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Cape Hangklip area. II. The vegetation*

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ABSTRACT

Various habitat factors influencing the fynbos vegetation of the Cape Hangklip area, such as topography, geology, soil and climate and historical features, are outlined. Data collected at 250 sampling sites are ordered using the Braun-Blanquet table method. The vegetation is subdivided into three main categories, namely coastal plain vegetation, mountain vegetation and riparian vegetation. A total of 29 communities is distinguished and related to habitat features. Aggressive introduced species which have become naturalized in the area, are also listed. A map showing the distribution of the plant communities is included.

RÉSUMÉ

RÉGION HANGKLIP DU CAP. II. LA VÉGÉTATION

On délimite divers facteurs d'habitat qui influencent la végétation de maquis dans la région Hangklip du Cap, tels que la topographie, la géologie, le sol, le climat et les circonstances historiques. Des données recueillies sur 250 sites d'échantillonnage sont mises en ordre par la méthode tabulaire de Braun-Blanquet. La végétation se divise en trois catégories principales: la végétation de la plaine côtière, la végétation de montagne et la végétation riveraine. On distingue un total de 29 communautés qu'on met en relation avec les caractéristiques de l'habitat. Les espèces introduites et agressives qui se sont naturalisées dans la région sont également répertoriées. Une carte y est jointe, qui montre la distribution des communautés de plantes.

CONTENTS

INTRODUCTION

Few ecological studies have been made of the fynbos vegetation of the south-western Cape, particularly of the mountainous regions (Taylor, 1972). The description of the fynbos outliers, with their relatively simple species composition, does not appear to have presented as much difficulty as has the fynbos in the south-western Cape (Boucher, 1972). Acocks (1953) described the fynbos as being a complex vegetation, and did not subdivide it to the same degree as the rest of the vegetation in South Africa. The only other relatively complete accounts of the fynbos vegetation prior to that of Acocks (1953) were those by Marloth (1908) and Adamson (1938).

The Hangklip area (Fig. 1), according to the vegetation map of Acocks (1953), consists entirely of Fynbos (Veld Type 69). One general survey and a few detailed studies have been carried out within the area. Rycroft (1953) described the mountain fynbos of the Kogelberg State Forest in broad terms. Grobler (1964) undertook a more detailed study of a small portion of this area in the vicinity of Oudebosch, near the Palmiet River mouth (Fig. 2). Two short popular accounts of the vegetation at De Wet's Bay (Fourie, 1972) and at Betty's Bay (Heydorn, 1975) have been published. The marine algal ecology has been discussed by Isaac (1949). The late T. P. Stokoe collected widely in the area, but unfortunately his localities were extremely poorly defined, so that the area was relatively unknown botanically.

The development of coastal townships, the construction of water storage dams in the mountains, the lack of knowledge about the flora and the need for a management plan of the area, all served as stimuli to investigate the vegetation of the Hangklip area. This also offered an opportunity to test certain methods of analysing the vegetation. The methods used during this investigation have been discussed in detail by Boucher (1976a) and are briefly discussed on p. 473.

1. THE STUDY AREA

1.1 *Location*

The area included in this survey is situated near the south-western extremity of the Cape Province, South Africa, forming the south-eastern limits of False Bay. It is approximately 30 km east of Cape Point (Fig. 1).

The area investigated (approximately 24 000 ha) comprises the 1: 50 000 Topographical Survey Sheet 3418 BD Hangklip and those portions of the Kogelberg State Forest outside this area (Fig. 2).

* Based in part on an M.Sc. thesis submitted to the University of Cape Town.

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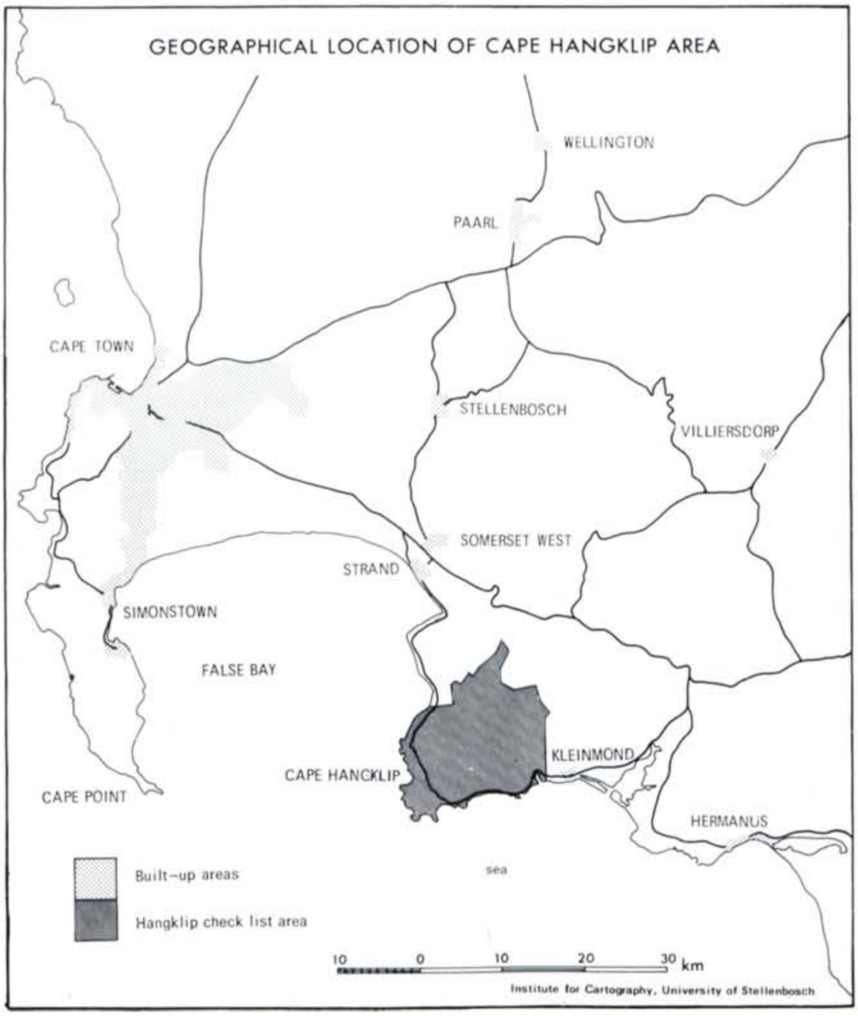

FIG. 1.—The location of the study area.

1.2 *Geology and topography*

The mountains forming the dominant feature of the scenery are part of the Cape Fold Belt, consisting of still intact anticlines of Permo-Triassic age (du Toit, 1939). Geomorphological features are described in detail by Wellington (1955), Mabbutt (1955) and de Villiers, Jansen and Mulder (1964). The following brief description is based on their findings.

An abrasion platform which has been partially regraded, occurs a few feet above sea-level forming part of the southern coastal foreland. This shows remnants of an old peneplain that dips seawards at an angle of about 1°. This gradual slope has resulted in marshy conditions, and sometimes in lakes, such as the Groot Vleie, Malkopvlei and Skilpadvlei.

Recent and Quaternary dunes are found along the coastal plain. The older dunes have undergone consolidation, yet are still relatively young. Near the surface a secondary enrichment zone of lime sometimes occurs, which forms a harder layer around the soft and crumbly rock.

River terrace gravel, originating from sandy sediments weathered from the Table Mountain Sandstones, occurs. It passes on the one hand into scree and on the other into alluvium.

The characteristically steep sides of the mountains are portions of anticlinal folds destroyed by erosion.

Haughton (1933), de Villiers *et al.* (1964) and Rust (1967) have described the following geological formations which occur in the area:—

(1) The pre-Cape Klipheuwel Group, represented by the Klipheuwel beds.

(2) Table Mountain Sandstones of the Cape Supergroup, dating from Ordovician or Late Cambrian to early Devonian, and consisting of the following formations:

(a) The Graafwater Formation, or basal shales, which are sporadically developed in occasional narrow bands.

(b) The Peninsula Formation, or lower sandstones and quartzites, about 1 700 m thick.

(c) The Pakhuis Formation, or tillite of glacial origin, tends to form a rock face immediately under the upper shale band.

(d) The Cedarberg Formation, or upper shale band which, together with the Pakhuis Formation, is about 50 m thick.

(e) The Nardouw Formation or upper sandstones and quartzites, which are about 1 000 m thick.

(3) The Bokkeveld Shales are associated with the folding in the Table Mountain Sandstones, but have been eroded away from the ridges and are now found in the valleys. The Elgin Basin borders closely on the Hangklip area and remnants of these shales occur here.

The major geological features have been mapped by de Villiers *et al.* (1964) for portion of the area. Additional data for the geological map (Fig. 3) are from unpublished information received from Dr J. de Villiers of Geological Survey.

Cole (1949) describes the genesis of the mountains and the rivers. These features are included in Fig. 2.

1.3 *Soils and relationship to communities*

Where underlain by the Table Mountain Series, the landscape is generally mountainous and the soils poorly developed. The grey sandstone facies weather slowly and, where the slopes are steep and the rainfall high, rapid run-off results in the removal of weathered

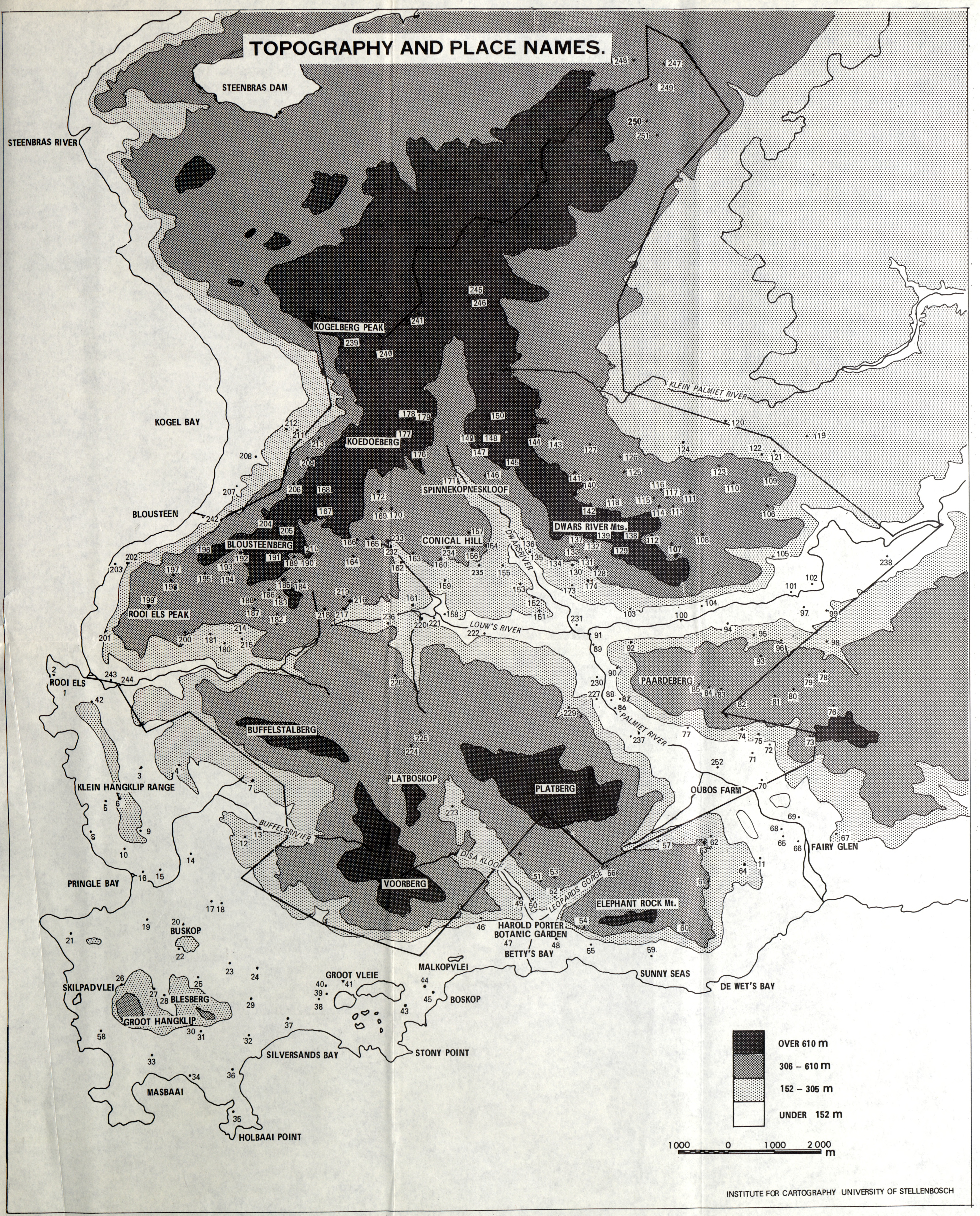

FIG. 2.—Map showing names and boundaries in the study area.

GEOLOGY OF THE CAPE HANGKLIP AREA

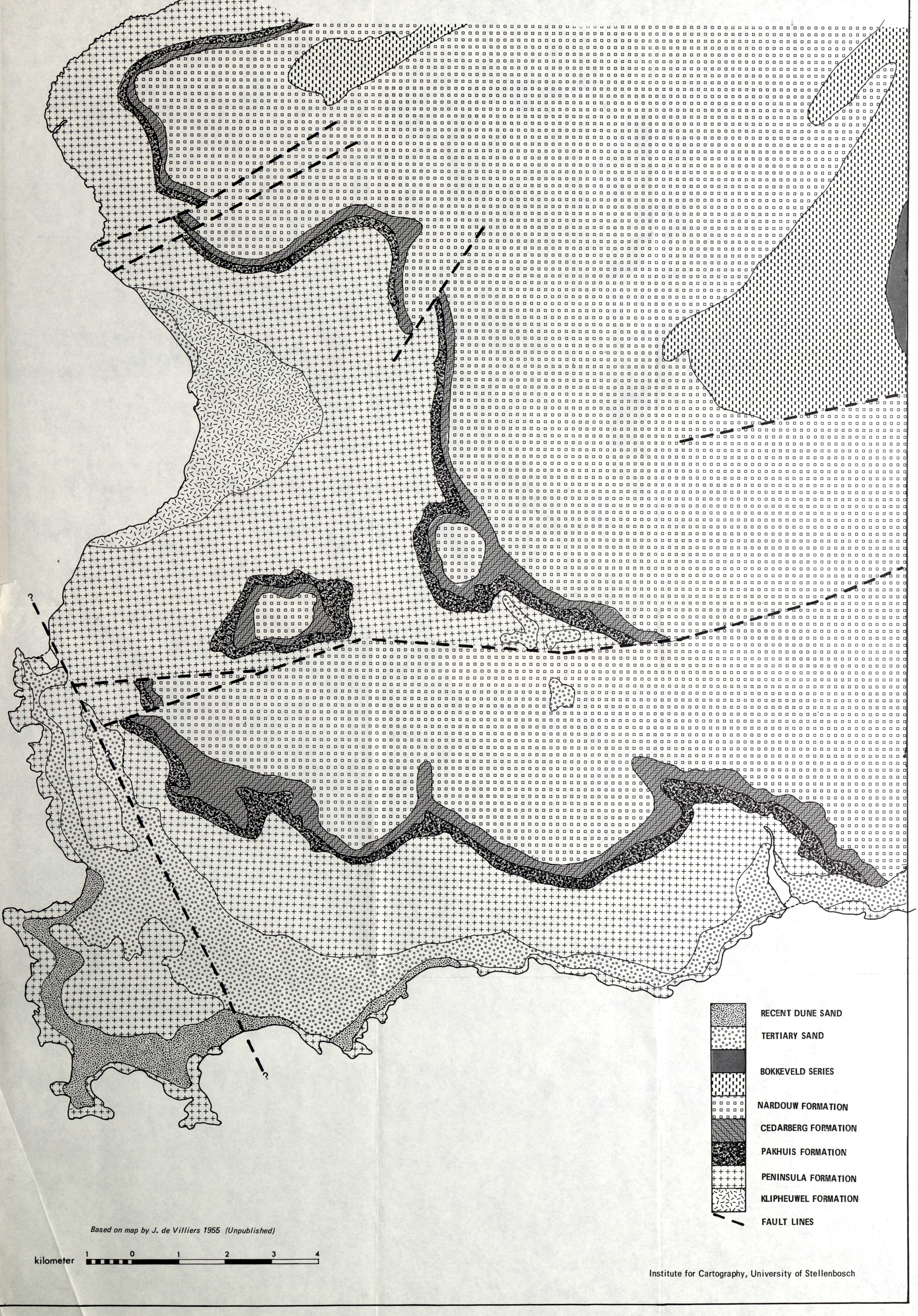

Fig. 3.—Geological map.

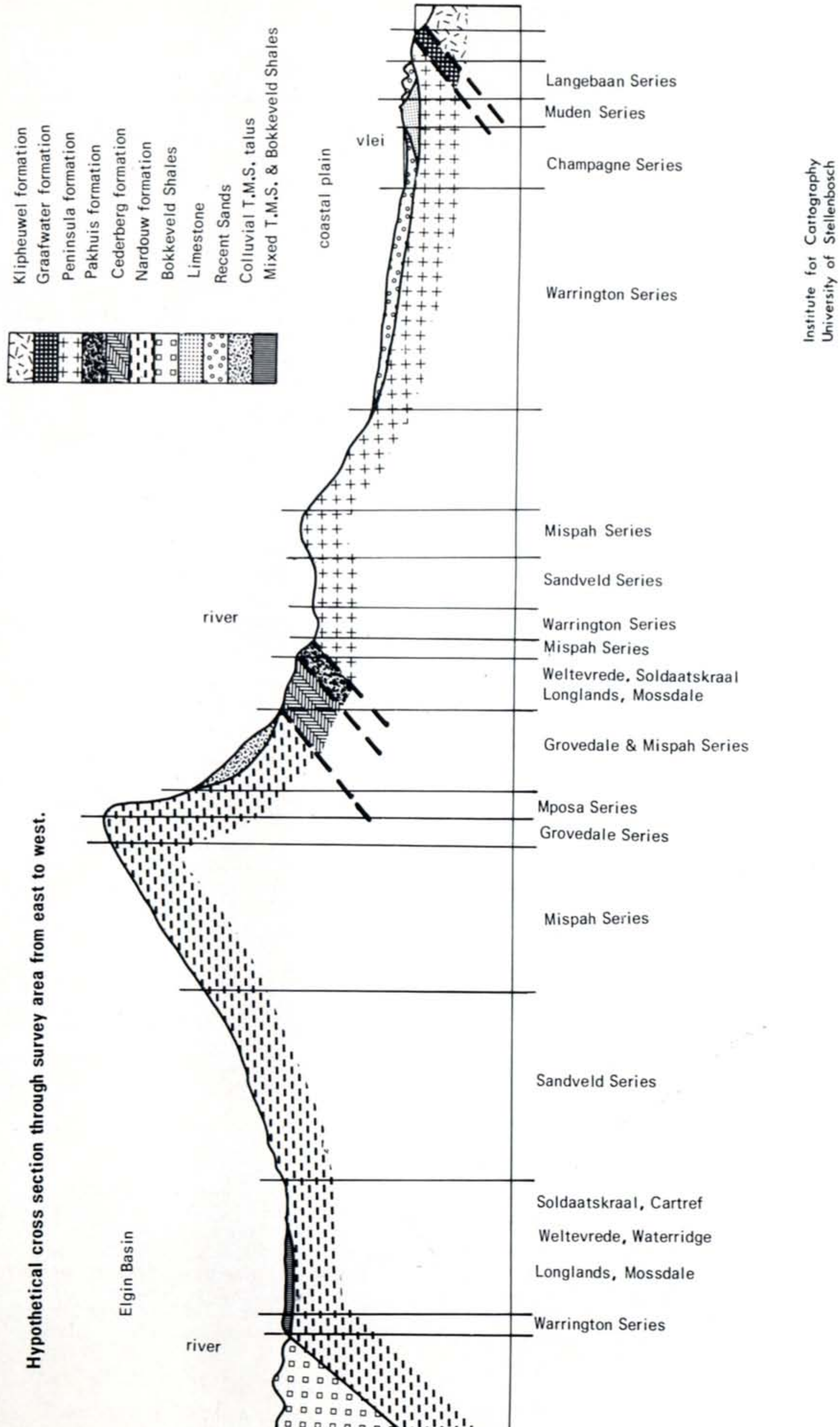

FIG. 4.—General relationships between geology and pedology.

products and bare rock outcrops are the general rule. Where the relief is less acute, shallow soils may be found, while on the gentler slopes at the foot of the mountains, somewhat deeper soils occur. They have mainly developed from accumulated colluvial material and have various stages and kinds of development. Cole (1949) describes the soils in broad outline. No published soil survey data are available, but Mr J. J. N. Lambrechts, senior lecturer in Soil Science at the University of Stellenbosch, has identified the following soil forms and series in the area based on the National Soil Classification System (Loxton *et al.* 1970).

The relationship between the geological formations and the soil series is indicated in Fig. 4.

1.3.1 *Mispah form*

The Mispah Form is represented by the Mispah and Kalkbank Soil Series in the Hangklip area. These soils have an orthic A horizon over rock or calcrete.

Soils of the Mispah Series carry a vegetation of the drier type of mixed ericoid and restioid fynbos usually found on northerly slopes associated with rock outcrops.

On the limestone outcrops of the coastal shelf, the soil is alkaline and belongs to the Kalkbank Series. The vegetation is transitional between dune and coastal plain fynbos.

1.3.2 *Fernwood Form*

Fernwood soils have an orthic A horizon on regic sands and are represented here by the Sandveld Series, Warrington Series and Langebaan Series.

Sandveld Series soils are usually found on gentler slopes than the acid Mispah soils and develop from colluvial material with very low accumulations of organic matter. A dry mixed fynbos is usually found.

The Warrington Series soils with accumulations of organic matter occur in low-lying areas such as on the younger river terraces. The vegetation associated with these soils is usually taller, because of the greater soil depth and moister conditions.

Soils of the Langebaan Series are neutral to alkaline. They are found near the coast, usually on coastal dunes, and are associated with dune fynbos.

1.3.3 *Champagne Form*

These soils are characterized by an organic O horizon and are represented here by the Champagne and Mposa Series.

The highly acid Mposa Series soils are found on the steeper mountain slopes usually with a southerly aspect. The continuous addition of organic material from the luxuriant vegetation and hydromorphic conditions results in a thick layer of relatively undecomposed organic material with very little mineral soil material in the O horizon. *Chondropetalum—Berzelia* fynbos is often found.

The Champagne Series soils are less acid than the Mposa Series and are usually found under coastal bog conditions with *Erica—Osmitopsis* seepage fynbos.

1.3.4 *Cartref Form*

These soils consist of an orthic A horizon on a diagnostic E horizon with rock beneath and are represented by three series: the Grovedale Series, the Waterridge Series and the Cartef Series, Grovedale Series soils are found at higher altitudes than the Waterridge Series, while the Cartef Series occurs at the lowest altitudes where more clayey colluvial material has accumulated. Mesic mixed ericoid and restioid fynbos types are found.

1.3.5 *Longlands Form*

This form is characterized by an orthic A horizon followed by a diagnostic E horizon on a soft plinthic B horizon. It is represented by the Longlands Series.

The Longlands soils occur in moister areas and have local accumulations of iron. This is a moister form than the Glencoe Form and a taller mixed fynbos rich in proteoid elements occurs.

1.3.6 *Estcourt Form*

The Estcourt Form is characterized by an orthic A horizon on an E horizon over a prismacutanic B horizon. It is represented by the Soldaatskraal Series, which has a high clay content below the E horizon. The vegetation is similar to that on the Longlands Form, but where the Estcourt Form occurs on the Table Mountain Sandstone shale band, it is generally fairly moist and a taller type of fynbos develops.

1.3.7 *Clovelly Form*

This soil form with an orthic A horizon on a yellow-brown apedal B horizon is represented by the Mossdale Series, on which occurs a *Protea—Tetraria* dry short fynbos, very similar to that found on the Glencoe Form.

1.3.8 *Glencoe Form*

This soil form consists of an orthic A horizon with a yellow-brown apedal B horizon on a hard plinthic B horizon, beneath.

The Weltevrede Series of this form is distinguished from the Mossdale Series of the Clovelly form by the hard plinthic B horizon. Vegetation found on the Weltevrede Series is similar to that found on the Mossdale Series.

1.3.9 *Regic sands*

Regic sands, in which more than 85% of the material is sand, are structureless, show no sedimentary layering and are sometimes grey in colour. They never have red or yellow colours. They can occur on their own, in which case they must be at least 25 cm thick, or they can occur beneath a diagnostic surface horizon. An *Ehrharta—Ficinia* Community typically occurs on such regic sands.

1.4 *Soil drainage*

The relationship between soil drainage and soil type are illustrated, according to the soil drainage classes defined by the United States Department of Agriculture (1951), in Table 1. The most poorly drained soils are those belonging to the Mposa, Champagne and Longlands Series, while the Sandveld and the Mispah Series soils are very well drained.

1.5 *Climate*

The Hangklip area, at a latitude of 34° south, is situated near the southern extremity of the African continent. The climate is influenced by the presence, off-shore, of the cold Benguela system. A Mediterranean-type climate prevails which, according to Köppens' classification, can be classified as Csb, Cfsa and Cfsb or, according to Thornthwaite's classification, as BB's, with a precipitation to evaporation ratio of more than 80 (Schulze, 1947). Swart (1956) and Tyson (1969) discuss the winds and climate of the area in detail.

1.5.1 *Wind*

Winter circulation patterns in the south-western Cape are associated with disturbances in the circumpolar westerly winds, taking the form of a succession of eastward moving cyclones or depressions and anticyclones. As the depression passes, the wind backs to south-westerly and later to southerly.

The summer circulation is characterized by south and south-east winds prevailing for about 60% of the time, with force and direction being modified to some extent by the alignment of the mountains. The south-easters are notoriously strong and gusty, often blowing with gale force for two or three days at a time. These winds blow during the dry season and are usually associated with typical fair weather clouds capping the mountains, such as the well-known "table-cloth" on Table Mountain (Jackson & Tyson, 1971). Grobler (1964) recorded winter storm damage from north-westerly gales, but no damage from south-easterly gales in the Oudebosch area.

Plants growing on the mountain peaks, where they are exposed to the full force of the south-east and north-west winds, are often deformed by the strength of the winds. Taller individuals are usually only found where rocks and crevices offer some protection. The vegetation along the coast shows characteristic deformation, particularly from the constant direction of the south-east wind. The strong persistent south-easters blow during the fire season and are instrumental in the formation of dunes, particularly in the constantly burnt areas.

South-westerly on-shore breezes often occur during the autumn months, especially when some calm days occur. These breezes are moisture laden (see section 1.5.2), but never attain much force and usually abate shortly after sundown.

Warm, dry berg winds occur on a limited number of occasions during the year.

Wind data for the area are only available for 1971 from Stony Point (recorded by Mr G. Affleck). These data are given in Table 2 as an indication of wind tendencies. On 132 days during 1971 south-east to easterly winds predominated through the year, occurring with a velocity of 19 km p.h. or greater. Northerly to north-westerly winds, were the second most common wind, occurring on 73 days. Calm or lightly variable wind conditions were experienced on 105 days.

1.5.2 *Precipitation*

The winter rainfall is associated with eastward moving cyclones passing the south-western Cape (Jackson and Tyson, 1971). Orographic rains occur which may last for several days, the rainfall being heavier in the mountains. As the depression passes, the wind backs to south-westerly and later to southerly when clearing showers occur. It is under these conditions that snow is often associated with the passage of a cold front. Fine weather following a depression may last for over a week (Weather Bureau, 1960b).

The variation in precipitation over different parts of the area is considerable, as is indicated by the data in Table 3. At Steenbras Dam, just north of the study area, the annual average rainfall of 1050,7 mm is recorded at a station at 579 m altitude, in contrast to 874 mm at a nearby station at 338 m altitude (Weather Bureau, 1960a). Between 80 and 120 days per year have at least 0,25 mm of rain, 80 days have more than 1,00 mm of rain and 10 days have 10,00 mm or more of rain per day (Weather Bureau, 1957).

TABLE 1.—Relation between soil drainage classes and soil types

Soil-drainage class	Very poorly drained	Poorly drained	Imperfectly or poorly drained	Moderately well-drained	Well-drained	Somewhat excessively drained	Excessively drained
	0	1	2	3	4	5	6
Soil series.....	Mposa		Warrington	Soldaatskraal		Sandveld	
		Champagne		Grovedale		Mossdale	
		Longlands		Weltevrede		Kalkbank	
							Mispah
						Langebaan	

TABLE 2.—Analysis of wind directions (velocities of 19 km.p.h. and greater) at Stony Point, Betty's Bay (in days) for 1971

Direction	N NW	NW N	W SW	SW S	S SE	SE E	E NE	NE N	Calm and Lt. vars.
January............	—	5	3	3	1	15	—	—	4
February............	—	—	5	1	1	15	1	—	5
March............	—	8	2	—	—	13	—	—	8
April............	1	5	1	—	—	10	—	—	13
May............	—	6	1	1	3	7	1	—	12
June............	—	11	3	—	—	4	—	—	12
July............	—	6	2	2	1	5	—	—	15
August............	—	12	3	—	—	7	—	—	9
September............	1	7	3	2	—	7	—	—	10
October............	1	6	4	1	—	16	—	—	3
November............	—	1	3	1	2	17	—	—	6
December............	—	6	1	—	—	16	—	—	8
Total no. of days	3	73	31	11	8	132	2	—	105

TABLE 3.—Average monthly rainfall data for four stations

	Betty's Bay	Steenbras No. 1	Highlands	Silver Sands	Average number of days rain at Silver Sands
	mm	mm	mm	mm	
January	41,15	26,9	33,9	34,8	7
February	39,12	30,3	41,2	27,3	7
March	31,24	31,5	50,2	25,3	7
April	72,90	83,2	90,7	39,3	8
May	95,00	126,5	125,0	59,9	9
June	152,65	135,5	124,1	112,9	13
July	150,37	118,9	122,8	103,0	13
August	126,49	110,5	114,1	123,7	16
September	83,82	80,0	94,7	60,7	11
October	76,96	62,3	77,4	73,5	10
November	36,32	40,7	50,7	25,2	8
December	33,53	27,7	31,1	32,2	7
Average annual	939,55	874,0	955,9	717,9	116

(1) Betty's Bay: Averages calculated from data collected weekly by Mr D. Heesom at "The Box", Betty's Bay. The data were collected over the period September, 1966 to February 1972. The altitude is approximately 35 m.
(2) Steenbras No. 1: Averages obtained from W.B. 29 (Weather Bureau, 1960a) over a period of 38 years. Altitude 338 m. This station is about 8 km to the north of the survey area.
(3) Highlands: Data were obtained from Highlands Forest Station (Grobler, 1964). This station is 6,5 km east of the survey area at an altitude of 366 m. The data were collected over a 22 year period.
(4) Silver Sands: Averages have been obtained from data collected by Mr G. Affleck at "The Four Seasons", Stony Point, Betty's Bay, over a period of three years (1969–71). The altitude is less than 15 m.

TABLE 4.—Average monthly temperature data for three stations

Month	Silver Sands		Steenbras No. 1		Elgin	
	Maximum	Minimum	Mean maximum	Mean Minimum	Mean Maximum	Mean minimum
January	23,9	16,4	32,8	9,7	34,9	6,6
February	23,0	15,8	32,2	11,2	35,1	6,6
March	22,5	15,4	30,4	8,9	33,2	5,2
April	19,8	13,5	30,1	7,3	32,1	2,3
May	18,8	12,1	26,3	4,7	27,3	—0,4
June	17,7	10,7	24,1	3,0	24,8	—1,8
July	16,7	9,6	22,7	2,4	23,2	—1,9
August	17,2	10,2	25,4	2,9	27,2	—1,4
September	17,6	10,3	26,6	4,6	28,4	0,2
October	19,6	13,1	28,1	5,2	30,2	1,8
November	20,6	13,8	30,7	6,9	33,3	4,3
December	22,1	15,4	31,4	8,2	34,1	5,6

The location of the Silver Sands and the Steenbras number one recording stations are given in Table 3. Elgin: 34° 09′ S and 19° 02′ E at an altitude of 259 m for the period 1927–50 (Weather Bureau, 1954).

Mists generally occur during autumn, but no month is necessarily free of mist. Some plants in the foredune communities were occasionally found to be very moist during the late afternoons, particularly on south-easter free days during autumn. The moisture presumably condensed from the onshore afternoon breezes. Grobler (1964) records heavy dew during the winter months.

Occasionally a so-called "black" south-easter may bring some rain to the south-western and southern Cape coastal areas during summer, but normally a cloud cap only on the mountains is associated with this wind (Jackson & Tyson, 1971). Marloth (1903; 1906) and Nagel (1955; 1962) have demonstrated that plants are instrumental in condensing considerable quantities of moisture out of the south-east mists. A number of species on the higher mountains in the area e.g. *Spatalla setacea* and *Mimetes argenteus* have much divided or very hairy leaves, which appear to function as fog traps intercepting the moisture. The very dense vegetation found on the upper southerly slopes in very shallow soil could depend on these mists for survival during the long rainless periods that may occur during summer.

The vegetation in the north-eastern portion of the area on the edge of the Elgin Basin generally gives the appearance of being a much drier type. Markedly xerophytic species that include Restionaceae and short, wiry Ericaceae are found in abundance, but no rainfall data are available from this area.

The Hottentots-Holland range, which terminates in the area, appears to be the dividing line between the area receiving its rainfall predominantly in winter to the north and that receiving a greater proportion during the summer to the south-east. A higher rainfall which is spread through the year may, therefore, occur in portions of the area, in contrast to other areas in the south-western Cape. This may well contribute towards the great variety of habitats and the diversity of species occurring here.

Snow has been recorded on a number of occasions, but the close proximity to the sea and the relatively low altitudes result in it being of short duration.

1.5.3 *Temperature*

Temperature data from the area are limited. At Silver Sands records for three years are given in Table

4. This recording station is located on the coastal plain and appears to be reasonably representative. Close proximity to the sea is the main reason for the equable climate. The average annual range between the mean daily maximum and minimum temperatures is 7,1 °C in comparison to 4,2 °C at Cape Point which is almost surrounded by the sea. The latter is regarded as having the narrowest average range in the Republic (Weather Bureau, 1954).

In contrast to the coastal plain, inland temperatures bordering the Elgin Basin are lower and frosts are common.

The higher altitude of the Steenbras Dam recording station shows intermediate conditions between the coastal plain and the Elgin Basin. Frost has not been recorded at this station during the last 30 years.

The average annual range between the maximum and minimum daily temperatures at Elgin is 28,1 °C, whereas at Steenbras Dam it is 22,3 °C (Weather Bureau, 1954), in contrast to 7,1°C at Silver Sands. The lowest average daily maximum and minimum temperatures occur during July and the highest in January and February.

Insolation is less on the south facing slopes than on the north facing slopes. The moister condition of some of the southerly slopes is probably associated with the reduced insolation.

1.5.4 *Relative humidity*

Average monthly relative humidity at 08h00 and 14h00 has been determined from readings made at Silver Sands over the period 1969 to 1971 by Mr. G. Affleck (Table 5). The monthly average is characteristically higher in the morning (averaging 77,4%) than in the evening (average 67,7%). The relative humidity remains fairly constant throughout the year, having a range of 11,3% at 0800 hours and 7,9% and 1400 hours. November has the lowest values (70,5% at 0800 hours and 63,8% at 1400 hours).

TABLE 5.—Average relative humidity (in percentage) at Silver Sands

Month	0800 hrs	1400 hrs
January	75,9	67,4
February	78,8	69,6
March	81,8	70,8
April	81,7	71,7
May	80,0	69,3
June	76,0	67,0
July	79,3	68,6
August	76,6	66,3
September	76,3	65,8
October	77,0	67,9
November	70,5	63,8
December	75,1	66,1
Average	77,4	67,7

The location of the Silver Sands recording station is given in Table 3.

1.5.5 *Fire*

Prevailing climatic conditions determine the influence of fire on the vegetation, its duration, its extent and sometimes its periodicity. It is generally held that fires may result from a number of sources, such as lightning strikes, spontaneous combustion of rotting organic material, friction from rolling stones, accidental and deliberate ignition by man. Man-made fires are not thought to be of very recent introduction. The earliest use of fire by man in Africa south of the Sahara is associated with the Chelles-Acheul and perhaps the Fauresmith industries, more than 53 000 years ago (West, 1965). According to Phillips (1931), the log-books of Bartholomew Diaz and Vasco da Gama recorded the presence of fires along the Cape coast in the late 15th century. These were associated with the Hottentot tribes.

Laws were passed in the 17th century to control veld fires (Botha, 1924). Burning of the indigenous vegetation was decried by various Cape botanists, particularly between 1918 and 1938 (Bews, 1918; Levyns, 1924; Marloth, 1924; Pillans, 1924; Adamson, 1927; Phillips, 1930, 1938; Compton, 1934). The knowledge of plant community development was scanty. The result of total protection from fire was a succession of large devastating "wild fires" in the mountains of the south-western Cape between the early 1940's and the late 1960's. In 1945, 10 280 ha of veld was burnt in the Kogelberg State Forest. A changed view of fire in fynbos started between 1950 and 1960. During 1956, Prof. C. L. Wicht, in a radio talk, said that controlled fires were permissible under certain circumstances (Le Roux, 1966). Wicht & Banks (1963) considered the total protection of fynbos from fire to be an unnatural condition, because this vegetation had been exposed to and survived fire for centuries, so that fire had become a natural factor.

Experiments in southern Australian heath vegetation (Specht, Rayson and Jackman, 1958) showed that with complete protection from fire the number of species was considerably reduced, from 36 species immediately after a fire to ten species after 50 years. Most of the ten species also showed a considerable reduction in numbers of individuals. The decline was primarily attributed to competition for water during the first 20 years, and thereafter to certain nutrients becoming limiting, even to reducing the uptake of other nutrients.

Recently, the idea of controlled burns to manage the vegetation has been applied by the Department of Forestry to some mountain catchments of the south-western Cape. The Kogelberg State Forest has mostly been protected from fires since 1945 and the fynbos communities were in a moribund state. Certain rare endemic species were decreasing to alarmingly low numbers. On the 10th July, 1968, the largest controlled burn attempted was started in the Kogelberg State Forest. Since then, portions of this area have been systematically burned in an effort to regenerate the fynbos communities.

An accidental fire on 23rd September, 1971, which destroyed 22 houses in the Betty's Bay area, also burnt the coastal plain and mountain vegetation. Thereafter a succession of species started flowering where they had not, in many cases, been previously observed in the tangled mass of rank vegetation.

1.6 *Historical Factors*

The Quaternary history of the area is relatively unknown. Mabbutt (1955) described a Palaeolithic or Early and Middle Stone Age site at Cape Hangklip. Gatehouse (1955) suggested that man lived at Hangklip without a break throughout the period of cultural development.

The Hangklip stone industry apparently commenced and ended during the Third Interglacial about 120 000 to 140 000 years ago (Gatehouse, 1955). Sampson (1962) has suggested that these Early Stone Age hunters used fire. The appearance of the Later Stone Age man, known as the "strandloper", extended from about 100 000 years ago into modern times (Goodwin, 1952).

FIG. 6.—The lower Palmiet River valley. A proposed dam having its wall between the lower peaks nearest the estuary and its overflow throught he pine trees to the left of the peak in the foreground will submerge to the 100 m contour, all of the valley visible here. The old Oudebos experimental farm in the centre is located below Platberg Mountain. Elephant Rock Mountain is located nearest the sea and Paardeberg Mountain on the extreme right.

On the basis of pollen diagrams, Schalke (1973) suggested climatic variations and corresponding vegetational changes from about 7 280 years B.P. to the present.

Lieutenant William Paterson gave the first written account of the Hangklip area in his description of a journey with Colonel Robert Gordon during October, 1777. Paterson (1789) found "lakes of fresh water, and plenty of wood" between Pringle Bay and Rooi Els. A small patch of *Sideroxylon inerme* dune scrub at Pringle Bay and a small lake, which dries out in summer, are all that remain today, although further on at Betty's Bay a few forest patches and larger lakes are to be found. He also records seeing several wild buffalo and eland. These animals are absent from the area now.

Since then the area has been used for stock farming, vegetable growing, and as a base for whaling activities, while the profitable trade in wild flowers, both fresh and dried, has continued to the present day. Good roads were constructed during the Second World War and since then the area has increased in popularity as a seaside resort. Township development commenced under the supervision of Harold Porter, who on his death in 1957 ceded his property, Shangri-la, to the National Botanic Gardens to cultivate and preserve the regional flora and vegetation. This property is now called the Harold Porter Botanic Reserve (Porter, 1967).

The Department of Forestry owns most of the mountains in the area. The Kogelberg State Forest is managed entirely for the protection of the indigenous vegetation.

2. METHODS

Field sampling was undertaken in two periods, 1969 to 1970 and from 1973 to 1974.

Data collected during the first period were synthesized and described by Boucher (1972). The adjoining area was sampled during the second period. Certain community concepts formed during the first period were modified once the additional data became available. Data collected during both periods were used to formulate the description of the vegetation presented here.

The various sampling strategies and analytical techniques applied have been described and compared (Boucher, 1977a). The sampling strategies can shortly be summarized as follows: aerial photographs were used as basis for the distribution of relevés (Fig. 2) and to delimit mapping units (Fig. 5). The aerial photographs were subdivided into physiographic-physiognomic units and sufficient relevés were located within each unit to ensure adequate sampling. Three phases of sampling were undertaken. During the first phase each relevé was strictly located along a north-south axis and exactly fixed on a randomly located point. Excessive sampling of transitional areas resulted, primarily because the photographs were not of a large enough scale and resolution was consequently inadequate and because of the rigid sampling technique. During the second phase the relevés were located so as to best sample the relevant community nearest to the randomly located point, care being taken to avoid transitions. The third phase involved extrapolation of the community concepts into the vegetation adjoining that already sampled by means of subjectively located "test" relevés. The vegetation map (Fig. 5) is based on the data collected during all the stages.

Relevés of 5 m × 10 m size were consistently used throughout, except in the forest communities where a 10 m × 20 m relevé was used because of the larger size and hence coarser distribution pattern of the component species.

The three methods of data analysis used are discussed by Boucher (1977a). The results of the Braun-Blanquet table method are reproduced in Tables 6 and 7. Table 6 represents the data collected during the first sampling period when the data were not collected strictly according to the Braun-Blanquet procedure. The communities described from these data were also based on the results of the association-analysis and homogeneity function analysis. The communities described during the second phase were entirely based on the tabular synthesis of the data as represented in Table 7. An overall picture of the vegetation of the area has been provided by relating the two tables in the community descriptions.

3. VEGETATION

In this account the vegetation has been subdivided into three main categories based on distinctive physiographic features. These are coastal plain, mountain and riparian vegetation (see Fig. 6).

Within these three categories two main vegetation types can be distinguished on the basis of physiognomy and floristic characters: (1) Broad-leaved scrub, which includes *Sideroxylon inerme* Dune Scrub, *Cussonia—Olea* Scree Forest, *Cunonia—Alsophila* Kloof Forest and *Podocarpus—Rapanea* Shale Forest, and (2) the fynbos (Taylor, 1972), which is the common vegetation in the area.

Adamson (1938), in his discussion of Sclerophyllous Bush (i.e. fynbos), recognized it as having three layers in its most developed form. The upper layer would be represented by emergent dominants which vary according to locality, but consist mainly of members of the families Proteaceae and Bruniaceae in the Hangklip area. The emergent Proteaceae generally have broad leathery sclerophyllous leaves, although *Sorocephalus clavigerus* and *Aulax cancellata* are examples of exceptions with narrow leaves. Tree proportions are sometimes attained by the Proteaceae, for example: *Leucospermum conocarpodendron*, *Protea arborea* and *P. mundii*. The middle layer in the fynbos is mainly composed of wiry dwarf shrubs with ericoid leaves, of the families Bruniaceae, Ericaceae, Rutaceae and Thymelaeaceae. The Compositae, Rosaceae and Restionaceae are also well represented. The lower layer consists of tufted or tussocky Restionaceae and Cyperaceae with smaller herbaceous plants and geophytes. Not all of the layers recognized by Adamson (1938) develop under all habitat conditions. Fires might even prevent the development of the upper layer.

A preliminary check-list of the flowering plants and ferns found in the area includes 1 407 species belonging to 110 families (Boucher, 1977b). The Cyperaceae (71 species), Gramineae (64 species), Iridaceae (98 species), Restionaceae (100 species), Compositae (152 species), Ericaceae (119 species), Leguminosae (103 species) and Proteaceae (62 species) are well represented. A number of endemic species are found, of which a few of the more attractive are: *Erica pillansii*, *E. leucotrachela*, *E. macowanii*, *E. vallis-aranearum*, *Mimetes hottentoticus* and *Sonderothamnus petraeus*. The variety of habitats could be one of the most important reasons for the diversity of species in the area.

A study of the communities in the area is not easy primarily due to the large number of species. It is difficult to obtain typifying species in many instances. The tussocky Restionaceae and Cyperaceae (referred to as "restiads" here) coppice or sprout rapidly after fires and mainly persist through the life of the fynbos community, as far as is known. This makes this element extremely valuable in the study of the vegetation because it can be found in all the fire successional stages.

3.1 *Coastal plain vegetation*

The coastal plain commonly has a sandy substrate, which can either be of marine origin or be derived from the weathering of the surrounding sandstone mountains. The latter sands differ from the littoral dune sands in their acid nature, although leaching by rain or fresh water eventually results in the marine sands also becoming acid. Calcification of dunes has occurred to a limited extent and is visible where the sand covering has been removed to expose the calcified sand referred to here as "limestone". Sandstone exposures occur particularly along the rocky coast lines. Schalke (1973) recorded a succession of moister periods with peat formation and drier periods during which sandy sediments were deposited. Species typical of the coastal plain, except in the very wet bog and vlei areas, are *Metalasia muricata* and *Myrica quercifolia*. The alien species, *Acacia cyclops*, is commonly encountered.

3.1.1 *Littoral dune communities*

Littoral dunes occupy a relatively small portion of the study area, being confined to a fairly narrow zone along approximately 8 km of the 44 km coastline. The strong south-east winds during the drier months soon cause dune movement if the vegetation cover is removed and the 1938 aerial photographs (Trigonometrical Survey Job No. 126/38) show two main areas of active dune formation. The largest reaches far up the slopes of the Blesberg into Hangklip kloof from the Silver Sands area, while the other occurs along the coast on the seaward side of Malkopvlei. The open uncolonized portions of these dunes have undergone considerable reduction in total area since 1938. This process is still actively continuing. Colonization of the dunes has doubtless been assisted by stricter fire control measures, absence of grazing by domestic animals, and by stricter control of trespassing and other denuding activities of man on the vegetation. The alien species *Acacia cyclops*, has also contributed toward the stabilization of the dunes.

The vegetation on the alkaline sandy soils is more complex than the broad simplified groups described here and would be an interesting study on their own. The salt-laden onshore winds constantly arrest the tender growing tips of the coastal scrub species giving them a pruned or "wind-shorn" appearance.

3.1.1.1 Ehrharta—Ficinia *Strand Pioneers*

Under "strand" is understood that area of beach above high water level subject to the action of wind and sand blasts.

For mapping purposes, the *Ehrharta—Ficinia* Strand Pioneer Community has been included with the *Colpoon-Rhus* Dune Scrub (p. 474), because an active gradation from one to the other occurs. The following ten relevés in Table 6 are located within these two communities: 2, 21, 32, 33, 34, 35, 36, 37, 44 and 45.

The sand dunes supporting this community are typically in the first stages of colonization. Sand movement still occurs and the recent marine origin of the sand ensures an alkaline pH. Sand depth varies considerably, from a few centimetres to a few metres deep. Moisture conditions vary according to locality, but the sand usually ensures rapid drainage and is prone to drying, particularly in summer. When they occur, afternoon onshore winds deposit some moisture.

Scattered patches of the *Ehrharta—Ficinia* Community (Fig. 7) represent the open phase in the initial colonization of the dunes, this community normally consisting of a single layer. Common species are: *Arctotheca populifolia*, *Agropyron distichum*, *Ammophila arenaria*, *Senecio elegans*, *Myrica cordifolia*, *Silene crassifolia*, *Sporobolus africanus*, *Stipagrostis zeyheri*, *Stenotaphorum secundatum*, *Tetragonia spicata*, *T. decumbens* and the two defining species, *Ehrharta villosa* and *Ficinia lateralis*.

Those dunes which are relatively stable have a taller, shrubby, less open vegetation of the following species, often in conjunction with the previous species: *Metalasia muricata*, *Passerina rigida*, *P. paleacea*, *P. vulgaris* and, as additional ground cover, *Psoralea repens*, *Restio eleocharis* and *Thesidium fragile*.

A variation of the strand pioneer community that occurs on the inland extremities of some partially mobile dunes has fynbos elements in conjunction with littoral dune elements. This strand pioneer community is closely related to Taylor's pioneer dune mixed fynbos sub-association and littoral dune mixed fynbos sub-association (Taylor, 1969).

3.1.1.2 Colpoon—Rhus *Dune Scrub*

Colpoon—Rhus Dune Scrub may be found on stable dunes (Fig. 7) and is closely related to the *Ehrharta—Ficinia* Dune Pioneer community previously described. The defining species are *Colpoon compres-*

FIG. 7.—Silver Sands Bay. *Colpoon—Rhus* Dune Scrub in the foreground and *Ehrharta—Ficinia* Strand Pioneers beyond the figure. The Voorberg Mountain in the background dominates the scenery.

sum and *Rhus laevigata*. Dune Scrub is found on grey alkaline sandy soils of the Langebaan Series with a greater percentage of organic material than in the pioneer community.

Initial development of *Colpoon—Rhus* Scrub occurs on the leeward side of the dunes in the dune slacks. Progressive colonization of the dunes takes place, the dune crests being the last portions of the dunes still having the strand pioneer community.

In its best developed form, this community is dense with shrubs having interlocking crowns. Its height may vary from 0,5–2,0 m. The more typical species are: *Rhus lucida*, *R. laevigata*, *Olea exasperata*, *Colpoon compressum*, *Cassine maritima*, *Metalasia muricata*, *Maytenus lucida* and *Euclea racemosa* in the drier portions with *Chrysanthemoides monilifera*, *Salvia aurea*, *Senecio halimifolius* and large *Myrica cordifolia* in the moister areas, particularly in the dune slacks. Transitions to wetter communities, such as in the case of Relevé No. 1 (Table 6), sometimes occur in the dune slacks, in which case sedges are common.

Transitions to the acid sand flats communities after long exposure to rain and acid seepage waters also occur, such as in Relevé No. 16. *Euclea racemosa*, which is an important component of the *Colpoon—Rhus* Dune Scrub, also occurs in the exposed limestone areas where a greater variety of restioids, proteoids and ericoids are found. Taylor (1969) describes a similar vegetation under his dwarf dune mixed fynbos and his broad-leaved scrub formation.

3.1.1.3 Sideroxylon inerme *Dune Scrub*

Sideroxylon inerme Scrub, or melkhoutbos, was not sampled during this survey, because it is easily recognizable on aerial photographs and on the ground by its distinctive physiognomy (Fig. 8).

This Scrub appears to represent the climax vegetation on the deep stabilized littoral sands of the Langebaan Series. Well-developed *Sideroxylon* Scrub patches can be found at Dawidskraal, Boskop, Pringle Bay and on the Elephant Rock Estates. Verbal reports from old inhabitants indicate that this community was more extensive at the end of the last century (Prof. C. M. Muller, pers. comm.). Frequent fires and sand movement after the fires appear to have contributed towards the reduction in the extent of this community. The introduced *Acacia cyclops* has also encroached and become dominant in many potential *Sideroxylon* scrub areas.

In its best developed form the *Sideroxylon* Scrub has a continuous upper canopy, 2–4 m high, formed mainly by *Sideroxylon inerme*, *Cussonia thyrsiflora*, *Euclea racemosa* and *Olea exasperata*. Margins of this scrub are usually composed of stunted and wind-shorn individuals of *Colpoon—Rhus* Scrub resulting from the effect of salt-laden on-shore sea breezes. *Sideroxylon inerme* appears to grow best where there is some protection from these winds. *Tarchonanthus camphoratus* and *Olea exasperata*, which often form dense stands, possibly develop eventually into a *Sideroxylon* Scrub. *Sideroxylon* Scrub in turn could represent a stage in the development of the *Maurocenia—Linociera* Tall Scrub found in the Cape of Good Hope Nature Reserve (c.f. Taylor, 1969). This is supported by the evidence of young individuals of *Maurocenia frangularia* and *Linociera foveolata*, which have been found in the *Sideroxylon* Scrub patches on the Elephant Rock Estates. *Linociera foveolata* is also a co-dominant in the scrub patch near the mouth of the Rooi Els River, and the scrub patch to the south of Hangklip kloof is also dominated by *Maurocenia frangularia* and *Linociera foveolata*.

A number of climbers can be found in the *Sideroxylon* scrub, including: *Cynanchum africanum*, *Kedrostis nana*, *Asparagus asparagoides*, *Solanum quadrangulare* and *Cussonia thyrsiflora*. The last species is often self-supporting when it becomes larger. The herbaceous layer usually includes *Asparagus scandens*,

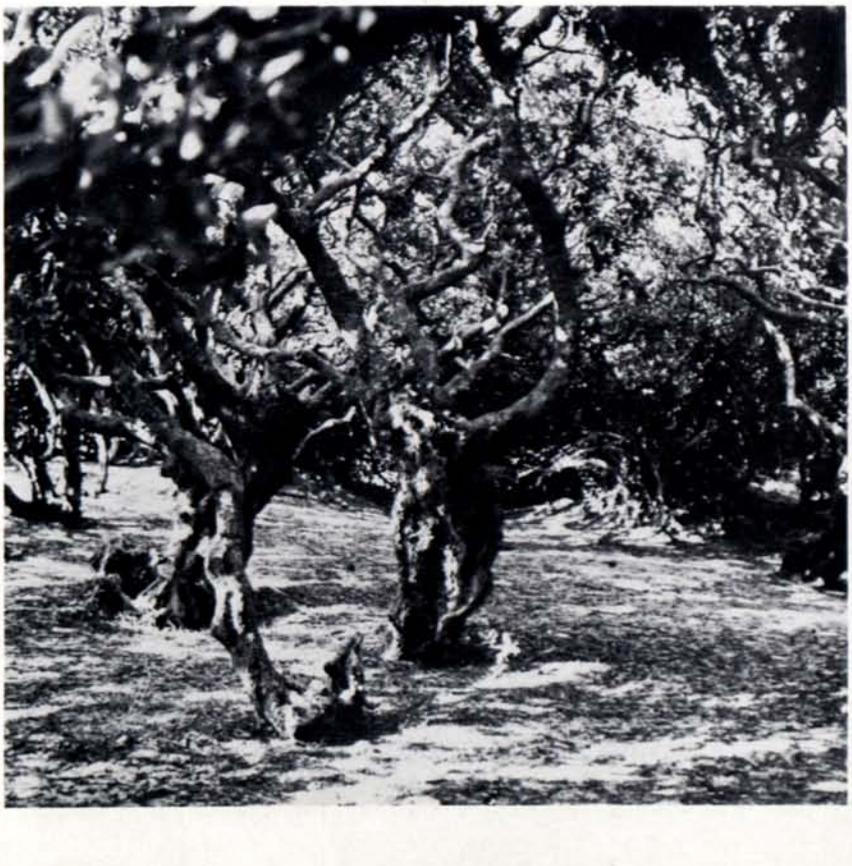

FIG. 8.—Dawidskraal. The interior of a patch of *Sideroxylon inerme* Dune Scrub.

FIG. 9.—Silver Sands. *Leucadendron coniferum* Limestone Fynbos.

Australina lanceolata, *Cineraria geifolia* and *Knowltonia capensis*.

Sideroxylon Scrub frequently occurs in very close proximity to sandy beaches and is popular for shelter from sun and wind. Disturbance by man adversely effects these scrub patches. Pathways through the scrub patches allow the salt laden sea breezes to penetrate into the thickets with detrimental results, the young growing tips dying back on exposure to these breezes. Heat from fires lit in these patches and trampling by man will also probably contribute towards their eventual destruction unless timely action is taken.

3.1.2 *Limestone communities*

In places, such as in the vicinity of the Groot Vleie, where the surface sands have been removed, the exposed limestones have a short, sparse limestone vegetation, for example Relevé 43. The vegetation usually occurs in shallow, sandy pockets amongst the rocks. Drought conditions are prevalent in summer, primarily because of the shallow sandy nature of the Muden Series soil. There are few defining species and some species such as *Restio eleocharis*, *Passerina paleacea*, *Carpobrotus acinaciformis* and *Rhus laevigata* are common to the *Coleonema album* Fynbos, to the *Ehrharta—Ficinia* Strand Pioneers and to this community.

Where a deeper sand covers the limestones, a more luxuriant vegetation, 2 m and more tall with overlapping crowns is found (Fig. 9). The sandy soil has a higher organic content and, generally, conditions are moister than in the shallow pockets in the exposed limestones. Relevés 25, 29 and 58 represent this community. *Leucadendron coniferum* is typical, together with *Rhus lucida* and *Cassine barbara*.

On the south-eastern slopes of Groot Hangklip Mountain and on the south-eastern slopes of Blesberg, wind-blown sand of marine origin has accumulated on the mountain sides to an altitude of about 180 m. Dune calcification has also taken place here and the vegetation is primarily of the taller limestone type, although elements of mountain fynbos and fynbos of the plinthic soils intermingle where the sands are shallower or mixed with the weathered products from the sandstones higher up the slopes. Typical species are *Aspalathus forbesii* and *Struthiola ciliata*. This form is represented by Relevés 28, 30, 31 and, in a depauperate form, by Relevés 43, 16 and 1.

3.1.3 *Acid sand flats communities*

The coastal plain has extensive deposits of Tertiary to Recent finer marine sands admixed with coastal sands, which are a weathered product from the Table Mountain Sandstones and result in acid Sandveld Series soils. Drainage is generally good and dry conditions occur periodically. Relevés representative of this community (15, 24, 38 and 39) have a slope of 2–4°, while the altitude varies from 9–75 m.

The vegetation generally consists of two strata with *Leucadendron xanthoconus*, *L. gandogeri* and *L. laureolum* forming the metre-tall emergent, open shrub layer. The lower shrub and herbaceous layer is formed by a 15–30 cm-tall mixture of ericoids and restioids. This community is illustrated in Fig. 10.

Differential species for this community are: *Berzelia abrotanoides*, *Erica multumbellifera* and *Erica patersonia*. The latter species has been listed as an endangered species on the basis of the vulnerability of the habitat which is well suited to township development.

3.1.4 Coleonema album *Short Coastal Fynbos*

This community can be found along the littoral rocky coastline (Fig. 11). It was not sampled during the survey (Boucher, 1977a).

The soil is rudimentary, consisting of an alkaline sand constantly exposed to salt spray. It can have calcareous material and belong to the Muden series or be without, in which case it belongs to the Mispah Series. A deep soil seldom develops except in local sand pockets. Heavy dewfall during late afternoons

FIG. 10.—Silver Sands. Acid sand flats fynbos. The Klein Hangklip Mountain Range is visible in the distance.

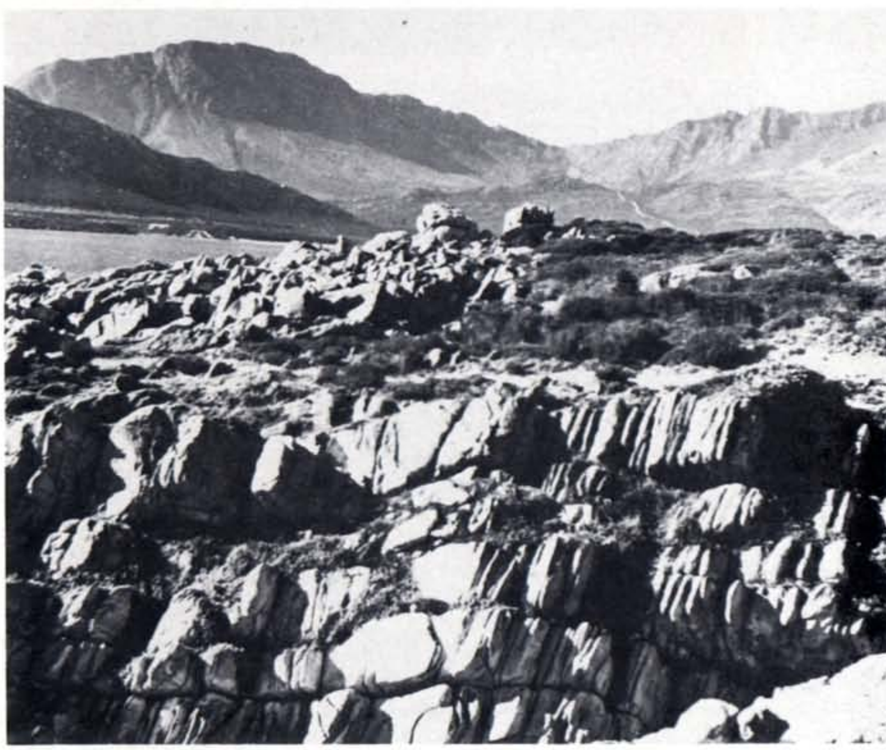

FIG. 11.—Pringle Bay. *Coleonema album* Short Coastal Fynbos. Note the typical rocky habitat. The highest mountain in the background is Buffelstalberg.

and evenings compensates to a large extent for a lack of moisture.

Coleonema Fynbos is distinguished from the littoral dune communities by its greater complement of ericoid species, and the restioid element is poor in species in contrast to the fynbos on acid sand. Coastal dune scrub or strand pioneer elements are sometimes found in local deeper sand pockets. A continuous canopy seldom occurs because of the rocky terrain. The vegetation consists of a dwarf shrub layer, generally about 30–50 cm tall with prostrate succulents. Conspicuous species are: *Aizoon sarmentosum, Carpobrotus acinaciformis, Drosanthemum floribundum, Tetragonia spicata, Coleonema album, Metalasia muricata, Orphium frutescens, Passerina ericoides, P. vulgaris, Phylica ericoides, P. stipularis* and *Senecio elegans*.

3.1.5 Erica—Osmitopsis *Seepage Fynbos*

This community commonly occurs along the coastal plain from Rooi Els to the Palmiet River mouth in the wet seepage areas usually found at the foot of talus slopes. Although the water table is high, standing or surface water seldom occurs.

The soil has a very high organic content, resembling peat, and belongs to the Champagne Series. The slope is slight.

The tall, ericoid-dominated shrub layer is about 2 m tall (Fig. 12), while the lower shrub and herbaceous layer varies from 45–75 cm. The seepage fynbos forms a very dense community, which becomes difficult to penetrate if allowed to develop for any length of time. The unpleasant sulphurous odour released by bruised *Carpococe spermacoce* can often be smelt when walking through this community.

FIG. 12.—Near Pringle Bay. *Erica—Osmitopsis* Seepage Fynbos. Groot Hangklip Mountain is the tallest mountain in the distance.

The following species identify this community, which is represented by Relevés 14, 17, 18, 19, 40 and 41: *Osmitopsis asteriscoides*, *Merxmuellera cincta*, *Erica perspicua*, *Carpococe spermacoce*, *Epischoenus gracilis* and *Cliffortia graminifolia*. Local dominance by *Merxmuellera cincta*, *Neesenbeckia punctoria*, *Cliffortia ferruginea* and *C. hirsuta* for instance, might sometimes occur. Relevé No. 3 is an example of local dominance by *Restio bifidus* where the defining species are locally totally absent. *Berzelia lanuginosa* and *Brunia alopecuroides* are usually dominant in the seepage fynbos but are not restricted to this community. Occasional large treelike individuals of *Psoralea affinis* and *P. pinnata* are usually found nearer the streams where the movement of seepage water is faster.

This seepage fynbos gives a rather drab and uniform impression during most of the year except when *Brunia alopecuroides*, *Berzelia lanuginosa* and *Erica perspicua* are in flower. The rare and showy protead, *Mimetes hirtus*, can form local colourful patches. The seepage fynbos is interesting from the successional aspect. After the accidental fire in February, 1971 at Betty's Bay, a number of species produced very showy mass displays of blossom. Three weeks after the fire, *Haemanthus canaliculatus* appeared as a mass of inflorescences reminiscent of a field of tulips. This species has previously been very rarely seen in the area and subsequently this site, after three years, has become completely overgrown with 2 m tall vegetation. It is now very difficult to find any trace of this species. Other species, particularly geophytes, have flowered profusely at intervals after the fire as follows:

(i) Within three months—*Kniphofia uvaria* and *Haemanthus canaliculatus*.

(ii) Within eight months—*Senecio rigidus*, *S. subcanescens*, *Gladiolus carneus*, *Geissorhiza wrightii* and *Watsonia pyramidata*.

(iii) Within eleven months—*Disa racemosa* and *Watsonia comptonii*.

(iv) Within thirteen months—*Elegia thyrsifera*.

(v) Within fourteen months—*Merxmuellera cincta*.

Subsequently *Mimetes hirtus*, *Erica patersonia*, *Pelargonium cucullatum* and *Erica perspicua* have also produced magnificent displays.

This seepage fynbos is similar to the *Berzelia—Osmitopsis* seepage scrub association recognized by Taylor (1969) and could perhaps also be included in Adamson's (1938) Wet Sclerophyll Bush, under "hygrophilous macchia", which he describes as having a denser, less xerophytic growth form with a prevalence of soft small leaves and an absence of hard leathery leaves.

3.1.6 *Marsh communities*

Under marsh is understood "a tract of soft wet land, commonly covered wholly or partially with water" (Carpenter, 1938). Locally such marshes are called "vleis" because they have permanent or temporary standing water and are not open to the sea. The various vleis which occur in the area are: Skilpad's Vlei, the two Groot Vleie, Malkopvlei (also known as Bass Lake) and numerous small unnamed vleis at Silver Sands.

3.1.6.1 Chondropetalum—Juncus *Vlei—fringing Tussock Community*

The tussock (Hanson, 1962) appearance of this community is due to members of the Restionaceae and Cyperaceae. This community was not sampled, because it occurs as a zone around the margins of the vleis, which were too narrow to be correctly sampled using the fixed relevé size (Boucher, 1977a). It is a distinctive community (Fig. 13) on large scale aerial photographs, but is too narrow to be mapped at 1: 50 000 scale.

Dominant species are *Condropetalum tectorum* and *Juncus kraussii*, which vary in height from 0,5–1 m. The latter species prefers the vlei fringes, which are inundated for slightly longer periods. Species that sometimes form a mat in this zone and can completely cover the ground are *Centella calliodes*, *Lobelia anceps*, *Plantago carnosa* and *Sporobolus virginicus*.

FIG. 13.—Groot Vleie. The *Chondropetalum—Juncus* Vlei-fringing Tussock Community occurs in the foreground and a *Phragmites australis* clump can be seen growing in the water.

The soils belong to the Champagne or Mposa Series, depending on their acidity.

3.1.6.2 Phragmites, Scirpus *or* Typha *Reed Beds*

Areas having relatively permanent surface water and Champagne Series soils are often colonized by 2–3 m-tall patches of *Phragmites australis*, *Scirpus littoralis* or *Typha latifolia* subsp. *capensis*.

Phragmites australis (Fig. 13) is most often found in those areas, where flowing water occurs, such as in drainage channels from the vleis and in the rivers. *Scirpus littoralis* and *Typha latifolia* do not appear to be restricted to areas where flowering water occurs and can be found growing in the vleis and bogs which can bevome completely overgrown by these species.

In vleis and rivers, the reed beds are usually restricted to the shallower water where *Crassula natans* and *Scirpus fluitans* may also be found. *Cyperus thunbergii* can occur in fairly dense stands in the slightly drier bog areas, together with *Typha latifolia* or on its own.

3.1.7 *Alien communities*

The term "alien" is used to denote introduced perennial plants, which grow spontaneously and successfully compete with the natural vegetation in their country of adoption. These are sometimes referred to as "pest-plants", because of their nuisance value.

In the Hangklip area considerable efforts have been made by various local and state authorities to eradicate and control the various pest-plants. A group of Betty's Bay citizens has a regular monthly meeting to eradicate the pest-plants on the local commonages.

The alien vegetation establishes itself in disturbed or uncolonized areas and extends into the natural vegetation, particularly after fire or some other disturbance destroys the natural vegetation cover. These hardy species then regenerate more vigorously than the indigenous flora and generally suppress it. Heat stimulates alien species seed germination (e.g. *Acacia* spp.), or opens their serotinous fruits and cones (e.g. *Hakea* spp. or *Pinus* spp.) thereby releasing the seed (Taylor, 1969).

Acacia cyclops was originally introduced into South Africa to fix the drift sands of the Cape Flats (Roux, 1961). This species has been very successful, even spreading naturally to the Cape Hangklip area, where the reduction in size of the large dune on the Blesberg must, to a large extent, be attributed to this species. *Acacia cyclops* has formed dense thickets and, together with the *Colpoon—Rhus* Scrub, has prevented the addition of fresh littoral sand to the Blesberg dune. Areas which have not been subjected to dune formation and which had well-developed *Colpoon—Rhus* Scrub, have also been invaded to the detriment of the indigenous vegetation (Fig. 14). Potentially, *Acacia cyclops* could completely replace the *Colpoon—Rhus* Scrub. This species forms the most extensive infestations of alien species in the area. The densest thickets occur along the south-east to westerly foot of the Groot Hangklip Mountain, but scattered small thickets and individual bushes are found scattered along the coastal plain and even up the slopes of the mountains.

Pinus pinaster, the cluster pine, was originally planted for saw timber (Taylor, 1969). The coastal plain supports cluster pine infestations in the rockier areas. The only established plantation of *Pinus pinaster* in the area is on the roadside between Pringle Bay and Betty's Bay. Various local cluster pine clumps can be found, such as at the Buffels River mouth on the Rooi Els side, near the plantation mentioned above, on the Elephant Rock Estates and near Fairy Glen (Fig. 6). Scattered individuals throughout the area could develop into clumps if not destroyed. No study has yet been made to determine the ability of fynbos to regenerate after plantations have been removed from an area. The dense litter of pine needles which accumulates under the pine trees and the shade from the trees suppress the fynbos vegetation. Fire is an important ecological factor governing the spread of this pest-plant.

Small plantations of *Pinus radiata* on private property alongside the road to Oudebos and alongside the road between Pringle Bay and Betty's Bay occur. This species does not appear to be invasive.

FIG. 14.—Blesberg. The darker community bordering the road is a dense stand of *Acacia cyclops*. The Hangklip lighthouse is just visible in the distance.

Acacia saligna occurs on the coastal plain where attempts have been made to control it by "hacking" operations.

Eucalyptus lehmannii spreads slowly into the indigenous vegetation particularly in areas of human activity. *Albizia lophantha* has become established in one locality, but is periodically removed by the local inhabitants.

Leptospermum laevigatum was introduced from Australia to combat drift sands and for use as a hedge plant (Taylor, 1969). It is able to regenerate by coppicing and has serotinous fruits. It occurs near the mouth of the Palmiet River in the vicinity of Fairy Glen, at the Oudebos turnoff and at the roadside between the Klein Hangklip range and the sea. *L. laevigatum* probably represents as much of a potential hazard to the coastal vegetation as does *Acacia cyclops*.

3.2 *Mountain vegetation*

The vegetation of the mountainous areas differs significantly in species composition from that on the coastal plain and along the rivers. This can readily be seen in Table 6. Two distinct vegetation types occur in the mountainous areas, namely (1) forest, which is poorer in species composition than the Knysna forests (Taylor, 1955), and (2) fynbos, where considerable intergradation between communities occurs.

Major factors of the habitat on which sub-divisions of the fynbos communities has been based are: (1) on the basic geological differences and (2) on proximity to the sea.

3.2.1 *Forest vegetation*

This vegetation includes communities dominated by trees with interlocking crowns and excludes plantations. The component species generally have broad leaves. The forests are generally shorter than those of the Knysna region, probably because of the greater climatic extremes found in the south-western Cape. Taylor (1955) found in the Grootvadersbosch Forest that some of the characteristic species of the Knysna type of forest, as described by Phillips (1928) and Laughton (1935), were either absent or rare in that forest. Similarly, the forests of the Hangklip area also have a much poorer species composition than the Knysna forests.

Forest patches cover a small percentage of the total area investigated, yet their distinctness, their economic importance through a scarcity of wood, the protection they can provide against the elements and their relative rarity make them important from the viewpoints of conservation and scientific interest.

The relevé size used to sample the forest vegetation was four times larger (10 m $\times$ 20 m) than that used in the fynbos vegetation. The forest patches were found to be best developed when associated with the shale bands in the Table Mountain Sandstones and have been described as *Podocarpus—Rapanea* Shale Forest. This forest community was found to be the most extensive in the area and was the only type sampled.

On Voorberg Mountain near Pringle East Peak on the northern slopes of Elephant Rock Mountain and to the north and north-west of Wynand Louws Bosch, scattered large *Podocarpus latifolius*, *Cunonia capensis* and *Curtisia dentata* individuals occur among boulders, but their spatial arrangement is such that they cannot be regarded as forest patches.

3.2.1.1 Cussonia—Olea *Scree Forest*

On the southerly slopes of Elephant Rock Mountain above Sunny Seas, two patches of scree forest occur (Fig. 22). This community was not sampled because of its limited extent. This type of forest is known locally as "dasbos", probably after the hyrax or dassie, which inhabit some of them. Characteristically, these forests contain large boulders in close proximity to one another with Mispah Series soils. The role of boulders in the ecology of these scree forests is a subject for further investigation. They possibly provide a suitable habitat for the initial colonization by tree species, birds eating the fruits of trees initially resting on these boulders, the boulders then serving to limit the effects and occurrences of fires. Other

FIG. 15. — Spinnekopneskloof. *Cunonia—Alsophila* Kloof Forest. The trees are *Cunonia capensis* and the large fern in the centre foreground is *Alsophila capensis*.

factors may also be involved. The 1970 fire which devastated portion of the village of Betty's Bay swept through these scree forest patches and appeared to have destroyed them. Some months later some of the component tree species started regenerating by coppicing, while *Haemanthus coccineus*, growing in the centres of the patches, flowered profusely. *H. coccineus* has usually only been found in the vegetative state in these forests. A possible deduction from this observation is that fire is a normal phenomenon of fairly regular occurrence in these forest patches.

Common species in the scree forests are: *Cassine barbara, Cunonia capensis, Cussonia thyrsiflora, Halleria lucida, Knowltonia capensis, Olea africana* and *Rapanea melanophloeos. Helichrysum crispum, Laurophyllus capensis, Myrsine africana, Glia gummifera* and *Solanum nigrum* are commonly found on the forest margins. The *Cussonia—Olea* Forests differ from the *Podocarpus—Rapanea* Forests in that they occur on sandstones and not on shale habitats, and differ from the *Cunonia—Alsophila* Forests in being drier and apparently subject to occasional fires. The shale bands on which the *Podocarpus—Rapanea* Forests occur occasionally become covered by some sandstone scree, in which case similarities occur with the *Cussonia—Olea* Scree Forests. An example of the latter case can be found in the Leopard's Gorge forest.

3.2.1.2 The Cunonia—Alsophila *Kloof Forest*

This forest type is rare in the survey area being restricted to narrow gorges such as that at the head of Spinnekopneskloof, where wet conditions exist and shallow Mispah Series soils occur (Fig. 15). Access to these forests is difficult because of the steep-sided and wet conditions of the gorges. Fire is probably excluded by the steep unvegetated nature of the ravine sides. Large old individuals of *Cunonia capensis*, which are 10–15 m tall and support a large growth of an *Usnea* sp., can be found. A notable feature of these kloof forests is their paucity of other species. *Alsophila capensis* is the main contributor towards the dense undergrowth.

The kloof forest patch on the southerly slopes of the Voorberg Mountain near the Betty's Bay Post Office is the most similar to the *Cunonia—Alsophila* type of forest although the presence of *Cussonia thyrsiflora* indicates a similarity to the scree forests.

3.2.1.3 Podocarpus—Rapanea *Shale Forest*

Shale Forest is represented by the following relevés in Table 7: 217, 218, 223, 233 and 244. It is the best known forest and covers the greatest area under indigenous forest in the investigated area. All of the Shale Forests found here occur in the Kogelberg State Forest in which prior to its declaration as a forest reserve, a certain amount of exploitation occurred. The Disa Kloof, Leopard Gorge and Oudebosch Forests and, to a lesser extent, the Wynand Louws Forest (Fig. 16), were the most accessible and therefore subject to the most disturbance. The Koedoebos and Platbos Forests and the forest patches at the head of the Spinnekopneskloof are less accessible and were probably the least interfered with.

The more rapidly weathering shale band in the Table Mountain Sandstone provides a deeper Longlands Series soil than *in situ* weathered sandstones sometimes resulting in steep-sided ravines, particularly on the contact zones between the shales and the lower sandstones. This affords a certain degree of protection from fire.

The forest margins generally have a dense stand of *Pteridium aquilinum*. This species builds up a certain amount of litter, which is highly inflammable. *Rumohra adiantiformis*, which is the more abundant component of the forest interior ground cover, does not build up a litter pile to the same extent. The boundary between the true forest and the forest margin is mostly indicated by these two species. Fires, which occur periodically in the surrounding fynbos, do not normally burn beyond this boundary line. This is a distinguishing feature from the Scree Forest.

FIG. 16.—Wynand Louw's Forest. *Podocarpus—Rapanea* Shale Forest. Note the rockier nature of the sandstone areas and the narrow tillite band to the right of the shale band in the distance. The *Berzelia—Leucadendron* Moist Tall Fynbos occurs in the foreground.

FIG. 17.—Oudebosch Forest. The interior of a *Podocarpus—Rapanea* Shale Forest. The initialled tree on the left is *Rapanea melanophloeos* and the large tree behind the figure is *Olinia cynosa. Rumohra adiantiformis* is the the common fern.

The canopy is from 6–15 m high while the discontinuous shrub layer, represented by tree saplings and tree ferns (*Alsophila capensis*), varies from 1–3 m in height (Fig. 17). The ground layer of *Blechnum attenuatum, B. capense, Rumohra adiantiformis, Elaphoglossum angustatum*, etc., is fairly continuous at a height of about 0,6 m except where interspersed with boulders.

Typical trees of the shale forests are: *Maytenus acuminata, Rapanea melanophloeos, Podocarpus latifolius, Curtisia dentata* and others, as listed in Table 7. Climbers are infrequent, although *Secamone alpini* sometimes occurs.

The forest margins, as typified by Relevé 232, 219 and 216, are formed by *Laurophyllus capensis, Cliffortia heterophylla* and *Protea mundii* with an admixture of *Berzelia—Leucadendron* Tall Moist Fynbos and riverine scrub elements such as *Diospyros glabra, Podalyria calyptrata, Restio subverticillaris, Pterydium aqualinum* and *Brachylaena neriifolia*. The *Protea mundii* individuals can become 8–10 m tall.

Observations at Wynand Louws Bos Forest indicate that the forest margin species immediately bordering the true forest are becoming moribund and dying through the absence of fire since 1945. Large *Protea mundii* individuals are falling over and dying, as are other fynbos forest margin components. Under this dense mass of vegetation, saplings of the true forest tree components are appearing. Wicht (1970) stated that "if the fynbos is indefinitely protected it will in time become increasingly dense and ultimately develop into natural forest". This statement appears to be true for this particular instance. In contrast, *Protea neriifolia*-dominated fynbos at Jonkershoek, which has been protected since 1942, does not have any forest species appearing yet, although the fynbos has already become moribund (Kruger, pers. comm.).

3.2.2 *Fynbos communities on yellow plinthic soils*

Soils included within this category, which occur in the area, belong to the Longlands, Estcourt, Clovelly and Glencoe Forms.

These plinthite soils are generally found in areas where an accumulation of, particularly, iron and manganese oxides has occurred, usually through impeded drainage or in association with the upper Klipheuwel Beds, the Cedarberg Formation, or in the Bokkeveld Beds.

In the drier areas, plinthites can often be recognized by the occurrence of ironpan fragments and ferruginized grit on the surface. In the wetter areas, the accumulation of organic material from dense vegetation often conceals the substrate. The drier plinthites have been subjected to extensive open cast mining for gravel. The vegetation on these soils could become rare because of the economic importance of the substrate.

3.2.2.1 Protea—Tetraria *Dry Short Fynbos*

Relevés representing this community are:

Table 6—104, 102, 72, 10, 7, 49, 99 and 42.

Table 7—209, 243, 206, 203, 201, 202, 242, 207 and 238.

This community is generally found at altitudes lower than 300 m, except on the north facing slopes of the Kogel Bay valley where it has been recorded at 490 m altitude. The plinthites on which this community occurs can be found throughout the area. Numerous intergradations between dry and moist conditions occur, particularly in the case of the Cedarberg Formation or shale band. The vegetation also shows numerous intergradations dependent on the moisture regime present.

Very rarely a tree of 3 m or more of *Widdringtonia nodiflora* may occur, but then it indicates a slightly moister phase. An upper shrub layer may be absent or present. It consists, when present, of proteoid elements emerging to heights varying from 0,75–3 m. In mature vegetation the taller the upper shrub layer, the moister the conditions. The lower shrub layer varies in height between 0,45–0,75 m and the ericoid element is prominent. The herbaceous layer of restioids and low ericoids varies from 0,2–0,6 m.

The more important indicator species for this community are *Protea scabra* and *Tetraria bromoides* (Fig. 18), which are used to define the community, and *Peucedanum sieberianum*, *Brunia neglecta*, *Leucadendron salignum*, *Elegia stipularis*, *Erica plukenetti*, *Phylica spicata*, *Cliffortia atrata*, *Erica longifolia*, *Protea lepidocarpodendron*, *P. longifolia* and *P. repens*.

Members of the Cyperaceae form an important element and give it a tussocky appearance, particularly during the first few years after a fire. The following are examples of this family: *Tetraria fasciata*, *T. flexuosa* and *T. cuspidata*. The restioid element remains important and examples are *Restio cuspidatus* and *Thamnochortus dichotomus*. Grasses such as *Themeda triandra*, *Hyparrhenia hirta* and *Cymbopogon excavatus* are also common. The latter species provide suitable fodder for ungulates and were probably the prime supporters of the eland and buffalo herds reported by Paterson (1789) in the area.

Geophytes are numerous, but are mostly not permanently recognizable and have therefore been excluded from this survey. A few examples found are *Aristea bakeri*, *A. oligocephala*, *A. spiralis*, *Anapalina nervosa*, *Lanaria lanata*, *Herschelia purpurascens*, *Bobartia indica* and *Gladiolus bullatus*. Stands 6 and 11 described by Grobler (1964) can be included within this community.

Taylor (1969) described a *Protea lepidocarpodendron* Tall Fynbos association and a *Protea arborea* Pseudo-savannah Association, which can be compared to this community. The latter association occurs in two phases in the Hangklip area. The drier phase along the north-facing slopes of the Kogel Bay valley is often subject to fires and the short twisted *P. arborea* individuals do not give the savanna-like effect found in the Cape of Good Hope Nature Reserve. Along the upper reaches of the Buffels River at the contact between the shale band and the

FIG. 18. — Spinnekopneskloof. *Protea—Tetraria* Dry Short Fynbos. *Tetraria bromoides* inflorescences are visible in the foreground. The upper boundary of the shale band is much less distinct than the lower boundary with the rockier sandstones.

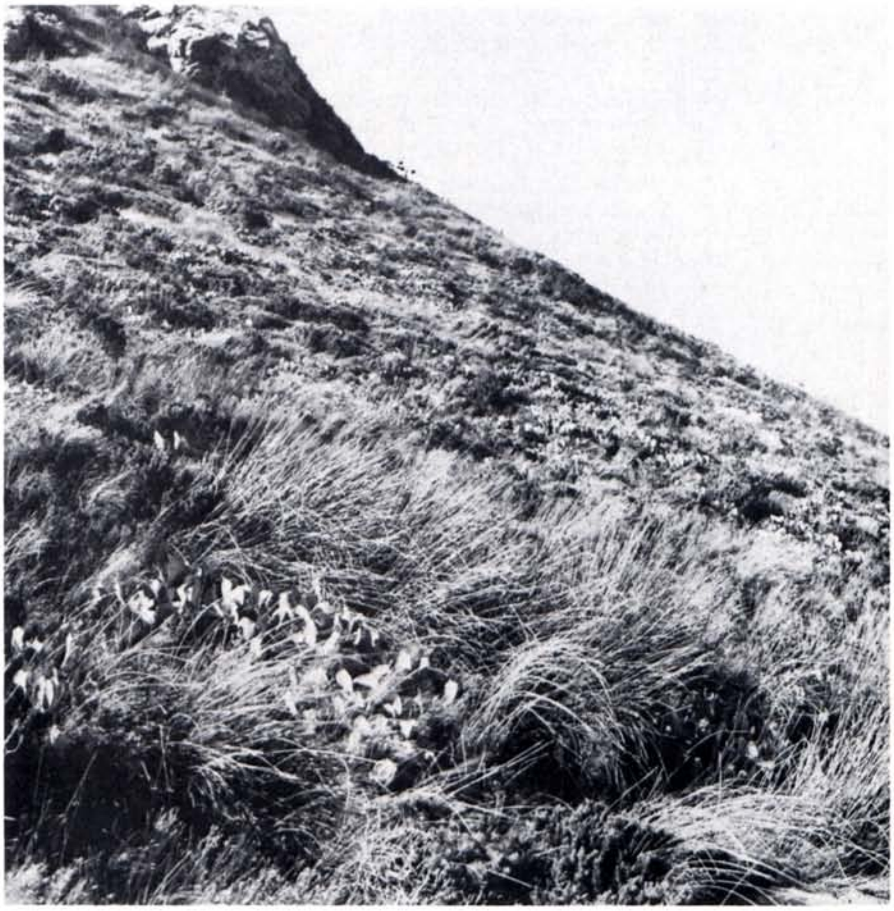

FIG. 19.—Five Beacon Ridge. *Protea oleracea* Community on a moist high altitude shale band. Co-dominants are *Cliffortia eriocephalina*, *Euryops abrotanifolius* while *Restio cascadensis* and *R. stokoei* are fairly common.

tillites, moister conditions persist and large trees of *P. arborea* can develop. These were felled during dam building operations in 1972.

Relevé 241 has not been included within the tables because it is a sample of an exceptional but extremely limited community occurring on the boundary of the area under consideration. It is located to the east of Kogelberg Peak on a shale band under very moist conditions (Fig. 19). Under these higher altitude (1 000 m) montane conditions the dominant species are *Cliffortia eriocephalina*, *Protea oleracea* and *Euryops abrotanifolius*, while *Restio cascadensis* and *R. stokoei* are fairly common. This is one of two localities where *Protea oleracea* is known to occur, the other being Victoria Peak at the head of the Jonkershoek valley. *Erica vallis-aranearum* has only been collected in this community.

3.2.2.2 Berzelia—Leucadendron *Moist Tall Fynbos*

This community is represented by Relevés 136, 128, 130, 135 in Table 6 and Relevés 212, 213, 211, 208, 154, 155 and 234 in Table 7.

This community represents the moister phase of the typical fynbos vegetation found on the plinthite soils. It grades into the drier *Protea—Tetraria* Community on the one hand, and forms the forest margin on the other hand with similarities to the wet *Berzelia—Metrosideros* Stream Fynbos. It is found on similar geological substrates to the *Protea—Tetraria* Community, but under moister conditions.

The dense tangle of vegetation (Fig. 20) often results in a highly organic soil, which can show bog-like tendencies. Where drainage is impeded, local single species dominance becomes prevalent, particularly of *Chondropetalum nitidum* and *C. mucronatum* (see Relevés 155 and 234 in Table 7). These facies are particularly poor in species. Scattered are *Leucadendron xanthoconus* and *Berzelia lanuginosa* individuals and a few low ericoids and wiry restioids in continuous stands, which resemble wheat fields. These bog conditions are more common near the contact zone between the Cedarberg Formation shale band and the Pakhuis Formation tillite.

Physiognomically certain forms of this community are similar to the *Erica—Osmitopsis* Seepage Fynbos of the coastal flats, but differ in floristic composition. The proteoid element can dominate in other forms, for example *Protea lepidocarpodendron* and *P. mundii*. The latter species is important in the forest margins and has been discussed under the *Podocarpus—Rapanea* Shale Forest. The constituent species of the shorter 2–4 m tall phase can also be found in the taller 4–10 m tall phase in the forest margins, but they are less prominent. The following species identify this community: *Berzelia lanuginosa*, *Leucadendron xanthoconus*, *Widdringtonia nodiflora*, *Restio stokoei*, *Anthospermum ciliare*, *Erica hispidula*, *Tetraria bromoides* and *Epischoenus quadrangularis*. This community is ill-defined in the Braun-Blanquet tables. Stands 9 and 10 described by Grobler (1964) are most similar to this community.

A more detailed study of this community might reveal the potential maximum extent to which the shale forests can extend with suitable management practices.

3.2.2.3 Hypolaena—Erica *Tillite Community*

Relevés representing this community are Table 6–119, 120; Table 7–199, 181, 214, 200, 173, 174, 252 and 235. It occurs wherever the Pakhuis Formation tillites are exposed as flat sheets of rock. Numerous exposures of the tillites, either on very steep slopes or in broken form, do not support the typical form of this community. In its typical form the tillites consist of continuous sheets of exposed rock with shallow hollows filled with quartz pebbles and coarse sand of the Mispah Series. The pockets fill with water in winter and dry out completely in summer. Extreme

FIG. 20.—Conical hill. *Berzelia—Leucadendron* Moist Tall fynbos. Note the figure in the centre. The shale-sandstone contact is very marked.

FIG. 21.—Upper Rooi Els. *Hypolaena — Erica* Tillite Community. Note the low cushion-like growth forms and the moss covering in the shallower soils bordering the rocks.

conditions are therefore experienced. The vegetation consists of 0,05—0,20 m-high, low, cushion-like restioids and ericoids (Fig. 21).

Geophytes are common. In cracks and hollows between the sheets of rocks the deeper soil supports taller ericoids and restioids from adjacent communities, even *Podocarpus latifolius* and *Cunonia capensis* individuals near the Wynand Louw's Kop.

The defining species are: *Hypolaena crinalis*, *Erica parvula*, *Agapanthus africanus* and *Leptocarpus hyalinus*. The geophytes are not permanently recognizable and cannot therefore be used to define this community. A few are *Disa vaginata*, *D. uncinata*, *Penthea patens* and *Urginea dregei*. Succulents are also fairly numerous and include *Erepsia inclaudens*, *Crassula fascicularis*, *C. obtusa* and *Othonna dentata*.

A portion of Stand 5 described by Grobler (1964) appears to belong to this community.

3.2.3 *Coastal mountain fynbos*

The coastal mountains referred to here are those which border on the sea, such as Elephant Rock Mountain, Voorberg, Cape Hangklip Mountain, the Klein Hangklip Range and Rooi Els Mountain.

The coastal mountain vegetation is found on the white sandstone soils. In contrast to the inland

FIG. 22.—Sunny Seas. Mixed ericoid and restioid fynbos of the xeric seaward mountain slopes. Note the two patches of *Cussonia—Olea* Scree Forest in the distance.

vegetation, this fynbos is influenced by the cool, salt-laden on-shore breezes, which blow against the 150–600 m mountain barriers. Where these mountain barriers are interrupted, the influence of the maritime breezes extends considerably further inland.

Groot Hangklip Mountain is an island of Table Mountain Sandstone surrounded by Tertiary and Recent deposits of marine sands on the coastal plain. The maritime influence on this mountain is effective on most sides.

3.2.3.1 *Mixed ericoid and restioid fynbos of the xeric slopes*

This mixed fynbos is found on the well-drained slopes of the mountains nearest the sea (Fig. 22). Fairly dry sandy Mispah Series soils are characteristic. This variable entity is a grouping of convenience that is not practical to subdivide into more homogeneous. units. Relevés of this mixed fynbos reveal a varying degree of characterization by the component species with some facies more strongly defined than others. The more poorly defined facies usually reveal a greater similarity to the inland mountain communities. Accordingly, the best defined relevés have been listed first and the more poorly defined ones last. The relevant relevés are: 6, 55, 26, 67, 70, 68, 69, 5, 27, 54, 11, 47, 59, 22, 57, 65, 4, 23, 61, 48, 64, 71, 20, 66, 62 and 60.

Ericaceae and the restioid elements are more important constituents in the western than in the south-eastern parts of this fynbos. The restioid element is particularly conspicuous during early successional stages after a fire. *Elegia parviflora* can occur as extensive golden carpets during the first few years after a fire, while white or yellow flowers of *Helichrysum sesamoides* are also conspicuous.

Scattered *Leucadendron xanthoconus*, *L. gandogeri* and *L. microcephalum* form the 1–2 m-tall shrub layer in the mature stages. At its south-eastern limits, this mixed fynbos is generally taller than in the western areas. The following species are important in the community: *Erica plukenetti*, *Anthospermum aethiopicum*, *Thesium carinatum*, *Ficinia albicans*, *Helichrysum vestitum*, *Lobelia capillifolia* and *Gnidia pinifolia*.

3.2.3.2 *Mixed ericoid and restioid fynbos of the mesic seaward slopes*

Relevés 9, 46, 50, 51, 52 and 53 represent this mixed fynbos of the seaward-facing slopes of the coastal mountains (Fig. 23). Slopes are generally steep, varying between 25° and 45° in the sampled areas. The aspect is usually southerly. The soils generally belong to the Champagne and Mispah Series, but the sandstone substrate is frequently exposed and is usually covered with lichens.

The shrub layer consists of a mixture of ericoid and restioid species. The dense stands between the sandstone rocks have interlocking crowns varying in height from 0,30–0,80 m, with scattered emergent proteoids of up to 2 m in height.

This fynbos is closely related to the inland mesic communities found on southerly aspects. This is indicated by the common species *Grubbia tomentosa*, *Drosera glabripes* and *Hermas villosa*, but it lacks *Brunia albiflora* and *Elegia spathacea* which are indicative of the inland mesic communities. There are no species which characterize this entity of convenience, although localized species such as *Erica lowryensis* are restricted to it. *Leucadendron gandogeri* and the large Cyperaceae, *Tetraria thermalis*, are often conspicuous.

3.2.4 *Inland mountain fynbos*

The major portion of the area covered by Inland Mountain Fynbos is underlain mainly by sandstones of the Table Mountain Series, which form the rugged mountains of the Cape Folded Belt. The soils are well-leached white and sandy, with local accumulations of organic materials. A low clay fraction is characteristic. The soil is poor in mineral nutrients, usually acid and well drained. When the south-easter blows during the

FIG. 23.—Betty's Bay. Mixed ericoid and restioid fynbos of the mesic seaward mountain slopes. The taller shrub is *Leucadendron gandogeri*. The nearest vlei in the distance is Malkop vlei.

summer months, the mountains are often covered in clouds that supply moisture to the vegetation at higher altitudes. The higher the mountains, the steeper are the slopes which are colonized. Taylor (pers. comm.) regards some of the southerly slopes as being amongst the most steeply vegetated he has seen in the south-western Cape.

3.2.4.1 *Northerly aspect communities*

"Northerly" aspects, as used here, group together those drier and warmer sites, which are subjected to the direct incident rays of the sun in contrast to the more or less permanently shaded "southerly" aspects. Because of the drier conditions, the more xeric communities found in these northerly aspects take a relatively long time to reach maturity after a disturbance such as fire.

3.2.4.1.1 *Mixed short ericoid and restioid fynbos of the xeric flat areas.*

This mixed fynbos occurs in its most xeric form in the lower foothills and at the base of the Dwarsrivier Mountains on the border of the Elgin Basin. The following relevés were located in this entity:

Table 6: 122, 111, 113, 116, 124, 121, 125 and 126.

Table 7: 230, 231, 248, 251 and 250.

The soil is generally more than 0,10 m deep and consists of coarse pebbly sand with good drainage, although the slope is usually only 2°–3°. The soil belongs to the Grovedale Series. The soil becomes very dry in summer. This habitat is not very extensive, although fairly common in the foothills of the mountains, where the broken terrain prevents large accumulations of sand. The cooler, less xeric conditions, accompanying an increase in altitude, is also accompanied by a gradual increase in the number of species.

Typically this mixed fynbos appears as a uniform stand of short, 0,2–0,3 m-tall restioids (Fig. 24) in which ericoids are also an important component. Dominant species are: *Chondropetalum hookerianum*, *Elegia parviflora* and *Erica cristata*. A slightly less xeric variation of this community is characterized by *Willdenowia lucaeana*, *Restio tenuissimus*, *Tetraria compar* and *Hypolaena diffusa*.

3.2.4.1.2 *Mixed ericoid and restioid fynbos of the lower drier slopes*

In the association-analysis of the data, the following relevés in Table 6 represent this mixed fynbos: 94, 95, 92, 96, 98, 97, 107, 115, 118, 123, 127, 140, 109, 110, 105, 114 and 141. The representative relevés in Table 7 are: 249, 153, 160 and 152. The above relevés mainly represent the drainage line vegetation, but Relevés 92, 96, 107, 115, 118 and 127 grouped separately in the association-analysis mainly represent the rocky areas between drainage lines. No clear-cut boundary could be distinguished between the dry, sandy flats community and the vegetation in the lower drainage lines. The drainage line vegetation intermingles with the rocky area vegetation and no clear boundary can be distinguished here either. The rocky areas show greatest similarity to the higher altitude vegetation.

The result is a highly mixed vegetation. The boundary between the flats and the lower rocky slopes can be more readily determined on aerial photographs than in the field. The boundary between the lower and upper slopes is an indistinct and gradual transition.

Owing to its very mixed nature, this fynbos (Fig. 25(on Mispah Series soils has no real dominants or distinguishing species. Even in the association-analysis this community was largely negatively defined. The more prominent species in the drainage lines are *Elegia spathacea*, *Restio bifarius*, *Scyphogyne longistyla* and *Erica cristata*, while *Erica imbricata*, *Lanaria lanata*, *Hypolaena digitata*, *Erica massoni*, *Nagelocarpus serratus*, *Phaenocoma prolifera*, *Sympieza pallescens* and *Elegia parviflora* are more widely distributed. On the dry, rocky lower slopes *Tetraria thermalis* forms a conspicuous element, but is distributed in scattered clumps, consequently it is not always recorded in the relevés. It was, however, usually recorded in the surroundings of the relevés.

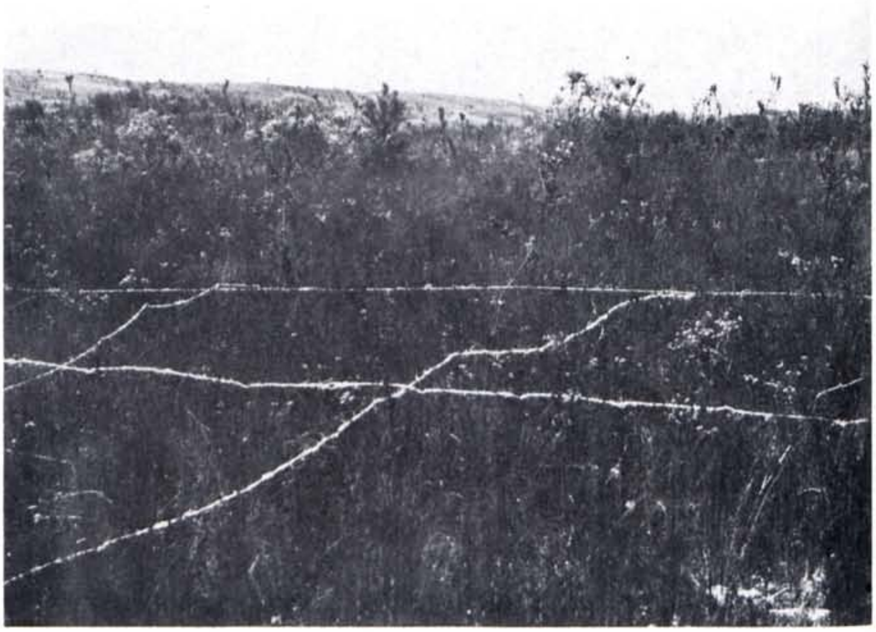

FIG. 24.—Dwarsrivier Mountain foothills. Mixed short ericoid and restioid fynbos of the xeric flat inland areas. The wiry ericoids are scarcely visible between the dense restioids. The taller vegetation in the middle distance (including the young alien pine tree) occurs on a moister zone.

FIG. 25.—Dwarsrivier Mountain foothills. Mixed ericoid and restioid fynbos of the lower drier rocky slopes. The large Cyperaceae in the right foreground is *Tetraria thermalis*. The rolling hills infested with alien pines, in the distance, are characteristic of the uncultivated Bokkeveld shales of the Elgin Basin.

3.2.4.1.3 *Mixed short ericoid and restioid fynbos of the xeric upper rocky slopes*

The following relevés were located in this mixed fynbos:

Table 6: 93, 138, 78, 79, 85, 80, 81.

Table 7: 237, 197, 228, 161, 198, 226, 229, 151, 159, 225 and 227.

This fynbos is commonly found on the upper northerly slopes (Fig. 26). It may be found at lower altitudes, but under moister conditions than prevail, in typical mixed fynbos on the lower, drier slopes. In such instances it usually exhibits a more varied composition. A slope of 10°–30° generally occurs. The soil is a rudimentary, coarse, shallow sand of the Mispah Series, which is prone to drying out, but not for the extended periods found at the lower altitudes, because of moisture from south-east clouds. It is therefore found under less xeric conditions than the lower slope and flats xeric mixed fynbos.

There is typically a single stratum varying in height between 0,45–0,75 m composed essentially of a mixture of ericoids and restioids. The restioid element often dominates in the form of *Restio purpurascens* or *R. egregius* up to 1 m tall. Other occasional taller species are 2–3 m-tall, ericoid individuals of *Brunia stokoei*, endemic to the area and 1 m-tall *Leucadendron microcephalum*.

FIG. 26.—Dwarsrivier Mountain. Mixed short ericoid and restioid fynbos of the xeric upper rocky slopes. Note the clumps of *Chondropetalum mucronatum* in the middle distance and the inevitable pine tree.

FIG. 27.—Dwarsrivier Mountain. Mixed ericoid and restioid fynbos of the upper mesic slopes. This is the rocky outcrop phase with the 2 m-tall *Brunia albiflora*.

The typical dry hillveld species *Lanaria lanata*, *Erica imbricata* and *Elegia parviflora* occur, but overlap with the moister hillveld species *Protea cynaroides*, *Erica massoni*, *Elegia juncea*, *Corymbium glabrum* and *Elegia persistens* (see Table 7). The rare and attractive *Sonderothamnus petraeus* can sometimes be found in rock crevices.

3.2.4.1.4 *Mixed ericoid and restioid fynbos of the upper mesic slopes.*

The following relevés in Table 6 have been included within this mixed fynbos based mainly on their grouping in the association-analysis hierarchy (Boucher, 1977a): 142, 143, 82, 12, 63, 139, 73 and 76.

A similar situation to that found in the lower northerly slopes exists where two forms of this mixed fynbos can be distinguished, but not entirely separated, namely a drainage line community and a rock outcrop community. The soil near the summits where this community is found consists generally of a coarse sand and belongs to the Mispah Series. The higher altitude and accompanying greater availability of moisture result in a shrub layer often dominated by 2–3 m-tall *Brunia albiflora* (Fig. 27). This species is not restricted to drainage lines (Fig. 28), which often show transitions to *Restio — Chondropetalum* Tussock Marsh. The lower shrub and herbaceous layers merge at between 0,45–1 m. Taller restioids, such as *Roesti*

FIG. 28.—Paardeberg Mountain. Mixed ericoid and restioid fynbos of the upper mesic slopes. This is the drainage line phase with the rocky outcrop phase in the left distance. The common shrub is *Nebelia fragarioides*.

occultus, *R. egregius* and *Elegia spathacea*, and the ericoids *Erica imbricata*, *E. massoni* and *E. fastigiata*, are common. The exposed plants on summit ridges show alpine features in a low cushion growth form.

There are more species typical of moister conditions, but none could be found to characterize this mixed community. An interesting monotypic genus, *Retzia capensis*, and *Raspalia microphylla*, a member of the Bruniaceae, can sometimes be found. *Chondropetalum hookeranum* is common at the lower altitudes, whereas *C. deustum* becomes the commoner species at the higher altitudes although *C. hookerianum* is still present. *C. hookerianum* indicates hillveld conditions.

The summit flora was found to be amongst the better collected because of the easier access provided along the summit ridges. This community can be compared to Grobler's (1964) rocky summit ridge community in his Stand 1.

3.2.4.2 *Southerly aspect vegetation*

This vegetation shows complex gradients between wet to dry conditions and low to high altitudes in addition to aspect variations. The typical forms of the communities are described here. Definite boundaries cannot always be determined, particularly where the dip of the geological strata is parallel to the slope.

Species indicative of the southerly slopes are *Restio dispar*, *Gnidia viridis*, *Villarsia ovata* and, to a lesser degree, *Alciope lanata*, *Drosera glabripes*, *Erica intonsa*, *Grubbia tomentosa*, *Osmitopsis parvifolia* and *Anthospermum bergianum*.

3.2.4.2.1 *Mixed lower slope fynbos*

The following relevés represent this mixed fynbos, which is a grouping of convenience:

Table 6: 131, 132, 74, 133, 90, 108, 77, 86, 87, 88, 106, 103, 134 and 149.

Table 7: 169, 171, 185, 182, 163, 195, 190, 162, 158, 184, 178, 166, 183, 193, 194, 192, 196, 164, 156, 157, 172, 186, 170, 191, 188 and 189.

This fynbos occurs predominantly on the lower moist slopes and on the drier portions of the upper slopes. The latter areas have a greater complement of higher altitude species. The boundary is very gradual between this community and the upper hygric fynbos. The boundary with the shale vegetation is possibly more abrupt but even here a transitional community has been recognized. The species complement shows certain similarities to the higher altitude northerly communities and to the coastal mountain fynbos communities. Steep slopes are generally associated with this community, a slope of less than 26° being the exception rather than the rule. The maximum recorded slope in the relevant relevés was 45°. The soil was found to be rudimentary consisting of coarse shallow sand with local accumulations of organic matter belonging to the Mispah and Grovedale Series.

Brunia albiflora is the most common emergent shrub varying in height between 2–4 m with the individuals usually scattered but sometimes forming fairly dense stands. *Leucadendron xanthoconus* is the common shrub at the lower altitudes in the mature communities and is replaced by *L. gandogeri* at higher altitudes. Hybrids between these two species occur. The Ericaceae and Restionaceae similarly show this replacement with an increase in altitude but no sudden line of demarcation occurs. The lower shrub layer varies between 0,6–1 m in height and consists of a mixture primarily of ericoids and restioids of which the following can be mentioned: *Erica hispidula*, *E. corydalis*, *Chondropetalum hookerianum* and *C. deustum*. The higher altitude drier slopes also have *Erica quadrangularis*, *Indigofera tetragonaloba* and *Retzia capensis*, occurring. Fig. 29 illustrates this community.

Stands 2 and 3 recognized by Grobler (1964) are similar to this community.

3.2.4.2.2 Chondropetalum—Berzelia *Upper Hygric Fynbos*

The following relevés were located in this community:

Table 6: 129, 145, 147, 148, 112, 75, 137, 146, 84, 144 and 150.

Table 7: 205, 204, 168, 176, 167, 245, 246, 177, 239 and 179.

This community occurs on the wetter steeper southerly slopes, generally at higher altitudes. Permanent moist conditions are a feature of the habitat. Moisture can be from seepage zones, rainfall particularly in winter or from the summer south-east clouds. Drainage is good. Where the drainage is impeded, the *Chondropetalum—Restio* Marsh Community may be found. This can result in a mosaic

FIG. 29.—Dwarsrivier Mountains Mixed lower southerly slope fynbos. The single stemmed mop-like shrub is *Brunia alopecuroides.*

FIG. 30.—Kogelberg Peak. *Chondropetalum-Berzelia* Upper Hygric Fynbos. The dominant shrub in the foreground is *Leucadendron gandogeri*. The erosion scars in the Klipheuwel shales of Kogel Bay are clearly visible on the right. The peak in the centre foreground is known as Koedoeberg.

between these two communities. The moist habitat is probably one of the major factors contributing towards this community vegetating particularly steep slopes. A deep organic soil of the Mposa Series can develop.

This community forms a dense stand of 1,5–3 m tall vegetation (Fig. 30). This is particularly difficult to penetrate when progressing up steep slopes without any pathways. The tall shrub layer is generally open and 2–3 m tall. The commoner emergent shrubs are *Priestleya calycina*, *Berzelia dregeana*, *Osmitopsis asteriscoides*, *Protea stokoei* and *Psoralea pinnata*. *Orothamnus zeyheri* and *Mimetes argenteus* occur in more specialized habitats within this community. The large number of these species requiring specialized habitat conditions are perhaps one of the more interesting features of this community. A few of the endemics in the area, which occur in this community are: *Erica leucotrachela*, *E. serratifolia*, *Berzelia dregeana* and *Mimetes hottentoticus*. Another feature of this community is its apparent uniformity in the mature state. A few species such as *Erica hispidula*, *E. coccinea*, *Chondropetalum deustum* and *Leucadendron gandogeri*, which have a fairly wide distribution, become dominant in the shorter shrub layer presenting a fairly uniform stand over large areas. It varies in height from about 0,8–1,5 m. A herbaceous layer is not easily distinguished if present because of the dense continuous nature of the shorter shrub layer.

Relevés 84, 144 and 150 have been included in this community on the basis of some of the character species from this community being present. They are not typical examples because they lack the other species usually associated with the southerly slopes. These relevés occur on local southerly aspects on otherwise northerly slopes. Relevé 112 is a local patch of upper hygric fynbos on an otherwise drier slope. It is mapped together with the mixed lower slope fynbos.

Species typical of this community are: *Chondropetalum ebracteatum*, *Berzelia dregeana*, *Cullunia setosa*, *Erica sitiens*, *Priestleya calycina* and *Erica desmantha*.

Stand 12 recognized by Grobler (1964) would be included within this community.

3.2.4.3 Chondropetalum—Restio *Tussock Marsh*

The following relevés were located in this community:

Table 6: 56, 83 and 117.

Table 7: 247, 215, 236, 180, 165, 187, 210, 240, and 224.

This community occurs on all mountain slopes irrespective of aspect or altitude where wet seepage marshes occur. Soils of the Mposa Series consisting of a wet peaty coarse sand, occur.

The scattered clumps of *Chondropetalum mucronatum* are distinct (Fig. 31) and the larger clumps are easily distinguished on aerial photographs. Local dominance by *Restio bifidus*, *R. ambiguus* and *R. obtusissimus* either by themselves or in various combinations with *Chondropetalum mucronatum* occurs. The first two restios usually form mats of about 0,50 m tall, while *Chondropetalum mucronatum* is between 1,5–2 m tall. *Osmitopsis asteriscoides* often occurs in this community and can reach 2 m or more in height; it occurs wherever there is a fairly high water table. One species only was found to be restricted exclusively to this tussock marsh community, namely *Erica intervallaris*, but it does not occur throughout the community. This community has a relatively small species composition as is demonstrated in Table 7.

Stands 14 and 15 recognized by Grobler (1964) show some similarity to this community, although Cyperaceae appear to be more important than the Restionaceae. This can probably be attributed to local dominance.

3.2.5 *Alien communities*

The mountainous areas are similar to the coastal plain in that *Acacia cyclops*, *A. saligna* and *Pinus pinaster* can also form large stands, although the two *Acacia* species do not develop into the extensive stands found in the coastal sands, but rather as scattered individuals.

Periodic campaigns are launched by the Department of Forestry to clear the isolated individuals of *Pinus pinaster*, where less dense infestations occur. The denser infestations are being systematically cleared. The densest infestations occur along the mountains bordering on the Elgin Basin nearest to the established plantations in the Steenbras Dam catchment area.

The fynbos vegetation cannot compete with the dense stands of *Pinus pinaster* and few species survive in the older plantations. The fynbos shows remarkable regenerative ability once these alien species have been removed. This aspect requires further investigation. The dense litter accumulating under the pine trees in combination with the shade from the trees suppresses the fynbos vegetation. Fire provides bare areas for the seedlings and stimulates germination by opening the serotinous cones. This is an important factor governing the spread of this pest-plant.

A dense stand of *Acacia mearnsii* surrounds the derelict Oudebosch farmhouse below Paardeberg (Fig. 6) and another is being cleared around the new farmhouse. At Fairy Glen this species provides shade at this popular camping site. This species extends its distribution considerably after fire, but is usually found only in areas of human activity here.

Hakea sericea occurs in fair quantities at only one locality near the source of the Buffels River below Buffelstalberg Mountain. The rest of the area supports only isolated scattered individuals, where these have been overlooked by the responsible authorities. The serotinous fruits of this problem species makes it a potential hazard in any fynbos vegetation. Members of the Mountain Club of South Africa, in association with some of Betty's Bay residents, keep a close watch

FIG. 31.—Dwarsrivier Mountain foothills. *Chondropetalum* — *Restio* Tussock Marsh. Note the sharp boundary and the density of the stand. *Mimetes cuculatus* can be seen in front of the stand.

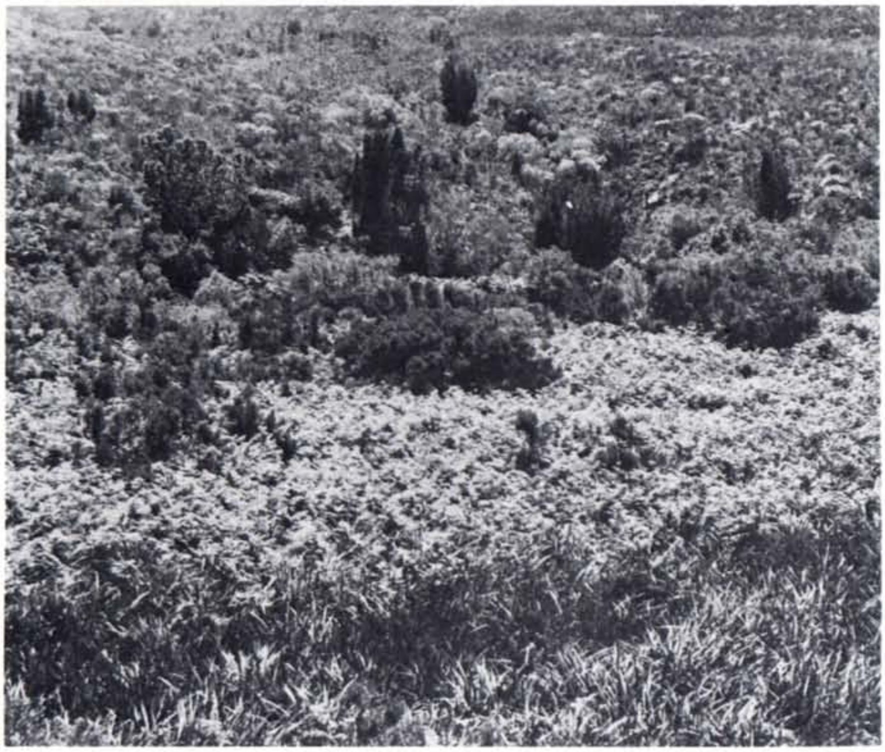

FIG. 32.—Louw's River. *Prionium—Wachendorfia* Swamp Vegetation. The darker band of vegetation in the foreground mainly consists of *Prionium serratum*, while *Todea barbara* and *Blechnum capense* become dominant in the central area. The darker erct trees are *Widdringtonia nodiflora* individuals.

on the appearance of these pest plants on private property.

3.3 *Riparian vegetation*

Distinct communities occur in or alongside drainage channels having temporary or permanent surface water movement.

Two principal riparian habitats occur namely:

(1) The rocky stream beds and banks, which have very little alluvium and strongly rooted plants occur wedged into cracks and crevices between the stones and boulders and on rock faces.

(2) The sand, loam and mud forming the alluvium in river systems, where deeper rooted plants occur.

The principal river systems having a permanent water flow are the following:

(1) The Palmiet River with its principal tributaries, the Klein Palmiet, the Dwars and the Louws Rivers.
(2) The Cascades stream.
(3) The Buffels River.
(4) The Rooi Els River.

3.3.1 Prionium—Wachendorfia *Swamp Community*

The slower flowing permanent streams in the area are often overgrown by dense stands of *Prionium serratum*, *Blechnum capense*, *Todea barbara* and *Wachendorfia thyrsiflora*. Occasional trees of *Psoralea pinnata, Cunonia capensis, Widdringtonia nodiflora* and *Brachylaena neriifolia* occur scattered among this dense growth usually on sand banks (Fig. 32). The appearance is rather park-like from a distance, but is very dense on closer inspection.

This community colonizes the shallower portions of these streams. The depth of the intervening open water is emphasized by the dark brown colour of the water. Occasional *Aponogeton distachyos* individuals occur in the pools in the Palmiet River, but the strong flow of water, particularly during the winter, probably prevents this species from becoming more common.

Water-flow through the dense growth of this community is slow and silt deposition eventually results in this community being found on dry land. This condition may be seen along the Cascades stream in the Harold Porter Botanic Garden. Sporadic floods either open new channels or remove this vegetation. The stems of *Prionium serratum* can reach 2–3 m, of which a large proportion is usually submerged.

Prionium—Wachendorfia Swamp is best developed in the Louws and Buffels Rivers. Sampling of this community is difficult if not dangerous, because of the deep holes which are hidden by this community.

The major river in the area, the Palmiet River, has been attributed the common name for *Prionium serratum*, because it is such a feature of the river.

3.3.2 Berzelia—Metrosideros *Tall Fynbos of the Rocky Streams*

This community is represented by Relevés 220, 221 and 222 in Table 7. It occurs along the rocky streams, where very little alluvium has accumulated (skeletal Mispah soils). The plants are strongly rooted between the rocks. Sampling of this community using a 5 m × 10 m relevé is not very successful, because the community exists as a narrow band in or alongside the streams.

The rocky streams are particularly numerous because of the nature of the terrain and have not been mapped because of their small size. Some have a permanent flow, while others are dry in summer.

The following are the commoner species found in this community: *Berzelia lanuginosa*, *Metrosideros angustifolia*, *Brunia albiflora*, *Leucadendron salicifolium*, *L. xanthoconus*, *Pseudobaeckea africana*, *Restio dispar* and *R. purpurascens*.

These species combine to form a taller shrub layer, which is often closed, of about 2 m in height and has a dense lower shrub and herbaceous layer of about 0,60 m. The proteoid and ericoid elements dominate the taller shrub layer, while the ericoids and restioids are more important in the lower layer.

The rocks in the streams themselves are often covered by *Scirpus digitatus*. This strongly-rooted sedge often forms a thick mat over the boulders with its long leaves trailing in the water. This species provides a suitable habitat for other species such as *Disa tripetaloides* and *D. uniflora*. The latter species

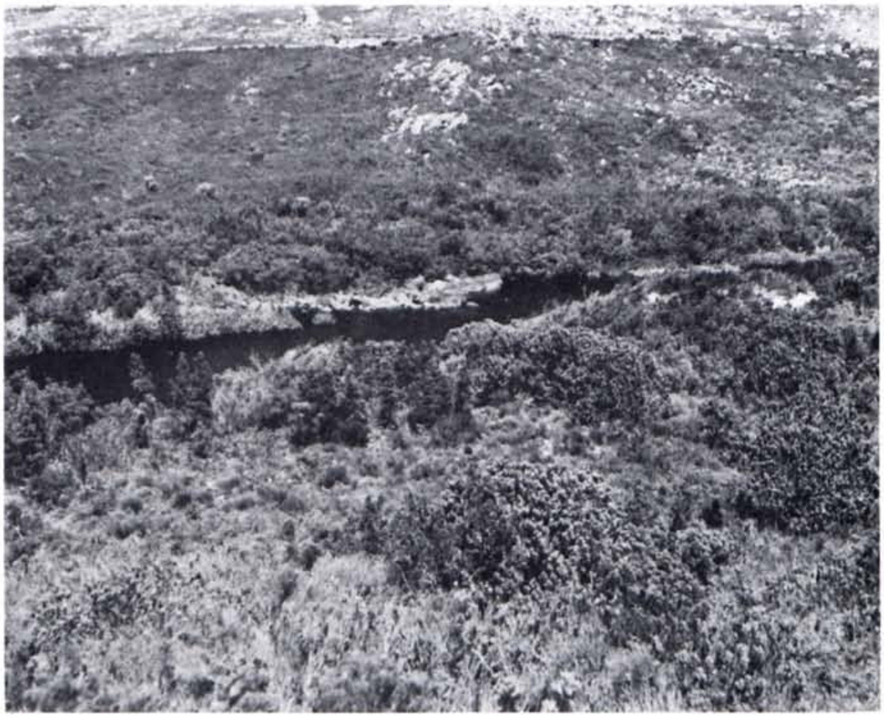

FIG. 33.—Palmiet River. *Brabejum—Rhus* Riverine Scrub. The tall lighter coloured shrubs on the right are *Leucospermum conocarpodendron* individuals.

occurs particularly under the moist overhangs. Eventually, the *Berzelia—Metrosideros* Community can become established on these rocks if the current allows.

Grobler (1964) has described a Stand 8, which could be included in this community.

3.3.3 Brabejum—Rhus *Riverine Scrub*

Relevés 13, 89, 91, 100 and 101 are samples of this community, which occurs where sand and mud are deposited as alluvium on river banks usually forming Sandveld Series soils. The rivers in this area only carry a heavy silt load during times of flood. The vegetation in the mountainous areas prevents much erosion except during spate conditions. The Palmiet River is dammed above the area in question and only flows strongly enough to carry silt during heavy winter rains. The Palmiet River drains the cultivated lands of the Elgin Basin and therefore carries a heavier silt load than the other rivers.

The undisturbed form of this community is a 3–4m-tall, dense scrub in which a number of tree species may be found (Fig. 33). Examples are: *Cunonia capensis*, *Laurophyllus capensis*, *Podocarpus elongatus* and *Rapanea melanophloeos*. This community can be subdivided into various zones as follows:

(1) The upper zone which fringes the water only during floods and contains many fynbos elements from adjacent communities. In many respects this can be compared to the forest margin community. The following species are common: *Asparagus thunbergianus*, *Arctotis semipapposa*, *Montinia caryophyllacea*, *Erica discolor*, *Halleria elliptica* and *Leucospermum conocarpodendron*. The latter species appears to have been replaced by *Protea arborea* in the upper Buffels River valley. Some exceptionally large individuals with trunks of about 0,60 m and up to 7,5 m in height occurred here, but were damaged during dam building operations.

(2) The middle zone is fringed by water during periods of normal high water flow and can become submerged during periods of floods. The tree species mentioned above occur here together with taller shrubs of *Brabejum stellatifolium*, *Halleria elliptica* and *Rhus tomentosa* amongst others.

(3) The lower zone, which fringes the water during summer flow and becomes submerged during wetter periods, consists mainly of *Cannamois virgata*, *Phragmites australis* and *Restio subverticillatus*. *Phragmites australis* can be permanently submerged. *Sporobolus virginicus* sometimes forms thick mats up to the water's edge in the vicinity of river mouths.

Each of the above zones does not always develop in each locality and can occur in various combinations.

Fires (Fig. 34) occasionally spread into the riparian scrub, particularly where piles of brushwood have accumulated during times of flood. As in the case of the shale forest community, total absence of fire would probably result in some of the tree species becoming more common.

Stand 7 recognized by Grobler (1964) could be included in this community.

In the association-analysis grouping of relevés (Boucher, 1977a), the highest indicator values were attributed to *Brabejum stellatifolium* and *Rhus tomentosa*. This indicates their high degree of specificity to this community compared to the other communities evaluated.

The lower Palmiet River riparian communities are probably the only remaining relatively undisturbed mature communities of their type left in the south-western Cape.

3.3.4 *Alien vegetation*

A few individuals of *Populus canescens*, of which male trees only are known in South Africa (Adamson & Salter, 1950), are found along the lower course of the Buffels River. This species spreads freely from suckers and could, therefore, be regarded as a potential danger to the indigenous vegetation.

Acacia longifolia, *A. saligna* and *A. cyclops* grow on some of the river banks, particularly along the Palmiet River. The upper reaches of the Palmiet River are particularly badly infested outside of the area in question. In the Kogelberg State Forest, officials periodically clear the alien vegetation from the river banks. This is not usually the case with privately owned property.

FIG. 34. — Platberg Mountain foothills. A wild-fire front, burning against the wind, testifies to the inflammability of the fynbos vegetation. Fires can occur naturally during all seasons of the year. This fire destroyed 22 houses at Betty's Bay during 1970.

4. DISCUSSION

The mountains in this study area form part of a chain, which subdivides the south-western Cape into two climatic zones. The area to the east of this chain receives more rain in summer, although it still falls within the winter rainfall zone. The area to the north receives much less rain in summer. The Hangklip area, therefore, falls within the transitional area between these two zones. Transitional areas can be expected to have a greater diversity of species, because they contain mixed floras, in contrast to the typical areas. The great diversity of habitats in the Hangklip area, from coastal to montane, together with different geological formations in a complexly folded mountain chain, results in a great variety of ecological niches. The total of the above, results in a complex flora as is indicated by 1407 different species being collected during the four year course of this study.

The data were not, in all cases, ideal for comparison using the Braun-Blanquet table method, yet a certain degree of success was achieved. The communities described here were based on the groupings obtained using this method. The study of vegetation communities in the south-western Cape is still in its infancy, particularly with regard to the Braun-Blanquet approach. This lack of knowledge precludes attaching nomenclatural status to the communities recognized. It was felt during the synthesis stage, that too few samples were available from certain communities (250 relevés in all were taken) and even perhaps for the whole area (24 000 ha). In mitigation, it should be mentioned that this was intended to be a semi-detailed or relatively broad scale study. Secondly, that the handling of such a large amount of data, particularly during the first stage when no sophisticated tabular sorting facilities were available, was unwieldy and difficult. Thirdly, it was fortunate that the vegetation, in the mountainous areas particularly, was in a mature to moribund state, because it had been protected for 26 years and more, and had been subjected to little unnatural disturbance by man. Fourthly, the inaccessibility of the terrain was a limiting factor, in the time available: certain areas were completely inaccessible for sampling purposes. Finally, once communities had been defined, their extent was determined by extrapolation to the surrounding areas by subjective comparison to the classification already constructed, in addition to the interpretation of the aerial photographs. Boundaries to communities for mapping purposes were determined on the aerial photographs. Where communities could not be distinguished on the aerial photographs, or they were too small to be mapped at the scale used, they were grouped together into wider mapping unit categories. Larger scale colour aerial photographs would have been preferable to the 1: 36 000 scale black and white photographs used, to increase the accuracy and detail of the vegetation map.

The coastal areas were found to contain completely different communities from the inland areas. Of the coastal communities, *Colpoon—Rhus* Dune Scrub and *Sideroxylon inerme* Dune Scrub are not typical fynbos communities: broad-leaved evergreen sclerophyllous plants dominate and the typical restioid and ericoid elements of fynbos are absent in the best developed forms of these communities. These two communities contain most of the species listed by Acocks under his coastal macchia or Veld Type 47 (Acocks, 1953). The following five species, out of the 24 listed by him for the southern and western coast belts, were not found: *Euclea undulata*, *E. tomentosa*, *Rhus glauca*, *Maytenus heterophylla* and *Zygophyllum morgsana*. There is, therefore, a reasonably close resemblance to the scrub forests of the coastal macchia and the transitional nature of the vegetation of the Hangklip area is emphasized. It is questionable whether these communities should, in fact, be regarded as fynbos at all. They lack or are poorly represented in most of the typical fynbos families as listed by Taylor (1972). The rest of the coastal communities described contain typical ericoid and restioid elements and contain the typical families. They qualify, therefore, as fynbos, but the question arises as to whether this is the coastal macchia, as referred to by Acocks (1953), or not. He does not provide any detailed description of his coastal macchia. On the basis of the geographical location of these coastal fynbos communities described here, they must be presumed to belong to this veld type. A modification to Acocks's veld type map (Acocks, 1953) would therefore be required, as he only shows Veld Type 69 or macchia in the area, but perhaps his scale of mapping (1 : 500 000) precludes such detail.

The inland communities may be subdivided into two entities for the purposes of discussion, namely, the forests and the fynbos. The forest communities develop as the climax after fynbos in areas normally left in an undisturbed state for long periods (even for centuries), where the habitat is suitable. These two completely different floras occur in juxtaposition to each other. The *Cussonia—Olea* Scree Forests and *Cunonia—Alsophila* Kloof Forests often mingle with fynbos by virtue of the rocky habitats in which they occur. The *Podocarpus—Rapanea* Shale Forests have very distinct boundaries with the fynbos, because they occur on uniform shale bands with deeper soils. The more important limiting factors for the existence of the latter forest community appears to be sufficient depth and type of soil associated with shale bands, an adequate moisture regime and the absence of fire. The forest margin is formed by a fire climax fynbos community. In the margin of the Wynand Louws Forest young plants of the forest species are starting to appear in the moribund fynbos, after 26 years of complete protection from fire. The larger fynbos components are dying and falling over. This indicates that the forest is probably in the process of expanding. A fire in the forest margin, at this stage, would probably kill the juvenile forest species and rejuvenate the fynbos elements. Particularly intense or regular fires would probably reduce the extent of these forest patches.

The riverine vegetation on deep alluvium, such as occurs along the Palmiet River, supports a mixed vegetation of fynbos and forest elements. This community has been protected for a number of years and trees of *Podocarpus latifolius* and *Cunonia capensis*, for instance, are fairly common. It is a rare occurrence to find undisturbed riverine vegetation such as this which is, in addition, also free of major alien infestations in the south-western Cape. Every effort should be made to conserve this community.

The mountain fynbos communities contain two fairly distinct forms. The fynbos on plinthic soils are rich in Gramineae and Cyperaceae. These elements give the communities a grassy appearance and the communities were probably major grazing areas for the herbivores which were recorded in the area in earlier times (Paterson, 1789). The rest of the mountain fynbos communities show complex variations dependent on a multitude of environmental factors such as altitude, aspect, slope, moisture conditions, proximity to the sea, and others. In a number of instances these communities are of greater complexity than is indicated in the above classification and will require more detailed research to define them more adequately.

The greatest threat to the vegetation from alien species probably lies in the areas of greatest disturbance, namely the coastal plain. Township development and the accompanying extensions to the road network and increased disturbances associated with increased human activity (this would probably also mean an increase in wild fires) are factors which will result in the existence of the coastal communities and species becoming endangered. Timely consideration will have to be given to these delicate ecosystems, if they are to be conserved.

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UITTREKSEL

Verskeie habitatsfaktore wat die fynbosplantegroei van die Kaap-Hangklipgebied beinvloed, soos topografie, geologie, pedologie en klimaat asook geskiedkundige gebeurtenisse, word uiteengesit. Data versamel by 250 *monsterpersele is gerangskik deur middel van die Braun-Blanquet tabelmetode. Die plantegroei is onderverdeel in drie hoofgroepe naamlik: die kusstrookplantegroei, die bergplantegroei en die rivieroewerplantegroei. 'n Totaal van* 29 *gemeenskappe is afgebaken, beskryf en in verband gebring met habitatsfaktore. Aggressiewe ingevoerde spesies wat in die gebied genaturaliseer is, word ook bespreek. 'n Verspreidingskaart van die plantgemeenskappe word ingesluit.*

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