre.

RIPARIAN AND FOREST COMMUNITIES

Hartogiella schinoides - Diospyros glabra Riparian and Forest Communities

The communities which make up the riparian and forest vegetation are mostly associated with moist situations, often with running water in kloofs, gullies and watercourses. Two groups of communities are distinguished: the Diospyros glabra - Halleria glabra - Rapanea melanophloeos Tall Forest.

The two groups of communities are floristically related but are different in many respects in terms of habitat requirements. They are found at different altitudes on slopes with different average gradients. Soil development and estimated rock and litter cover are also strikingly dissimilar between the situations where the respective groups are found.

The Halleria elliptica - Cliffortia cuneata Shrubland is at the interface between the fynbos and the riparian communities. This community has a large proportion of fynbos species as well as some forest species. It therefore forms a link between the fynbos and forest vegetation types in Swartboschkloof.

1. Halleria elliptica - Brabejum stellatifolium Short Forest

Campbell et al (1981) structural equivalent: Low Forest
Map symbol: T Community area: 0,79 ha
Relevés (4): 107, 108, 109, 110 Age of vegetation in relevés: 24 years
Average number of species per relevé: (15-18)

Differential species: Brabejum stellatifolium is shared with the Halleria elliptica - Cliffortia cuneata High Closed Shrubland and the Rapanea melanophloeos - Cunonia capensis High Forest. Blechnum australe is shared with both the above communities and the Rapanea melanophloeos - Heeria argentea Short Forest.

Dominant species: Blechnum australe, Brabejum stellatifolium and Halleria elliptica.

The Halleria elliptica - Brabejum stellatifolium Short Forest form of the Hartogiella schinoides - Diospyros glabra Riparian and Forest Communities is distinctive in physiognomic appearance and relatively easy to distinguish from the other forest communities, except where it intergrades with the Rapanea melanophloeos - Cunonia capensis Forest. It is found in drainage lines in the lower reaches of the study area, at altitudes between 300 metres to 400 metres. Along the drainage line between the Boland Hiking Trail path and the major Swartboschkloof stream it occurs as a pure stand. To the west of the lower reaches of the main Swartboschkloof stream it occurs in patches interspersed with other communities, along a drainage line which enters the Sosyskloof stream. The gradient is shallow, varying between six degrees and seven degrees. At the sites sampled, the aspect is northerly, but it can change owing to changes in course of the drainage lines.

Two relevés of this community are on Oakleaf Form soils (Fry, in preparation). The soils of the other two relevés were not classified, but it was observed that they are composed of granite and sandstone material. These latter two sites are wet in the winter when runoff water fills the drainage lines and is not confined to the main streams. Estimated rock cover ranges widely from one per cent to 95 per cent with an average of 29 per cent. Litter cover is high except in relevé 110; it ranges from 40 per cent to 95 per cent with an average of 79 per cent.

The vegetation has a projected canopy cover of 100 per cent; it is very dense and almost impenetrable. The crowns of the individual plants of Brabejum stellatifolium interlock, creating shady conditions for plants in the understorey (Figure 16).

Three strata are distinguished in this community. The upper stratum (three metres to six metres high) has an estimated cover of 97 per cent and is dominated by Brabejum stellatifolium which reaches the stature of a short forest. Below the upper stratum is a layer, one metre to three metres high, which can have a percentage cover ranging from five per cent to 80 per cent, with an average of 35 per cent. Dominant species in this stratum are Diospyros glabra, Halleria elliptica and Rhus angustifolia. This stratum was not found in relevé 110. A short to low stratum (less than one metre) was found in three relevés (all except relevé 109) with an average percentage cover of 29 per cent. The dominant species in this stratum is Blechnum australe.

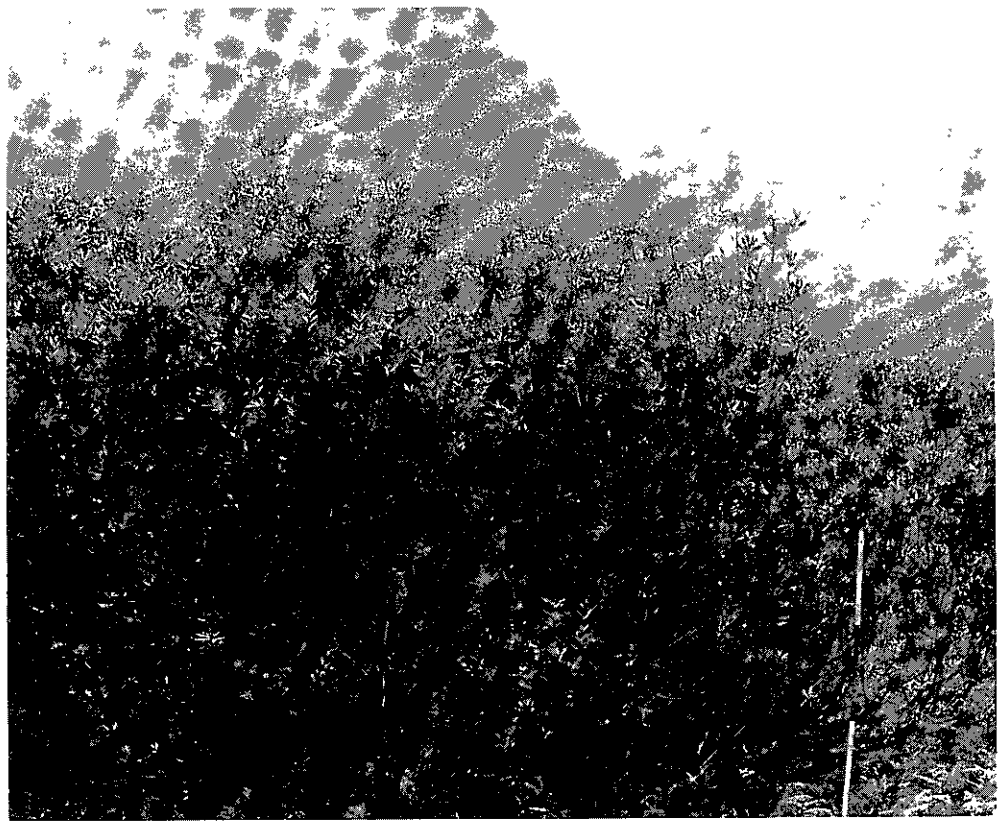

Figure 16. Halleria elliptica - Brabejum stellatifolium Short Forest found on seasonal drainage lines.

Van der Merwe (1966) recognized the existence of this community but included it in his broad concept 'Oewergemeenskappe' (streambank communities). Werger et al (1972) described what they termed the 'Brabejum stellatifolium Community'. It has been found that the relevés (31, 37 and 39) used by Werger et al (1972) to characterize the latter community, fit more precisely into the Halleria elliptica - Cliffortia cuneata Shrubland, which is described below.

2. Halleria elliptica - Cliffortia cuneata High Closed Shrubland

Campbell et al (1981) structural equivalent: Tall Closed Shrubland
Map symbol: S
Community area: 2,17 ha
Relevés (7): 3, 5, 6, 35, 93, 94, 166
Age of vegetation in relevés:
23 years (6 relevés)
24 years (1 relevé)
Average number of species per relevé: 30 (23-37)

Differential species: Anthospermum aethiopicum, Aristea major, Asparagus asparagoides, Cymbopogon marginatus, Erica sphaeroidea, Ficinia filiformis, Freylinia lanceolata, Glia gummifera, Lichtensteinia lacera, Mohria caffrorum, Montinia caryophyllacea, Oxalis bifida, Pelargonium myrrhifolium, Phylica pubescens, Protea neriifolia, Protea nitida, Psoralea spicata, Restio triticeus, Rhus rosmarinifolia, Salvia africana, Schizaea pectinata, Tetraria bromoides.

Dominant species: Brabejum stellatifolium, Cliffortia cuneata.

The Halleria elliptica - Cliffortia cuneata Shrubland is found on the forest margins at the interface between the fynbos communities and the riparian forest communities, at altitudes from 320 metres to 560 metres (Figure 3). Aspect varies from south-easterly to north-westerly and gradient of the slopes ranges from six degrees to nine degrees with an average of seven degrees. Land facets where this community occurs include pediment slopes, detrital slopes, plane slopes and convex-concave slopes.

The soils where this community is found are derived from granite and sandstone. They average half-a-metre in depth and are classified into the Hutton Form, Clansthal Series (Hu 24), Fernwood Form, Warrington Series (Fw 31), Magwa Form (Ma 9, undescribed series) and Oakleaf Form (Oa). Estimated rock cover is low compared with the overall average (25 per cent) for the study area; it ranges from one per cent to 13 per cent with an average of five per cent. Estimated litter cover is very high, ranging from 85 per cent to 99 per cent with a mean value of 93 per cent. Most of the sites are well drained. The only site subject to seasonal waterlogging is at relevé 5, situated on Warrington Series (Fw 31) soils.

The vegetation of the Halleria elliptica - Cliffortia cuneata Shrubland has a high average projected canopy cover (96 per cent); it ranges from 88 per cent to 100 per cent. Three strata are distinguished. The tallest is dominated by Brabejum stellatifolium, Cliffortia cuneata and Protea nitida. It has an average projected canopy cover of 22 per cent. Below the high stratum is a tall stratum (one metre to two metres high) with an average projected canopy cover of 41 per cent. The tall stratum is dominated by Diospyros glabra and Halleria elliptica. A short stratum (less than one metre high) with an average projected canopy cover of 54 per cent is found below the tall stratum. This layer is dominated by Aristea major and Pteridium aquilinum.

This community is floristically closely akin to the Restio gaudichaudianus - Myrsine africana High Closed Shrubland. These two communities could be considered to be one were it not for the presence of Brabejum stellatifolium in the Halleria elliptica - Cliffortia cuneata Shrubland. Estimated average rock cover of these communities is also markedly different.

Diospyros glabra - Rapanea melanophloeos Tall Forest

This is the second major form of the Hartogiella schinoides -Diospyros glabra Riparian and Forest Communities found within the study area.

Campbell et al (1981) structural equivalent: Tall Forest
Map symbol: W Community area: 8,35 ha
Relevés (7): 113, 160, 161, 162, 183, 193, 198 Age of vegetation in relevés: Unknown

Differential species: No true differential species are found in this community.

Dominant species: Hartogiella schinoides, Maytenus acuminata, Olinia ventosa, Podocarpus elongatus, Rapanea melanophloeos.

This Tall Forest is found on stabilized boulder screes below the sandstone cliffs in the south-central and south-west parts of the study area (Figure 4). The aspect of these screes varies from north-easterly to north-westerly. The gradient ranges from 25 degrees to 34 degrees with an average of 28 degrees.

There is very little soil development on the boulder screes. What soil there is amongst the boulders is humus which comes from decayed leaf litter and other organic matter. For this reason Fry (in preparation) simply mapped these areas as screes or established screes. It was noted that the Community occurs where the boulder scree has stabilized. A possible reason for this is that it is in this situation that the trees can develop fully. On less stable screes it is most likely more difficult for trees to become established. As expected, rock cover is high, 80 per cent to 99 per cent, averaging 92 per cent. Litter is estimated to have an average cover of 24 per cent, ranging from ten per cent to 45 per cent.

The development of these forests probably also depends largely on moisture availability. Apart from the dense canopy which creates shady, cool, moist conditions on the ground, there is also perennial percolation of water through the rock crevices. This water is trapped on the upper slopes of the catchment; it runs over the cliffs, percolates through the boulder screes and finally runs into the main streams which drain Swartboschkloof. The trees can exploit this water as it passes through the boulder screes.

The canopy trees, mainly Hartogiella schinoides, Olinia ventosa and Podocarpus elongatus reach from eight metres to 16 metres in height. As noted above, they form a dense canopy with only a few patches through which light can penetrate. The cover of this stratum is estimated at 77 per cent. The vegetation of relevés 113 and 193 does not have a canopy which reaches up to 16 metres. The height of the canopy of these latter stands is comparable with the height of the sub-canopy (two metres to eight metres high) of the forest stands in the other relevés. However, they still have the same dominant species. The sub-canopy is dominated by Halleria lucida, Maytenus acuminata, Podocarpus elongatus and Rapanea melanophloeos and has an average projected canopy cover of 63 per cent. Below the sub-canopy there is a ground layer (less than one metre high), with Asparagus scandens, Knowltonia vesicatoria and Zantedeschia aethiopica

most common. The ground layer has an average projected canopy cover of 11 per cent. A climber, Secamone alpinii, is found entwined in the sub-canopy shrubs and trees.

Van der Merwe (1966) referred to this community under the general title, 'Dasbosse of woude op talus' (Dasbosse or forest on talus). He did not distinguish between the typical variant, the Rapanea melanophloeos - Cunonia capensis High Forest and the Rapanea melanophloeos - Heeria argentea Short Forest Community variant. Heyns (1957) in a study of the forest communities at Assegaaibos (near Swartboschkloof) also made no distinction between these two variants. Werger et al (1972), however, did make a distinction. The former community they designated as the 'Rapanea melanophloeos Community' and the latter as the 'Heeria argentea Community'.

1. Rapanea melanophloeos - Cunonia capensis High Forest

Campbell et al (1981) structural equivalent: Tall Forest
Map symbol: U Community area: 15,89 ha
Relevés (7): 163, 164, 194, 199, 200, 201, 202 Age of vegetation in relevés: Unknown
Average number of species per relevé: 18 (14-22)

Differential species: Blechnum punctulatum, Brachylaena neriifolia, Cunonia capensis, Dipogon lignosus, Ehrharta sp, Ilex mitis, Kobresia lancea, Oxalis sp, Sanicula elata, Todea barbara.

Dominant species: Brabejum stellatifolium, Cunonia capensis, Ilex mitis, Maytenus acuminata, Rapanea melanophloeos.

This is the typical community variant of the second group of forest communities. It is found along the main drainage lines and streams where there is perennial running water. It is restricted to the stream banks and can be seen as a narrow ribbon of dark coloured vegetation following the main watercourses. In the mid-central region of the study area it is well developed, particularly around the middle reaches of the main Swartboschkloof stream. At this point two tributary streams flow into the main stream. This community does not occur in relatively short, seasonal drainage lines where the Halleria elliptica - Brabejum stellatifolium Short Forest is found (Figure 17).

The Rapanea melanophloeos - Cunonia capensis Forest from the middle to upper reaches of the Nuwejaarkloof stream is fragmented. This is probably due to a lack of strong perennial waterflow and the nature of the boulder bed, which is like a boulder scree in places.

In the study area the altitude range of this community is from 330 metres to 800 metres. Aspect varies between north-easterly (the main stream flows from south-west to north-east) and north. The tributary streams flow in a northerly direction before they are intercepted by the main stream. The gradient ranges from ten degrees to 27 degrees with an average of 18 degrees.

Soil development is minimal. The soil that is present is usually a mixture of sand and humus which accumulates on the banks of the streams. This alluvial soil material is often washed away when the streams rise in winter after heavy rains. These soils are not described by Fry (in preparation) who simply refers to the streams as 'incised drainage lines'. Average rock cover (62 per cent) is much less than that of the boulder screes where it exceeds 90 per cent. Accumulated litter has an average cover of 41 per cent (ten per cent to 70 per cent) which is greater than that of the boulder screes.

There are two tree layers and a field layer in this community. The highest stratum (eight metres to 20 metres high) is dominated by Cunonia capensis, Ilex mitis, Rapanea melanophloeos and Brabejum stellatifolium. It has an estimated cover of 88 per cent. The sub-canopy (one metre to eight metres) has an estimated cover of 38 per cent. It is dominated by Maytenus acuminata, Halleria lucida and Brabejum stellatifolium. The undergrowth is estimated to have an average cover of 16 per cent. Dominant species in the field layer are: Asparagus scandens, Blechnum australe and Kobresia lancea.

Van der Merwe (1966) included the vegetation described as the Rapanea melanophloeos - Cunonia capensis High Forest in this study in the broad concept of 'Oewergemeenskappe' (streambank communities). Werger et al (1972) did not distinguish the streambank forests as a separate community from the tall forests on the boulder screes. The reason for this is that they only had two samples (relevés 330 and 332 in Figure 2) in the tall to high forest vegetation, which represent the Diospyros glabra - Rapanea melanophloeos Forest variant.

Figure 17. Rapanea melanophloeos - Cunonia capensis High Forest found along perennial streams in the study area.

2. Rapanea melanophloeos - Heeria argentea Short Forest

Campbell et al (1981) structural equivalent: Low Forest
Map symbol: V Community area: 3,3 ha
Relevés (4): 115, 116, 196, 197 Age of vegetation in relevés: Unknown
Average number of species per relevé: 14 (13-16)

Differential species: Heeria argentea.

Dominant species: Hartogiella schinoides, Heeria argentea, Maytenus acuminata, Podocarpus elongatus.

This community variant of the Diospyros glabra - Rapanea melanophloeos Forest occurs on the loose, unstable boulder screes and on rocky outcrops. In Swartboschkloof it is best developed at two localities; firstly on a boulder scree below the contour path near the south-east boundary and secondly on a scree in the south-west sector of Swartboschkloof adjacent to the path to Haelkop Ridge. It is found in drier situations than the Diospyros glabra - Rapanea melanophloeos Forest where drainage is good.

Figure 18. Rapanea melanophloeos - Heeria argentea Short Forest which occurs on boulder screes and rocky outcrops in Swartboschkloof.

The Rapanea melanophloeos - Heeria argentea Short Forest (Figure 18) does not occur at altitudes higher than 700 metres in Swartboschkloof and since the boulder screes face north-east to north this community is exposed to high temperature and insolation.

There is little or no soil development on the boulder screes where the Rapanea melanophloeos - Heeria argentea Short Forest is found. The average litter cover is low (18 per cent), with a range from 15 per cent to 20 per cent. There is almost total cover of large boulders under the vegetation (97 per cent on average) and drainage is consequently good.

A single tree stratum and a field layer were distinguished. The tree stratum (two metres to eight metres high) has a projected cover of 80 per cent and is dominated by Hartogiella schinoides, Heeria argentea, Olinia ventosa and Maytenus acuminatus. Below this is a short stratum (less than one metre high) where Podocarpus elongatus can spread in a prostrate fashion on the boulders. Other species in this stratum include Aloe mitriformis, Blechnum australe, Knowltonia vesicatoria and Rumohra adiantiformis. None of these species is dominant and Aloe mitriformis is found where the canopy is open. Secamone alpinii is found from ground level into the sub-canopy, intertwined amongst other plants.

Van der Merwe (1966) did not distinguish or describe a community with Heeria argentea as an important species. Werger et al (1972) described the Heeria argentea Community, but two of the three relevés used to characterize this community were situated outside Swartboschkloof, in the adjacent Sosyskloof catchment. The Rapanea melanophloeos - Heeria argentea Short Forest is restricted to a few patches on the rock screes in the study area and although Werger et al (1972) recorded high cover-abundance scores for Heeria argentea in their relevés, this was not found to be generally true in Swartboschkloof.

SYNTHESIS

In 1977 the Fynbos Biome Project was established (Kruger 1978) and attention became focused on two intensive study sites in the western Cape Province. One is situated in Coastal Fynbos at Pella near Atlantis and the other is located in Mountain Fynbos at Swartboschkloof, Jonkershoek. Classification and maps of the vegetation of these study sites were required. Swartboschkloof additionally presented a useful opportunity to survey the vegetation and re-evaluate the work done there by Werger et al (1972). This study therefore represents a direct acceptance of the challenge by these workers to "prove and improve" their classification of the vegetation of Swartboschkloof.

In this vegetation survey the Braun-Blanquet method with the TABSORT suite of computer programmes (Boucher 1977) has proved successful, though time-consuming, in determining both the forest and fynbos communities. It was difficult to clearly define the transitional or ecotonal communities because they have no true differential species. As one proceeds through the ecotone there is a decrease in occurrence of those species which are usually associated with granite or colluvial soils. This decrease corresponds with a gradual change from heavier, deeper soils to shallow sandy soils. A concurrent increase in occurrence of sandstone associated species is evident. The transitional communities are thus defined on the basis of relative abundance of the two 'types' of species.

Sampling in Swartboschkloof has been more intensive in this study than in the survey carried out by Werger et al (1972). There are three reasons for this:

(i) Werger et al (1972) only did a quick survey to test the application of the Braun-Blanquet method in Mountain Fynbos;

(ii) in the first phase, 101 of Fry's (in preparation) soil pits were relocated;

(iii) it was necessary to have sufficient sample points for mapping at a detailed scale.

The highest concentration of relevés is in the area below the contour path (see Figure 2) where Fry (in preparation) concentrated his work. There are fewer relevés on the higher slopes above the contour path because the sample sites were carefully selected in predetermined physiographic-physiognomic units from aerial photographs.

Two vegetation types were recognized on the basis of their floristic composition and structure, namely fynbos and forest. Sixteen fynbos communities were identified which are grouped into three groups. The first fynbos group includes the hygrophilous communities and the shrublands associated with soils of granite or colluvial derivation. The hygrophilous communities are placed in this fynbos group for convenience only. They are essentially azonal. The second or intermediate group includes the transitional or ecotonal communities which fall between those communities associated with granite-derived and colluvial soils and the third group which consists of the 'true' Mountain Fynbos communities associated with sandstone-derived soils. Five forest communities are recognized, grouped into two groups. The first group consists of a community transitional between fynbos and forest vegetation, and a short forest community along seasonal drainage lines. The second group of forest communities comprises the three variants of the Diospyros glabra - Rapanea melanophloeos Forest. In addition to these communities there is the Brunia nodiflora - Psoralea rotundifolia Community, a fynbos community recognized by Werger et al (1972). It was not found within the boundaries of the present study area but occurs on granite-derived soils on south-east-facing slopes on the northern side of Sosyskloof. This community has, however, been mapped (Figure 3) from the raw data of Werger et al (1972) but requires further investigation and verification. Psoralea rotundifolia and Osteospermum tomentosum, two differential species of this community, were seldom encountered in the study area defined for the present study. They do, however, occur more abundantly in the area on the northern side of Sosyskloof.

The forests at Swartboschkloof are poorer in species than the forests of Table Mountain (Campbell and Moll 1977; McKenzie et al 1977) or the Kogelberg (Boucher 1978). This difference is most likely due to the substrate on which these respective forests are found. In Swartboschkloof the forests are found on sandstone boulder screes and along boulder lined watercourses; at Orange Kloof, Table Mountain, and in places in the Kogelberg the forests are found along watercourses but often on soils derived from shale. The shale-derived soils are much finer textured (Campbell 1983) than the rocky scree substrate as well as being more nutrient rich. This would allow for greater diversification of the forest flora at Orange Kloof and in the Kogelberg whereas this process is probably restricted in the forest communities of Swartboschkloof.

Correlation between the distribution of the plant communities and the occurrence of the soil forms is generally good, whereas relating plant communities to soil series is more difficult except in some instances where the communities are localized and reflect specific edaphic conditions. An example of this is the 'tall form' of the Rhus angustifolia - Zantedeschia aethiopica Shrubland which is found on deep organic soils of the Champagne Series (Ch 11). Localized communities of phreatic sites such as the Berzelia lanuginosa - Merxmuellera cincta Shrubland also show association with specific soil series; in this case with the Fernwood Form, Warrington Series (Fw 31).

Perhaps the most important aspect arising from the correlation of the soils with the vegetation is the broad relationships between the groups of communities and the soil geology, rather than specific communities associated with specific soil forms or series. This is demonstrated by the relationship between the tall to high shrublands occurring on granite derived or colluvial soils where the soils are deep, have a higher clay content due to the granite and are probably more nutrient rich. The sandstone derived soils have less clay, less nutrients, lower pH and are shallow. These soils consequently support a shorter vegetation with more restios and sedges than shrubs. Campbell (1983) presented results which suggest that soil texture variables and not chemical variables are important in distinguishing quartzite-derived soils from non-quartzitic soils. This may offer some explanation for the distribution of plant communities in Swartboschkloof, particularly in the case of the Restio gaudichaudianus - Myrsine africana Shrubland (Waboomveld) and in the transitional communities, where rockiness is considered to be important.

A striking feature of the fynbos vegetation of Swartboschkloof is the lack of coincidence between the structure of the vegetation and the boundaries of the communities (Werger et al 1972). In the present study this feature was noted particularly in the Protea dominated shrublands. Widespread tall to high shrubs with high cover abundance, like Protea neriifolia, extend across and mask floristically determined community boundaries. A suggested explanation for this is the prevalence of extreme habitat factors or occurrence of extreme events such as fires which result in deceptive boundaries (Werger et al 1972). I agree with the latter part of this explanation in the instance of the Rhus angustifolia - Restio sieberi Shrubland, the structure of which can be attributed largely to the accidental fire of September 1973. The pre- and post-fire structural boundaries of the Rhus angustifolia - Restio sieberi Shrubland do not agree, yet floristically the community appears to have remained the same. The lack of coincidence between the floristic boundaries and the structural boundaries of the shrublands of the lower to middle slopes is attributed to edaphic factors rather than to extremes of climate or to fire. This is particularly so since this vegetation is considered to be mature; it was last burnt in 1958.

Since the greater part of Swartboschkloof has a northerly aspect it is not easy to assess the effect of aspect on plant growth. A few slopes face southwards but these slopes do not support vegetation noticeably different from that in the rest of the study area. North-west-facing slopes most likely intercept more rain in winter than slopes with other aspects, but once again any noticeable effect on community structure or composition is not apparent.

Altitude and topography are closely linked. The high slopes comprise waxing, talus and detrital slopes whereas the lower slopes comprise plane, convex-concave, concave-convex and pediment slopes. The type of vegetation that becomes established on these different land facets depends on the steepness of the slopes and the amount of soil developed. The steep cliffs at high altitude in Swartboschkloof where soil development is probably minimal, support low restioid-ericoid vegetation. (This vegetation was not sampled because the cliffs are inaccessible). In contrast the lower slopes, where soils are better developed, support much taller shrubland vegetation such as the Rhus angustifolia - Restio gaudichaudianus High Closed Shrubland. Incised drainage lines where riparian vegetation is found occur from low to high altitude in Swartboschkloof.

Kruger (1974) recognized two categories of Cape Mountain Fynbos ecosystems. Swartboschkloof falls within the limits of the first of these where, 'the climate is warm, less humid and has a more pronounced contrast between winter and summer'. Annual precipitation is high at Jonkershoek although the summers are hot and dry. During the summer months the fynbos is dormant, except for seep vegetation, whereas in the winter, when moisture is readily available from rain, active growth occurs which is not depressed by cold temperatures. The forest vegetation continues to grow throughout the year (Wicht et al 1969), but growth is most vigorous in spring. The optimum time for sampling the vegetation is therefore in late winter and spring, when the greatest number of species are growing vigorously and flowering, rather than during the dry summer and autumn months when the plants are difficult to identify or do not have visible above-ground parts.

The last major fire in Swartboschkloof was in February 1958. The vegetation has apparently recovered its former stature and composition except in the area subsequently burnt in September 1973. A considerable amount of litter has built up under the vegetation, particularly under the Protea dominated shrublands. In some places the large shrubs are dying, which adds to the litter and creates openings in the canopy, which in turn allow understorey plants to proliferate. Absence of seed-regenerating shrubs in the firebreaks on the perimeter of the study area is attributed to the short fire frequency of the burning regime and to the shallow sandy soils as the firebreaks are mostly at high elevations (van Wilgen 1981).

There are two main alien plant species in Swartboschkloof: Pinus pinaster and Hakea sericea. Both pose a threat to the natural vegetation. Pinus pinaster can invade undisturbed sites, whereas Hakea sericea tends to invade disturbed sites (Neser and Fugler 1978) although it has been noted in undisturbed vegetation in Swartboschkloof (Figure 4). An interesting observation is that there are many Hakea sericea individuals (nine to ten years old) which have become established in the area burnt in the 1973 fire. In one stand on the western slopes, as many as 57 individuals were counted. This is cause for concern because if another uncontrolled fire occurs, Hakea sericea could invade other areas of Swartboschkloof. Urgent eradication of these invader plants is required before they spread further.

It is clear, therefore, that the distribution of the plant communities is not determined by any single factor but by an interaction of all the environmental factors mentioned. As Campbell (1983) points out, it is difficult to separate the effects of the environmental factors, like the effects of soil from the effects of climate. No single environmental component can be treated in isolation although it does appear that in Swartboschkloof, water availability and soil geology play a dominant role in determining the pattern of community distribution.

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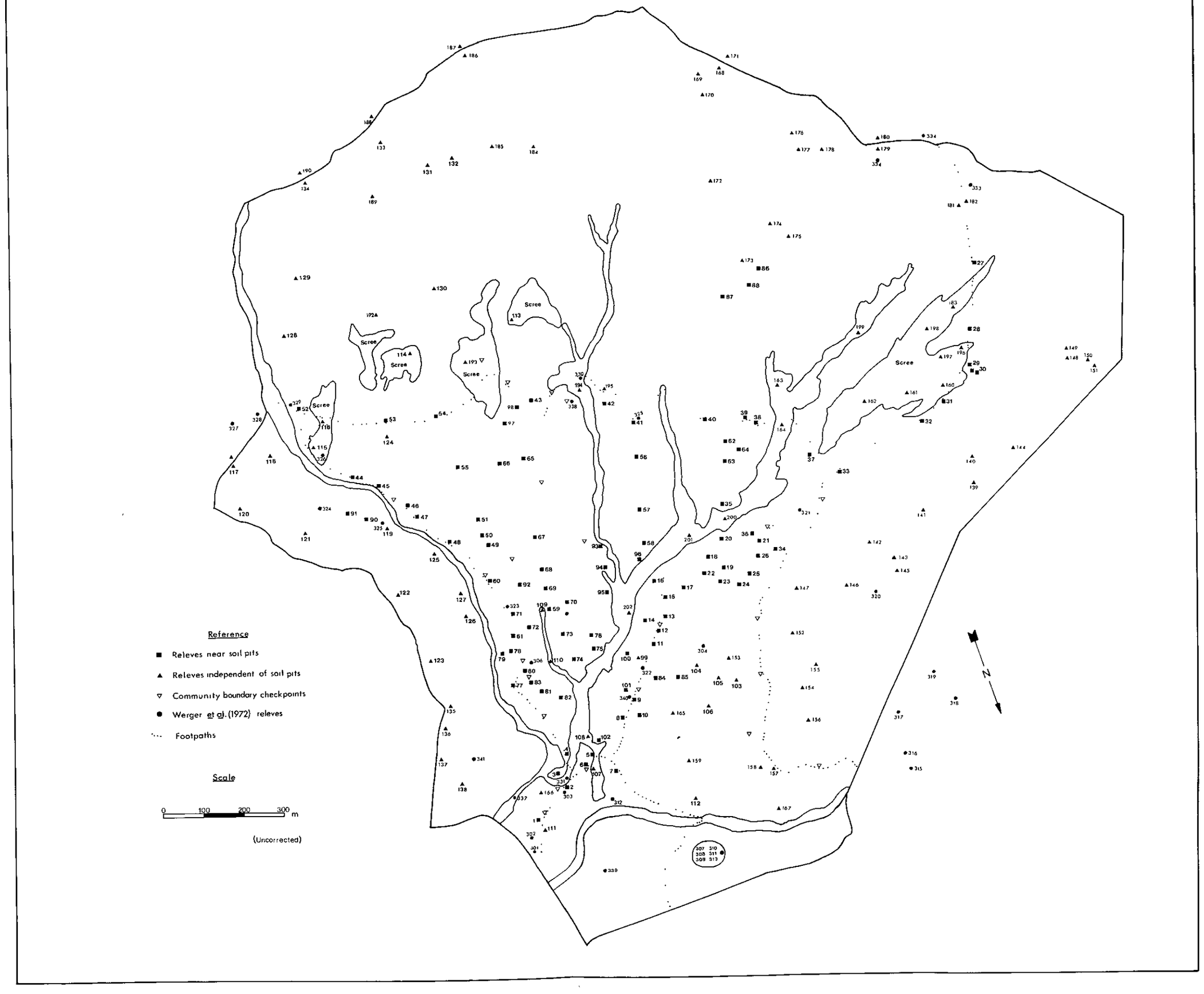

Fig.3 . Sketch-map of Swartboschkloof, showing location of relevés.

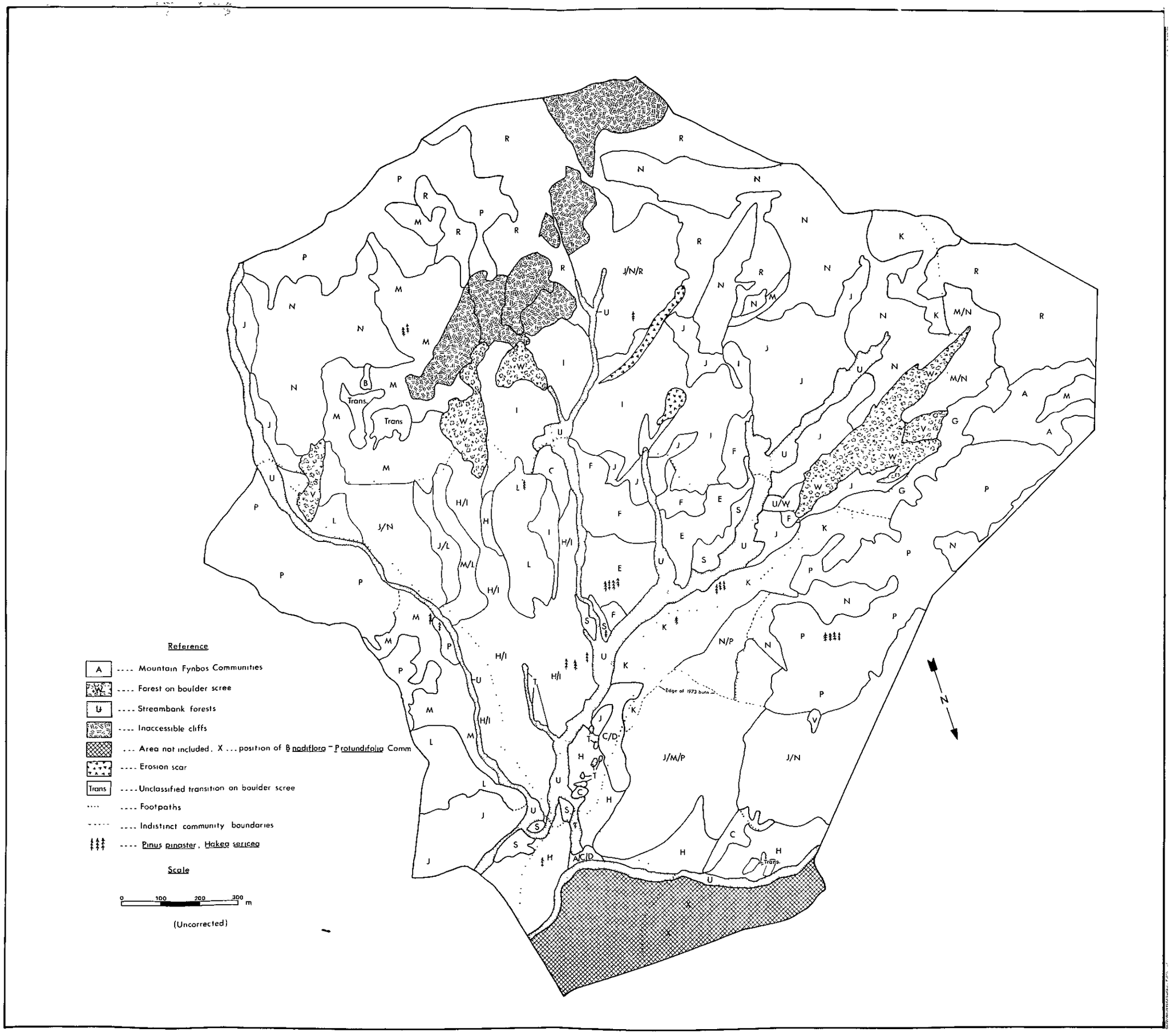

Fig. 4. The Plant Communities of Swartboschkloof.