STUDIES IN THE PLANT ECOLOGY OF FERN KLOOF NEAR GRAHAMSTOWN.

A thesis submitted for the degree of Master of Science of the University of South Africa

by

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Further acknowledgements are made in the text.

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Pencil, ink marks and highlighting ruin books for other readers.

STUDIES IN THE PLANT ECOLOGY OF FERN KLOOF NEAR GRAHAMSTOWN.

INTRODUCTION.

The area studied at Fern Kloof, near Grahamstown, consists of a strip of vegetation approximately 260 yds. long and 50 yds. wide, in which there are two communities:

(1) Indigenous forest,

(2) Exotic Pine forest,

(which has only one tree species *Pinus pinaster*.) Throughout the thesis this community is referred to as the pine.

The object of the investigation has been to determine whether these communities are natural or not. This has involved a study of the floristic composition, the life forms and the structure of the plant communities. In addition various soil and environmental factors have been studied.

PART I.

TOPOGRAPHY.

Three miles south of Grahamstown lies the Mountain Drive. It is a range structurally continuous with the Suurberg which extends westwards for 30 miles to Alicedale. The Mountain Drive makes its appearance at Waai Nek (the head of Harrison's Poort) in the west, and rises to 2535 feet at Dassie Krantz. It continues with slight variations in height to Signal Hill, 2421 feet, a distance of 4 miles to the east of Waai Nek. It forms the watershed from which the Kowie River rises. Fern Kloof is about a quarter of a mile west of Signal Hill and has an altitude of 2360 feet. (See Fig. 1)

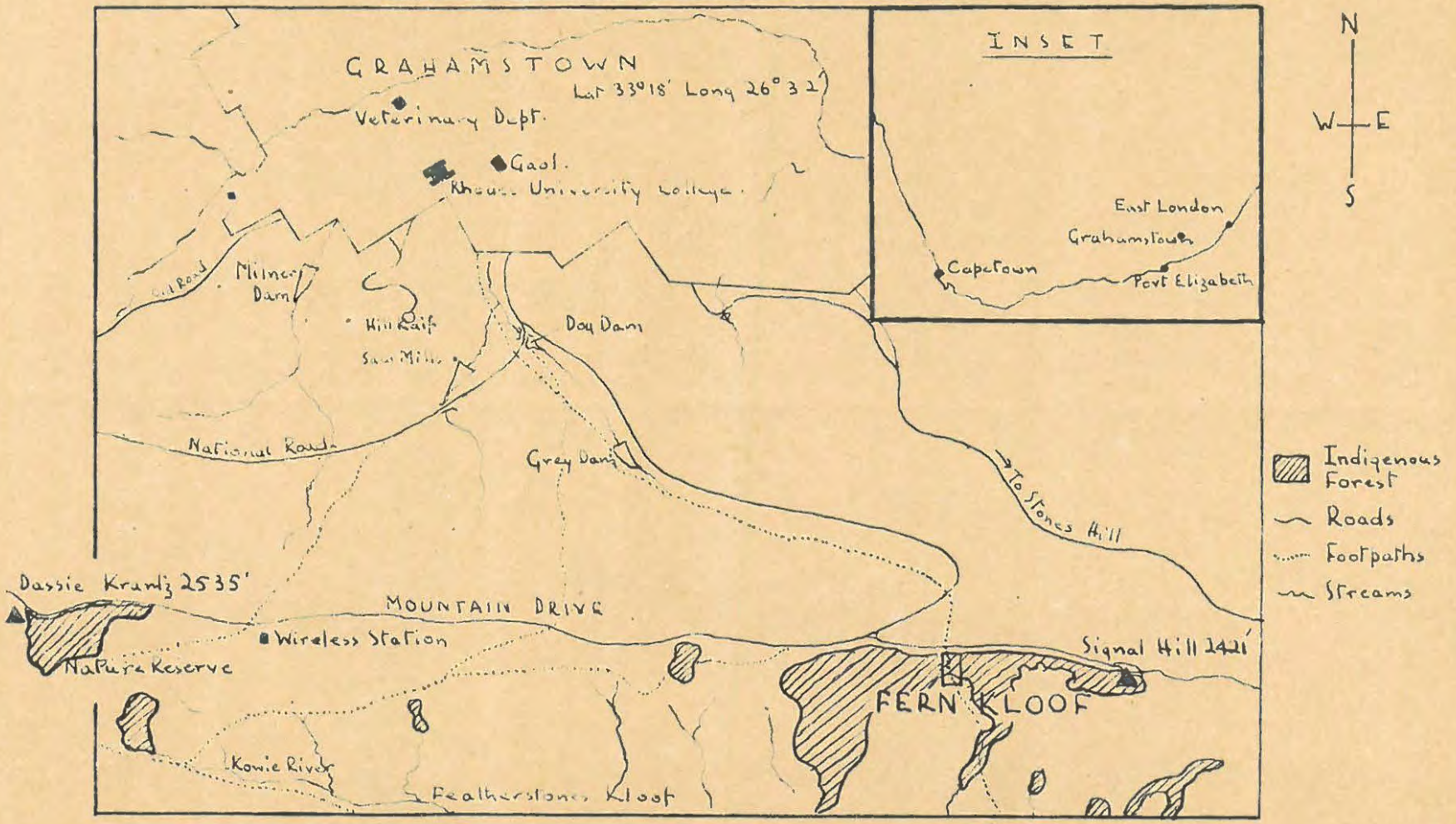
The southern slopes of the Mountain Drive are slightly undulating, forming a series of shallow kloofs. As one would expect there are small patches of forest in the kloofs (Clements 1934). The remainder of the relatively steep slope is occupied by elements of the South-Western Cape Flora which are rapidly being obliterated by the spread of Pinus pinaster. Fern Kloof is the largest of the Kloofs and here contrary to the others, the indigenous forest extends over the intervening ridge into the next fold thus covering a fairly extensive area. (See Fig. 1).

The area of investigation is situated where the forest and the pine occur on the same slope (15-20°), have the same S.S.W. aspect and have similar climatic conditions.

I

MAP SHOWING POSITION OF FERN KLOOF

Drawn from an Aerial Photograph.



GEOLOGY.

For a full description of the Geology see L.D. Mountain. (1946). Suffice it to say that the Mountain Drive is composed entirely of the Witteberg Series consisting of pale grey quartzitic sandstone interbedded in places with horizons of micaceous flagstones and shales up to 20 feet in thickness. The Series is part of the Cape System and since the end of the Triassic, when most of the Cape Foldings had taken place, there has been little disturbance of the beds. The strike is east-west and the dip 45° towards the north. As the Witteberg Series is very resistant, it forms the back-bone of all the elevated parts near Grahamstown. Due to metasomatism a highly massive non-porous rock has been formed which affords excellent drainage of the slopes.

At Fern Kloof the parent rock is nowhere far from the surface and frequently breaks through onto the surface as irregular outcrops of greyish stone partially covered with lichens and mosses. In places stones have moved down the slope accumulating at any decrease in the gradient to a depth of about 2 feet - See Quadrat Q6.

Soils formed from the Witteberg Series are poor.

CLIMATE.

RAINFALL.

There are no records for the Mountain Drive. The nearest figures are from Grahamstown and are used to give some indication of this indirect but important factor in determining the vegetation of the district. Since 1878 rainfall records have been kept at the Grahamstown gaol. Later records are from Gowies in 1891 and the Veterinary Office 1915. Rhodes University College has data from 1943 onwards and the Aerodrome has a few records. The Union of South African Meteorological Blue-Books from 1933 to 1943 contain all the data for those years. The records from 1943 up to September 1949 have been obtained from the individual departments concerned.

Tables I - III have been drawn up to show various features of the rainfall. Table I gives the average rainfall for 10 year periods from 1884 to October 1949. There appears to have been a steady decrease in the amount of rain since 1884, but not too much significance can be attributed to this because strict meteorological methods may not have been adhered to so far back.

TABLE I.

AVERAGE RAINFALL FOR 10 YEAR PERIODS.

1884	-	1893	-	33.6"
1894	-	1903	-	25.6"
1904	-	1913	-	29.6"
1914	-	1923	-	25.7"

TABLE I (cont.)

1924	- 1933	-	25.8"
1934	- 1943	-	28.6"
1944	- 1948	-	23.8"
1949 up to October		-	7.94"

In Table II is given the data illustrating the discrepancy in the yearly precipitation amounts when these are listed according to

(a) the calendar year - January to December; this system is used in the official Meteorological Reports.

(b) the Agricultural year - October to September, which is more illuminating since it covers the period from the beginning of one rainy season to the beginning of the next. The year 1949 had 13.68", the lowest rainfall total for many years.

TABLE II.

DISCREPANCY BETWEEN AMOUNTS FOR

CALENDAR YEAR AND AGRICULTURAL YEAR

FROM GAOL RECORDS.

Calendar Year. Jan. to Dec.

1944	1945	1946	1947	1948
29.00	19.63	19.25	26.12	24.80

Agricultural Year. Oct. to Sept.

1944-45	1945-46	1946-47	1947-48	1948-49
22.19	17.17	24.87	27.49	13.68

Table III compares the annual precipitation for 1941 of four stations within 60 miles of Grahamstown and which have approximately the same latitude.

RAINFALL RECORDS FOR YEARS 1933 — 1948 FROM VETERINARY DEPT. AND GAOL — GRAHAMSTOWN.

2

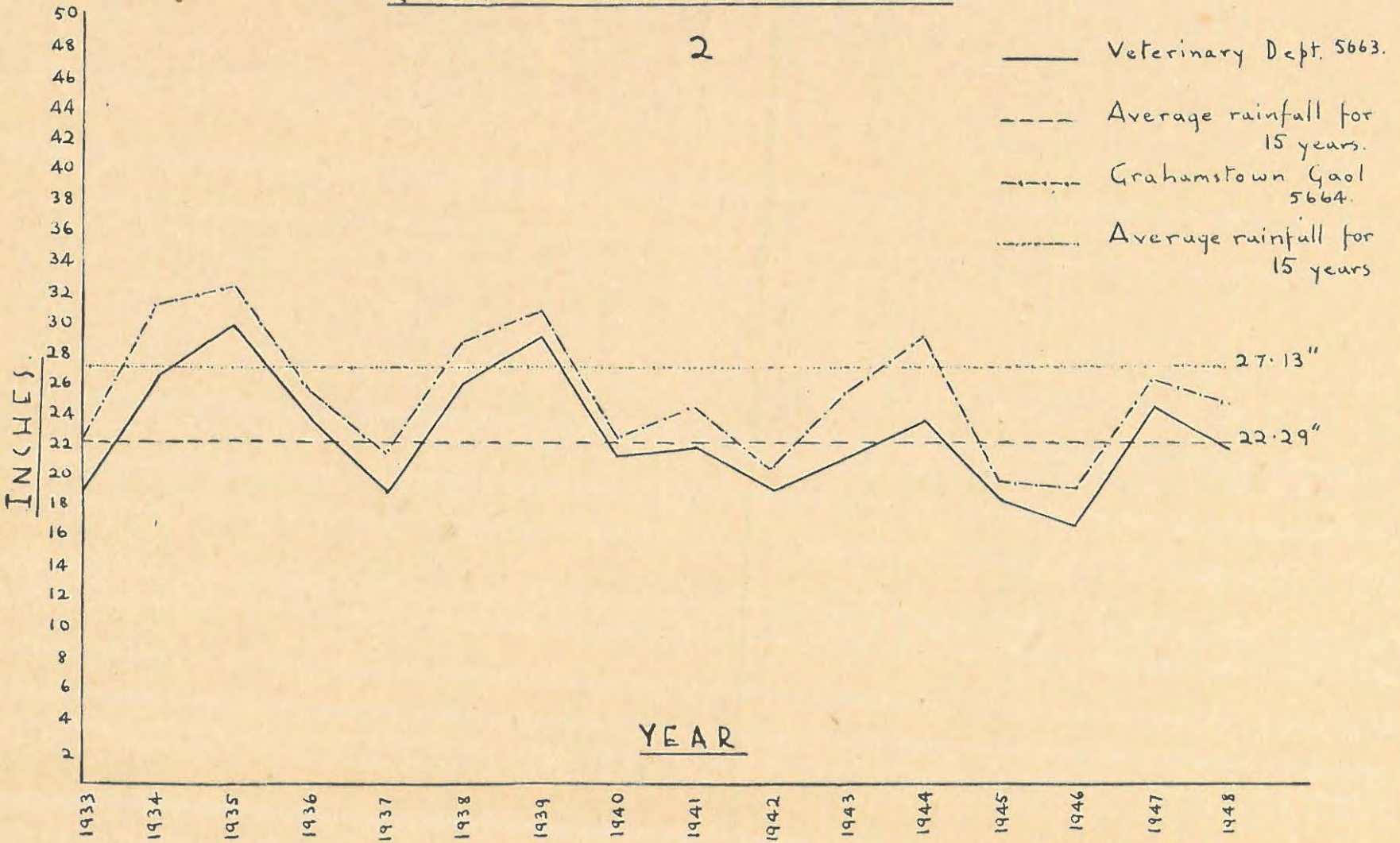


TABLE III. 1941.

	Annual Rainfall in inches.	Lat.	Long.
Kowie Golf Club	26.08	33° 20'	26° 5'
Bathurst Golf Club	27.54	33° 24'	26° 50'
Experimental Station	26.08	"	"
Grahamstown Gaol	24.58	33° 18'	26° 32'
Riccdale	18.47	33° 55'	26° 51'

A comparison of the Gaol and the Veterinary Department rainfall records (Fig. II) shows that although the stations are barely ½ mile apart there is a consistent difference of 2 inches between the annual totals. The explanation for this is apparent The Mountain Drive forms the first efficient barrier for the south-westerly rain bearing winds. Hence a larger percentage of moisture is deposited there than in Grahamstown which is 500 feet lower in altitude on the leeward side, in the rain-shadow area. Furthermore, the greater the distance form the watershed the greater is the decrease in the rainfall. (See Rainfall Map of S.A.). A list of totals for 1943 is given in Table IV below to show this decrease.

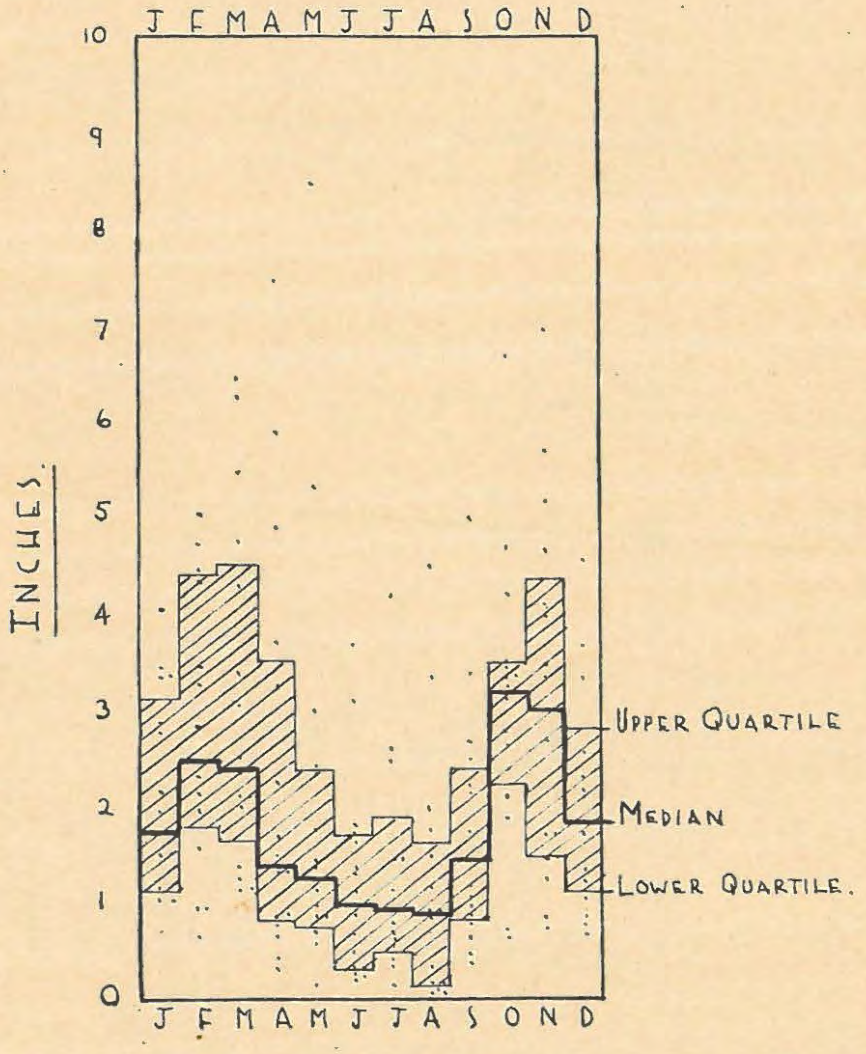
TABLE IV.

1943	Amount of Rain in Inches	Approx. Distance from Watershed in miles.
Gaol	25.49	3
Rhodes University	25.25	3½
Veterinary Dept.	21.82	3½
Aerodrome	20.74	5

RAINFALL DISPERSION GRAPH

FROM 1933-'34 — 1948-'49

GAOL



MONTHS.

This is supported by further evidence. Gowies Kloof on the north side of Grahamstown has a much drier type of vegetation than Fern Kloof, although both are on the south facing slopes.

Therefore, the Mountain Drive must have at least as much rain as Grahamstown and the facts mentioned above indicate that it may have considerably more. Mists, too, contribute a tangible amount of moisture to the Mountain Drive, by condensation on the leaves of the plants (Liebenberg MSS.)

The rainfall dispersion graph (See Fig. 3) (after Crowe1933) illustrates how the precipitation is distributed throughout the year at Grahamstown. October and November are the peak months, while July and August are the months of least rain. Approximately 60% of the rain falls in summer. The winter rains no doubt account for the extension of the South Western Cape Flora so far to the east.

TEMPERATURE (GRAHAMSTOWN).

Consistent records for Grahamstown have been kept at the Veterinary Dept. Table V gives the mean monthly temperatures for the years 1944 - 1948, and in Table VI there are records from 1943 - 1948 for

(a) the absolute maximum temperature A.M.,

(b) The absolute minimum temperature a.m., and

(c) the mean air temperature for each year.

TABLE V.

MEAN MONTHLY TEMPERATURE FROM 1944 - 1948.

°F Month	1944	1945	1946	1947	1948
Jan.	70	74	71	69	71
Feb.	69	74	69	no record	67
March	66	63	66	no record	66
April	60	66	65	64	62
May	53	59	63	60	60
June	51	56	48	55	55
July	53	53	53	51	55
Aug.	57	55	51	59	58
Sept.	60	62	59	58	57
Oct.	62	56	50	62	58
Nov.	66	68	65	64	62
Dec.	65	66	63	69	66

From Table V, January and February and the hot months and June and July are the cold months of the year.

TABLE VI.

YEARLY RANGES OF TEMPERATURE FROM 1933 - 1948.

°F

Year	A.M.	a.m.	T
1933	102.2	24.8	60.1
1934	98.2	27.2	60.9
1935	103.2	29.0	59.0
1936	99.8	30.0	59.9
1937	102.4	30.0	no result
1938	106.2	29.0	59.3
1939	99.8	30.6	60.4
1940	101.2	26.7	62.5
1941	101.3	27.0	62.1
1942	99.6	28.2	61.7
1943	110.0	30.0	61.1
1944	102.0	32.0	61.3
1945	106.0	32.0	63.0
1946	104.0	29.0	61.2
1947	100.0	33.0	61.3
1948	101.0	33.0	61.5

Where:

A.M. is Absolute maximum temperature

a.m. is Absolute minimum temperature

T. is Mean Air temperature.

For most years the highest summer temperature exceeds 100°F and the lowest winter temperatures seldom go much below freezing point. The range between the absolute maximum and the absolute minimum is a matter of 70° each year. The mean air temperature is 61.8°F as compared with 62.0°F Capetown, 66°F East London and 64.00°F Port Elizabeth.

Grahamstown's climate is quite unpredictable, and changes of temperature and wind direction are rapid. There is a tendency towards greater extremes of heat than cold.

TEMPERATURE AND HUMIDITY. (FERN KLOOF).

Hair hygrometers were used for measuring the relative humidity. Evans (1939) states that they "tend to be inaccurate above about 90% to such an extent that individual readings above 93% cannot be considered as significantly different from saturation".

A few air temperatures were obtained and they are included in Table VII.

TABLE VII.

TEMPERATURE AND RELATIVE HUMIDITY.

	DATE	TIME	FOREST Rel. Hum.	FOREST Sat. Def.	PINE Rel. Hum.	PINE Sat. Def.	TEMPERATURE °F Forest	TEMPERATURE °F Pine
1.	26.10.49	11.26a.m.	87	13	91	9		
	"	12.20p.m.	98	2	96	4		
2.	28.10.49	12.20p.m.	67	33	67	33		
	"	5.30p.m.	78	22	59	41		
	"	9.30p.m.	93	7	86	14		
3.	29.10.49	9.30a.m.	97	3	97	3		
	"	6.25p.m.	90	10	82	18		
4.	1.11.49	5.30p.m.	87	13	69	31	68.9	72.0
5.	2.11.49	12.10p.m.	46	54	41	59	61.7	64.4
	"	9.25p.m.	92	8	92	8	52.7	52.2
6.	3.11.49	10.00a.m.	56	44	57	43	57.2	59.0
	"	5.00p.m.	81	19	82	18	54.1	54.1
7.	4.11.49	12.35p.m.	71	28	64	36	60.1	60.8
8.	5.11.49	5.00p.m.	69	31	46	54	63.5	66.2

REMARKS.

1. Mist rolled up from sea at 11.20a.m. and stayed till 4.00p.m.

2. Warm day coming on to rain in evening. Rain continued throughout the night.

3. Rain all day but stopping in evening.

4. Warm day little wind.

5. Westerly winds. Showers.

6. Hot, dry north wind in morning, changing to cool westerly wind in evening.

7. Warm day with wind.

8. Warm day with wind.

There are not enough results on which to base a definite statement, but there appears to be some indication that the relative humidity is less (saturation deficit is more) at mid-day when the temperature is higher than in the morning or evening. There is apparently no significant difference in relative humidities of the forest and the pine. On days of mist or rain the relative humidity in both gem up to saturation point. During the hot dry "berg" wind from the north the saturation deficit was considerable in both communities.

LIGHT INTENSITY.

Values of light intensity were obtained with a General Electric Exposure meter. Readings were taken on 2.11.49 at the four points of the compass.

(a) in the open - the lawn in front of Rhodes University College at 11.15a.m.

(b) in the pine at 12.15p.m.

(c) in the forest at 12.10p.m.

To avoid light flecks in the forest, the meter was shaded. Multiplication by the factor gave the following results in foot candles.

TABLE VIII.

LIGHT INTENSITY.

Direction.	Open.	Pine.	Forest.
North	1500	500	50
South	1000	550	115
East	1700	360	110
West	1500	700	80
Average Light Intensity	1620	502	88

From the figures above it will be noted that the forest has a much lower light intensity than the pine, and that both these light intensity values are considerably less than those for the open conditions.

EDAPHIC FACTORS.

SOIL.

Little information is available about the soils of the Witteberg Series. The soils of a great part of Albany District are largely derived from the quartzites of the Suurberg Range and are notably poor. Juritz 1907 lists some figures (Table IX) for soils of various series.

TABLE IX.

	CaO	K_2O	P_2O_5
Witteberg Series	0.051	0.058	0.065
Table Mountain Sandstone	0.034	0.031	0.036
Bokkeveld	0.387	0.231	0.118

Recently Mr. W.J.A. Steyn has done a soil analysis near the National Road behind Hill Kaif. I am indebted to him for the use of the results as they are, as yet, unpublished.

TABLE X.

	K_2O	P_2O_5	N_2
Witteberg Series	0.134	0.0148	0.1016

It will be seen that the phosphorous and nitrogen contents of the soil are very low. The potash content is fairly good. The soil tends to be acid because there is very little lime. On the whole there is slightly more clayey material in the Witteberg soils than in the Table Mountain Sandstone soils.

It is difficult to classify the type of soil occuring on the Mountain Drive on Van de Merwe's classification,1941, since he bases his classification on summer or winter rainfall and Grahamstown is intermediate between these regions. I have assumed, however, that the soil at Fern Kloof belongs to the category:

A Summer-Rainfall Area

Section II Sub-humid and humid Regions.

g. Gley-like Podsolic Soils.

(2) Semi-coastal Belt of Eastern Province and Intrazonal Soils.

SOIL PROFILES.

Four soil profiles were completed, their positions are marked on map 3.

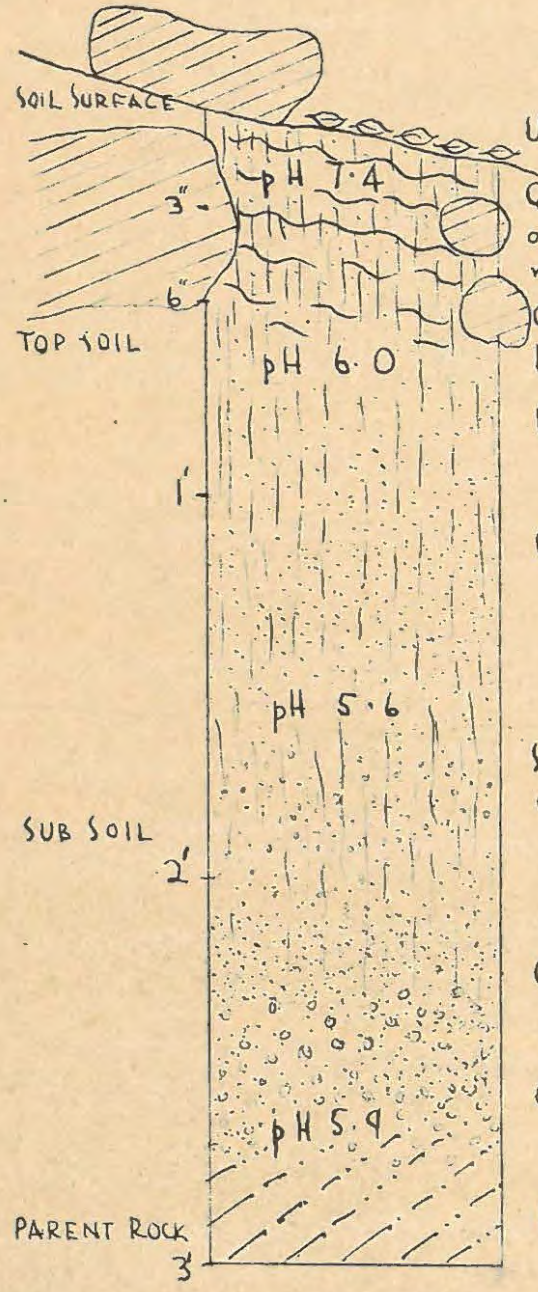
Each profile has been drawn to scale and is fully annotated making further description unnecessary (Figs. 4-7).

The most noticeable difference in the soils is in the texture; the pine soil is very fine and powdery to feel, while the forest soil is much coarser. The forest soil has more leaf debris on the surface than the pine soil. As regards the colour there is a variation through different tones of grey in Pine soils (lighter near the surface), but in the forest soils there is a distinct change through successive colours, i.e. at the surface the soil is dark grey-brown, then it becomes progressively lighter until it passes from orange-yellow to coarse white at a depth of nearly 3 feet.

The soils are similar in that they both become compact at a

FERN KLOOF – FOREST.

SOIL PROFILE F1 DATE 28. 10. 49.



Undecomposed leaf debris

Granular soil rich in decomposing organic material. Closely interwoven mass of roots.

Organic matter decreases as depth increases.

Dark grey-brown loam.

Roots noticeably fewer.

Compact brown soil - small particles.

Soil becoming progressively lighter in colour and coarser in texture.

Orange yellow powdery soil

Coarse white pulverising rock.

Disintegrating rock.

KEY

- Humus.
- Colour.
- Rock.
- Particle size.

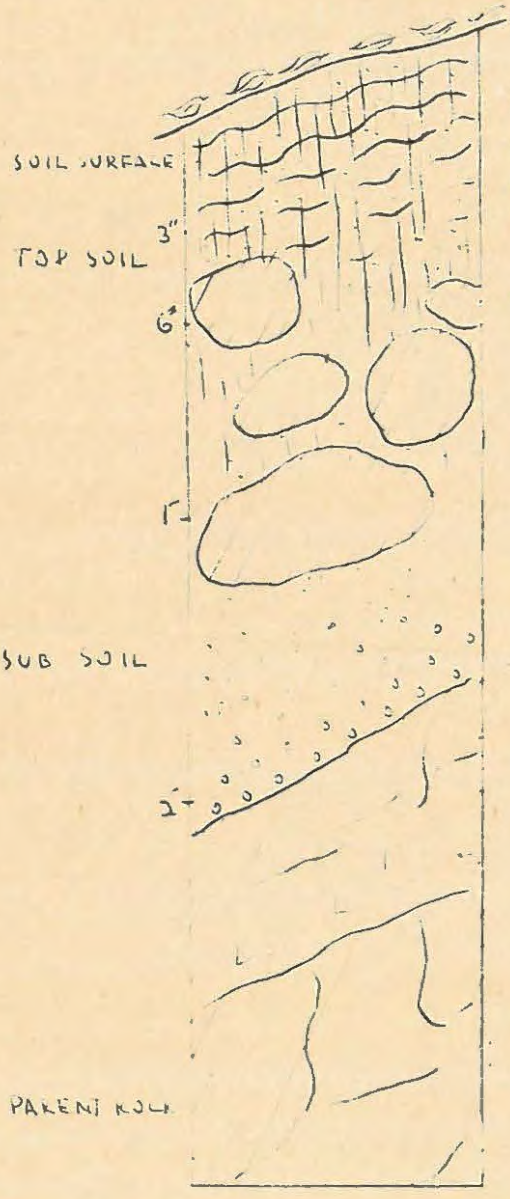
FEET

0 3" 6" 1 2

SCALE

FERN KLOOF – FOREST

SOIL PROFILE F2 DATE 4. S. 44.



Undecomposed leaf debris

7" of dark coloured loam, rich in decomposing organic matter in upper few inches and traversed by numerous roots

4–12" layer of stones.

Soil dark-brown loosely compacted.

5" coarse gravel providing good drainage.

Soft powdery rock decomposing to form orange coloured soil.

Disintegrating rock.

KEY

Humus

Colour

Rock

Parent rock

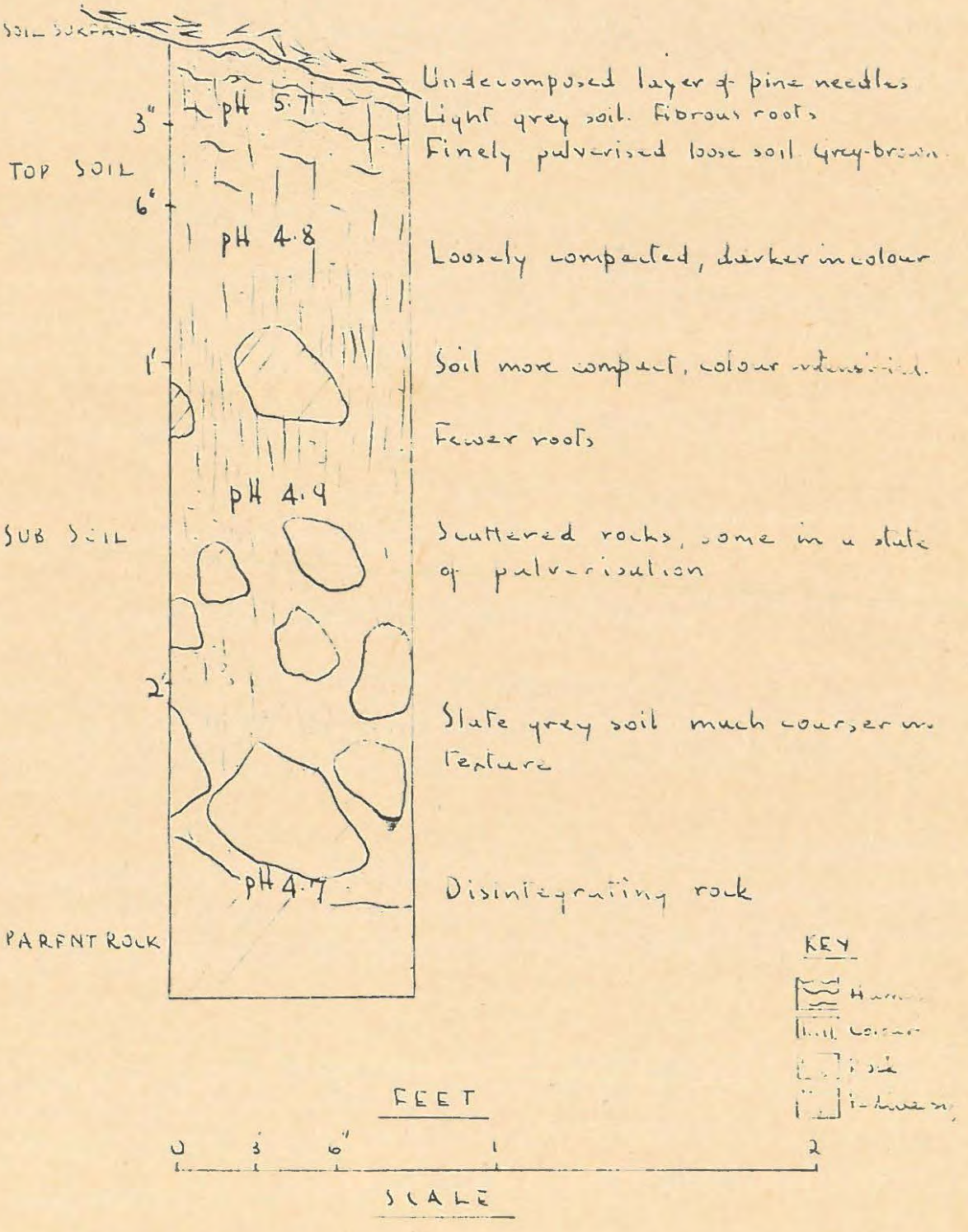
FEET

0 3" 6" 1 2

SCALE

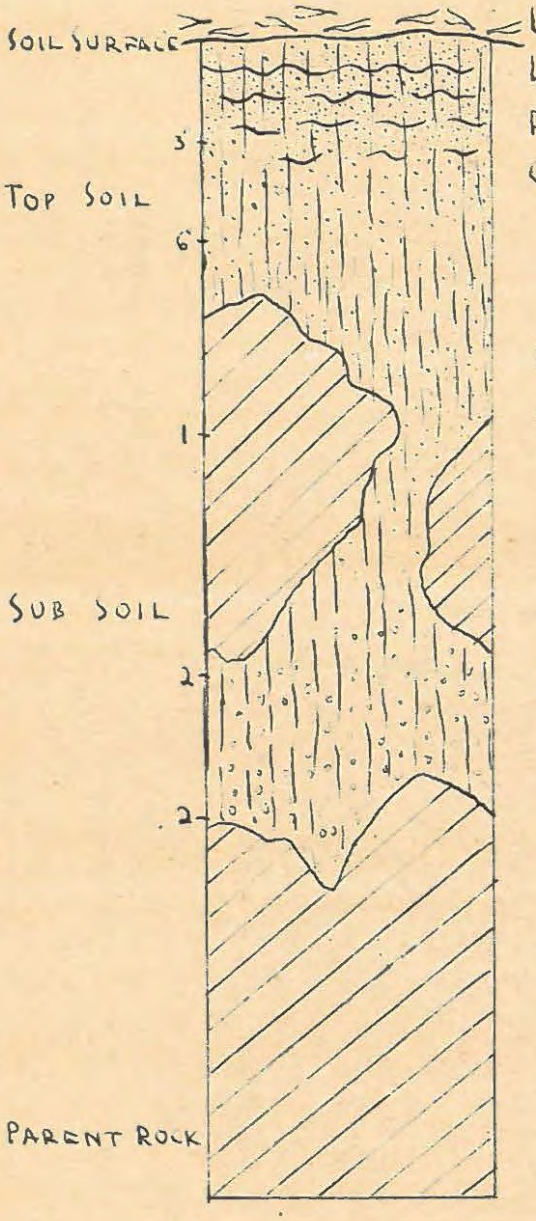
FERN KLOOF — PINE

SOIL PROFILE P3 DATE 28 10 49.



FERN KLOOF - PINE

SOIL PROFILE P4 DATE 4. 5. 49.



Undecomposed layer of pine needles.
Light grey soil
Finely pulverised soil.
Grey brown in colour.

Large hard rocks. Soil compact and darker in colour

Slate grey soil much coarser in texture.

Rocks showing few signs of disintegration

KEY
- Humus
- Colour
- Rock
- Particle size

FEET
0 3" 6" 1 2
SCALE

COLLECTS-

depth of 1 foot. A pick leaves a shiny gouged hollow in the compact layer indicating that there is a certain amount of clayey material in the soil.

pH values taken in Profiles 4 and 6 show that there is a slight decrease in pH with increasing depth.

Loose stones abound in both soils at all layers making it difficult to excavate profiles.

SOIL REACTION or pH.

Many pH recordings were taken in theforest and the pine. At first samples for soil analysis were collected by using soil borers and augers , but these proved unsatisfactory because of the extremely stony nature of the surface and also because of the thick mat of roots near the surface in the forest. Instead, after removing the surface litter, holes were dug with a pick and samples were removed from the cut wall and placed in tins. A portion of the sample was then treated in the laboratory with a small amount of Barium sulphate. To the soil was added double its volume of water and after being well shaken the samples were kept for 12 hours before being examined with a Beckman Glass Electrode pH meter.

A series of pH values was taken at depths of 2 feet and 6 feet throughout the length of the plot. These results are given in Table XI. There is the same slight decrease in pH with increase in depth in the surface layers that was noted in the soil profiles. pH values for the surface layer in the forest very from 6.0 to 7.6. In the pine the variation is 4.0 to 6.3.

Therefore it may be said that the pH of the forest tends to be normal, while the pine is decidedly acid.

The pH values vary throughout the forest but are generally highest in the central portion. The drop in pH at the change over from forest to pine begins well inside the forest, so that it seems unlikely that the difference in pH alone can explain the sudden change from forest to pine.

Apart from the effect the pH has on the micro-biological population in the soil the slight variations in pH that occur in the forest community seem to have little effect on the distribution of the plants in that area. The same may be said for variations of pH in the pine community.

TABLE XI.

pH VALUES AT DEPTHS OF 2" AND 6"

IN FOREST AND PINE.

Depth.	Forest.													
2"	6.7	7.0	7.1	7.6	7.3	7.1	6.9	7.6	7.6	7.4	6.9	6.4	6.1	6.7	4.9
6"	6.4	6.8	6.7	7.1	7.3	6.9	6.8	7.5	7.5	7.6	6.9	6.0	6.2	5.7	5.0

Depth.	Pine.						
2"	4.4	4.1	4.5	5.7	5.1	5.0	5.7
6"	4.0	4.1	4.4	5.9	4.9	5.0	5.2

WATER CONTENT.

The water content of the soil was measured by placing a weighed amount of soil (approximately 25 grams) in a weighing

bottle in an oven at a temperature of 105° until constant weight was obtained, and then calculating the percentage loss in weight which gives the water content.

It can be seen from the results (Table XII) that the water content varies considerably, but almost always the forest appears to have a higher water content than the pine.

ORGANIC MATTER (HUMUS) CONTENT.

A rough method described below was used throughout the year to determine the organic matter content.

About 25 grams of oven dried soil of each sample were heated strongly in crucibles over a Bunsen flame until all sign of organic matter had disappeared. The percentage loss in weight was then calculated. The process took about 2 hours.

The results are given in Table XII. There is a wide discrepancy in some of the results, due, I think, to variations in the technique of heating the crucibles.

The average organic matter content for the forest are confirmed in the next section with the more accurate McLean and Ivimey Cook Method (1946). It may be stated then that the forest has a higher organic content than the pine.

TABLE XII.

COMBINED pH ORGANIC CONTENT AND WATER CONTENT

RESULTS FOR FERN KLOOF.

FOREST.

Sample Number	pH	Organic Content	Water %Content
1	5.5	15.8	13.5
2	6.0	17.9	10.3
3	6.1	8.9	6.4
4	7.0	16.4	13.9
5	6.3	16.9	11.9
6	6.0	15.3	13.4
7	6.3	9.8	11.4
8	6.1	8.3	20.1
9	6.5	11.5	20.1
10	6.2	19.5	25.0
11	7.5	19.0	21.3
12	6.9	15.4	22.3
13	7.2	13.7	17.1
14	6.7	9.9	-
15	6.1	11.62	24.28
		13.3	Average.

PINE.

Sample Number	pH	Organic Content	Water %Content
1	4.8	4.8	5.9
2	5.5	10.5	11.1
3	5.3	19.1	8.3
4	5.1	7.9	8.8
5	5.2	10.3	9.9
6	6.3	6.1	5.8
7	5.3	13.9	12.6
8	5.7	13.1	17.1
9	5.6	9.3	10.0
10	5.4	3.3	9.5
11	5.1	8.5	12.7
12	5.7	5.0	20.3
13	5.2	8.38	12.59
14	4.9	10.29	-
15	4.7	8.39	17.63
		9.2	Average

OXIDIZABLE ORGANIC CONTENT.

The method used has been fully described by McLean and Ivimey Cock 1946 p.101. Only one modification had to be made in the technique and that was to use sintered glass crucibles instead of Gooch crucibles as the pine soil was in such a fine state of division that it tended to impede filtration in the latter. I am indebted to Mr. J. Kelly for doing this experiment.

The oxidizable organic content has been examined at depths of 1 - 3", 3 - 6" and 6 - 8" and the results are compiled in Table XIII. In the 3 - 6" layer some attempt was made to determine whether the oxidizable organic content varied in different parts of the area. The samples were collected from:

(1) the top of the forest.

(2) the base of the forest.

(3) the top of the pine, i.e. that portion nearest the lower margin of the forest.

(4) the base of the pine.

Elsewhere the samples were a mixture of soils for that particular layer from various parts of the forest or pine.

TABLE XIII.

Depth of Soil.	Forest.	Pine.
1 - 3"	13.35%	7.68%
3 - 6" Top	(1)10.30%	(3)7.96%
3 - 6" Base	(2) 7.65%	(4)5.08%
6 - 8"	4.67%	4.26%

From this it can be seen that the oxidizable organic content is highest in the surface layer of 1 - 3", decreases rapidly in the 3 - 6" layer and is very low in the 6 - 8"layer. Also, the forest has a higher organic content than the pine.

SATURATION CAPACITY.

As defined by Mclean and Ivimey Cook the saturation capacity is "the percentage of water held against gravity by a soil in which the pores are completely filled with water. Their "soil bom" method has been used. It was noted that in general the forest soils absorbed water more quickly than the pine soils, and that the pine soil lost water in the oven more quickly than the forest soil.

Table XIV contains the results of 7 experiments. Different drainage times were employed giving widely varying results. Numbers 6 and 7 were done with a 2-hour drainage period and the results seem more probable than the others which are included for interest.

The forest soils appear to have a greater saturation capacity than the pine.

TABLE XIV.

SATURATION CAPACITY.

Sample Number.	Date.	Forest %	Pine %
1	9.4.49	48.94	45.07
2	1.5.49	64.21	63.39
3	13.6.49	72.95	55.26
4	29.7.49	89.95	64.52
5	15.8.49	71.65	47.14
6	24.8.49	74.74	71.17
7	2.11.49	76.85	63.52

CARBONATE CONTENT AND LIME DEFICIENCY.

In a preliminary experiment a few grams each of soil from forest and pine were treated with a few drops of 20% hydrochloric acid. No fizzing took place, indicating that very little carbonate is present in either of the soils.

A further test for lime deficiency was done as follows: absolute alcohol was saturated with ammonium thiocyanite to provide the reagent. 0.2 grams each of the soils was added to 2 ml. of the reagent in a test tube; a few drops of 20% H_2O_2 were admitted to oxidize any iron present. On shaking, both solutions turned a deep red showing that both soils are deficient in lime.

STICKY POINT DETERMINATIONS.

Samples of forest and pine soils weighing about 20 grams each were wetted with constant kneading until thoroughly saturated and sticky. Each sample was rolled into a ball, cut through with a knife, weighed and put in the oven at 105°C until constant weights were obtained. This gives a measure of the amount of water necessary to saturate the colloidal soil particles, i.e. the sticky point.

TABLE XV.

STICKY POINT.

SAMPLE.	FOREST.	PINE.
1	38.9	30.7
2	37.2	31.2

To the sticky point is added the constant 23.5 to give the "water holding capacity of the soil" (McLean and Ivimey Cook). These figures can be compared with the saturation capacity "soil box" experiments. The general trend is the same in both cases although the figures vary.

TABLE XVI.

WATER HOLDING CAPACITY.

SAMPLE.	FOREST.	PINE.
1	62.4	54.2
2	60.7	54.7

SOIL TEMPERATURES.

Liebenberg (MSS.) has shown that there is a considerable time lag before the first rise in temperature is observed after the sun has risen. This usually occurs at about 11 a.m. in both exposed and protected situations. Similarly he found the same time lag existed throughout the day and long after sunset. The extent of the time lag depended on whether the soil was in an exposed or protected situation i.e. in fynbos the maximum soil temperature was reached at 7.00 p.m. while in the forest this was not reached until 10.00 p.m..

Soil temperatures for the forest and the pine are given in Table XVII. They are barely sufficient to corroborate Liebenberg's work, and many more readings are required in the critical periods of the rise in temperature in the morning and the maximum temperature

after sunset. However, it can be seen that the daily range of soil temperatures is slightly less in the forest than for the pine. There is also an indication that the maximum temperature in the forest occurs after 9.30 p.m. whereas the soil temperature has already begun to drop by that time in the pine.

TABLE XVII.

SOIL TEMPERATURES °F.

Date.	Time.	Forest.	Pine.
26.10.49	11.20a.m.	56.0	59.0
"	12.20p.m.	56.0	59.0
28.10.49	12.20p.m.	55.0	56.8
"	5.30p.m.	55.5	60.0
"	9.30p.m.	56.0	59.0
29.10.49	9.20a.m.	55.0	57.5
"	6.25p.m.	56.5	60.5
1.11.49	5.00p.m.	58.0	61.0
2.11.49	12.10p.m.	55.0	59.5
"	5.00p.m.	58.0	60.5
"	9.25p.m.	58.0	60.0
3.11.49	10.00a.m.	55.5	58.0
"	5.00p.m.	55.5	59.0
4.11.49	12.35p.m.	55.0	57.0
5.11.49	5.00p.m.	56.0	59.5

The results in the preceding pages for the edaphic and environmental factors are just sufficient to indicate that the conditions for growth are more favourable in the forest than in the pine.

FOREST

I

Photograph I illustrates: great number of shrubs and tree saplings (mostly about 3' in height) in this part of the forest; thick litter of plant debris on the soil surface, and the moss patches on tree trunks.

II

Photograph II shows fewer shrubs and saplings. Trees are closely grouped together and have moss patches on trunks.

PART III.

THE VEGETATION AT FERN KLOOF.

HISTORY.

Very little is known about the history of the indigenous forests around Grahamstown. It seems probable that from the number of large moss covered stumps to be found in any of the forests, there has been considerable exploitation of trees in the past. That veld-fires have prevented the forest from spreading is almost certain, but again there is no information about the former limits of the forests to uphold this assumption.

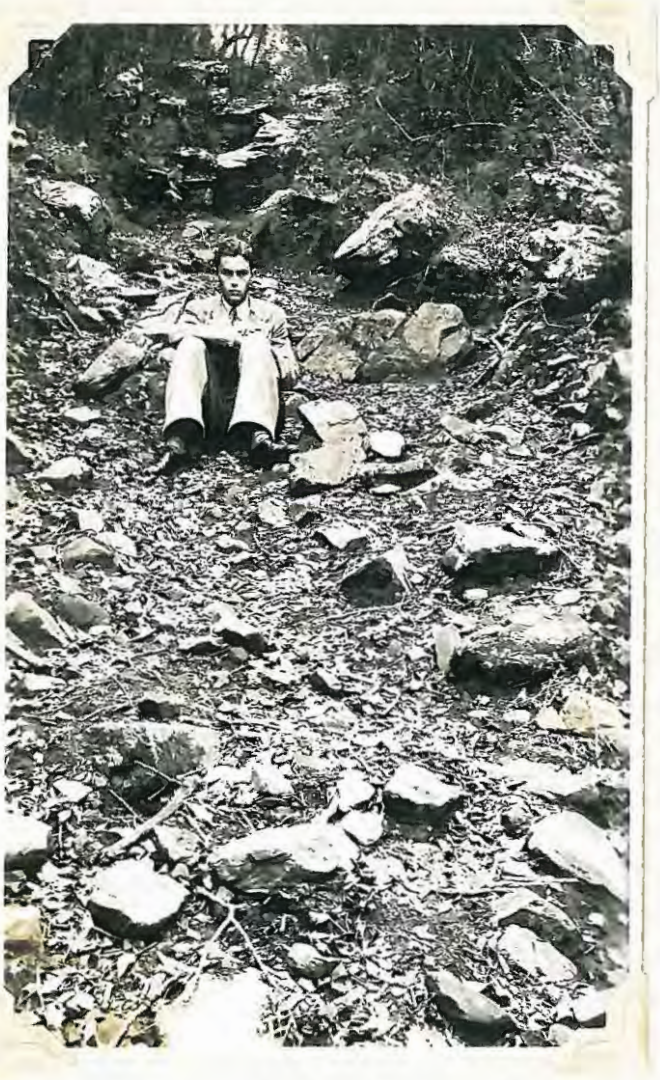
The history of the pine forests is less of a mystery, as it has been fully dealt with in the reports of the Conservator of Forests for 1926 and 1933. Briefly, the history is as follows: about 1870 Mr. Watson planted the first exotics near Dog Dam. The work was continued by Messrs. W. Smith, G. Reynolds, J. Wood, C. Grant and P. Graham. The planting of various species of Pinus Eucalyptus and Acacia was gradually extended to Grey Reservoir, Goodwin's Kloof and finally to Waai Hek. Of the species of Pinus planted Pinus pinaster has become very troublesome. It has spread by means of wind dispersed seeds with alarming rapidity along the length and breadth of the Mountain Drive, replacing the vegetation that existed there previously. Only the indigenous forest appears to be immune from this invasion.

BIOTIC FACTORS.

A glance at map 3 will show that there are many paths through the area, caused by the extensive trampling of cattle. With the exception of Nature Reserve which is fenced, this trampling is,

FOREST

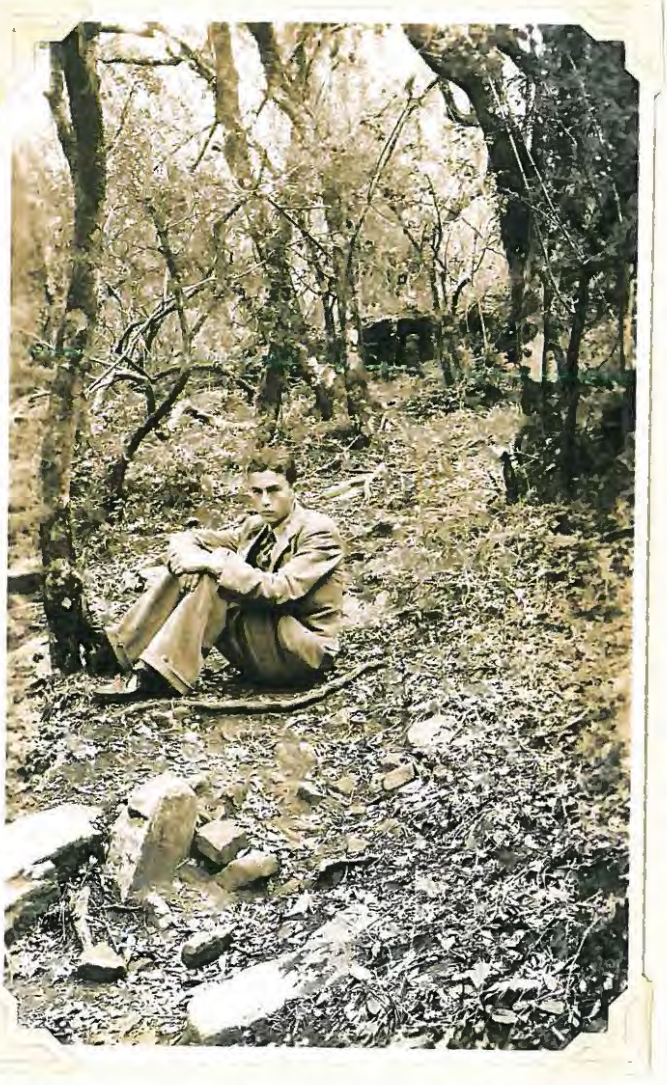
III



Main path eroded. Note: outcrops of Witteberg Quartzite and number of loose stones.

FOREST

IV



Badly trampled area on west side of main path (see map 13). Shrubs and ground flora almost obliterated.

SECTIONAL VIEW OF FERN KLOOF SHOWING EXTENT OF PINE AND FOREST

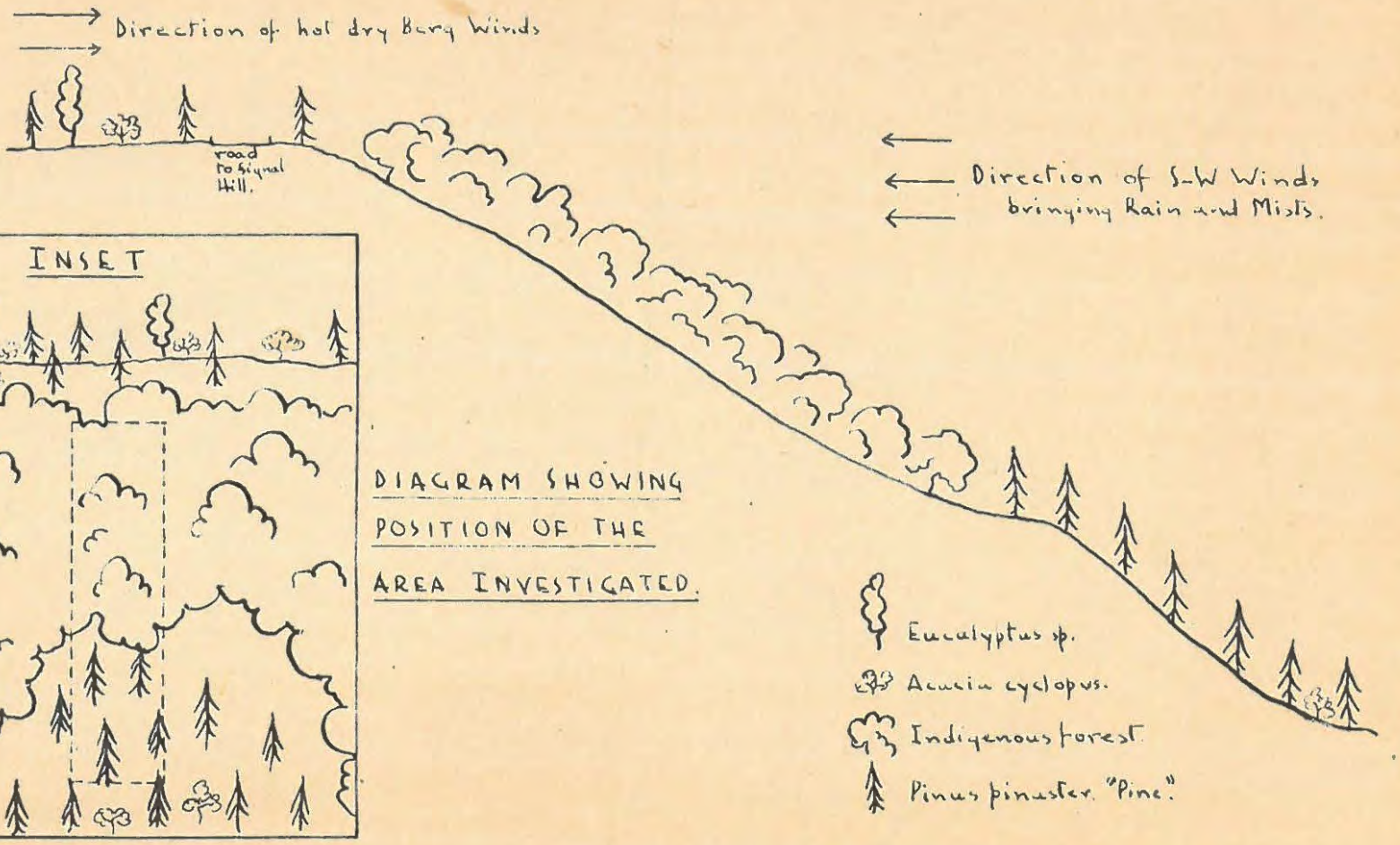


DIAGRAM SHOWING POSITION OF THE AREA INVESTIGATED.

unfortunately, more or less typical for the whole of the Mountain Drive.

Photograph 3 and 4 illustrate the effect of trampling on the forest undergrowth.

DESCRIPTION OF THE PLANT COMMUNITIES.

The indigenous forests of Grahamstown are almost completely evergreen and belong to the Temperate Forest Group of Adamson (1938) They occur only on the southern slopes of the Mountain Drive or in similar localities on other ranges near Grahamstown e.g. Paradise Kloof and Rabbits Wood.

The rather scrotchy bush found on north facing slopes is quite different in species composition and structure and does not come into the category of Temperate Forest.

The forests approach to within a few yards of the tops of the ranges but seldom succeed in crossing over them into the harsher conditions on the northern slopes.

At Fern Kloof the forest forms a closed community with the canopy from 25-30 feet in height.

Inside the forest is cool and pretty. The boles of the trees are moss covered. There are a few epiphytes and a number of lianes. Plants like Browallea coerulea, Argyrolobium tomentosum and Streptocarpus rexii brighten up the forest at different times of the year with their attractive flowers. It can be seen from photograph 1 that there are many small shrubs in parts of the forest.

Fig. 8 indicates the extent of the forest and pine and the position of the area of investigation.

The pine is an open community (see photograph 5) composed entirely of Pinus pinaster with individuals up to 40 feet in height, which has invaded the original community composed of elements of the South-Western Cape Flora. It must be emphasized that the pine is at an early state of development and consequently the undergrowth is still quite a prominent feature. Observations in other parts of the Grahamstown area show that in well developed pine forests there is very little undergrowth.

The conventional methods for examining vegetation have been followed. Both communities have been divided into the following groups:-

a. ground flora,

b. shrub layer,

c. tree layer.

Most of the plants have been collected and a list of species with statistics of the families and genera at Fern Kloof will be found in the appendix. Only 80 species out of approximately 190 species (not including Mosses) occur in the statistics, and although more quadrats and transects could have been done, they do illustrate the extremely rich flora that can be found in such a small area.

ANALYSIS OF THE GROUND FLORA.

Permanent quadrats have been marked in the forest and the pine using an aluminium frame 1 metre square with adjustable cross wires at 10cm. intervals. Their positions are noted on map 13. Each quadrat has been drawn to scale (diagrams Q_1 - Q_{14}) with the positions of individual plants represented by symbols. In cases of creeping plants like Plectranthus ciliatus, Hypoestes verticillaus, Oplismenis hirtellus and Cressula spatulata whose limits are hard to define, each rooted shoot has been counted. The position of rocks has been indicated in the diagrams.

Accompanying each diagram is a brief description of the quadrat and a list of the numbers of each species present.

The quadrats have been divided into 3 sections representing forest, transition and pine zones.

At the end of each section there is a summary of points arising out of the quadrats.

THE FOREST ZONE.

QUADRAT Q1.

It is situated 8 yards east of the main path near the top of the forest. It is protected from trampling by the closely grouped trees surrounding it. There are some small outcrops of rock.

Total number of individuals 111. Number of species 21.

Q1.

SPECIES.	NUMBER OF INDIVIDUALS.
Plectranthus ciliatus	65
Olea laurifolia	14
Rhoicissus cuneifolia	5
Cecamone alpini	3
Clausena inaequalis	3
Gymnosporia peduncularis	3
Canthium ciliatum	2
Fagara capensis	2
Senecio deltoideus	2
Apodites dimidiata	1
Asparagus plumosus	1
Burchellia bubalina	1
Crassula spatula	1
Doryalis rhamnoides	1
Dracaena hookeriana	1
Gardenia neuberia	1
Hippobromus pauciflorus	1
Hypoestes verticillaris	1
Oplismenus hirtellus	1
Rhoicarpus capensis	1
Scolopia mundtii	1

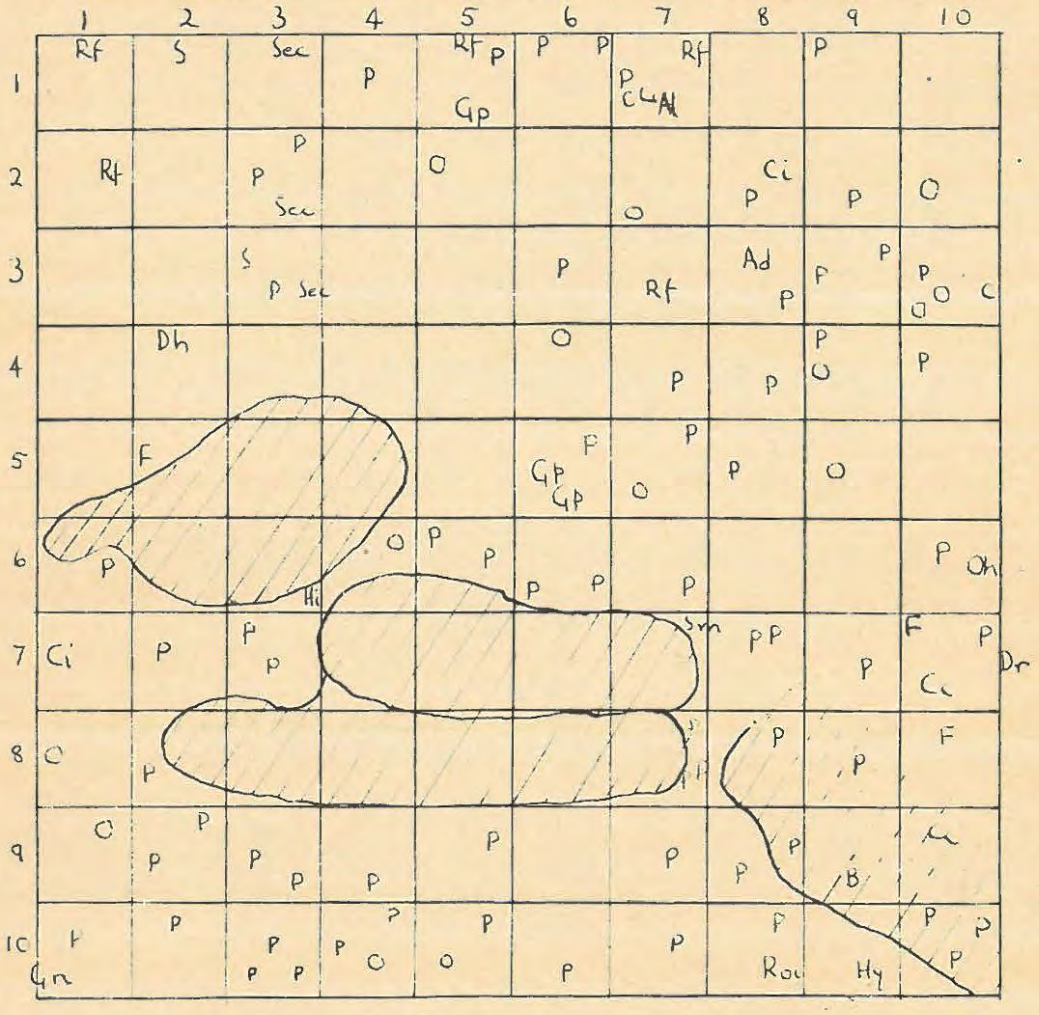
Plectranthus ciliatus is by far the commonest plant and occurs more frequently in the bottom part of the quadrat.

Olea laurifolia is represented by seedlings up to 1" in height and several small saplings of ½" diameter.

A large proportion of the plants occur as isolated individuals and Dracaena hookeriana appears once and not again in any of the other quadrats although it is found sporadically elsewhere in the forest.

FERN KLOOF — FOREST.

QUADRAT Q1 DATE 14.6.49.



Rf - Rhoicissus cuneifolia Planch.
Sec - Secamone alpini Schult.
S - Senecio deltoideus Less.
Gn - Gardenia neuberia F+Z.
Gp - Gymnosporia pedunculatis L Bolus
P - Plectranthus ciliatus E Mey.
O - Olea laurifolia Lam.
Al - Asparagus plumosus Baker.
Ci - Clausena inaequalis Benth.
C - Crassula spatulata Thunb.
Ad - Apodytes dimidiata E. Mey
Dh - Dracaena Hookeriana N E Br.
Hi - Hippobromus pauciflorus Radlk
Oh - Oplismenus hirtellus P Beauv.
Sm - Scolopia mundtii Warb.
Dr - Doryalis rhamnoides Harv.
Cc - Canthium ciliatum Sond.
F - Fagara capensis Thunb
Roi - Rhoicacarpos capensis A.D.C.
Hy - Hypoestes verticillaris R Br.
B. - Burchellia bubalina Sim.

ROCK

QUADRAT Q2.

It is about 8 yards west of the main path near the top part of the forest. The slope of the bank is steep and consequently there has been little interference. One tree trunk covered with moss occurs in the top and at the base there is an outcrop of stone shelving back into the quadrat.

Total number of individuals 129. Number of species 27.

Q2

Species.	Number of Individuals.
Apodytes dimidiata	68
Cyperus albostriatus	9
Asparagus africanus	5
Olea laurifolia	5
Grewia occidentalis	4
Plectranthus ciliatus	4
Clausena inaequalis	3
Hypoestes verticillaris	3
Streptocarpus rexii	3
Burchellia bubalina	2
Canthium ciliatum	2
Fagara capensis	2
Rhoicissus cuneifolia	2
Scolopia mundtii	2
Asplenium bipinnatum	2
Senecio deltoideus	2
Argyrolobium tomentosum	1
Asparagus medeoloides	1
Cassinopsis capensis	1
Doryalis rhamnoides	1
Gardenia neuberia	1
Gymnosporia pedunculoris	1
Unidentified Grass	1
Unidentified legume	1
Royena lucida	1
Sesamone alpini	1
Vepris lanceolata	1

The quadrat possesses 27 different species - a considerable number for an area of 1 square metre - the majority of species occuring a few times or once only.

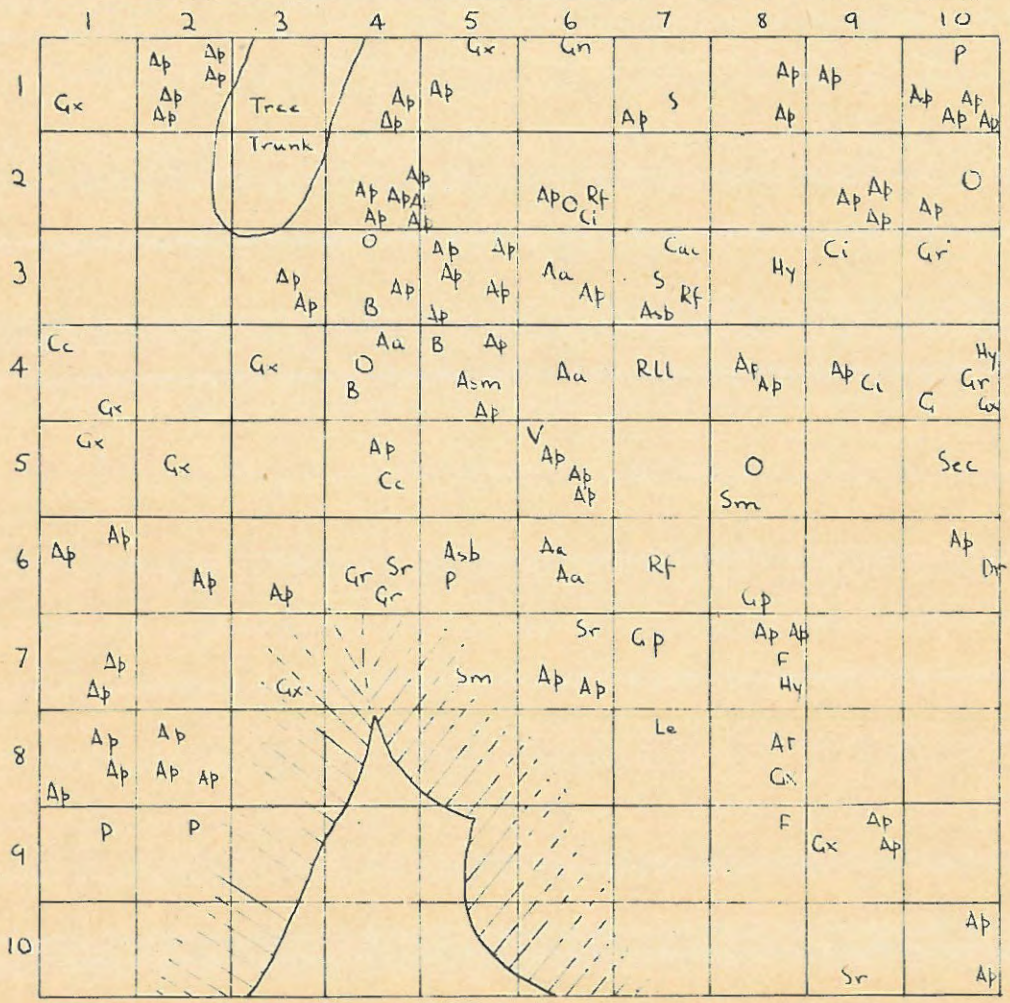
The large number of Apodites dimidiata seedlings of 1 - 5" in height is surprising considering how dry the year 1949 has been. There are very few seedlings under 2 feet in height to be found anywhere in the area, whether this is due to bad germination in former years or to some limiting factor when the seedlings are a few inches high is not known.

The "unidentified Cyperaceae" has since been identified, it is Cyperus albostriatus.

Asparagus medeoloides only occurs in Q2 and Gardenia neuberia is infrequent.

FERN KLOOF — FOREST

QUADRAT Q2 DATE 14.6.49.



Ap - Apodytes dimidiata E Mey (Seedling).
G - Unidentified grass
Gn - Gardenia neuberia E + Z.
O - Olea laurifolia Lam.
Rf - Rhoicissus cuneifolia Planch
Ci - Clausena inaequalis Benth
S - Senecio deltoideus Less.
P - Plectranthus ciliatus E Mey.
B - Burchellia bubalina
Aa - Asparagus africanus Lam.
Asb - Asplenium bipinnatum
Cac - Cassinopsis capensis Sond.
Dr Doryalis rhamnoides Harv.
Gx - Unidentified Cyperaceae
Hy - Hypoestes verticillaris R Br
Le - Unidentified Legume seedling
Gr - Grewia occidentalis Linn
Cc - Canthium ciliatum Sond
Rll - Royena lucida Linn
V - Vepris lanceolata G Don
Sm - Scolopia mundtii Warb.
Sec - Secamone alpini Schult
Sr - Streptocarpus rexii Lindl
Gp - Gymnosporia peduncularis L Bolus
F - Fagara capensis Thunb
Asm - Asparagus medeoloides Thunb.
At - Argyrolobium tomentosum Druce.

QUADRAT Q3.

Q3 is in the top west corner of the forest 15 yards in from the main path.

Total number of individuals 139. Number of species 21.

Q3.

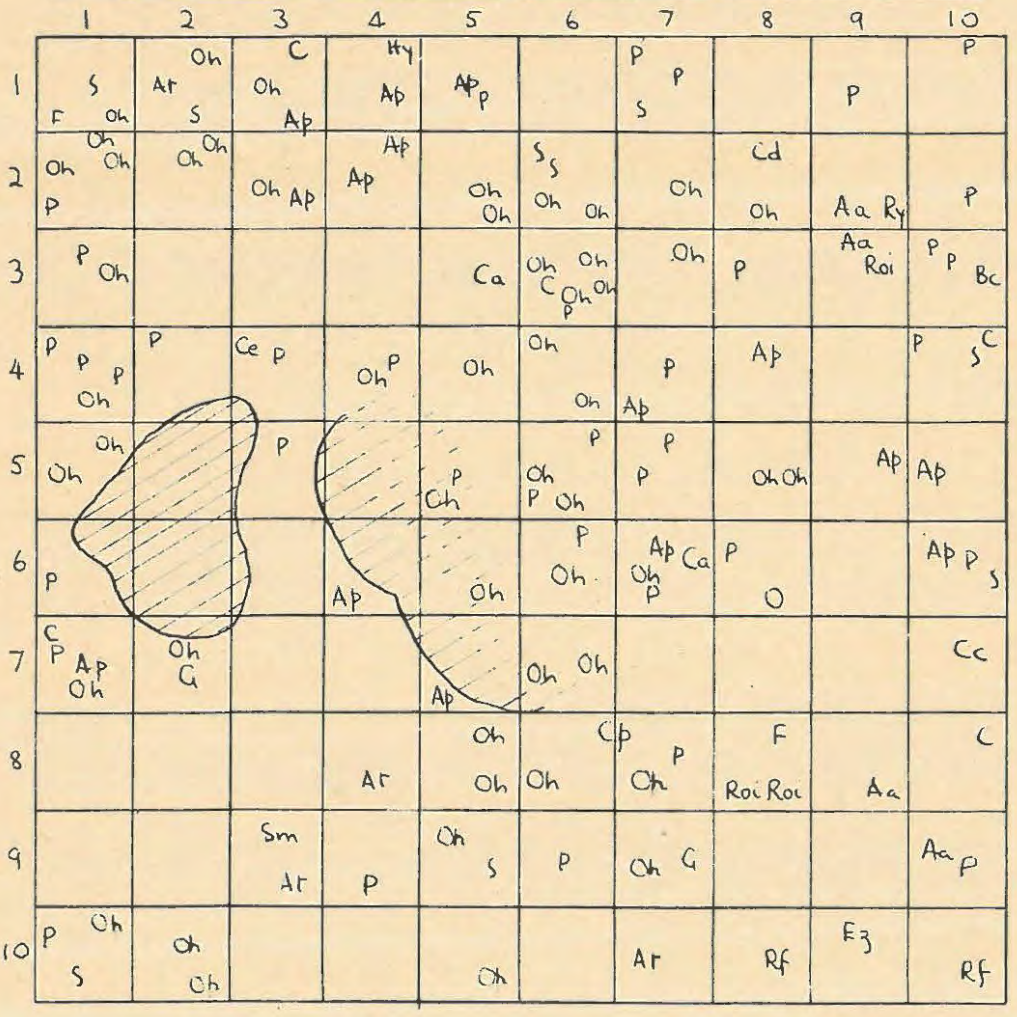
Species.	Number of Individuals.
Oplismenus hirtellus	50
Plectranthus ciliatus	37
Apodytes dimidiata	15
Senecio deltoideus	9
Argyrolobium tomentosum	4
Crassula spatulata	4
Asparagus africanus	2
Cyperus albostriatus	2
Pegara capensis	2
Unidentified Grass	2
Rhoicarpos capensis	2
Brownlea coerulea	1
Canthium ciliatum	1
Ceratiosicyos ecklonii	1
Cynodon dactylon	1
Eugenia zeyheri	1
Hypoestes verticillaris	1
Olea laurifolia	1
Rhoicissus cuneifolia	1
Royena lucida	1
Scolopia mundtii	1

Oplismenus hirtellus forms a mat with Plectranthus ciliatus over most of the quadrat. Apodytes dimidiata seedlings are fairly numerous. Brownlea coerulea, although listed once in the quadrats, occurs frequently in other parts of Fern Kloof.

The small shrub Rhoicarpos capensis is nowhere abundant. Lower down the hillside there are many plants of Ceratiosicyos ecklonii, but in the plot there are few specimens of this very pretty creeper.

FERN KLOOF — FOREST.

QUADRAT Q3 DATE 15.6.49



F-Fagara capensis Thunb.
S-Senecio deltoideus Less
Ar-Argyrolobium tomentosum Druce
Oh-Oplismenus hirtellus P. Beauv.
P -Plectranthus ciliatus E. Mey.
C-Crassula spatulata Thumb.
Ap-Apodytes dimidiata E Mey (Seedling)
Hy-Hypoestes verticillaris R. Br
Cd-Cynodon dactylon Pers.
Aa-Asparagus africanus Lam.
Ry-Royena lucida Linn.
Roi-Rhoicacarpos capensis A DC.
Ca Cyperus albostriatus Schrad.
Bc Brownlea coerulea Harv.
Ce Ceratiosicyos ecklonii Ness
O Olea laurifolia Lam.
Cc Canthium ciliatum Sond
G Unidentified Grass.
Sm Scolopia mundtii Warb.
Ez Eugenia zeyheri Harv
Rf Rhoicissus cuneifolia Planch

QUADRAT Q4.

At the top east corner of the plot, 15 yards from the main path is Q4.

Total number of individuals 156. Number of species 16.

Q4.

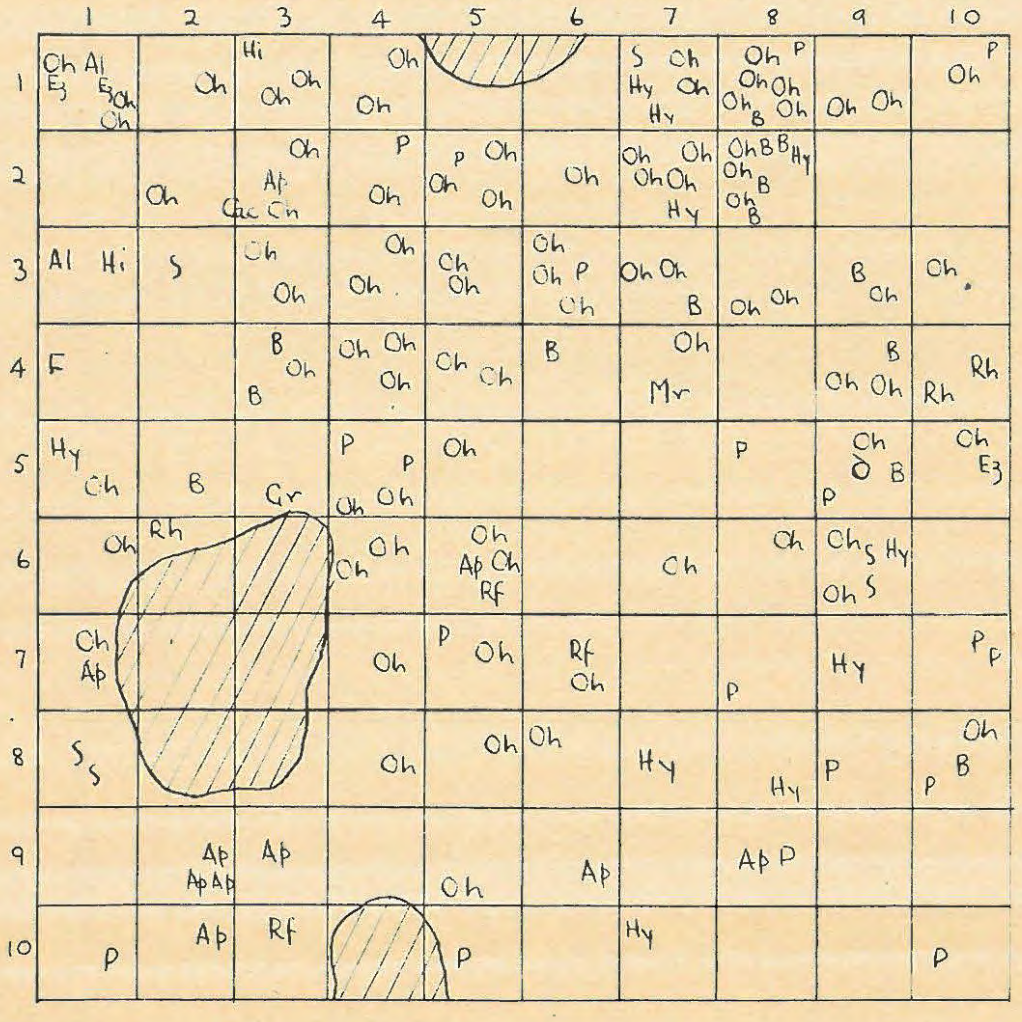
Species.	Number of Individuals.
Oplismenus hirtellus	80
Plectranthus ciliatus	18
Burchellia bubalina	13
Hypoestes verticillaris	10
Apodytes dimidiata	10
Senecio deltoideus	6
Rhoicissus cuneifolia	4
Eugenia zeyheri	3
Rhus legati	3
Asparagus plumosus	2
Hippobromus pauciflorus	2
Cassinopsis capensis	1
Pagara capensis	1
Grewia occidentalis	1
Rhamnus racemulosa	1
Olea laurifolia	1

Oplismenus hirtellus is again conspicuous. Young plants of Burchellia bubalina are in evidence and seedlings of Apodytes dimidiata occur for the last time in the forest quadrats.

Rare occurrences : Rhus legati, Rhamnus racemulosa and Cassinopsis capensis.

FERN KLOOF — FOREST.

QUADRAT Q4 DATE 15. 6. 49.



S - Senecio deltoideus Less.
Oh - Oplismenus hirtellus P Beauv
Ez - Eugenia zeyheri Harv.
Hi - Hippobromus pauciflorus Radlk.
Hy - Hypoestes verticillaris R Br.
P - Plectranthus ciliatus E. Mey.
Ap - Apodytes dimidiata E Mey
Al - Asparagus plumosus Baker
F - Fagara capensis Thunb.
Cac - Cassinopsis capensis Sond.
B - Burchellia bubalina Sim.
Mr - Maerua racemulosa Gilg + Benedict.
Rh - Rhus Legati Schonl
Gr - Grewia occidentalis Linn
Rf - Rhoicissus cuneifolia Planch
O - Olea laurifolia Lam

QUADRAT Q5.

Q5 is situated on the west side near the bottom margin of the forest. It is about 13 yards from the main path and below the very badly trampled area in the centre of the plot.

Total number of individuals 138. Number of species.11.

Species.	Number of Individuals.
Plectranthus ciliatus	64
Oplismenus hirtellus	32
Streptocarpus rexii	11
Crassula spatulata	8
Cyperus albostriatus	4
Unidentified Grass	3
Seemanne alpini	3
Asparagus plumosus	2
Olinia cymosa	1
Asplenium cuneatum	1
Rhodobryum umbraculum	small patch

The quadrat has Plectranthus ciliatus widely scattered.

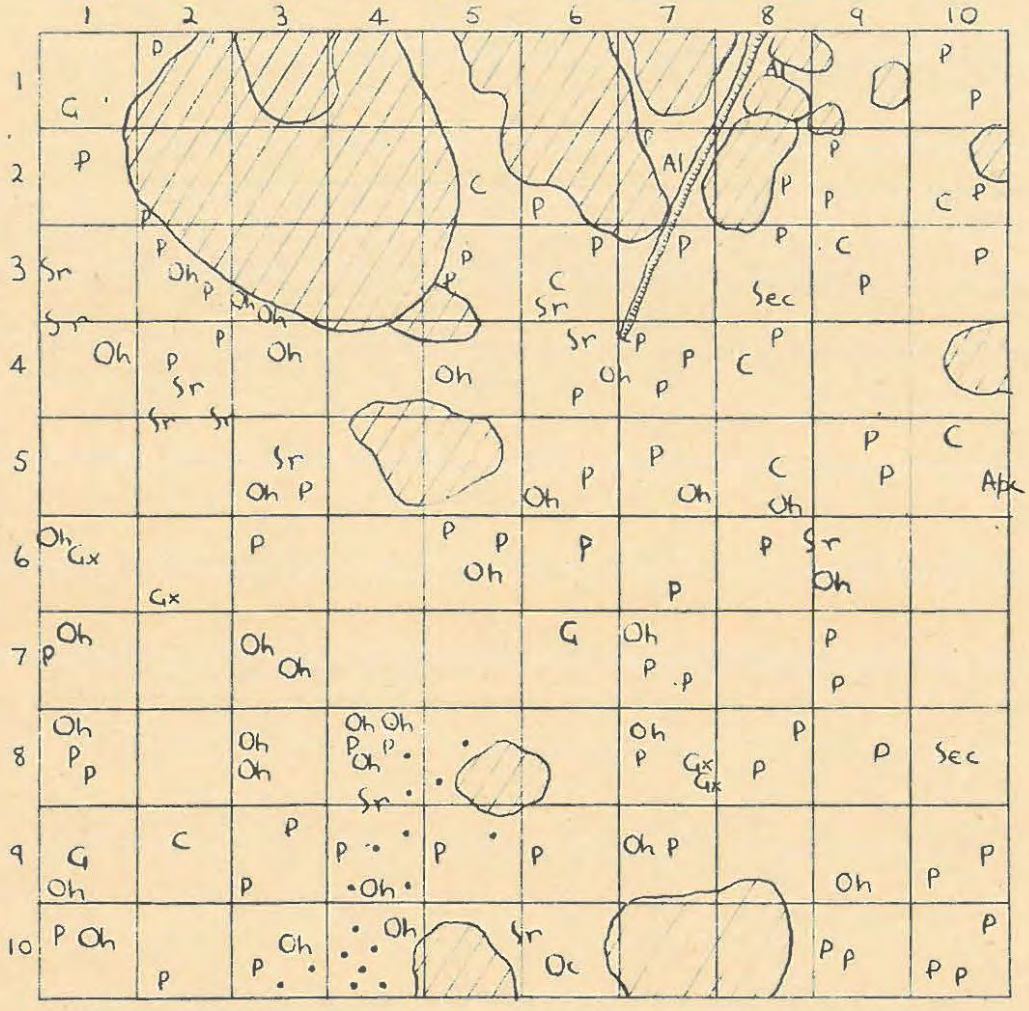
Streptocarpus rexii grows in clumps here. The unidentified Cyperaceae is again Cyperus albostriatus. There are no tree seedlings.

Asplenium cuneatum makes its first and last appearance in the quadrats.

At the bottom of Q5 there is a small patch of Rhodobryum umbraculum, one of the few non-colonial mosses. The list of mosses in the appendix includes data on the substrate on which they grow.

FERN KLOOF — FOREST.

QUADRAT Q5 DATE 15 6 49.



G = Unidentified Grass.
Al - Asparagus plumosus Baker.
P - Plectranthus ciliatus E Mey.
C - Crassula spatulata Thunb.
Sr - Streptocarpus rexii Lindl.
Gx - Unidentified Cyperaceae
Sec - Secamone alpini Schult
Oh - Oplismenus hirtellus P. Beauv
Apc - Asplenium cuneatum.
Oc - Olinia cymosa Thunb.
• - Rhodobryum umbraculum (Esch

ROOT

QUADRAT QG.

Situated 13 yards of the main path near the bottom margin of the forest QG is remarkable in being almost completely covered with loose stones leaving very little space for plants. The roots serve, to some extent, to keep the stones from moving.

Total number of individuals 65. Number of species 12.

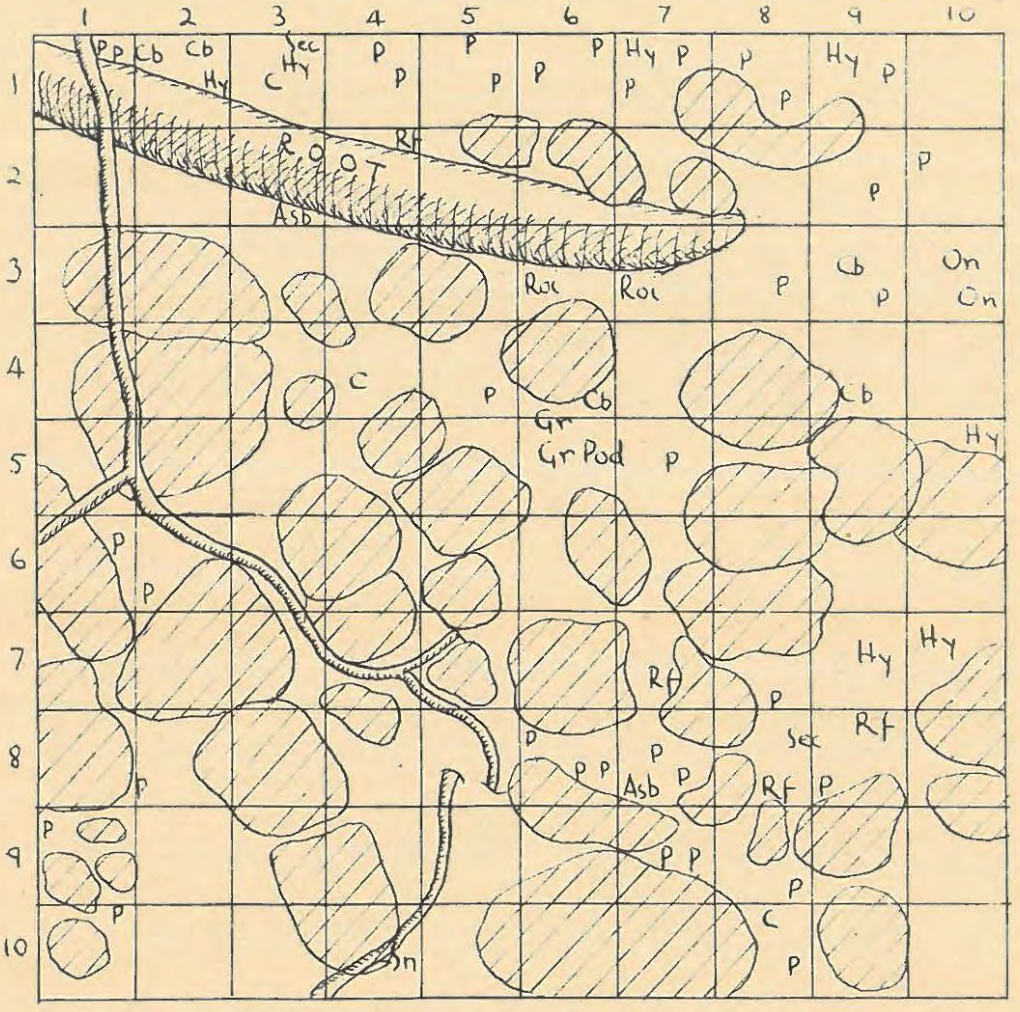
Species.	Number of Individuals.
Plectranthus ciliatus	34
Hypoestes verticillaris	7
Carissa bispinosa	5
Rhoicissus cuneifolia	4
Crassula spatulata	3
Grewia occidentalis	2
Cayndicarpos natalensis	2
Rhoicarpos capensis	2
Secamone alpini	2
Asplenium bipinnatum	2
Podocarpus latifolius	1
Scutia myrtina	1

Only 4 members of the ground flora are present, the remainder are creepers, shrubs or seedling trees. Plectranthus and Hypoestes, by virtue of their rambling habit, can find sufficient footing in the scant humus in between the rocks.

Podocarpus latifolius, Scutia myrtina and Cayridicarpos natalensis occure for the first time in the quadrats. Podocarpus latifolius seedlings are rare in Fern Kloof.

FERN KLOOF — FOREST.

QUADRAT Q6 DATE 15.6.49



P – Plectranthus ciliatus E Mey.
Cb – Carissa bispinosa Desf
C – Crassula spatulata Thunb.
Sec – Senecio alpini Schult.
Hy – Hypoestes verticillaris R Br.
Pod – Podocarpus latifolius Endl.
Rf – Rhoicissus cuneifolia Planch.
Asb – Asplenium bipinnatum Forsk
On – Osyridicarpos natalensis A DC
Roi – Rhoicarpos capensis A DC
Sn – Scutia myrtina Kunz.
Gr – Grewia occidentalis Linn

ROOT ROCK.

RESULTS OF FOREST QUADRATS.

From the Abundance and frequency columns in Table XVIII it can be seen that:

(1) Plectranthus ciliatus, Oplismenus hirtellus and Hypoestes verticillaris are the chief species of the ground flora.

(2) Plectranthus ciliatus is the most abundant species, but it cannot be called the dominant plant since it only forms 30.9% of the total ground flora. It is, however, distributed through all the quadrats.

(3) 60% of the species is composed of trees, shrubs or creepers. From this it is clear that the herbaceous plants do not form a conspicuous element of the forest. Only where there have been breaks in the canopy do herbaceous plants grow to any extent.

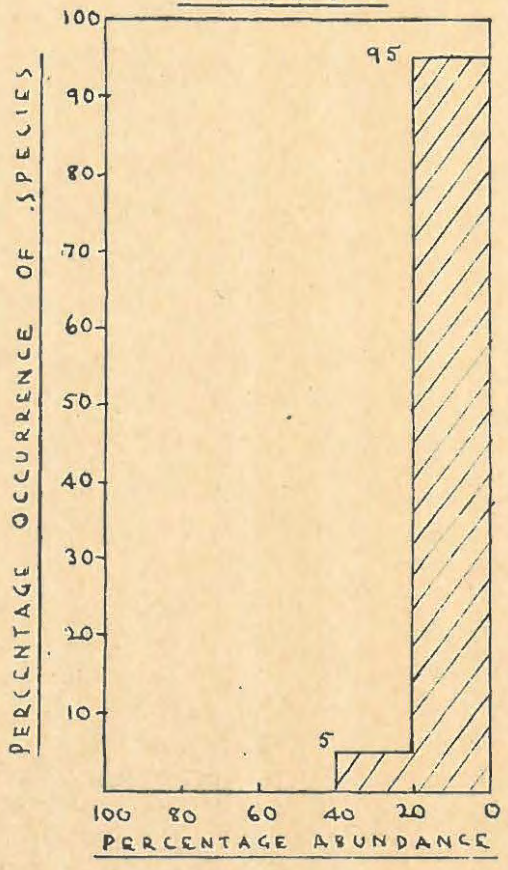
The quadrats contain most of the forest ground flora species.

(4) Histogram 9 shows that 95% of the species occur very frequently and therefore their distribution in the forest is limited.

HISTOGRAMS SHOWING ABUNDANCE OF SPECIES IN QUADRATS

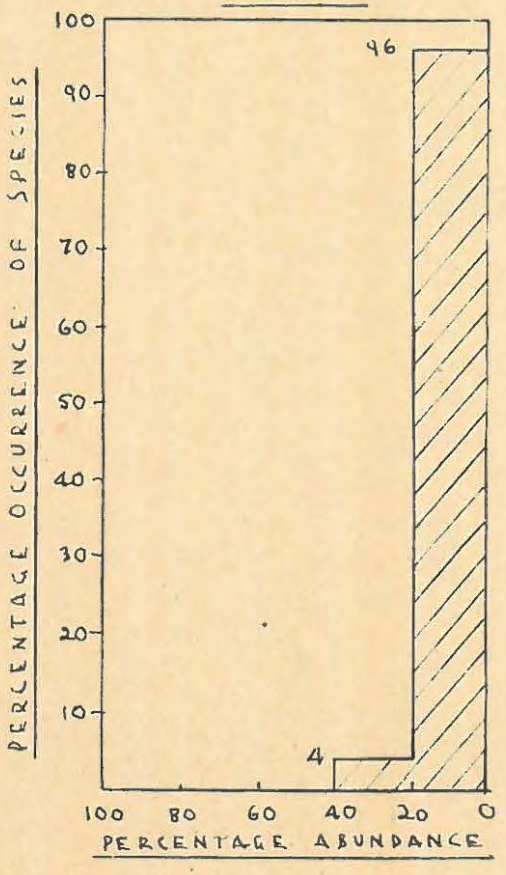
9

FOREST



10

PINE



RESULTS OF FOREST QUADRATS.

TABLE XVIII

Total number of Individuals 728. Number of species 45.

	Species.	Actual Number of Individuals	ABUNDANCE Total Indiv. %	FREQUENCY Total 6
	Plectranthus ciliatus	225	30.9	6
	Oplismenus hirtellus	163	22.4	4
T	Apodytes dimidiata	94	12.9	4
	Hypoestes verticillaris	22	3.0	5
T	Olea laurifolia	21	2.9	4
	Senecio deltoideus	19	2.6	4
	Cressula spatulata	16	2.2	4
•	Burchellia bubalina	16	2.2	3
•	Rhoicissus cuneifolia	16	2.2	5
	Cyperus albostriatus	15	2.1	3
	Streptocarpus rexii	14	1.9	2
•	Seemannia alpini	8	1.1	4
	Asparagus africanus	7	.9	2
T	Fagara capensis	7	.9	4
•	Grewia occidentalis	7	.9	3
T	Clausena inaequalis	6	.8	2
	Unidentified grasses	6	.8	3
•	Rhoicarpos capensis	6	.8	3
	Asparagus plumosus	5	.7	3
	Argyrolobium tomentosum	5	.7	3
•	Canthium ciliatum	5	.7	3
•	Carissa bispinosa	5	.7	1
T	Eugenia zeyheri	4	.6	2
T	Gymnosporia pedunculoris	4	.6	2
T	Scolopia mundtii	4	.6	3
	Asplenium bipinnatum	4	.6	2
•	Hippobromus pauciflorus	3	.4	2
T	Rhus legati	3	.4	1
•	Cassinopsis capensis	2	.3	2
•	Doryalis rhamnoides	2	.3	2
•	Gardenia neuberia	2	.3	2
•	Oxyridicarpos natalensis	2	.3	1
•	Royena lucida	2	.3	2
	Asparagus sedooloides	1	.2	1
	Brownlowa coerulea	1	.2	1
-	Ceratiosicyos ecklonii	1	.2	1
	Cynodon dactylon	1	.2	1
	Dracaena hookeriana	1	.2	1

	Species.	Actual Number of Individuals	ABUNDANCE Total Indiv. %	FREQUENCY Total 6
	Legume seedling	1	.2	1
•	Murraya racemulosa	1	.2	1
T	Olinia cymosa	1	.2	1
T	Podocarpus latifolius	1	.2	1
•	Scutia myrtina	1	.2	1
T	Vepris lanceolata	1	.2	1
	Asplenium cuneatum	1	.2	1

Where:-

• is Shrub

~ is Creeper or Liane

T is Tree.

Abundance is the number of rooted shoots of a species expressed as a percentage of the total number of rooted shoots for all species.

Frequency is the number of sample areas containing a species out of a total number of sample areas - this has not been expressed as a percentage.

THE TRANSITION ZONE.

QUADRAT 97.

Immediately outside the forest is Q7. It is 15 yards from the main path on the west side. Pine needles cover the surface.

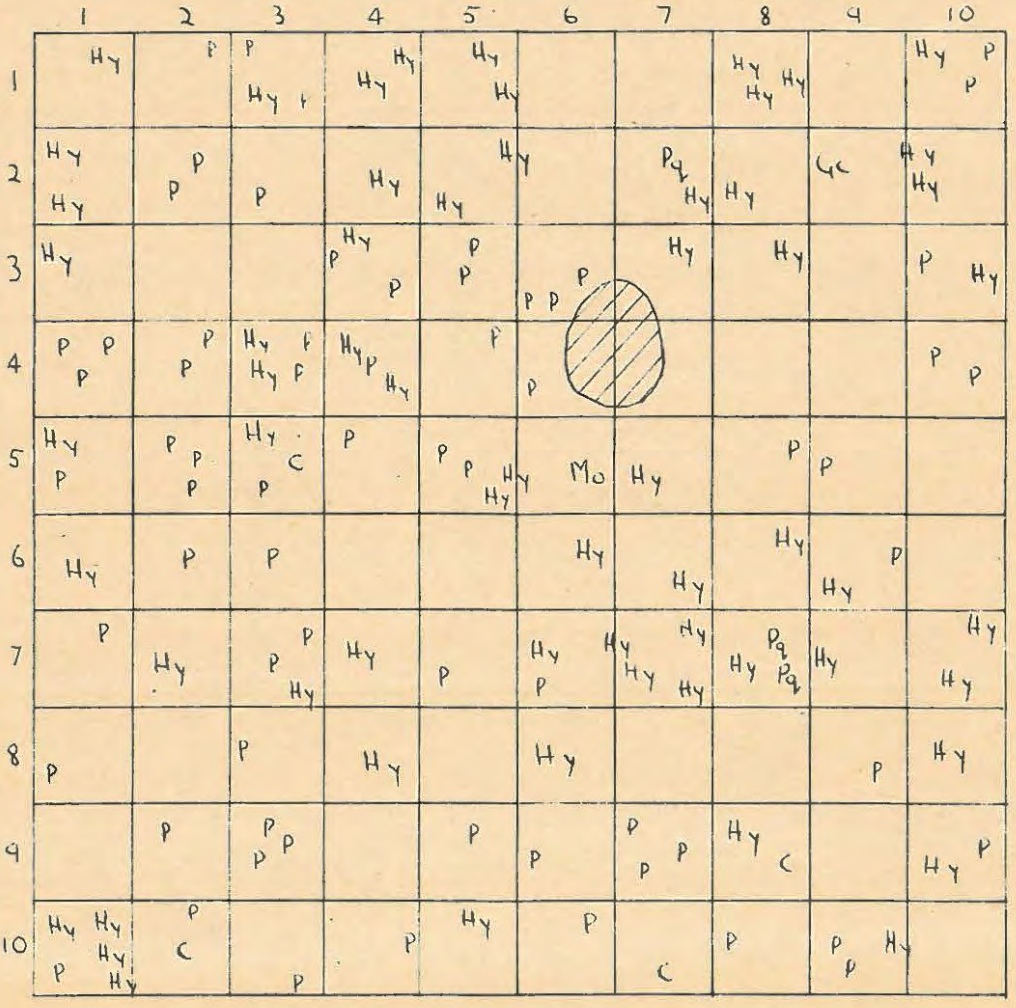
Total number of individuals 137. Number of species 6.

Species.	Number of Individuals.
Plectranthus ciliatus	67
Hypoestes verticillaris	61
Crassula spatula	4
Pteridium aquilinum	3
Galopina circaeoides	1
Mohria sp	1

The whole quadrat consists of a tangled mass of Plectranthus and Hypoestes. The latter species is particularly characteristic of the margin and outskirts of the forest. Pteridium aquilinum appears once. The species Galopina circaeoides grows abundantly on the forest floor but is not recorded from any of the forest quadrats, it also grows to a limited extent in the pine forest.

FERN KLOOF – FOREST TO PINE.

QUADRAT Q7 DATE 16.6.49



P- Plectranthus ciliatus E Mey
Hy- Hypoestes verticillaris R Br.
Pq- Pteridium aquilinum Linn.
Gc- Galopina circaeoides Thunb.
C - Crassula spatulata Thunb
Mo- Mohria sp.

QUADRAT Q8.

Like Q7 this quadrat is in the transition region between indigenous forest and pine forest. It is about 25 yards east of the main path and near the tall pine tree marked on the map. The outcrop of Witteberg quartzite provides numerous cracks and hollows which are colonised by plants.

Total number of individuals 136. Number of species 10.

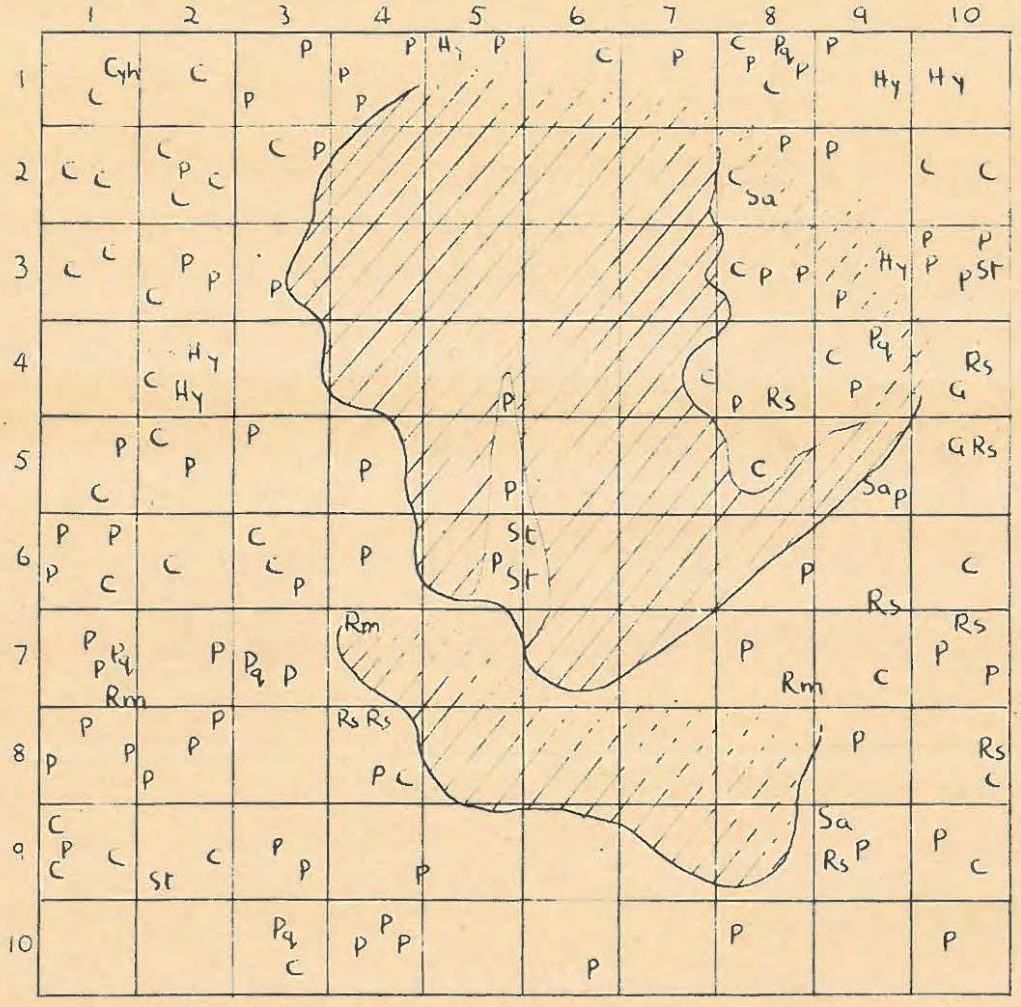
Species.	Number of Individuals.
Plectranthus ciliatus	66
Crassula spatulata	38
Pleinia trichodes	9
Hypoestes verticillaris	8
Pteridium aquilinum	5
Rapanea melanophloeos	3
Senecio tropaeolifolius	3
Unidentified Grass	2
Cyphia heterophylla	1

Plectranthus ciliatus is still prevalent. Senecio angulatus and S. tropaeolifolius are seen for the first time. Both are climbers, the latter is found in the pine and has not been observed in the forest. The former on the other hand is found in both communities but more often on the margin.

Another climber Cyphia heterophylla occurs in the quadrat; it is characteristic of open fynbos though it has been found in the forest. The extremely tolerant tree Rapanea melanophloeos has its only occurrence among the quadrats in S. At Fern Kloof it fulfils the function of (a) a pioneer on the outskirts of the forest and (b) one of the canopy forming trees.

FERN KLOOF – FOREST TO PINE.

QUADRAT Q8 DATE 16.6.49.



C- Crassula spatulata Thunb.
P- Plectranthus ciliatus E Mey.
Hy- Hypoestes verticillaris R. Br.
Pq- Pteridium aquilinum Linn.
Cyh- Cyphia heterophylla Presl
Sa- Senecio angulatus Linn.
St- Senecio tropaeolifolius MacOwan
Rm- Rapanea melanophloeos R. Br.
G - Unidentified Grass
Rs- Ficinia trichodes (Schrad) Benth

RESULTS OF TRANSITION QUADRATS.

The most important change is the almost complete absence of shrub and tree seedlings in the transition zone. See Table XIX. Although Plectranthus ciliatus is still the most abundant plant, Hypoestes verticillaris has increased in importance. Pteridium aquilinum, a plant characteristic of open localities occurs here for the first time.

ANALYSIS OF TRANSITION QUADRATS 37 - 60.

TABLE XIX.

Total number of individuals 275. Maximum number of occurrences 2.

Species.	Actual Number of Individuals.	ABUNDANCE. Total Indiv. %	FREQUENCY. Total 2
Plectranthus ciliatus	133	47.3	2
Hypoestes verticillaris	69	25.1	2
Crassula spatulata	42	15.3	2
Ficinia trichodes	9	3.3	1
Pteridium aquilinum	8	2.9	2
Rapanea melanophloeos	3	1.1	1
Senecio angulatus	3	1.1	1
Senecio tropaeolifolius	3	1.1	1
Unidentified Grasses	2	.7	1
Cyphia heterophylla	1	.4	1
Calopsina cirsioides	1	.4	1
Mohria sp.	1	.4	1

Abundance is the number of rooted shoots of a species expressed as a percentage of the total number of rooted shoots for all species. Frequency is the number of sample areas containing a species out of a total number of sample areas. This has not been expressed as a percentage.

THE PINE ZONE.

QUADRAT Q 9.

Well into the pine 9 yards west of the main path is Q9, covered almost completely by Hypoestes verticillaris and surrounded by low thickets of bramble and bracken. The pines do not overshadow Q9 to any extent and so there is no lack of sunshine.

Total number of individuals 105. Number of species 5

Species.	Number of Individuals.
Hypoestes verticillaris	87
Plectranthus ciliatus	12
Pteridium aquilinum	3
Leonotis leonurus	2
Mohria sp	1

Plectranthus ciliatus numbers have dropped considerably, in fact the plant does not occur again in any of the quadrats. A smaller leafed species of Plectranthus, P. thunbergii is found fairly frequently in the pine but does not come into the quadrats. Leonotis leonurus, a striking plant when in flower, is more abundant than the figures lead one to suspect, and with Plectranthus sp and Hypoestes sp forms a conspicuous element along footpaths on the margins of forest and also in the pine.

FERN · KLOOF — PINE.

QUADRAT Q9 DATE 16.6.49.

	1	2	3	4	5	6	7	8	9	10
1	P	P	Hy		Hy			Hy Pq Hy		
2	P	Hy		Hy			Hy	Pq	Hy Hy	Hy
3			Hy Hy	Hy	Hy		Hy	Hy		Hy Hy Hy
4	Hy		Hy Hy	Hy Hy Hy		Hy	Hy		Hy Hy Hy	Hy
5	Hy Hy	Hy Hy Hy Hy				Hy Mo	Hy	Hy	Hy	
6	Hy Hy	Hy Hy Hy	P		Hy	Hy Hy Hy	Hy	Hy LL	Hy	
7	Hy		Hy	Hy		Hy	Hy	Hy	Hy	
8		Hy	Hy	Hy Hy	Hy Hy			Hy Hy Hy	Hy	Hy
9	P P P	P Hy Hy	Hy Hy	Hy	Hy Pq Hy		Hy	Hy	Hy	
10	P P P P	P	Hy	LL Hy		Hy	Hy	Hy Hy	Hy	Hy Hy

Hy - Hypoestes verticillaris R Br.
P - Plectranthus ciliatus E. Mey.
LL - Leonotis leonurus R. Br.
Pq - Pteridium aquilinum Linn
Mo - Mohria sp.

QUADRAT Q10.

It is situated among the large scattered outcrops of rock and it is covered with a thick layer of pine needles.

Total number of individuals 159. Number of species 10.

Species.	Number of Individuals.
Senecio deltoideus	123
Unidentified Grasses	12
Pteridium aquilinum	6
Lycopodium intermedia	4
Aspalanthus sp	3
Berkheya lanceolata	3
Hypoestes verticillaris	3
Leonotis leonurus	2
Peucedanum capense	2
Oplismenus hirtellus	1

Senecio deltoideus, a small delicate creeper is exceptionally abundant.

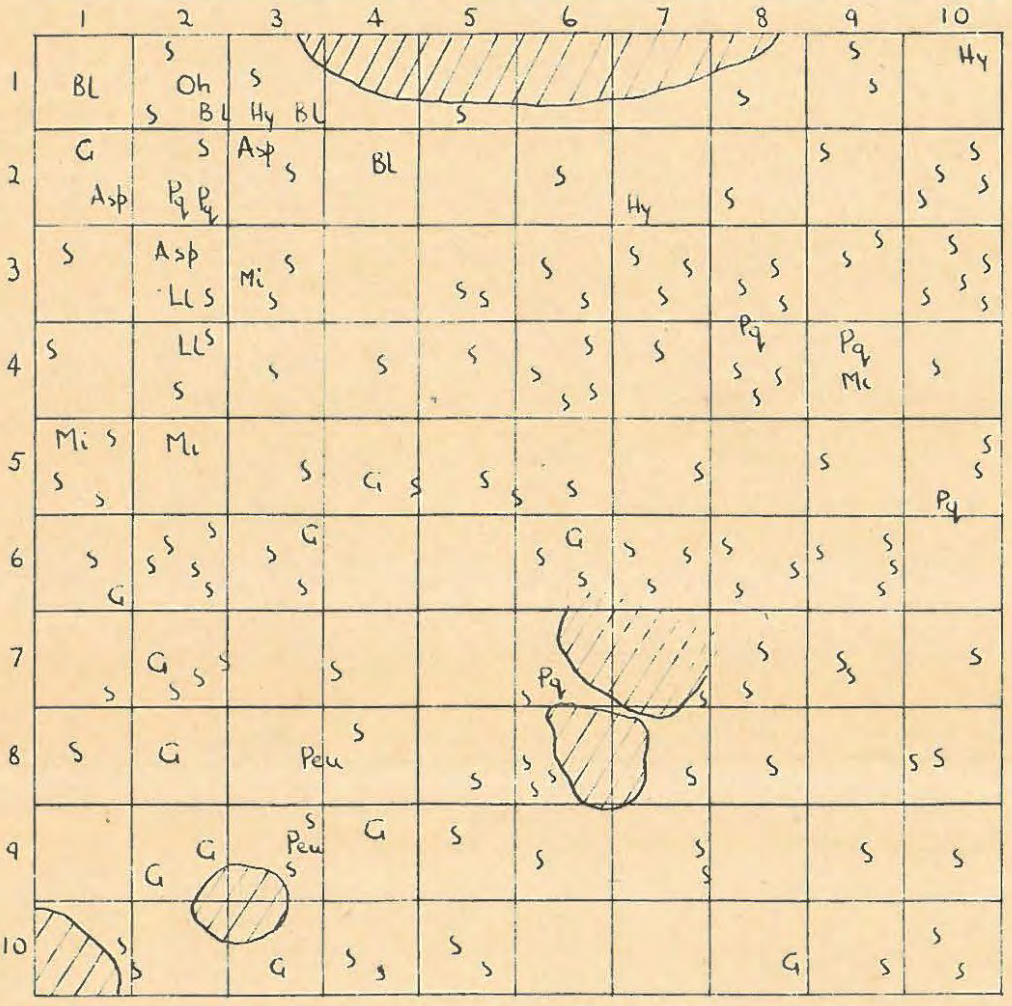
The grasses, are characteristic of the ultimate phase of pine domination and in this part they are becoming conspicuous.

Aspalathus sp, Berkheya lanceolata and Peucedanum capense are typical members of the South-Western Cape Flora.

The record of Oplismenus for the pine is baffling since it is normally found only in forests.

FERN KLOOF — PINE.

QUADRAT Q10 DATE 16.6.49.



Bl - Berkheya lanceolata Willd.
S - Senecio deltoideus Less
Oh - Oplismenus hirtellus P. Beauv
Pq - Pteridium aquilinum Linn.
Mi - Myosotis intermedia Link.
Asp - Aspalathus sp.
LL - Leonotis leonurus R. Br.
Peu - Peucedanum capense Sond.
G - Unidentified grass.
Hy - Hypoestes verticillaris R Br

QUADRAT Q11.

Q11 is 6 yards below the main path in the middle of the plot on a rather steeper part than the rest of quadrats and has small stones distributed through it.

Total number of individuals 70. Number of species 13.

Species.	Number of Individuals.
Senecio deltoideus	32
Pteridium aquilinum	11
Ficinia trichodes	8
Senecio juniperinus	5
Anthospermum herbaceum	2
Berkheya lanceolata	2
Cluytia pulchella	2
Helichrysum petiolatum	2
Pinus pinaster seedlings	2
Scabiosa columbaria	1
Thesium fruticosum	1
Pellaea viridis	1
Oxalis sp	1

Again Senecio deltoideus is evident. Pteridium aquilinum shows an increase in number. On the right side of the quadrat there is a small cluster of Ficinia trichodes.

Senecio juniperinus is often found associated with pine woods where there has been felling and disturbance.

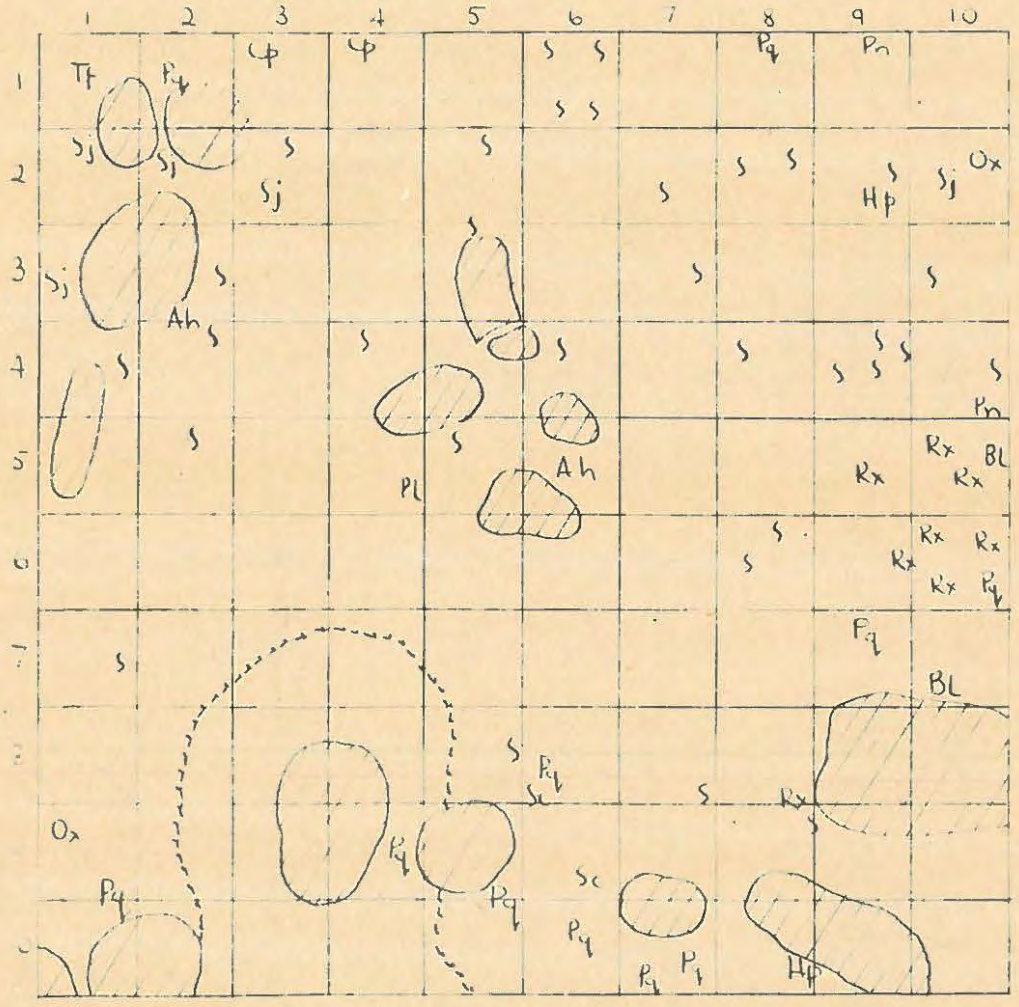
The Pinus pinaster seedlings have died from the drought.

Thesium fruticosum a member of the South-Western Cape Flora makes a belated appearance in Q11, although it is never very abundant. Cluytia pulchella and Scabiosa columbaria are found occasionally in the pine.

The patches of moses growing on the soil surface are Ptychomitrium crispatum.

FERN KLOOF — PINE.

QUADRAT Q11 DATE 17 6 49



Cp - Claytia pulchella L.
Th - Thesium frutescosum A.W. Hill
Pq - Pteridium aquilinum Linn
S - Senecio deltoideus Less
Pl - Pellaea viridis Prantl
Bl - Berkheya lanceolata willd
Sj - Senecio juniperinus Linn.

Ah - Anthospermum herbaceum Linn
Sc - Scabiosa columbaria Linn
Ox - Oxalis sp
Hp - Helichrysum petiolatum DC
Rx - Ficinia ...
Pn - Pinus pinaster Ait

Ptychomitrium crispatum ... P. Sch

QUADRAT Q12.

Also on a steep slope Q12 is 20 yards from the path on the west side of the plot. Just outside it are some healthy specimens of Erica demissa. The patches of moss are probably Rhychomitrium crispatum.

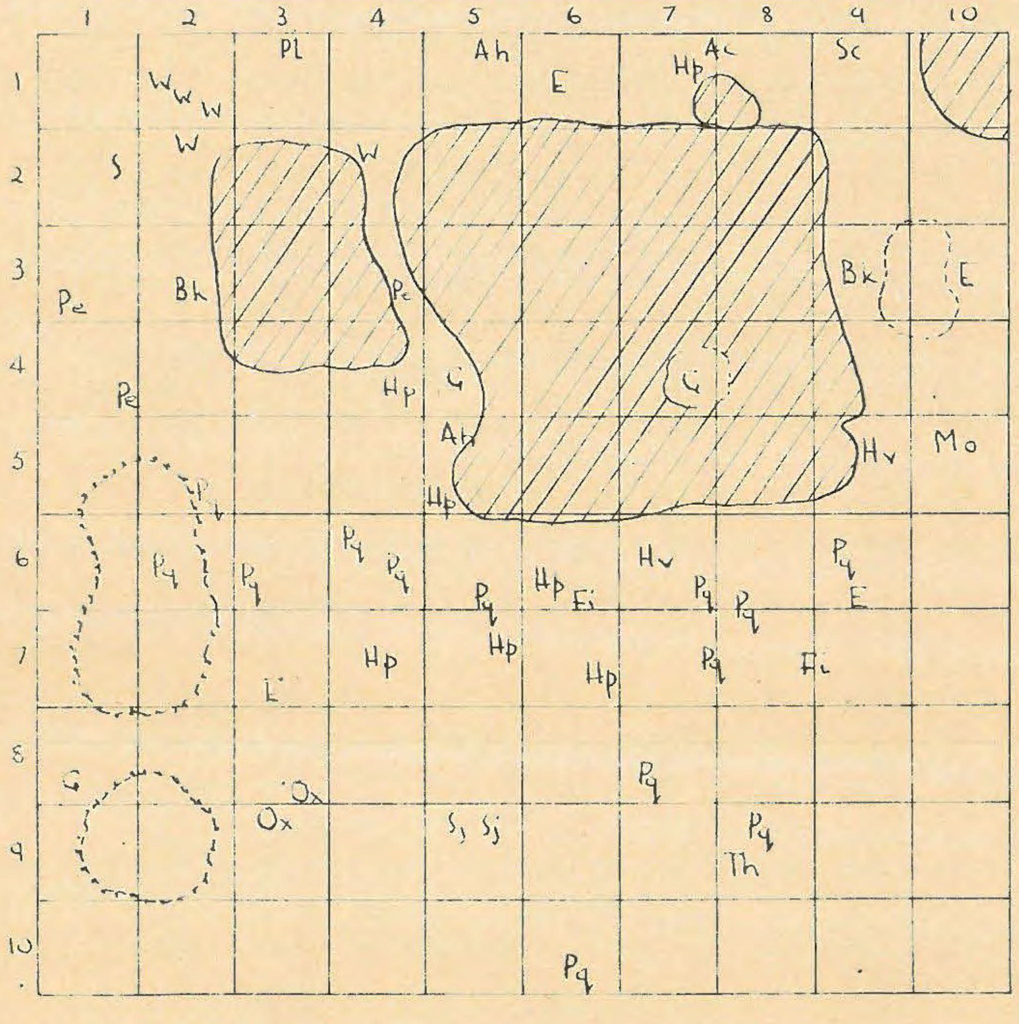
Total number of individuals 52. Number of species 18.

Species.	Number of Individuals.
Pteridium aquilinum	13
Helichrysum petiolatum	7
Watsonia marianna	5
Panicum ecklonii	3
Elionurus argenteus	3
Unidentified Grass	2
Berkheya carduoides	2
Anthospermum herbaceum	2
Ficinia trichodes	2
Hypoxis villosa	2
Oxalis smithii	2
Senecio juniperinus	2
Alchemilla capensis	1
Scabiosa columbaria	1
Thesium frutiscosum	1
Pellaea viridis	1
Mohria sp	1
Senecio deltoideus	1

Q12 has the greatest number of species present in any of the pine quadrats. Nearly all the species belong to the South Western Cape Flora and few of them are found elsewhere in the pine.

FERN KLOOF – PINE.

QUADRAT Q12 DATE 17.6.49.



S – Senecio deltoideus Less.
Pq – Pteridium aquilinum L.
W – Watsonia meriana Mill
Ah – Anthospermum herbaceum Linn
Hp – Helichrysum petiolatum DC.
Sj – Senecio juniperinus Linn
Pe – Panicum ecklonii Nees.
Th – Thesium fruticosum L
Ox – Oxalis smithii Sond.

Hv – Hypoxis villosa Linn
Mo – Mohria
PL – Pellaea viridis Prantl.
Ac – Alchemilla capensis Thunb
Sc – Scabiosa columbaria Linn
E – Elionurus argenteus Nees.
Bk – Berkheya carduoides Less.
Fi – Ficinia trichodes Schrad.
G – Unidentified grass.

( ) Ptychomitrium crispum Wrich. [ ] Rock.

QUADRAT Q13.

This quadrat is situated on the east side of the plot near the bottom corner. At this point the slop is very slight.

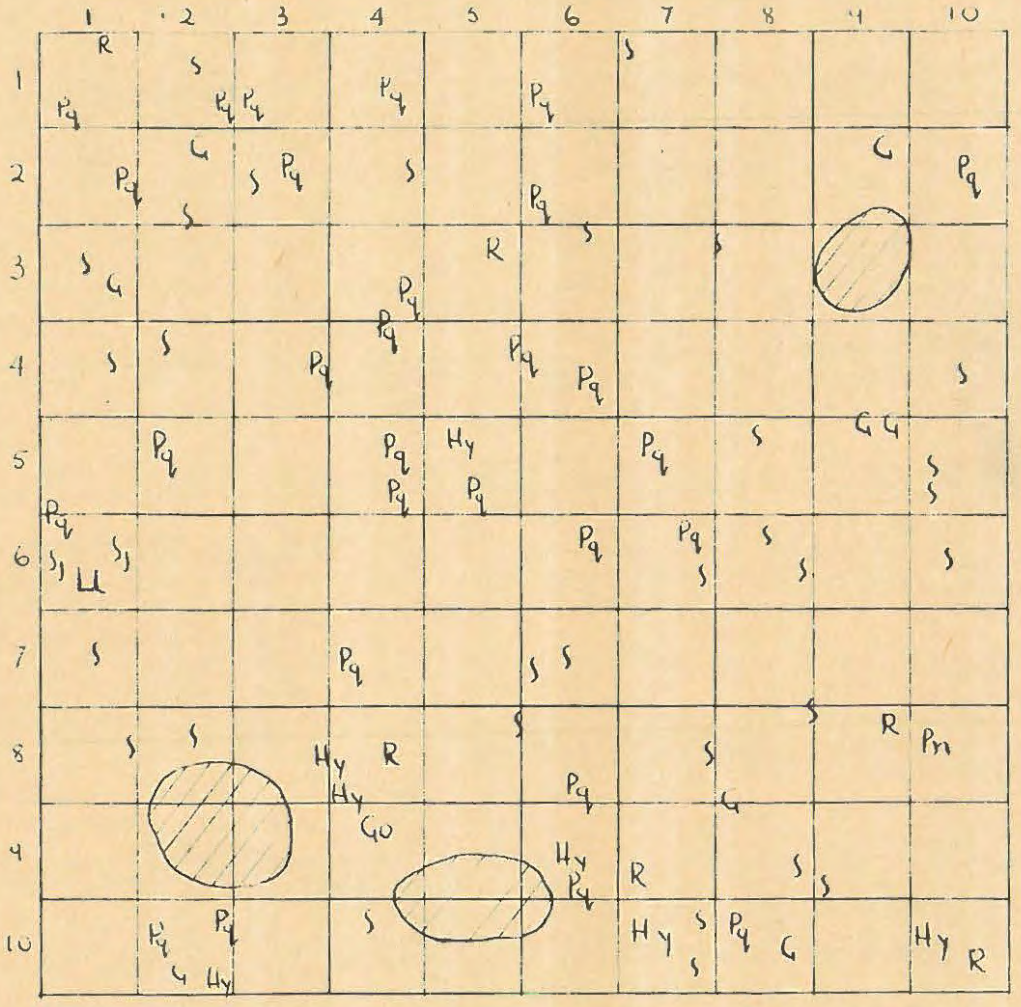
Total number of individuals 84. Number of species 9.

Species.	Number of Individuals.
Senecio deltoideus	31
Pteridium aquilinum	28
Unidentified Grass	8
Hypericum vertisillaris	7
Rubus pinnatus	6
Geranium ornithopodium	1
Leonotis leonuris	1
Pinus pinaster seedlings	1
Senecio juniperinus	1

Pteridium aquilinum is the most prominent plant, though Senecio deltoideus is numerically more abundant. The bramble (Rubus pinnatus) provides protection from trampling for the more delicate plants e.g. Senecio deltoideus and Geranium ornithopodium.

FERN KLOOF — PINE.

QUADRAT Q13 DATE 17.6.49



Pq - Pteridium aquilinum L.
R - Rubus pinnatus Willd.
G - Unidentified Grass
S - Senecio deltoideus Less.
Sj - Senecio juniperinus Linn
LL - Leonotis leonurus R. Br
Hy - Hypoestes verticillaris R Br
Go - Geranium ornithopodium E+Z.
Pn - Pinus pinaster Ait.

QUADRAT Q14.

The last quadrat Q14 is 3 yards from the marker pine at the bottom of the plot. This quadrat comes in for a certain amount of trampling as there is an ill-defined path crossing it.

Total number of individuals 142. Number of species 10.

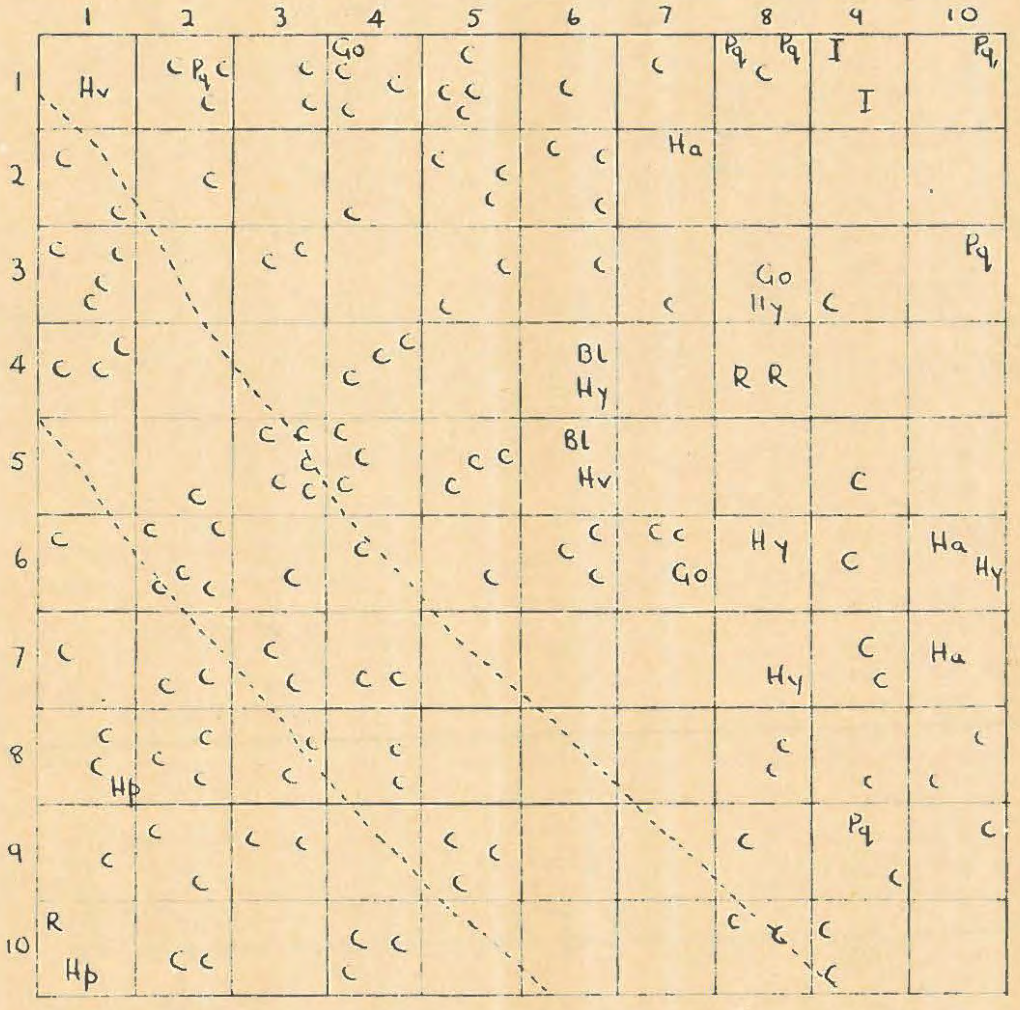
Species.	Number of Individuals.
Crassula spetulata	114
Pteridium aquilinum	6
Hypocotes verticillaris	5
Geranium ornithopodium	3
Helichrysum anomalum	3
Rubus pinnatus	3
Berbheya lanceolata	2
Helichrysum petiolatum	2
Hypoxis villosa	2
Indigofera hedyantha	2

Crassula spetulata is very abundant.

Pteridium aquilinum, Helichrysum petiolatum and Rubus pinnatus grow in great confusion for although their numbers are small they cover a wide area. Indigofera hedyantha is rare, it does occur elsewhere in the pine. Helichrysum anomalum Berbheya lanceolata, Hypocotes verticillaris and Hypoxis villosa are characteristic of this part.

FERN KLOOF — PINE.

QUADRAT Q14 DATE 14.6.49.



Hv-Hypoxis villosa Linn.
C - Crassula spatulata Thunb
Go-Geranium ornithopodium E+Z
Hy- Hypoestes verticillaris R.Br
Pq - Pteridium aquilinum L.
Lightly tramped Path.

R. -Rubus pinnatus Willd
Hp-Helichrysum petiolatum DC
Bl - Berkheya lanceolata Willd.
I - Indigofera hedyantha E+Z
Ha Helichrysum anomalum Less.

RESULTS OF FIRE QUADRATS.

Analysis of the results in Table XX illustrate the following features:

(1) Since 90% of the species in the quadrats are herbaceous it follows that the ground flora is a well defined feature. Many of the plants are members of the South Western Cape Flora and their distribution is patchy. A number of species do not occur in the quadrats but they are of limited occurrence anyway.

(2) The species occurring most abundantly i.e. Senecio deltoideus, Crassula spatulata, Hypoestes verticillaris and Pteridium aquilinum differ from those in the forest. The more widely distributed ones are, however, common to both. Once again there is no dominance.

(3) From histogram 10 it can be seen that 90% of the species occur infrequently.

There is then in this small area a heterogeneous assortment of plants from different communities and from this it is assumed that the vegetation is in a state of flux.

RESULTS OF PINE QUADRATS.

TABLE XX.

Total number of individuals 600. Number of species 33.

Species.	Actual Number of Individuals	ABUNDANCE Total Indiv. %	FREQUENCY Total 6
Senecio deltoideus	187	30.7	4
Cressula spetulata	114	18.7	1
Hypoestes verticillaris	102	16.8	4
Pteridium aquilinum	67	11.0	4
Unidentified grasses	23	3.8	3
Plectranthus ciliatus	12	2.0	1
Helichrysum petiolatum	11	1.8	2
Ficina trichodes	10	1.6	2
Senecio juniperinus	8	1.3	3
Berkheya lanceolata	7	1.2	3
Rubus pinnatus	7	1.2	2
• Leonotis leonurus	5	.8	3
Watsonia meriana	5	.8	1
Anthospermum herbaceum	4	.7	2
Geranium ornithopodium	4	.7	2
Hypoxis villosa	4	.7	2
Hyptis intermedia	4	.7	1
Aspalathus sp	3	.5	1
Eliomurus argenteus	3	.5	1
Helichrysum anomalum	3	.5	1
Oxalis smithii	3	.5	2
Panicum ecklonii	3	.5	1
T Pinus pinaster	3	.5	2
Cluytia pulchella	2	.3	1
Indigofera hedyantha	2	.3	1
Pencedanum caponse	2	.3	1
Scabiosa columbaria	2	.3	2
Thesium fruticosum	2	.3	2
Pellaea viridis	2	.3	2
Rubria sp	2	.3	2
Alchemilla capensis	1	.2	1
Berkheya carduoides	1	.2	1
Ophiomenus hirtellus	1	.2	1

Where: • is Shrub
× is Creeper
T is Tree.

Abundance is the number of rooted shoots of a species expressed as a percentage of the total number of rooted shoots for all species.

Frequency is the number of sample areas containing a species out of a total number of sample areas - this has not been expressed as a percentage.

THE SHRUB TRANSECTS.

Shrubs are defined as having several branches arising close to the ground as distinct from trees which have a trunk bearing branches in the upper portion of its total height (Henkel 1934). On this assumption it is possible to distinguish between shrubs and trees, but it is not as easy to separate them into distinct layers. Nineteen belt transects (sample area 12 x 3ft.) were completed for the forest and the pine. They were laid out in a line from north south traversing the length of the area. Their positions can be seen from Map 13. Each transect has been charted (see diagrams T_1 - T_{19}). The method used for charting has been to plot the position of each shrub or tree with its height where this has been over 1 foot. Those plants over 10 feet in height have been marked by a thin black ring, while those over 20 feet in height have a thicker and larger ring round the initial marking their position.

ANALYSIS OF FOREST SHRUB TRANSECTS.

The effect of trampling by cattle is shown in the diagrams T_1 - T_{11}. There is a progressive decrease in the number of shrubs per transect which reaches its climax in the region of T_9 where all that remains of the vegetation is a small broken plant

of Cyrtosperma buzifolia and a large tree - Scolopia mundtii. There is of course no ground flora in the worst trampled areas. The lower portion of the forest has many loose stones on the surface, this may also account for the small number of shrubs in this area.

Many of the shrubs and seedlings of trees are under 1 foot in height, indicating that, where conditions permit, germination is readily accomplished.

Transects T_{12} and T_{13} were done in an area where there was very little trampling. The difference is striking. Instead of a rather scanty undergrowth beneath the trees, there is a continuous development of shrubs and trees from ground level to canopy, and herbaceous plants are almost completely absent.

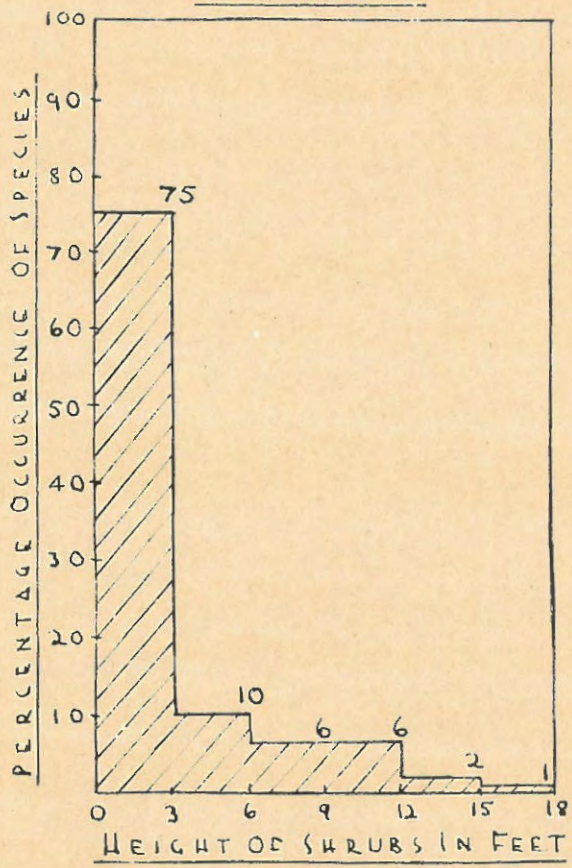
The abundance and frequency of the species occurring in the shrub transects can be seen in Table XXI. Species not occurring in the transects are Hallaria lucida, Cyrtosperma heterophylla, C. acuminata, Heteromorpha arborescens and Psychotria capensis. One fact is immediately apparent, the majority of the shrub layer species are young individuals of tree species which form the canopy. This has been observed by Richards 1939 for forests on the West coast of Africa.

To obtain some idea of the stratification of the shrub layer a histogram has been drawn (11). This shows that 75% of the species constitute a layer not higher than 3 feet. Above this height there is a sharp drop in numbers of species. Since most forest shrubs grow to a maximum height of more than

HISTOGRAMS SHOWING STRATIFICATION OF SHRUBS IN FOREST AND PINE

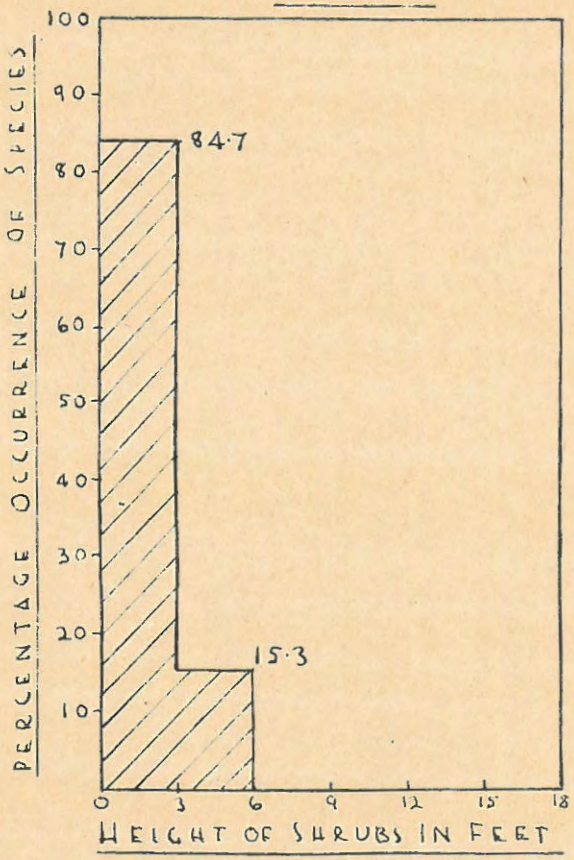
11

FOREST



12

PINE



3 feet it is reasonable to assume that this numerical preponderance in the height group 0' - 3' is purely temporary and that no clear stratification exists.

The shrubs form an important and characteristic feature of the forest.

TABLE XXI.

ANALYSIS OF FOREST SHRUB TRANSECT.

Total number of plants 365.

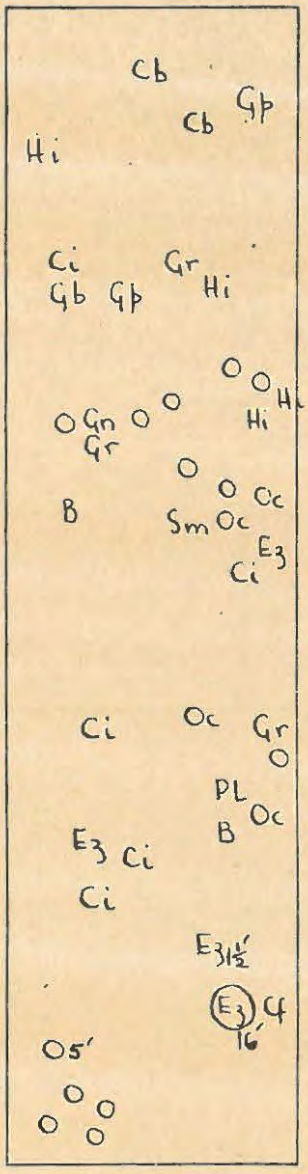
Species.	Actual Number of Plants	PERCENTAGE ABUNDANCE.	FREQUENCY Total 13
Olea laurifolia	64	17.4	8
• Gymnosporia buxifolia	29	7.9	11
~ Rhoicissus cuneifolia	23	6.3	5
Scolopia mundtii	22	6.0	10
Clausena inaequalis	22	6.0	7
Gymnosporia pedunculariis	20	5.4	6
• Burchellia bubalina	18	4.9	6
• Grewia occidentalis	17	4.6	7
• Gardenia neuberia	14	3.8	7
• Royena lucida	13	3.5	7
Apodytes dimidiata	13	3.5	6
Secamone alpini	11	3.0	5
Eugenia zeyheri	10	2.7	6
• Canthium ciliatum	9	2.4	4
• Argyrolobium tomentosum	7	1.9	3
• Carissa bispinosa	7	1.9	4
• Hippobromus pauciflorus	7	1.9	2
Olinia cymosa	6	1.6	2
Pagara capensis	5	1.4	5
Pavetta lanceolata	4	1.1	3
Rapanea melanophloeos	4	1.1	3
~ Rhoicissus capensis	4	1.1	2
• Cryptocarpos natalensis	3	.8	3
• Rhoicarpos capensis	3	.8	2
Cassine kraussiana	3	.8	1
Cussonia spicata	3	.8	3
• Doryalis rhamnoides	3	.8	2
• Casuinopsis capensis	2	.6	2
Curtisia faginea	2	.6	2
Dracaena hookeriana	2	.6	2
• Maerua racemulosa	2	.6	1
Podocarpus latifolius	2	.6	2
• Scutia myrtina	2	.6	1
Rhus legati	1	.3	1
Voyria lanceolata	1	.3	1

Where • is Shrubs
~ is Creepers or lianes

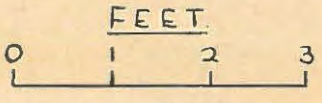
Abundance is the number of rooted shoots of a species expressed as a percentage of the total number of rooted shoots for all species.

FERN KLOOF – FOREST.

SHRUB TRANSECT T1 DATE 5. 8. 49.



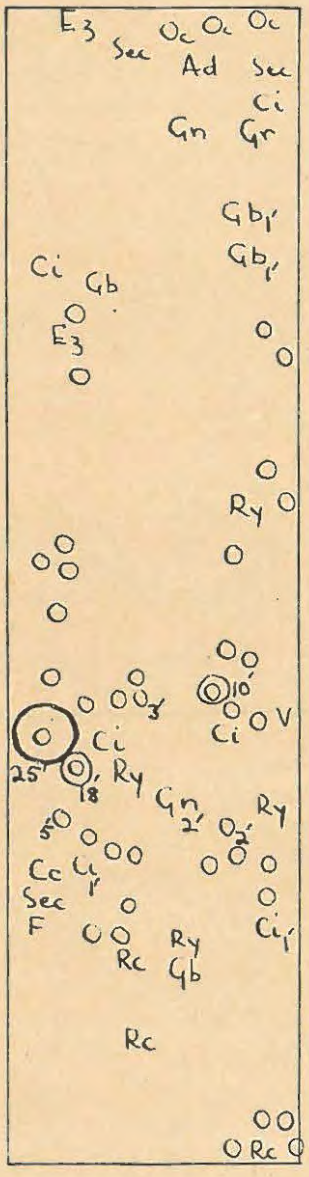
Cb - Carissa bispinosa Desf
Gp - Gymnosporia peduncularis L. Bolus.
Hi - Hippobromus pauciflorus Radlk.
Ci - Clausenia inaequalis Benth.
Gb - Gymnosporia buxifolia Szyszyl.
Gr - Grewia occidentalis Linn.
O - Olea laurifolia Lam.
Gn - Gardenia neuberia E+Z.
Oc - Olinia cymosa Thunb.
B - Burchellia bubalina Sim.
Sm - Scolopia mundtii Warb.
E3 - Eugenia zeyheri Harv.
Pl - Pavetta lanceolata Eckl.
Cf - Curtisia faginea Ait.



SCALE

FERN KLOOF – FOREST.

SHRUB TRANSECT T2 DATE 5. 8. 49.

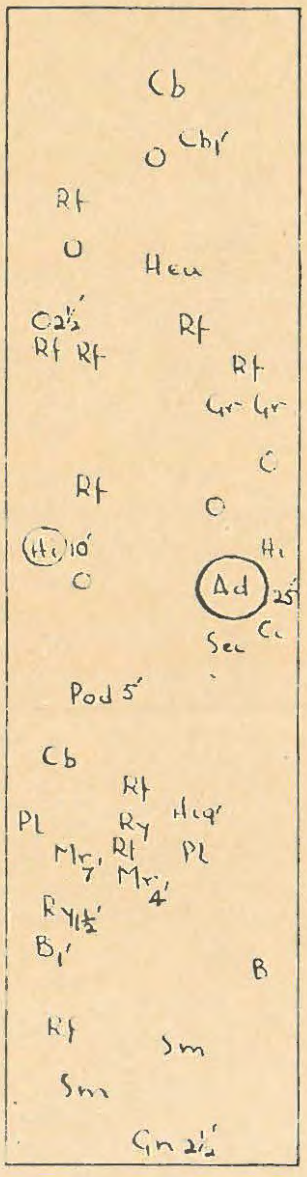


E3 – Eugenia zeyheri Harv.
Sec – Secamone alpini Schult.
Oc – Olinia cymosa Thunb.
Ad – Apodites dimidiata E. Mey.
Ci – Clausena inaequalis Benth.
Gn – Gardenia neuberia E + Z
Gr – Grewia occidentalis Linn.
Gb – Gymnosporia buxifolia Szyszyl.
O – Olea laurifolia Lam.
Ry – Royena lucida Linn.
V – Vepris lanceolata G. Don.
Cc – Canthium ciliatum Sond.
F – Fagara capensis Thunb
Rc – Rhoicissus capensis Planch.

SCALE

FERN KLOOF – FOREST.

SHRUB TRANSECT T3. DATE 5. 8. 49

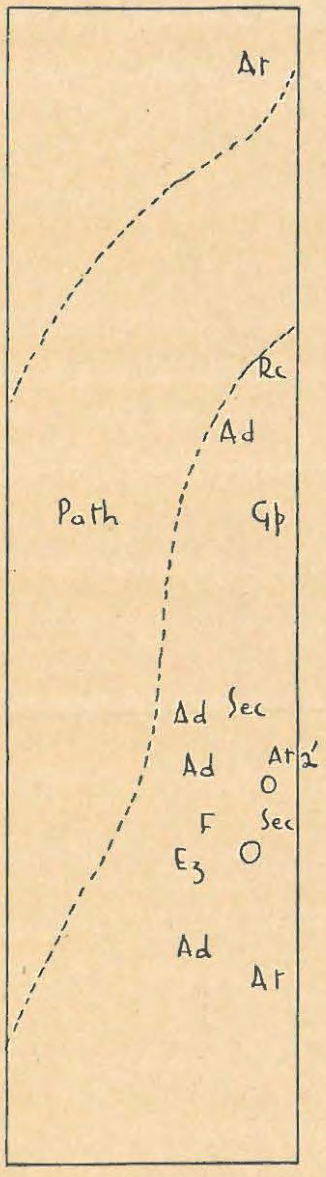


FEET
0 1 2 3
SCALE

Cb – Carissa bispinosa Desf
O – Olea laurifolia Lam.
Rf – Rhoicissus cuneifolia Planch.
Hea – Heteromorpha arborescens Ch + Schltr.
Gr – Grewia occidentalis Linn
Hi – Hippobromus pauciflorus Radlk
Ad – Adodytes dimidiata E. Mey
Cc – Clausena inaequalis Benth
Sec – Secamone alpini Schult
Pod – Podocarpus latifolius Endl.
PL – Pavetta lanceolata Eckl
Mr – Maerua racemulosa Gilg + Benedict
Ry – Reyenia lucida Linn
B – Burchellia bubalina Sim
Sm – Scolopia mundtii Warb.
Gn – Gardenia neuberia E + Z

FERN KLOOF – FOREST.

SHRUB TRANSECT T4 DATE 6. 8. 49.

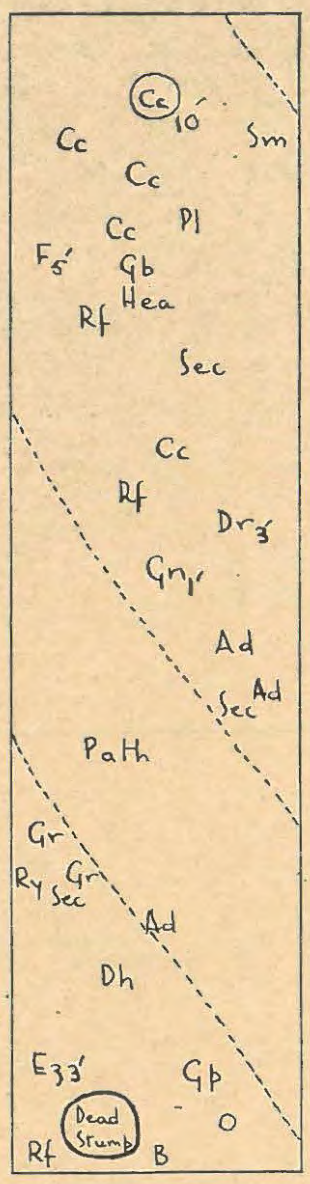


Ar – Argyrolobium Fomentosum Druce
Rc – Rhoicissus capensis Planch
Ad – Apodytes dimidiata E. Mey.
Gp – Gymnosporia peduncularis L. Bolus.
Sec – Secamone alpini Schult.
O – Olea laurifolia Lam.
E3 – Eugenia zeyheri Harv.
F – Fagara capensis Thunb.

SCALE

FERN KLOOF – FOREST.

SHRUB TRANSECT T5 DATE 6. 8 49.



FEET

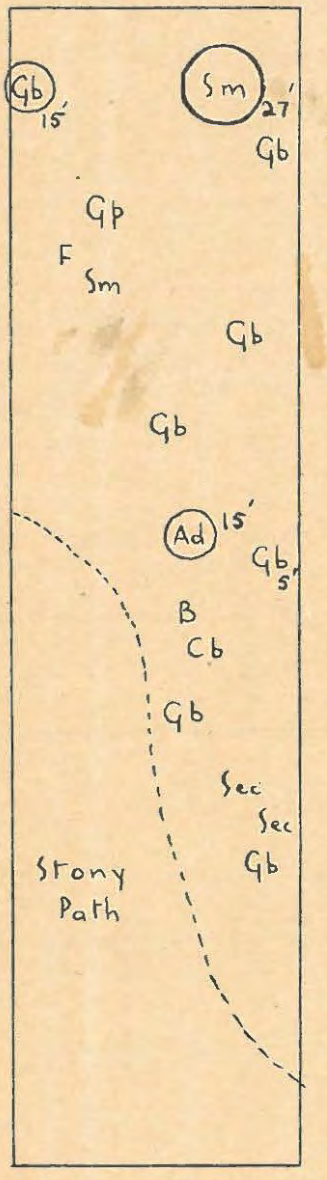
0 1 2 3

SCALE

Sm – Scolopia mundtii Warb.
Cc – Canthium ciliatum Sond.
F – Fagara capensis Thunb
Gb – Gymnosporia buxifolia Szyszyl.
Pl – Pavetta lanceolata Ecklon.
Hea – Heteromorpha arborescens Ch+ Schltr.
Rf – Rhoicissus cuneifolia Planch.
Sec – Secamone alpini Schult.
Dr – Doryalis rhamnoides Harv.
Gn – Gardenia neuberia E+Z.
Ad – Apodites dimidiata E. Mey.
Gr – Grewia occidentalis Linn.
Ry – Royena lucida Linn.
Dh – Dracaena hookeriana N E. Br.
E 3 – Eugenia zeyheri Harv
Gp – Gymnosporia pedunculatis L. Bolus.
O – Olea laurifolia Lam.
B – Burchellia bubalina Sim.

FERN KLOOF – FOREST.

SHRUB TRANSECT T6 DATE 6. 8. 49.

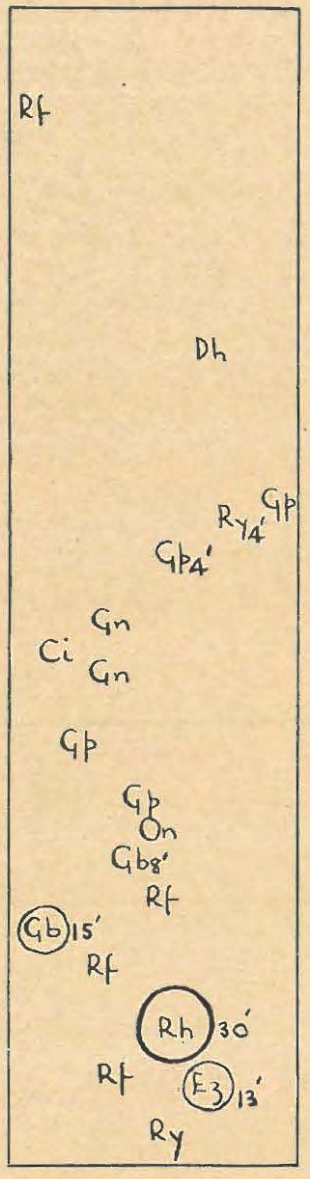


Gb – Gymnosporia buxifolia Szyszyl.
Sm – Scolopia mundtii Warb.
Gp – Gymnosporia peduncularis L. Bolus
F – Fagara capensis Thunb.
Ad – Apodytes dimidiata E. Mey.
B – Burchellia bubalina Sim.
Cb – Carissa bispinosa Desf.
Sec – Secamone alpini Schult.

SCALE

FERN KLOOF — FOREST.

SHRUB TRANSECT T7 DATE 6.8.49.

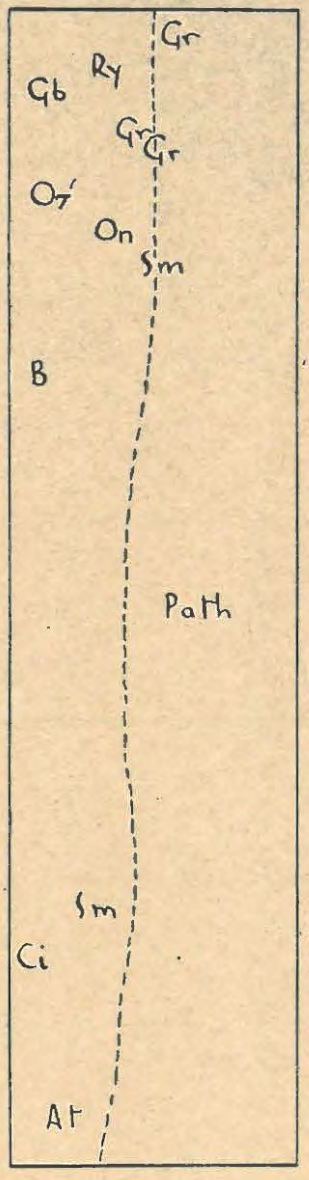


Rf – Rhoicissus cuneifolia Planch
Ry – Royena lucida Linn.
Gp – Gymnosporia peduncularis L. Bolus.
Dh – Dracaena hookeriana N.E.Br.
Ci – Clausena inaequalis Benth.
Gn – Gardenia neuberia E+Z.
On – Osyridicarpos natalensis A.DC.
Gb – Gymnosporia buxifolia Szyszyl.
Rh – Rhus legati Schonl.
Eg – Eugenia zeyheri Harv.

SCALE

FERN KLOOF – FOREST.

SHRUB TRANSECT T8 DATE 6. 8. 49.

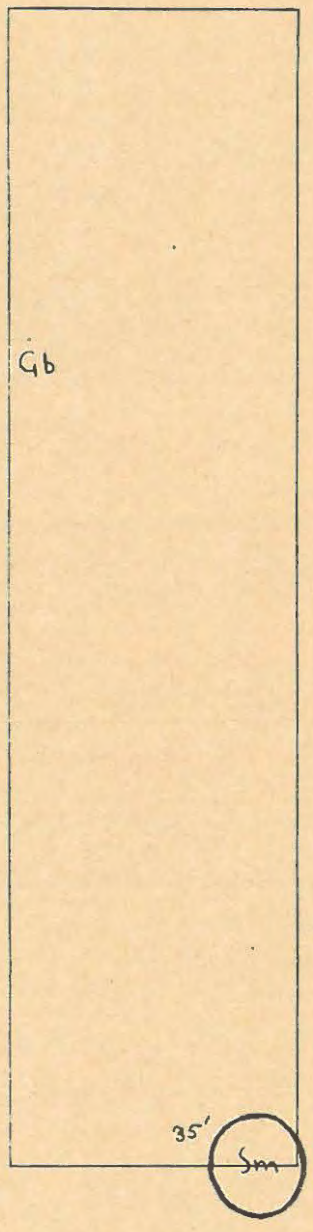


Gb – Gymnosporia buxifolia Szyszyl.
Gr – Grewia occidentalis Linn.
Ry – Royena lucida Linn
O – Olea laurifolia Lam.
On – Osyridicarpos natalensis A.DC.
Sm – Scolopia mundtii Harv.
B – Burchellia bubalina Sim.
Ci – Clausena inaequalis Benth.
At – Argyrolobium tomentosum Druce.

FEET.
0 1 2 3
SCALE

FERN KLOOF – FOREST

SHRUB TRANSECT T9. DATE 6. 8. 49



Gb – Gymnosporia buxifolia Szyszyl
Sm – Scolopia mundtii Warb.

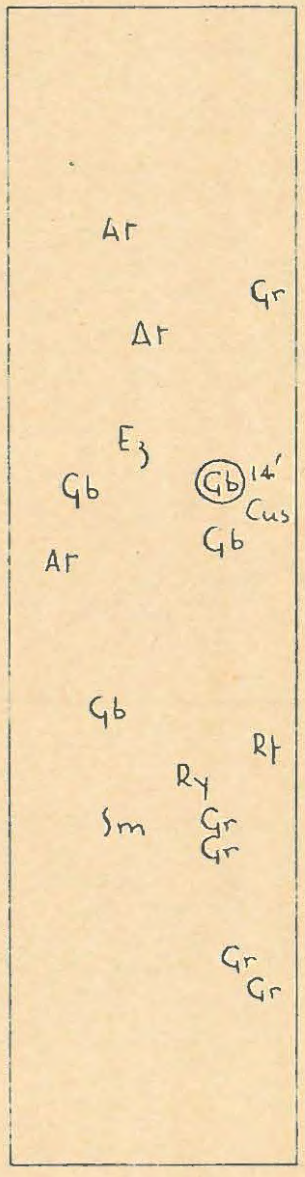
FEET

0 1 2 3

SCALE

FERN KLOOF – FOREST.

SHRUB TRANSECT T10 DATE 6. 8. 49.

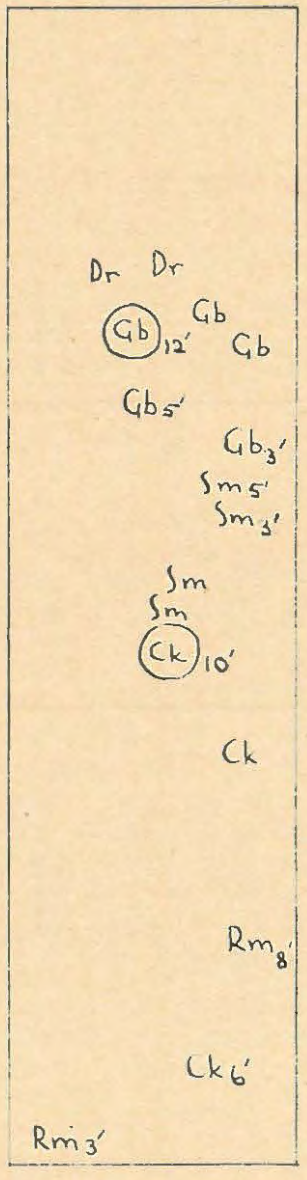


Ar – Argyrolobium tomentosum Druce
Gr – Grewia occidentalis Linn.
Gb – Gymnosporia buxifolia Szyszyl.
Ez – Eugenia zeyheri Harv
Cus – Cussonia spicata Thunb
Ry – Royena lucida Linn
Rf – Rhoicissus cuneifolia Planch.
Sm – Scolopia mundtii Warb.

SCALE

FERN KLOOF – FOREST.

SHRUB TRANSECT T11 DATE 6. 8. 49.

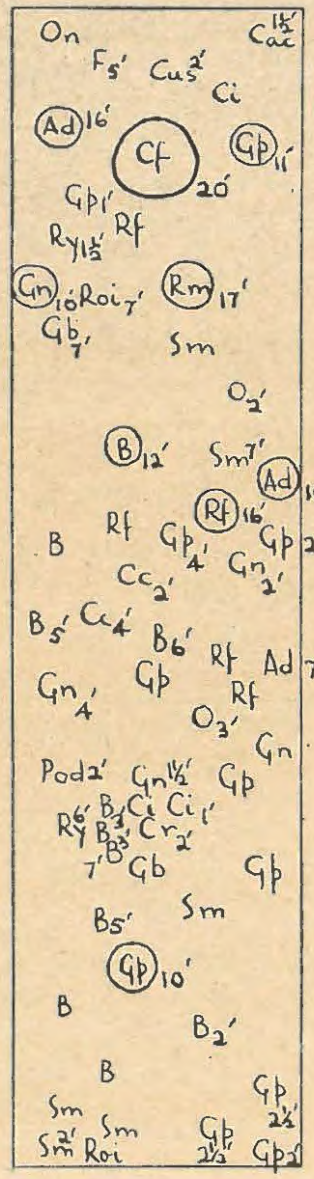


Dr – Doryalis rhamnoides Harv
Gb – Gymnosporia buxifolia Szyszyl
Sm – Scolopia mundtii Warb
Rm – Rapanea melanophloeos R Br
Ck – Cassine kraussiana Bernh.

SCALE

FERN KLOOF — FOREST.

SHRUB TRANSECT T12 DATE 7. 8. 49.



On – Osyridicarpos natalensis A DC
F – Faqara capensis Thunb.
Cus – Cussonia spicata Thunb
Ci – Clausena inaequalis Benth.
Cf – Curtisia faginea Ait.
Gp – Gymnosporia pedunculares L Bolus.
Ad – Apodytes dimidiata E Mey.
Rf – Rhoicissus cuneifolia Planch.
Ry – Royena lucida Linn.
Rm – Rapanea melanophloeos R. Br.
Gn – Gardenia neuberia E+Z.
Roi – Rhoiacarpos capensis A.DC.
Gb – Gymnosporia buxifolia Szyszyl.
Sm – Scolopia mundtii Warb.
O – Olea laurifolia Lam.
B – Burchellia bubalina Sim.
Cc – Canthium ciliatum Sond.
Pod – Podocarpus latifolius Endl.
Gr – Grewia occidentalis Linn.
Cac – Cassinopsis capensis Sond.

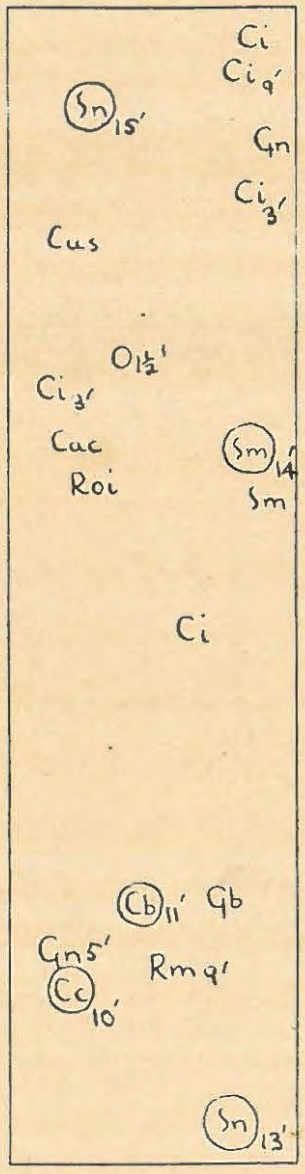
FEET.

0 1 2 3

SCALE.

FERN KLOOF — FOREST.

SHRUB TRANSECT T13 DATE 7. 8. 49.



Sn - Scutia myrtina Kunz
Ci - Clausena inaequalis Benth.
Cus - Cussonia spicata Thunb.
Gn - Gardenia neuberia E+Z.
O - Olea laurifolia Lam.
Cac - Cassinopsis capensis Sond
Roi - Rhoiacarpos capensis A. DC.
Sm - Scolopia mundtii Warb.
Cb - Carissa bispinosa Desf.
Cc - Canthium ciliatum Sond.
Rm - Rapanea melanophloeos R. Br.
Gb - Gymnosporia buxifolia Szyszyl.

SCALE

Frequency is the number of sample areas containing a species out of a total number of sample areas - this has not been expressed as a percentage.

ANALYSIS OF THE PINE SHRUB TRANSECTS.

Examination of the photograph 5, diagrams T_{14} - T_9 and the results in Table XXII (even though a number of species do not occur in the quadrats) show very clearly that shrubs do not form an important feature in the pine. Of those that are present 84% are between 0 - 3' in height and the remaining 16% are between 3 - 6' in height (see Histogram 12). Occasionally outlier species of the forest grow over 6' in height.

Observations show that the shrubs of the pine can be classified into the following groups:-

(1) Members of the South Western Cape Flora (Fynbos) such as Erica demissa, Passerina vulgaris, Metalasia muricata and Phylica paniculata which have the characteristic "ericoid" leaves of this community and also the species with larger leaves belonging to the Leguminosae Euphorbiaceae and Geraniaceae.

(2) The outlier trees and shrubs of the forest - Rapanea melanophloeos, Rhus sp, Royena pallens, Gymnosporia sp, Burchellia bubalina and Tarchonanthus camphoratus.

(3) Exotic species like Hakea aciculeris and Acacia cyclopis which have become a menace on the slopes of the Mountain Drive.

The South Western Cape Flora which originally occupied this area is a community of small shrubs and herbaceous plants. This community has been invaded by Pinus pinaster which has completely altered the original structure by the introduction of a tree layer. Although quite a number of species of the shrub layer

are present they are randomly distributed and in no way form a continuous layer. They are merely components of the ground flora.

TABLE XXII.

ANALYSIS OF PINE SHRUB TRANSECTS.

Total number of Plants 46.

	Species.	Actual Number of plants.	PERCENTAGE ABUNDANCE.	FREQUENCY Total 6.
	Cluytia pulchella	10	21.7	3
	Rubus pinnatus	6	13.0	3
T	Pinus pinaster	5	10.9	3
T	Rapanea melanophloeos	4	8.7	1
T	Rhus legati	3	6.5	1
	Euphorbia epicyparissias	3	6.5	1
	Teprosia grandiflora	3	6.5	2
	Euphorbia krausiana	2	4.4	2
	Peucedanum emponse	2	4.4	2
*	Seemone alpini	2	4.4	1
	Argyrolobium tomentosum	1	2.2	1
	Chrysanthemoides moniliformum	1	2.2	1
	Cluytia laxa	1	2.2	1
	Leonotis leonurus	1	2.2	1
	Pelargonium vibifolium	1	2.2	1
	Psoralea tomentosa	1	2.2	1

Where: * is Creeper.

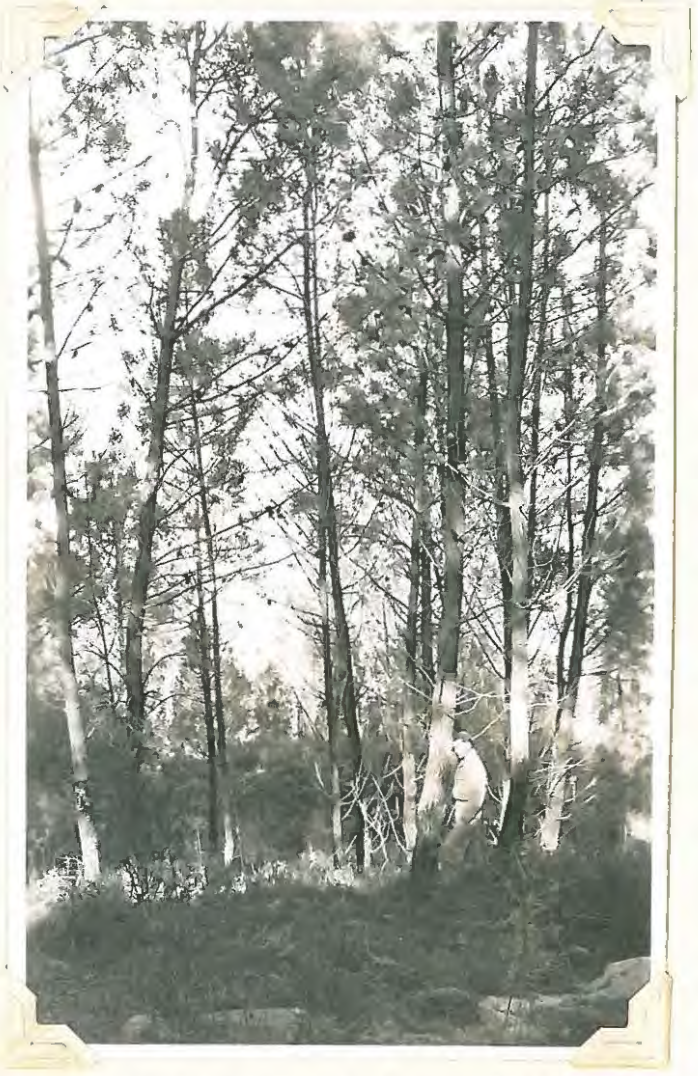
T is Tree.

Abundance is the number of rooted shoots of a species expressed as a percentage of the total number of rooted shoots for all species.

Frequency is the number of sample areas containing a species out of a total number of sample areas - this has not been expressed as a percentage.

PINE

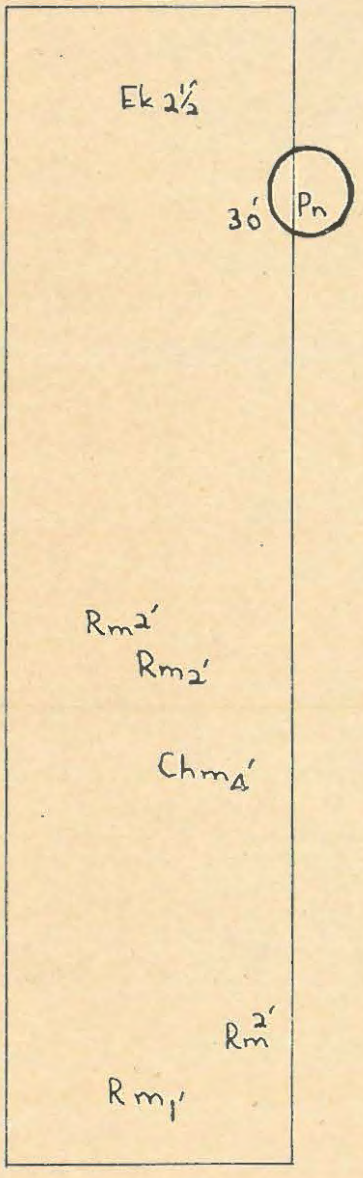
V



A complete contrast from the forest. Low tangled undergrowth consisting mainly of bracken & brambles, with odd patches of grass.

FERN KLOOF – PINE.

SHRUB TRANSECT T.14 DATE 8. 8. 44.

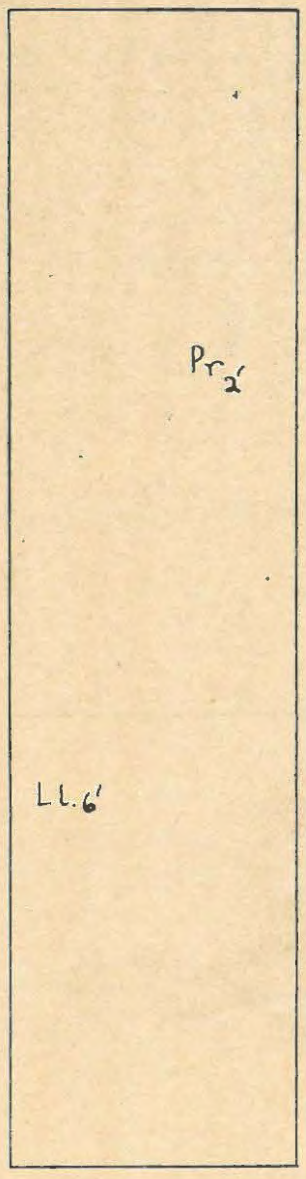


Ek – Euphorbia kraussiana
Pn – Pinus pinaster Ait
Rm – Rapanea melanophlœos R. Br.
Chm Chrysanthemoides moniliferum L.

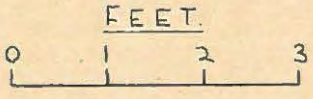
SCALE

FERN KLOOF — PINE.

SHRUB TRANSECT T15 DATE 8. 8. 49.



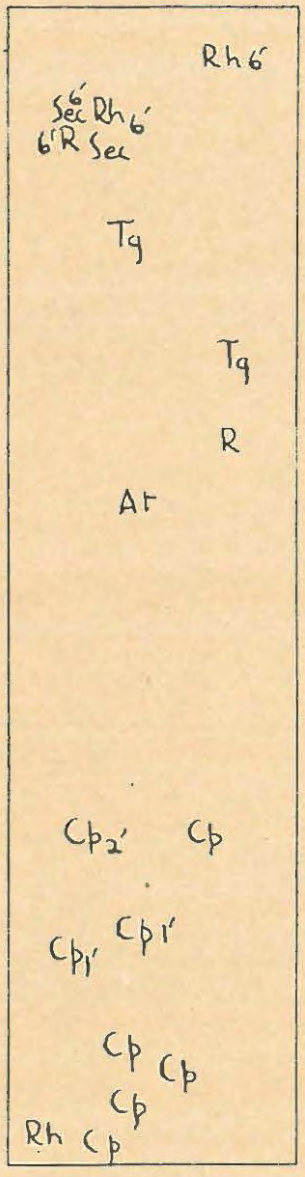
Pr – Pelargonium ribifolium Jacq.
LL – Leonotis leonurus R. Br.



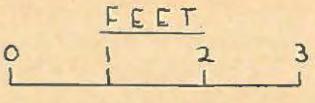
SCALE

FERN KLOOF — PINE.

SHRUB TRANSECT T16 DATE 8. 8. 49.



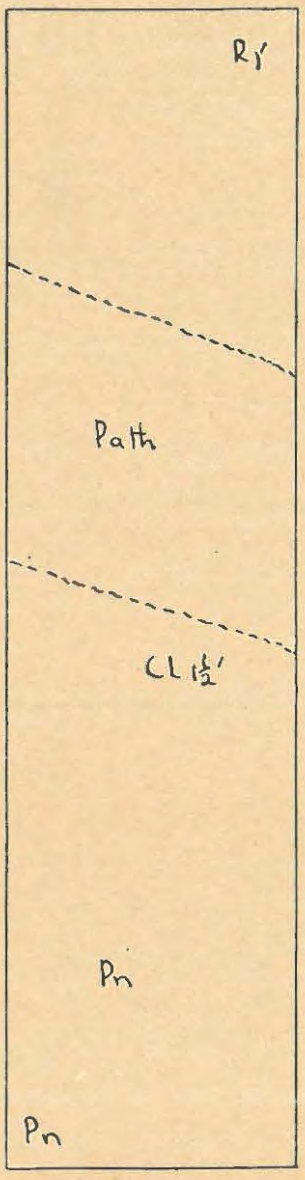
Rh - Rhus legati Schonl.
R - Rubus pinnatus Willd
Sec - Secamone alpini Schult
Tg - Tephrosia grandiflora Pers.
At - Argyrolobium tomentosum Druce
Cp - Cluytia pulchella L.



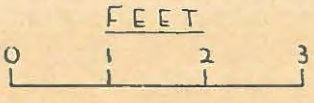
SCALE

FERN KLOOF – PINE.

SHRUB TRANSECT T17 DATE 8. 8 49.



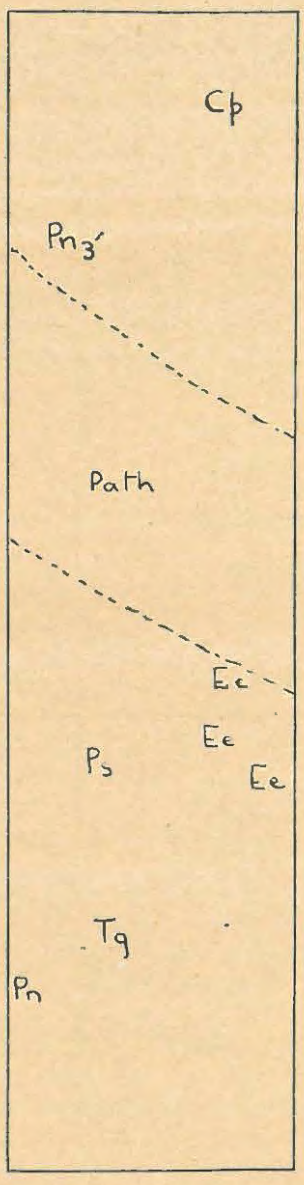
R – Rubus pinnatus Willd.
Cl – Cluytia laxa Eckl.
Pn – Pinus pinaster Ait.



SCALE

FERN KLOOF — PINE.

SHRUB TRANSECT T1·8 DATE 8. 8 49.



Pn – Pinus pinaster Ait.
Cp – Cluytia pulchella L.
Ps – Psoralea tomentosa Thumb.
Tg – Tephrosia grandiflora Pers.
Ee – Euphorbia epicyperissius E Mey.

FEET.
0 1 2 3
SCALE

THE FOREST TREE TRANSECTS.

Two belt transects were done in the forest. Transect I covers a longitudinal section of the forest on the east side of the main path (see Map 13). Transect II is situated at right angles to Transect I in the lower portion of the forest.

The size of each sample area was 18' x 12'. Poles cut to this length were used to mark it out.

All shrubs and trees with a diameter of over 1" at breast height have been recorded. The analysis of the results are contained in Table XXIII and Table XXIV. Table XXIII lists the following:

(a) The average height in feet. The height of trees were judged by eye, and in doubtful cases one of the 18' transect poles was held up against the tree to give the scale.

(b) The average diameter in inches. This distinguishes between trees and shrubs. Shrubs rarely have a diameter of more than 2" at breast height.

(c) The number of stems. Counts were made of the number of stems at breast height whether or not they came from the same stock.

In Table XXIV there is the following information:-

(a) The percentage frequency, defined as the percentage ratio of the number of sample areas containing a particular species to the total number of sample areas. (Braun Blanquet 1932, Raunkiaer 1934 and Weaver and Clements 1938).

(b) The abundance, defined as the number of stems of a particular species expressed as a percentage of the total number of stems of all species.

(c) A comparison of the average abundances of Fern Kloof with those of Paradise Kloof - a kloof on the same mountain range about 6 miles west of Fern Kloof. The data for Paradise Kloof was provided by Mr. R. Story.

RESULTS.

No single species of tree can be said to be dominant in the forest at Fern Kloof. The dominant tree species forming the canopy are Apodites dimidiata, Scolopia mundtii and Olea laurifolia. Even the term "dominant" is open to question here since the species are not strikingly more abundant than the rest of the species. This is in complete contrast with the pine where Pinus pinaster is a dominant supreme.

It will be noticed from Table XXIV that the majority of species are of limited distribution. Contributing to the canopy in Fern Kloof are the following species, Podocarpus latifolius, Curtisia faginea, Cussonia spicata, Gymnosporia peduncularis, Cassine Kraussiana and Clinia cymosa. Less frequent but in evidence because of their large size are Ficus capensis, Harpephyllum caffrum and Rhus legati.

Eugenia zeyheri, Clausena inaequalis and Euclea daphnoides are small tree species seldom growing over 25 feet high but they play quite an important part in the formation of the canopy.

Of rare occurrence are, Vepris lanceolata, Fagara capensis, Pavetta lanceolata, Psychotria capensis, Podocarpus latifolius, Ekebergia capensis, Heteromorpha arborescens and Trimeria trinervis.

Inextricably interwoven into the canopy are the lianes, Rhoicissus cuneifolia and Rhoicissus capensis. When well

developed these lianes allow little light to penetrate through to the forest floor. Epiphytes include Peperomia reflexa and an orchid which was not identified. Shrubs do not form a conspicuous element in the tree transects. The limit of horizontal visibility is 25 yards in the forest.

Another observation that becomes apparent on examining the data of the average abundance of species in Fern Kloof and Paradise Kloof is that the dominant species vary in the two forests, although the forests are similar in all other respects.

In Paradise Kloof, Olea laurifolia, Olea foveolata and Podocarpus latifolius are the prominent canopy-forming trees.

TABLE XXIII.

Species.	AVERAGE HEIGHT (FEET) TRANSECT I	II	AVERAGE DIAMETER (INCHES) TRANSECT I	II	NUMBER OF STEMS TRANSECT I	II
Apodytes dimidiata	24.3	18.6	7.1	5.0	22	3
Scolopia mundtii	25.0	24.4	6.5	4.8	18	10
• Gymnosporia buxifolia	13.0	15.2	1.8	1.5	16	5
Olea laurifolia	15.8	16.3	3.0	2.3	12	2
Eugenia zeyheri	12.6		1.6		9	
~ Rhoicissus cuneifolia	23.4		2.6		8	
Podocarpus latifolius	20.5	17.0	4.5	3.3	7	3
Cussonia spicata	19.9		4.4		6	
• Royena lucida	13.8		2.1		6	
• Burchellia bubalina	10.8	13.5	1.8	1.3	5	1
• Hippobromus pauciflorus	14.0		1.3		3	
Curtisea faginea	25.5	21.8	7.5	4.8	3	5
Gymnosporia pedunculoris	15.5		2.5		2	
• Grewia occidentalis	13.0	15	1.2	1	2	1
Rhus legati	23.0	13.3	9.0	3.8	2	2
• Canthium ciliatum	12.3		2.0		1	
• Carissa bispinosa	10.0		1.0		1	
Cassine kraussiana	12.7		2.1		1	
Clausena inaequalis	18.0	20	2.0	3	1	1
Fagara capensis	19.5		3.0		1	
Olinia cymosa	20.0		5.0		1	
Pterocelastrus tricuspidatus	19.5		5.5		1	
Rapanea melanophloeos		19.3		4.3		3
• Scutia myrtina		12.6		1.3		2
~ Rhoicissus capensis		23		1.6		2

Where:

• is Shrub

~ is Liane

Average height in feet.

Average diameter in inches at breast height.

TABLE XXIV.

Species.	PERCENTAGE FREQUENCY TRANSECT I	PERCENTAGE FREQUENCY TRANSECT II	PERCENTAGE ABUNDANCE TRANSECT I	PERCENTAGE ABUNDANCE TRANSECT II	AVERAGE ABUNDANCE FERN KLOOF	AVERAGE ABUNDANCE PARADISE KLOOF
Apodytes dimidiata	53	50	17.5	5.0	11.2	1.5
Scolopia mundtii	40	100	14.3	25.0	19.6	5.0
• Gymnosporia buxifolia	67	50	12.7	12.5	12.6	?
Olea laurifolia	27	33	9.5	5.0	7.0	16.3
Eugenia zeyheri	27		6.4		6.4	.9
Rhoicissus cuneifolia	34		6.4		6.4	.8
Podocarpus latifolius	27	33	5.6	7.5	6.5	8.5
Cussonia spicata	27		4.8		4.8	.6
• Royena lucida	27		4.8		4.8	3.2
• Burchellia bubalina	20	17	4.0	2.5	3.2	2.5
• Hippobromus pauciflorus	7		2.4		2.4	6.2
Curtisia faginea	20	50	2.4	12.5	7.4	4.3
Gymnosporia pedunculoris	13		1.6		1.6	2.3
• Grewia occidentalis	13	17	1.6	2.5	2.0	.2
Rhus legati	13	33	1.6	7.5	4.6	4.3
• Canthium ciliatum	7		.8		.8	3.3
• Carissa bispinosa	7		.8		.8	.4
Cassine kraussiana	7		.8		.8	.8
Clausena inaequalis	7	17	.8	2.5	.8	-
Fagara capensis	7		.8		.8	.8
Olinia cymosa	7		.8		.8	2.0
Pterocelastrus tricuspidatus	7		.8		.8	.9
Rapanea melanophloeos		33		7.5	7.5	7.7
• Scutia myrtina		17		2.9	2.9	1.0
Rhoicissus capensis		33		5.0	5.0	.8

Where:

• is Shrub

is Liane

Frequency = $\frac{\text{number of occurrences in transects}}{\text{total number of transects}} \times 100$

Abundance = $\frac{\text{number of stems of species}}{\text{total number of stems for all species}} \times 100$

LIFE - FORMS AT FERN KLOOF.

The most generally used system of life-forms is that of Raunkiaer 1934. He defines the life-form as "the sum of the adaptations of the plant to the climate," but it is based on the way in which the plant survives the unfavourable season of the year i.e. the position and protection of the "renewal buds".

From the statistical analysis of the flora of Fern Kloof a "life-form spectrum" has been obtained. This is compared with a normal spectrum for the whole world and gives a rough idea of the relation between the life-forms and the climate of the area.

The forest and pine floras are dealt with separately, because, although they grow side by side under more or less similar climatic conditions, they are representative of different vegetational, and therefore climatic groups. The indigenous forest belongs to the Temperate Forest Group (S.A. classification by Adamson 1938) with summer rains and the pine community is really a community comprising elements of the South Western Cape Flora (characteristic of a winter rainfall region) and which has been invaded within the last 80 years by the exotic Pinus pinaster. Table XXV gives the combined result for Forest and Pine figures for the Seychelles and Iceland for comparison.

TABLE XXV.

Species	S	E	MM	M	N	Ch	H	G	HH	Th
Indigenous Forest: Fern Kloof	93	-	1	22	27	32	1	8	10	-	-
Pine and Cape Flora: Fern Kloof.	88	1	-	1	3	44	13	27	10	-	2
Combined Fern Kloof	181	.5	.5	12	14	38	7	17	10	-	1

(cont.) TABLE	Species	S	E	MM	M	N	Ch	H	G	HH	Th
Seychelles	258	1	3	10	23	24	6	12	3	2	16
Iceland	329	-	-	-	-	2	13	54	10	10	11
Normal spectrum	400	1	3	6	17	20	9	27	3	1	13

The classification into life-forms of all the plants at Fern Kloof will be found in the appendix.

As one would expect the forest has the greatest number of the least protected life-forms - the Phanerophytes. There are no Hydrophytes and, as far as is known, very few Therophytes. Hemicryptophytes and Geophytes are quite well represented. The low percentage of epiphytes is in agreement with the amount of rainfall per annum. Chamaephytes are not typical of forests.

I have said elsewhere that a shrub layer is not characteristic of pine forest. The high percentage (44%) of Nanophanerophytes seems to contradict this. However, this is not the case since a large percentage of these are herbaceous Nanophanerophytes. The pine contains more plants with advanced methods of bird protection than the forest.

The combined life-form spectrum of Fern Kloof shows how closely the distribution of life-forms among the groups agrees with the climate of the region, which is one of winter and summer rains, and is, therefore, intermediate in character.

As a result seperated and distinct communities can exist in close proximity to one another.

THE EFFECTS OF THE DROUGHT ON THE VEGETATION AROUND GRAHAMSTOWN.

The last year of good rains was in 1944, since then the yearly average has been will below the average (27 inches). In 1948 a cloudburst of over 7 inches filled up the dams and raised the annual total by an amount far beyond the actual benefit derived by the vegetation. After this, infrequent showers of .50 inches did little to alleviate the effects of the drought which by this time had become serious.

The herbs and the small shrubs were the first to show signs of water deficiency. All the grass became grey in colour. By July 1949 when the drought was at its worst, even hardy species of the South Western Cape Flora (the fynbos) such as Pedalyria velutina, Erica spp, Passerina vulgaris, Metalasia muricata and Phylica paniculata were looking "the worse for wear". Succulent leaves of the Cotyledons and Crassulas became shrivelled.

In the forest and pine the ground flora was to a large extent completely withered. Thesium fruticosum appeared to suffer very little. The small herbaceous climbers like Ceratocicyos schlonii, Senecio spp and Asparagus spp died back to ground level.

As the drought progressed it became apparent that its effect on the exotics planted or self set along the Mountain Drive was far more devastating than that on the indigenous vegetation. Hundreds of thousands of seedlings, saplings and trees of Pinus pinaster, Pinus halipernus and Pinus insignis died. Acacia cyclopis and A. mollissima, which have spread so widely through indigenous communities and pine plantations alike, have been

killed over large areas, providing heaps of fire wood for the natives and a potential veld-fire menace. Many Eucalyptus trees have succumbed, but as these coppice freely from the base they may recover.

Although all the forest trees showed some signs of the drought it is surprising how few were killed. Curtisia faginea seemed to fare the worst of the larger trees, while Podocarpus latifolius was scarcely touched; this is no doubt due to its glaucous covering and thick cuticle of the leaves. Most trees lost their most exposed leaves in the canopy. The shrubs on the margins of the forest lost nearly all their leaves regardless of their position in relation to the elements.

The drought was partially broken in September 1949 by sharp showers of short duration. Their immediate effect was observed on the Bryophytes, Pteridophytes and smaller herbaceous Angiosperms which recovered quickly and showed signs of renewed growth within a few days. Only after the good rains in October and November was there any appreciable renewal of growth among the shrubs and trees.

CONCLUSION.

It seems likely that the pine is not a natural community since it has only existed here for 60 years at the outside and has not in this short time reached a sufficiently mature state of development. Moreover, the shrubs and ground flora belong to different communities, showing that the pine is having a marked effect on the indigenous vegetation and there is no indication of dominance among the species.

From acquaintance with the vegetation of the Eastern Province and from the investigation carried out at Fern Kloof it is found that the forest is a natural and characteristic community and not just a jumble of plants. But, on comparison with Paradise Kloof it appears that, although the general features tally, when the criteria of vegetational analysis are applied, it is difficult to say why the forest should be considered as a natural community. The difficulties are:

(1) the large number of species,

(2) the absence of dominance and

(3) the absence of clear stratification.

These difficulties lead one to suspect that many of the methods and conceptions worked out for Europe and America will have to be modified for South Africa. Obviously much more research needs to be done. This work has served to indicate the complexity of the problem and the need for a different approach.

SUMMARY.

The vegetation at Fern Kloof consists of two communities, the indigenous forest and the exotic *Pinus pinaster*. The latter has invaded and in part replaced the original South Western Cape Community. The object has been to determine whether these communities are natural.

Part I. This begins with a brief descriptions of the topography, geology and certain climatic factors of the Grahamstown district. Results for temperature, humidity and light intensity at Fern Kloof have been included.

Soils profiles indicate the differences in texture, litter and colour. It is shown that the pH of the forest soil tends to be normal, while the pine soil is definitely acid. The forest soils have more organic matter, a higher water content and saturation capacity than the pine.

Part II. An account of the history and biotic factors is given.

The communities have been analysed and it is found that the ground flora does not form a conspicuous constituent of the forest. There is no clear stratification and a complete lack of dominance in spite of the fact that this community is very stable and of long standing.

It is seen that the ground flora is a well defined feature of the pine. There are a large number of species and there is no dominance or stratification.

A life-form spectrum has been constructed on Raunkiaer's

system.

Notes on the effect of the drought are also given.

It is concluded that the pine is not a natural community. The forest is found to be natural, but has characteristics different from those usually attributed to natural communities in Europe and America.

Appendix.

It contains lists of plants found at Fern Kloof and the classification of the species into Raunkiaer's Life-Forms.

APPENDIX.

FAMILIES GENERA AND SPECIES AT FERN KLOOF.

GYMNOSPERMAE.
TAXACEAE.

P. floccatus R.Br.
P. latifolius Endl.

ANGIOSPERMAE.
DICOTYLEDONES.
PIPERACEAE.

Peperomia Ring and Pav.
P. reflexa Dietr.

ULMACEAE.

Celtis rhamnifolia Pred.

MORACEAE.

Ficus Linn.
F. capensis thumb.

PROTEACEAE.
Hakea Schrad.
H. sciularis Knight (an exotic).

SANTALACEAE.

Rhoiscarpus A. DE.
R. capensis A.DC.
Osyridicarpus A.DC.
O. natalensis A.DC.
Thesium Linn.
T. fruticosum A.W.Hill

POLYGONACEAE.

Rumex Linn.
R. crispus Linn - growing at base of Fern Kloof.

AIZOACEAE.
Carpobrotus N.E.Br.
C. deliciosis L. Bolus (C. edulis?)

RANUNCULACEAE.
Clematis Linn.
C. brachiata Thumb. at side of Fern Kloof on margin, and in Fern Kloof in the pine.

CRUCIFERAE.

CRUCIFERAE.
Lepidium Linn.
Lepidium spp.

CAPPARIDACEAE.
Maerua Forsk.
M. racemulosa Gilg and Benedict

CRASSULACEAE.
Cotyledon Linn.
C. multicava Lem.
C. obvallata L.
C. spatulata Thunb.

PITTOSPORACEAE.
Pittosporum Banks.
P. viridiflorum Sim.

ROSACEAE.
Cliffortia Linn.
C. graminea Linn.
Rubus Linn.
R. pinnatus Willd.
Alchemilla Linn.
A. caponsis Thunb.

LEGUMINOSAE.
Acacia Willd.
A. karroo Hayne - below Fern Kloof.
Argyrolobium A - Z.
A. tomentosum (Andr) Druce = A.androwsiana
Aspalathus Linn
A. sp.
Dolichos Linn.
Dolichos gibbosus Thunb.
Erythrina Linn.
Erythrina caffra.
Indigofera Linn.
I. hedyantha E - Z
Podalyria Lam.
P. volutina Birch.
Psoralea Linn.
P. tomentosa Thunb.
Schotia Jacq.
S. latifolia Jacq.
Tephrosia Pers.
T. caponsis Pers.
T. grandiflora Pers.

GERANIACEAE.

Geranium Linn.
G. ornithopodium E + Z.

Pelargonium L Her.
P. alchemilloides Ait.
P. caffrum E - Z
P. vibifolium Jacq.

OXALIDACEAE.
Oxalis Linn.
O. smithii Sond.
O.spp.

LINACEAE.
Linium.

RUTACEAE.
Barosma Willd.
Barosma Scoparia E - Z.
Clausena Burm.
C. inaequalis Benth.
Fagara Linn.
F. capensis Thunb.
Vepris Comm.
V. lanceolata G.Don.

MELIACEAE.
Ekebergia Sparm.
E. capensis Sparm.

POLYGALACEAE probably Polygala Linn.

EUPHORBIACEAE.
Acalypha Linn.
A. glabrata Thunb.
Adenocline Turcz.
A. mercurialis Baill.
Cluytia Linn.
C. heterophylla Thunb.
C. laxa Eckla
C. pulchella L.
Euphorbia Linn.
E. epicyparissias E. Mey.
E. Krausciana.

ANACARDIACEAE.
Harpephyllum Bernh.
H. caffrum Bernh.
Rhus Linn.
R. legati scharl.
R. lucida var scoparia E Mez.
R. pyroides Burch.
R. tomentosa.

CELASTRACEAE.
Cassine Linn.
C. krausiana Bernh.

C. tetragona.
Cymosporia Wight and Arn.
C. acuminata Szyszyl.
C. buxifolia Szyszyl.
C. heterophylla Loesnen.
C. pedunculoris L. Bolus.
Pterocelastrus Meisen.
P. tricuspidatus Sond.

ICACINACEAE.
Arodytes E Mey.
A. dimidiata E. Mey.
Cassinopsis Sond.
C. capensis Sond.

SAPINDACEAE.
Hippobromus E + Z.
H. pauciflorus Radlk.

RHAMNACEAE.
Phylica Linn.
P. paniculata Willd.
Scutia Brongn.
Scutia myrtina Kurz.

VITACEAE.
Rhoicissus Planch.
R. capensis Planch.
R. cuneifolia Planch.

TILIACEAE.
Grewia Linn.
G. occidentalis Linn.

MALVACEAE.
Abutilon Gaertn.
A. sonneratianum Cav.
Sida Linn.
Sida triloba Cav.

STERCULIACEAE.
Hermannia Linn.
H. velutina DC.

OCHNACEAE.
Ochna Linn.
O. arborea Burch.

FLACOURTIACEAE.
Doryalis E Mez.
D. rhamnoides Harv.
Scolopia Schreb.
S. mundtii Warb.

Trimeria Harv
T. trinervis Harv.
T. trinervis.

ACHARIACEAE.
Ceratiosicyos Nees.
C. ecklonii Nees.

OLINACEAE.
Olinia Thunb.
O. cymosa Thunb.

THYMELAEACEAE.
Passerina Linn.
P. vulgaris Thod.
Struthiola Linn.
S. ovata Thunb.

MYRTACEAE.
Eugenia Linn.
E. zeyheri Harv

ARALIACEAE.
Cussonia Thunb.
C. spicata Thunb.

UMBELLIFERAE.
Heteromorpha Cham and Schelt.
H. arborescens Cham and Schelt.
Hydrocotyle Linn.
H. asiatica Linn.
Peucedanum Linn.
P. capense Sond.

CORNACEAE.
Curtisia Ait.
C. faginea Ait.

ERICACEAE.
Erica Linn.
E. demissa Kl.

MYRSINACEAE.
Myrsine Linn.
Myrsine africana Linn.
Rapanea Aubl.
Rapanea melanophloeos R.Br.

EBENACEAE.
Euclea Murr.
E. daphnoides Hiern.
Royena Linn.
R. lucida Linn.
R. pallens Thunb.
R. villosa Linn.

OLEACEAE.
Olea Linn.
(O. africana)
O. laurifolia Lam.

APOCYNACEAE.
Carissa Linn.
C. bispinosa Desf.

ASCLEPIADACEAE.
Sarcostemma R.Br.
Secamone R.BR.
S. alpini Schult.

CONVOLVULACEAE.
Ipomea Linn.
I. contorta Choisy

BORRAGINACEAE.
Lycostis Linn.
M. Intermedia Link.
Lithospermum Linn.
L. papillosum Thunb.

VERBENACEAE.
Lantana.

LABIATAE.
Leonotis Pers.
L. leonurus R.Br.
Plectranthus L'Her.
P. ciliatus E. Mez.
P. laxiflorus Benth.
P. Thunbergii Benth.
Salvia Linn.
S. repens Burch.
Stachys Linn.
Stachys sp. (aethiopica) Linn.

SOLONACEAE.
Solanum Linn.
S. sodomeum linn.

SCROPHULARIACEAE.
Halleria linn.
H. lucida Linn.
Selago Linn.
S. corymbosa Linn.

GESNERIACEAE.
Streptocarpus Lindl.
S. rexii Lindl. (~~Meyeri~~).

ACANTHACEAE.
Hypoestes R.Br.
H. verticillaris R.Br.

RUBIACEAE.
Anthospermum Linn.
A. herbaceum Linn.
Burchellia R.Br.
B. bubalina Sims.
Canthium Lam.
C. ciliatum Sond - Canthium obovatum.
C. ventosum Linn.
Galopina Thunb.
G. circaeoides Thunb.
Gardenia Ellis.
G. neuberia E - Z.
Pavetta Linn.
P. lanceolata Eckl.
Psychotria Linn.
P. capensis Vatke.

VALERIANACEAE.

DIPSACACEAE.
Scabiosa Linn.
S. columbaria Linn.

CUCURBITACEAE - probably present but not flowering - Kedrostis, Melothria.

CAMPANULACEAE.
Cyphia Berg.
C. heterophylla Presl.
C. longifolia N.E.Br.
(Lobelia Linn - come up with summer rains).
L. tomentosa.
L. evinus.

COMPOSITAE.
Athenaeia Linn.
A. punctata L.
Berkheya Ehrh.
B. carduoides Less.
B. lanceolata Willd.
Chrysanthemoides - Osteospermum L.
C. herbaceum L.
C. moniliferum L.
Cryptostemma R.Br.
C. calendulaceum R.Br.
Helichrysum Gaertn.
H. anomalum Less.
H. cymosum Less.
H. latifolium Less.
H. nudifolium Less.

H.petiolatum D.C.
H. squamosum Thunb.
Hypochoeris Linn.
H. radicata Linn.
Metalasia R.Br.
M. muricata Less.
Nidorella Cass.
N. auriculata D.C.
Senecio Linn.
S. concolor D.C.
S. angulatus Linn.
S. deltoideus Less.
S. Junipernus Linn.
(S. mikanoides)
S. tropaeolifolius Mac Owen.
Turpheonanthus Linn.
T. camphoratus Linn.

ANGIOSPERMAE.

MONOCOTYLEDONES.

GRAMINEAE.
Cymbopogon Sprang.
C. marginatus Stapf.
Cynodon Pers.
C. dactylon Pers.
Elionurus Humb and Bonpl.
E. argenteus Nees.
Eragrostis Beauv.
E. sp.
Heteropogon Pers.
H. sp.
Melica Linn.
M. racemosa Thunb.
Oplismenus P. Beauv.
O. hirtellus P. Beauv.
Panicum Linn.
P. deustum Thunb.
P. ecklenii Nees.
Poa Linn.
P.binata Nees.
Sporobolus R.Br.
S. indicus R.Br.
Stipa Linn.
S. dregeana Steud.
Themeda Forsk.
T. triandra Forsk.

CYPERACEAE.
Cyperus Linn.
C. albostriatus Schrad.
Ficinia Schrad.
F. trichodes (Schrad) Benth.

RESTIONACEAE.
Restio Linn.
R. eleocharis.
R. triticeus Rott.

COMMELINACEAE.
Commelina Linn.
C. africana Linn.

LILIACEAE.
Agapanthus L'Her
A. umbellatus L. Her.
Asparagus Linn.
A. africanus Lam.
A. medeoloides Thumb.
A. plumosus Baker.
A. sarmentosus L.
Bulbine Linn.
B. eleoides Willd.
Chlorophytum Ker.
C. comosum Bak.
Dracaena Linn.
D. hookeriana N.E.Br.
Scilla Linn.
S. spp.

AMARYLLIDACEAE.
Hypoxis Ait.
Hypoxis villosa Linn.

IRIDACEAE.
Dietes Salisb.
D. vegeta N.E. Br.
Watsonia Mill.
W. meriana Mill.

ORCHIDACEAE.
Brownleea Harv.
B. coerulea Harv.
Habenaria Willd.
H. arenaria Lindley.
Satyrium Sw.
S. membranaceum

LIST OF FAMILIES WITH NO. OF SPECIES AT FERN KLOOF.

	Genera.	Species.
1. Compositae	10	21
2. Graminae	12	14
3. Leguminosae	10	11
4. Liliaceae	6	9
5. Rubiaceae	7	8
6. Euphorbiaceae	4	7
7. Celastraceae	3	7
8. Labiatae	4	6
9. Anacardiaceae	2	5
10. Rutaceae	4	4
11. Crassulaceae	2	4
12. Campanulaceae	2	4
13. Geraniaceae	2	4
14. Ebenaceae	2	4
15. Flacourtiaceae	3	3
16. Rosaceae	3	3
17. Santalaceae	3	3
18. Umbelliferae	3	3
19. Orchidaceae	3	3
20. Borraginaceae	2	2
21. Cyperaceae	2	2
22. Malvaceae	2	2
23. Myrsinaceae	2	2
24. Iaeinaceae	2	2
25. Restionaceae	1	2
26. Oxalidaceae	1	2
27. Gleicaceae	1	2
28. Scrophulariaceae	2	2
29. Asclepiadaceae	2	2
30. Iridaceae	2	2
31. Taxaceae	1	2
32. Thymelaeaceae	2	2
33. Vitaceae	1	2
34. Rhamnaceae	2	2
35. Acharidaceae	1	1
36. Aizoaceae	1	1
37. Araliaceae	1	1
38. Acanthaceae	1	1
39. Apocynaceae	1	1
40. Capparidaceae	1	1
41. Cruciferae	1	1
42. Cornaceae	1	1
43. Commelinaceae	1	1
44. Amaryllidaceae	1	1
45. Ericaceae	1	1
46. Melianae	1	1
47. Myrtaceae	1	1
48. Gesneriaceae	1	1
49. Moraceae	1	1
50. Convolvulaceae	1	1

	Genera.	Species.
51. Dipsacaceae	1	1
52. Proteaceae	1	1
53. Polygonaceae	1	1
54. Ochnaceae	1	1
55. Oliniaceae	1	1
56. Piperaceae	1	1
57. Pittosporaceae	1	1
58. Solonaceae	1	1
59. Sterculiaceae	1	1
60. Ranunculaceae	1	1
61. Sapindaceae	1	1
62. Tiliaceae	1	1

Families	62
Genera	138
Species	181

LIST OF PTERIDOPHYTA AT FERN KLOOF.

Asplenium bipinnatum (Forsk) C. Chr.

A. cuneatum (Lam) Au.

* Blechnum punctulatum Sw.

Cheilanthes multifida Sw.

* Gleichenia polypodioides

* Hypolepis sparsisora

Mohria sp.

Pellaea viridis (Forsk) Prawitt.

Polypodium lanceolatus Linn

Polystichum adiantiforme Forsk

Pteridium aquilinum. Linn

* Todea barbara.

Unidentified species.

* These plants occur near to but not in the plot.

LIST OF BRYOPHYTA AT FERN KLOOF.
(compiled by Mr. A.R.H. Martin.)

HEPATICAE.

Metzgeria Perrotens Steph	f (ers)
Frullania sp.	o (e)
Brachiolejeunea crenata Sim	lf (er)
Microlejeunia sp.	o (e)
Eulejeunia sp (cf. capensis (Gott Steph)	o (e)
Eulejeunia sp. (cf. Wilmsii Steph)	o (s)
Radula capensis Steph	f (e)

MUSCI.

Fissidens sp. (cf. Pycnophyllus C. Mey.)	o (s)
Fissidens glaucescens. Hornsch.	l.s.(r.s.)
Ptychomitrium crispatum (Hk and Gr) W.P.Sch.	l.f.(r)
Rhodobryum umbraculum (Burch Hook.) Par	l.(s)
Forsstroemia producta (Horns) Par.	r.(e)
?Pleuropus sericeus (Horns) Broth. (habit and funcwg leaves, but nerve.	
Haplohymerium pseudotriste (C.Mey) Broth	o.?
Papillaria nfr cana (C.Mey) Jaeg	a.(e)
Leptodon Smithii (dicks) Mohr	a. (e.r.)
Neckera Valentiniana Besch	a. (e.r.)
Porotrichium natalense (C.Mey) Lindb.	o.?
?Entodon Dregeanus (Horns) C. Mey (not found fruiting.)	(e.r.)
Hypnum (= Stereodon) cupressiforme L (very variable, at least 2 forms present)	(e.r.s.) f-a
Catagonium micronatum (C.Mey) Broth	l.f(s)
Diplolepideae Pleurocarpae sp.	a (e.r.s.)
	f (e.r.)
	o (e)
Isopterygium punctulatum Besch and Wefer. (No. 12)	fr.

(e) is epephyte
(r) on rocks
(s) on soil

a is abundant
f is frequent
o is occasional
r is rare
l is local

CLASSIFICATION OF SPECIES INTO LIFE FORMS.

All the plants recorded from Kern Kloof have been classified according to Raunkiaer and are given in the lists below. The herbarium specimens for each section are contained in folders kept in the Botany Department, Rhodes University College.

These plants whose buds are apical shoots destined to survive the unfavourable period of the year project into the air on stems which live for several or many years. Buds may or may not have bud covering. Characteristic of tropics and subtropics.

a. Mega and Mesophanerophytes MM. over 25'

FOLDER I.

Apodytes dimidiata
Cassine Kraussiana
Curtisea faginea
Cussonia spicata
Ekebergia capensis
Erythrina caffra
Fagara capensis
Ficus capensis
Gymnosporia peduncularis
Harpephyllum caffrum
Olea africana
Olea laurifolia
Olinia cymosa
Pavetta lanceolata
Pinus pinaster
Pittosporum viridiflorum
Podocarpus falcatus
Podocarpus latifolius
Rapanea melanophloeos
Rhus legati
Vepris lanceolata.

b. Microphanerophytes M. 10-25'

FOLDER II.

Burchellia baline
Canthium ciliatum
C. ventosum
Clausena inaequalis
Euclea daphnoides
Eugenia zeyheri
Gardenia neuberia
Grewia occidentalis

Gymnosporia acuminata
Gymnosporia buxifolia
Halleria lucida
Heteromorpha arborescens
Hippobromus pauciflorus
Maenia racemulosa
Psychotria capensis
Pterocelastrus tricuspidatus
Rhus lucida
Rhus tomentosa
Royena lucida
Royena pallens
Royena villosa
Scolopia mundtii
Scutia myrtina
Tarchonanthus camphoratus
Trimeria trinervis

c. Nanophanerophytes. 8"-10' (under 2 metres)
FOLDER III.
Barosma ecoparva
Carissa arduina
Cassine tetragona
Cassinopsis capensis
Chrysanthemoides monoliferum
Dorycnium rhamnoides
Dracaena hookeriana
Erica demissa
Gymnosporia heterophylla
Hakea acicularis
Hermannia velutina
Leonotis leonurus
Metalasia muricata
Myrsine africana
Ochna arborea
Oxyridiocarpos natalensis
Passerina vulgaris
Pelargonium ribifolium
Phylica paniculata
Peucedanum capense (?)
Podalyria velutina
Psoralea tomentosa
Rhoicarpos capensis
Rubus pinnatus
Selago corymbosa
Thesium fruticosum (?)

(Nanophanerophytes.)

Herbaceous Nanophanerophytes.
FOLDER IV.
Abutilon sonneratianum

Adenocline mercurialis
Anthospermum herbaceum
Argyrolobium tomentosum
Aspalathus sp.
Athanasia punctata
Ceratocarpus ecklonii
Chrysanthemoides herbaceum
Cluytia pulchella
Commelina africana
Crassula multicava
Dolichos gibbosus- Herbaceous creeper
Euphorbia kraussiana
Galopina circaeoides
Helichrysum anomalum
H. cymosum
H. petiolatum
H. squamosum
Ipomoea contorta Choisy
Indigofera hedyantha
Hypoestes verticillaris
~~Nerine sarniensis~~
Plectranthus ciliatus
P. laxiflorus Benth.
P. thunbergii
Rumex crispus
Salvia repens
Scabiosa columbaria
Senecio angulatus
S. deltoideus
S. mikanoides
Sida triloba
Stachys sp.
Struthiola ovata Thunb var MacOwanii
Tephrosia grandifolia

Woody climbers (Phanerophytes).

FOLDER V.

Clematis brachiata
Cynanchum sp.
Rhoicissus capensis
R. cuneifolia
Secamone alpini

II CHAMAEPHYTES.

These plants whose surviving buds are situated on shoots which lie either on the surface of the ground or close to it. The buds are much better protected than those of the Phanerophytes.

FOLDER VI.

Acalypha glabrata Thunb.
Alchemilla capensis
Cluytia heterophylla

Crassula spatulata
Cryptostemma calendulaceum
Geranium ornithopodium
Hydrocotyle asiatica
Lobeckia mucronata
Lepidum sp.
Lithospermum papillosum
Myosotis intermedia (?)
Tephrosia capensis

III HEMICRYTOPHYTES.

Shoots die back to the level of the ground at beginning of unfavourable period so the surviving buds are actually in soil surface and protected by withered leaves. This is an advance on the Chamaephytes.

FOLDER VII.

Berkheya cerduoides
B. lanceolata
Cliffortia graminea
Crassula obvallata I.
Cymbopogon marginatus
Cynodon dactylon
Cyperus albostriatus
Digitaria argenteus
Eragrostis
Ficinia trichodes
Helichysum latifolum
H. nudifolium
Heteropogon
Hypochoeris radicata
Hypoxis villosa
Melica racemosa
Nidorella auriculata
Panicum deustum
P. ecklonii
Pelargonium coffrum
Poa annua
Restio dieccharis
R. triticeus
Senecio concolor
S. juniperinus
S. tropaeolifolius
Sporobolus indicus
Stipadregeana
Streptocarpus rexii
Themeda triandra

IV CRYPTOPHYTES.

Plants whose buds or shoot-apices destined to survive the unfavourable season are situated under the surface of the ground

or at the bottom of water. This offers the most perfect protection of all the groups.

a. Geophytes include land plants whose buds or shoot-apices are born on subterranean shoots which are adapted as storage organs.

FORMS VIII.

Asparagus africanus
A. plumosus
A. medeoloides
A. sarmentosus
Bobartea aphaceae
Brownlowia coerulea
Bulbine aloeides
Chlorophytum comosum
Cyphia heterophylla
C. longifolia
Dietes vegeta
Dioscorea sylvatica
Habenaria arenaria
Oxalis smithii
Satyrium membranaceum
Scilla sp.
Watsonia meriana

V THEROPHYTES.

Plants of the favourable season only, i.e. they survive the unfavourable season in the form of seeds. They are annuals.

Lobelia tomentosa
L. erinus

STEM SUCCULENTS.

Sarcostemma

EPIPHYTES.

One species of Orchid and
Peperomia reflexa.

PHOTOGRAPHS.

I. This photograph shows the continuous growth of shrubs and trees from ground level to canopy. There is very little ground flora.

II. A portion of the forest.

III. The main path is very badly eroded.

IV. A badly trampled portion in the forest left of the main path (see map 13)

V. The pines a complete contrast from the forest. Note the low undergrowth consisting of tangled masses of bracken and brambles, odd patches of grass.

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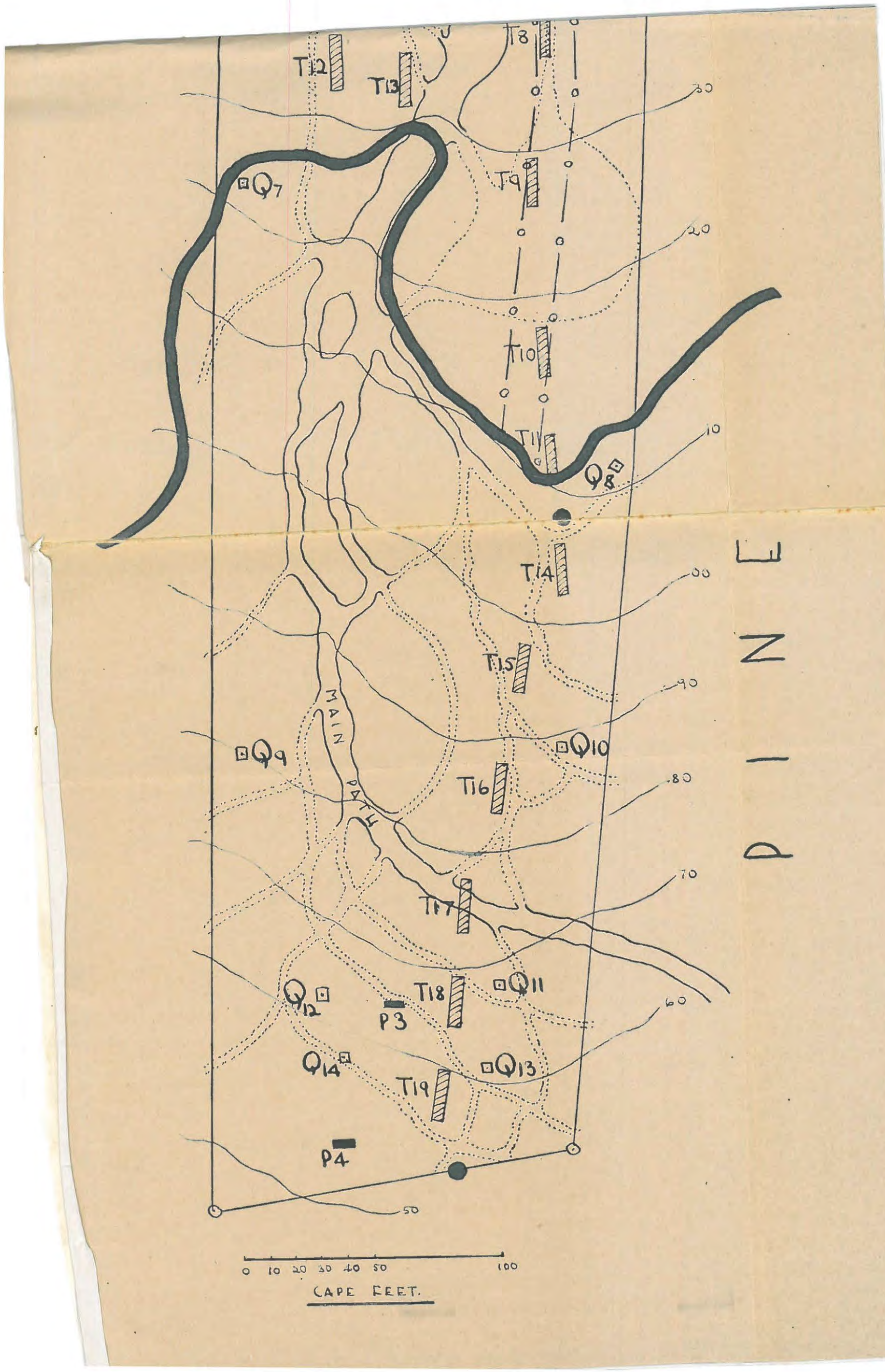
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CAPE FEET.

MAP OF THE AREA OF INVESTIGATION

AT FERN KLOOF

13

Survey by Messrs J. W. King and E. Clarke.