A BRAUN-BLANQUET SURVEY OF SOME CAPE - FOREST VEGETATION

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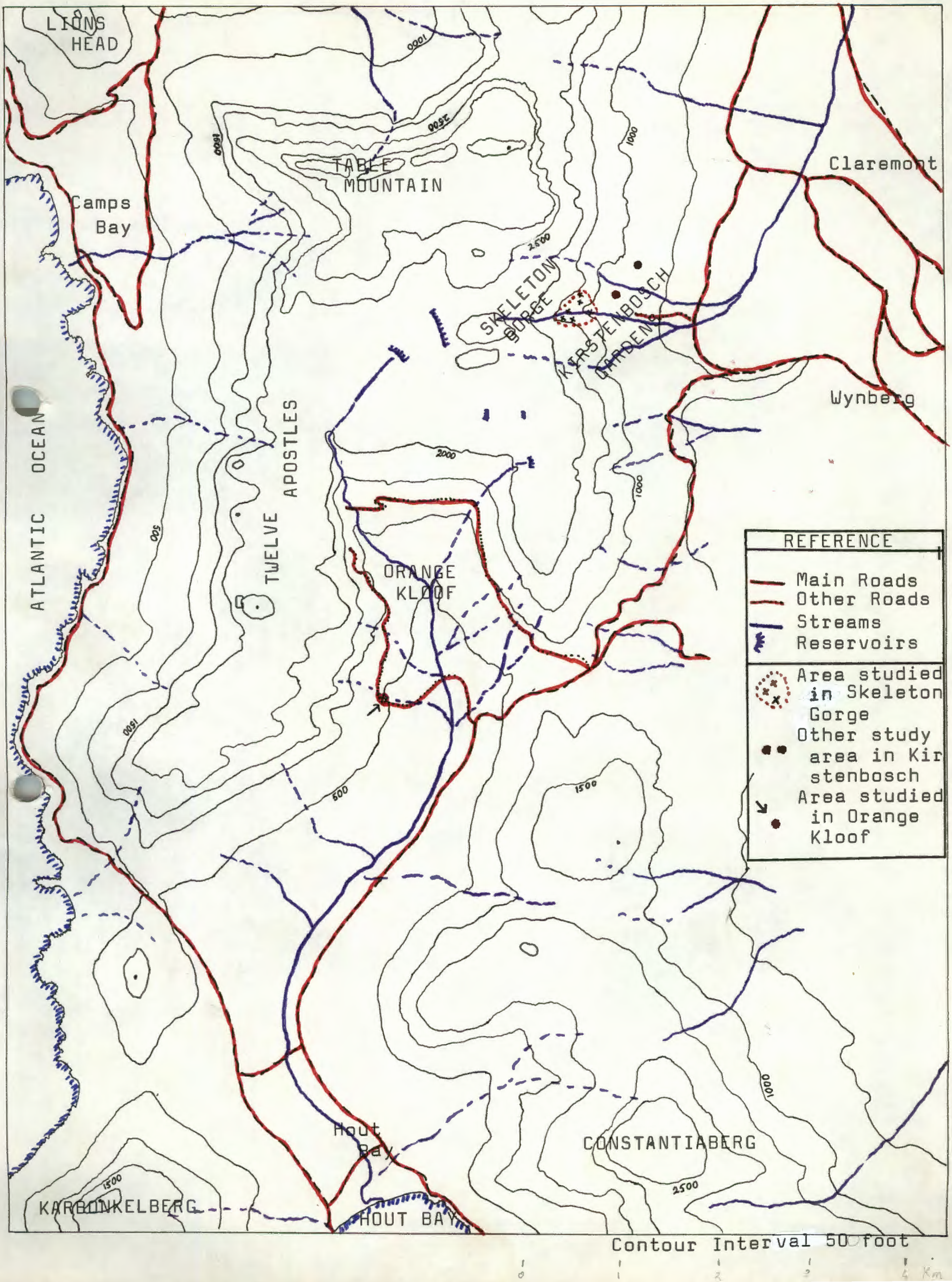
Botany Honours, 1974.

Page No.

Fig.2.1 Location map of the areas studied.



1 INTRODUCTION

A present requirement of synecologists working in South Africa is the description, at a semi-detailed level, of large areas of the relatively unstudied South African vegetation. The Braun-Blanquet approach (Werger, 1974) provides a method whereby a number of ecologists can contribute to such a study, the end result being a description and classification of large areas of vegetation. The results will serve as the basis not only for further scientific work, but also for land use management and conservation practises.

The aim of this communication is the description and classification of some forest patches on the Cape Peninsula. The applicability of the Braun-Blanquet approach and the use of a numerical grouping technique is considered.

2 THE AREA STUDIED

2.1 GENERAL

The areas studied are all on the Cape Peninsula, on the slopes of Table Mountain (Fig.2.1). One study area was in Orange Kloof, which is 5km NE of Hout Bay, while the other study area falls within the National Botanic Gardens, Kirstenbosch. The relic forest patches remaining on Table Mountain (all those studied are less than 1,5km^2), remain as a result of being protected from fire ~~or~~ and over-exploitation.

2.2 TOPOGRAPHY

Within the rather protected Orange Kloof, the forest studied is situated on an exposed gentle to moderate (3^o-16^o), south-facing slope. Some Kirstenbosch plots were taken from exposed open slopes while others were taken from Skeleton Gorge, which represents a protected habitat. Within Skeleton Gorge a variety of aspects and slopes were sampled.

2.3 GEOLOGY AND SOILS

Except for 6 plots in Skeleton Gorge where the soils were derived from Granite and Table Mountain Sandstone (T.M.S.), the remaining plots (33) were taken from areas where the soils were derived only from T.M.S. These latter soils were generally shallow, sandy and well drained whereas the former soils were generally deeper and had a higher clay content.

Table 4.2 The environmental data collected at each plot and some structural characteristics of the vegetation at each plot. The plots are grouped according to floristics.

(Slope: g = gentle; m = moderate; s = steep; vs = very steep:: Geology: T = Table mountain sandstone; g = granite: : Rock type: B = boulder; S = stone; s = small; m = medium; l = large; o = outsize:: Soil texture: s = sand; ls = loamy sand; sl = sandy loam; scl = sandy clay loam:: Soil structure: s = structureless; c = weak fine crumb; b = weak fine subangular blocky; m = moderate fine subangular blocky.)

Plot groupings	VIRGILIA COMMUNITY				MAUROCENIA COMMUNITY				LINOCIERA - GREWIA COMMUNITY											
Plot number	34	35	32	6	38	36	37	5	39	53	18	17	16	22	13	15	14	19	20	21
Topographical features affecting exposure	open slope				open slope				open slope in Orange Kloof											
Slope	m	m	m	m	s	s	m	m	g	g	g	g	g	g	m	m	m	m	g	g
Aspect	sse	sse	sse	sse	sse	sse	s	sse	sse	s	s	s	sse	sse	sse	sse	sse	ese	sse	sse
Geology	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
% Rock cover	3	10	2	5	95	90	95	90	50	35	45	90	5	60	60	<1	<1	75	40	70
Dominant rock types					Bl Bo	Bl Bo	Bl Bo	Bm Bl	Bm	Bs	Bl	Bl Bo		Bm	Bl			Bl	Bm	Bm
Soil characteristics:																				
total depth (cm)	20	30	>50	30	0	15	0	5	5	5	10	5	20	10	10	50	50	6	10	10
A horizon:																				
depth	10	15	10	10	0	15	0	5	5	5	10	5	20	10	10	50	50	6	10	10
texture	sl	sl	sl	sl	-	s	-	ls	ls	ls	ls	ls	ls	ls	ls	sl	ls	ls	ls	ls
structure	s+c	s+c	s+c	s+c	-	s	-	s+c	s	s	s	s	s	s	s	s+c	s+c	s	s	s
B horizon:																				
texture	scl	scl	scl	scl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
structure	s+b	s+b	s+b	s+b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Canopy height (m)	10	10	10	12	10	9	8	8	10	12	12	12	15	15	13	15	15	12	13	15
Canopy cover (%)	60	80	60	75	60	70	60	75	95	90	75	90	85	95	75	70	65	75	95	80
Ground layer cover (%)	20	25	10	5	1	1	1	1	1	15	1	1	5	3	5	10	50	3	5	15

Plot groupings	CELTIS COMMUNITY		SCOLOPIA COMMUNITY		CURTISIA GROUPING													CUNONIA COMMUNITY	
					CURTISIA-LINOCIERA COMMUNITY							CURTISIA - HARTOGIA COMMUNITY							
												RAPANEA FACIES			CUNONIA FACIES				
Plot number	8	12	7	9	25	23	4	3	24	11	1	27	28	26	31	29	30	2	10
Topographical features affecting exposure	Skeleton Gorge (p = protected; e = less protected areas)																	Skeleton Stream	
	p	p	p	p	e	e	p	p	e	p	p	e	e	e	p	p	p		
Slope	m	m	s	vs	s	s	vs	vs	s	vs	s	s	s	s	vs	vs	s	m	m
Aspect	ses	ses	ene	nee	e	e	ssw	ssw	e	sw	ssw	s	sse	ses	ses	ssw	sws	see	sse
Geology	T	T	T	T	T	T	T	T	T	T	T	Tg	Tg	Tg	Tg	Tg	Tg	T	T
% Rock cover	60	25	5	30	3	12	25	3	4	30	75	7	15	15	8	1	1	95	98
Dominant rock types	Bm	Bs	Bm	Bm			Bm			Bs	Bs							Bm	Bs
Soil characteristics:																			
total depth (cm)	10	10	10	10	30	15	10	10	30	10	3	60	50	50	30	50	30	5	2
A horizon:																			
depth	10	10	10	10	15	8	10	10	5	10	3	10	10	10	10	8	8	5	2
texture	ls	ls	ls	ls	ls	ls	ls	ls	ls	ls	s	ls	sl	ls	sl	sl	sl	s	s
structure	s+c	s+c	s+c	s+c	s+c	s+c	s+c	s+c	s+c	s	s	s+c	s+c	s+c	s+c	s+c	s+c	s	s
B horizon:																			
texture	-	-	-	-	sl	sl	-	-	sl	-	-	scl	scl	scl	scl	scl	scl	-	-
structure	-	-	-	-	s	s	-	-	s	-	-	s+m	s+m	s+m	s+m	s+m	s+m	-	-
Canopy height (m)	17	13	12	12	15	15	15	17	15	25	12	16	10	14	17	15	16	20	30
Canopy cover (%)	70	85	75	75	60	55	80	70	80	75	75	75	75	75	83	90	93	85	98
Ground layer cover (%)	1	1	1	2	5	3	1	1	3	25	1	1	1	1	1	1	1	1	1

See TM 1980

2.4 CLIMATE

Little climatic data is available from the areas studied. Rainfall at both areas is on the average 1500 mm per annum, most of the rain falling from May to October, but even in the drier months (January to March) there is 20-40 mm per month. For most of the Skeleton Gorge study areas, which were at an altitude of 250 m or higher, mist is an added source of precipitation. The Orange Kloof forest at an altitude of c. 150m, and the forest on the open slopes above Kirstenbosch (c. 200m) are probably less affected by mists. Temperatures are relatively mild with little or no frost. In Winter the temperatures remain above 5°C, while in Summer they rarely exceed 30°C.

2.5 GENERAL FOREST DESCRIPTION

A feature of all the forest studied is the paucity of ground layer. This apparently is a characteristic of evergreen broad-leaved forest of winter rainfall areas (Ellenberg and Mueller-Dombois, 1967). Definite vegetation strata were often difficult to distinguish, the understory and subcanopy layers having minimal cover values. Canopy height was mainly between 10-15m but it was lower in the scree forest (c.8m) and higher in the wetter forest (c.25m). Epiphytes ahd lianes are few in number.

3 METHODS

3.1 THE BRAUN-BLANQUET APPROACH

3.1.1 Introduction

The Braun-Blanquet approach to the study of vegetation has been widely used in Europe, since its origin shortly after the turn of the century, and it has proved an efficient and reliable method for the semi-detailed description and classification of vegetation (cf. Whittaker, 1962). However, until recently, this method has been largely rejected by English-speaking ecologists, probably because there have been few comprehensive English accounts of the method. Fuller and Conard's translation of Braun-Blanquet's Pflanzensoziologie (Braun-Blanquet, 1932) was, for a long time, the only reference to the method. This contains omissions and in many respects is out of date. Poore

(1955a, 1955b) probably provided the earliest detailed account of the method, although many of his criticisms, which led to a rejection of some of the techniques of the Braun-Blanquet method, were ill-founded, not applying " to the system as practised by most continental phytosociologists " (Moore, 1962). According to Küchler (1967), misunderstanding of the method is partly due to Braun-Blanquet himself, "who failed in his book, even in his third edition, to instruct the reader in his method". Personal instruction was therefore previously, and to some extent still is, the important method of understanding the techniques applied in the Braun-Blanquet approach. Another probable reason for rejection of the method, or mere disinterest, may be that the research efforts of British and American ecologists have been directed more towards detailed quantitative ecological studies and not primary survey work, for which the Braun-Blanquet system is most applicable (Whittaker, 1962). Other ecologists reject the method on the grounds of its supposed subjectivity. The situation with respect to the literature has improved and a number of comprehensive English accounts of the approach have been published (eg. Backing, 1957; Moore, 1962; Küchler, 1967; Shimwell, 1971; Werger, 1974). These have resulted in the uses of the system being recognised. This can be seen by the fact that Whittaker (1962), who is himself a statistical and quantitative ecologist, concludes an evaluation of the Braun-Blanquet approach by saying that "with its limitations clarified and accepted, the system of Braun-Blanquet is the most successful and most widely applicable means of formal classification that has yet been developed."

In South Africa a multitude of techniques have been used in the study of vegetation. These have ranged from statistical methods to mere descriptive accounts of the vegetation. A basic need in South Africa is a large-scale semi-detailed vegetation survey. For such a survey the uses of purely statistical methods would be impractical as they are usually time-consuming. Most of the descriptive methods used do not allow for comparison of results obtained by different workers in different areas. The Braun-Blanquet approach provides a happy mean between descriptive methods and statistical methods (Moore, 1962). The use of the latter methods will probably be restricted to small-scale detailed studies. In South Africa the Braun-Blanquet method was first used only in 1969 (Werger, 1973a). Werger has been important in providing the impetus for the use of the method in South Africa. Because of the success of the Braun-Blanquet surveys which have been carried out (eg. Werger, 1973a; Werger 1973b; Werger, Kruger and Taylor, 1972; Leistner and Werger, 1973) it is envisaged that this method will be increasingly used, the end result being an accurate description and classification of the South African vegetation at a more detailed level than that of Acocks (1953).

The basic aim of the Braun-Blanquet method, that is the description and classification of vegetation, is accomplished by sampling homogeneous areas which are representative of the stand of vegetation in which the sample is taken. Sampling is achieved by use of plots of a certain minimal size. Each species present in a plot is rated on the Braun-Blanquet cover-abundance scale. Environmental data is collected from each plot and various other vegetation characteristics may be noted. The samples are entered into a table from which units of vegetation are extracted. These are floristically and ecologically characterised and may be ranked in a hierarchy. The most important quality of the Braun-Blanquet system is that it provides a reasonably accurate and uniform approach to vegetation classification.

Various facets of the method are briefly discussed below. Discussion is more or less limited to those facets which have importance with reference to the present study. For a detailed account of techniques and concepts applied in the Braun-Blanquet approach, reference should be made to Werger (1974).

3.1.2 Data collection

a. Plot selection

Plot selection is usually subjective, the aim being to sample vegetation which is representative of the stand of vegetation in which the sample is taken.+ Plots are selected such that heterogeneity of habitat features, floristics and structure are

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+ Stand - " A concrete area of vegetation in the field " (Moore, 1962).

avoided. Subjective plot selection has been criticised. However, it is the practical approach, the aim of the method being the description of communities, not the description of transitional, heterogeneous and/or unrepresentative areas. The increasing objectivity which one gains, by using random, stratified random or systematic plot selection is balanced against the greater number of plots required for a basic description of the communities (Taylor, 1969). Samples from transition areas are of little value for such a description. There is, however, no fundamental objection against the use of more objective methods of site selection.

In the present study 39 plots were taken. Eight of these were sited by stratified random means as data collected from these plots was used in a more objective study of some characteristics of the forest. The remaining plots were sited subjectively. Appendix 1 shows the areas from which the plots were taken. Because the data from Orange Kloof was collected by undergraduate students doing practical work, this area was oversampled as compared to the forests at Kirstenbosch.

b. Plot size and shape.

The basic problem involving plot size is the determination of that size in which the community can manifest itself, such that the information obtained from the plot is representative of the stand of vegetation in which the plot is placed. The use of plots larger than the above size would result in a waste of time and effort. Although species-area curves are unreliable for determining plot size (cf. Campbell, 1974a), they were used in the present study as an aid to choice of plot size. Nested quadrats in Skeleton Gorge (in the area of plots 26, 27 and 28) and in Orange Kloof were used to construct species-area curves (Fig. 3.1). From these curves and due to the fact that Werger et al (1972) had successfully used a plot size of $100m^2$ in similar vegetation, ~~this size was used.~~ it was decided to use a plot of $100m^2$.

(INSERT FIGURE 3.1)

One is not bound to any plot shape in the Braun-Blanquet method. The shape should be such that the conditions of representativeness and homogeneity are met. In the present

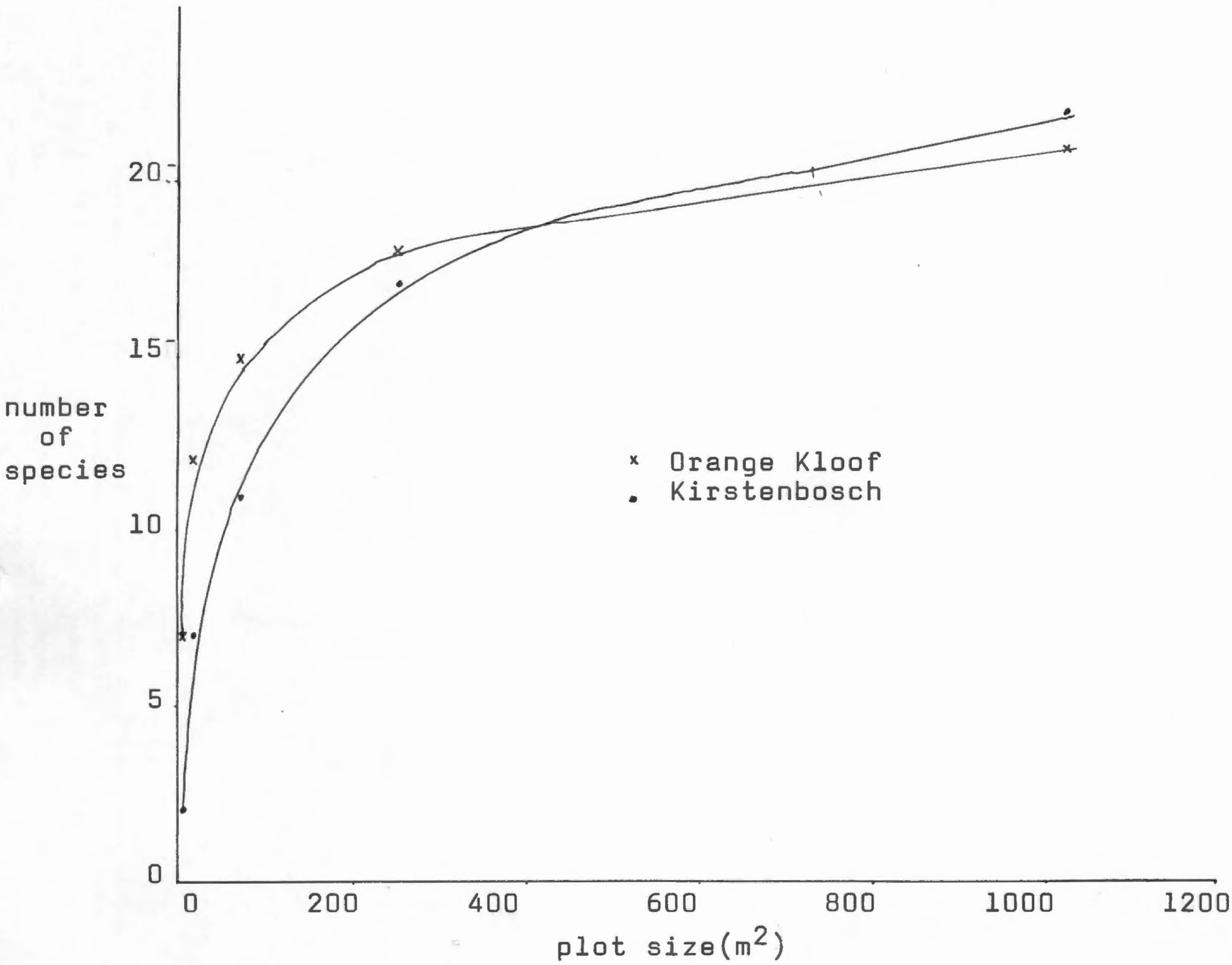

Fig.3.1 <u>Species-area curves used for the determination of plot size.</u>

study the majority of plots were square (10m x 10m), but the two riverine plots (2 and 10) were rectangular (c.14m x 7m and c.16m x 6m respectively) such that only the riverine community was sampled.

c. Floristic list.

In the Braun-Blanquet approach a total floristic list including ferns, mosses, hepatics, lichens, fungi and algae should be compiled from each plot. In the present survey all vascular plants were considered. There were very few taxonomic problems in the present survey. However, three small 'species' occuring in 5 of the 39 plots were eliminated from the final results. They may have been tree seedlings, but there was doubt whether they had been consistently recognised in the field.

d. Cover-abundance and Sociability.

Each species in the plot is assigned a cover-abundance value. Although each value is estimated, it has been found that estimations by different phytosociologists in the same patch of vegetation have been very similar (Dahl, 1957 quoted by Werger, 1974). This is due to the fact that each value is clearly defined and encompasses a wide range of actual percentage cover values.

The cover-abundance scale used is that as set out by Werger (1974). The 2m category was not found necessary. The scale is as follows:

- r Very rare and with negligible cover (usually just a single individual). In the present study area an r was only assigned if there was a single individual in the stand of vegetation within which the plot was taken.
- \+ Present but not abundant and with small cover value (less than 1% of the quadrat area).
- 1 Numerous but covering less than 1% of the quadrat area or not so abundant but covering between 1 and 5% of the quadrat area.
- 2m Very numerous, covering less than 5% of the quadrat area.
- 2a Covering between 5 and 12% of the quadrat area independent of abundance.
- 2b Covering between 13 and 25% of the quadrat area independent of abundance.
- 3 Covering between 25 and 50% of the quadrat area independent of abundance.
- 4\. Covering between 50 and 75% of the quadrat area independent of abundance.
- 5 Covering between 75 and 100% of the quadrat area independent of abundance.

When a species was absent from the plot but occurred outside the plot in the stand of vegetation in which the plot was taken, it was recorded by (r) or (+). (r) Was used if there was only a single individual with minimal cover, while (+) was used if there was more than just a single individual and/or if the cover was not negligible.

Braun-Blanquet phytosociologists often indicate grouping of the same species by means of a sociability scale. The original rationale behind its use is that the same species will show different grouping under different ecological conditions. However, such information is usually not reflected by the scale as the scale values are ill-defined. Even if such information was refelcted by the sociability scale I do not feel it would be useful in a primary survey where such detail is not required. Nevertheless, the scale is often retained as an indication of a species growth form. Rainkiaer's life forms, which are more widely accepted, would probably be more suitable. In the present study, the sociability value of each species has been recorded in the final column of the phytosociological table. The scale reads as follows:

1 Single individuals
2 Grouped or tufted
3 In troops, small patches or cushions.
4 In small colonies or extensive patches, or forming carpets.
5 In extensive crowds or pure populations.

For primary survey work, sociability values will be of little use in delineating communities. However, the cover-abundance scale is very suitable for primary surveys as it is one step better than mere presence and absence data and it is not as time-consuming as more accurate quantitative measures of abundance, which would, in any case, have little value in large scale, semi-detailed surveys.

e. Environmental data

The amount of environmental data collected from each plot in a survey should be dependent on the scale and purpose of the study. In the present case the following habitat features were recorded:

1) Altitude
2) Slope (flat: 0°-3°; gentle: 3°-$8,5^{\circ}$; moderate:

8,5°-16,5°; steep: 16,5-26,5°; very steep: 26,5°-45°; very very steep: more than 45°)

3) Aspect
4) Geology
5) Percentage boulder or stone cover and the size class of the dominant type of boulders or stones if the cover was greater than twenty percent. Two dominant size classes were noted if these had a cover of greater than twenty percent. The size classes used were as follows: boulders outsize 2m; boulders large: 1m-2m; boulders medium: 30-100cm; boulders small: 10-30cm; stones large: 5-10cm; stones medium: 2-5cm; stones small: $<$ 2cm.
6) Total soil depth
7) Texture and structure of the various soil horizons. The field procedures outlined by Loxton (1962) were used.

In recording environmental and other data a modified version of the Ec/2 form of the Botanical Research Institute was used (Appendix 2).

f. Structure.

The structure of the vegetation in each stand of vegetation was recorded by means of noting the height and cover values for each vegetation stratum.

3.1.3 Data analyses

a. Tabulation

The cover abundance values for each species are entered into a matrix where the columns represent plots and the rows represent species. The resulting table is known as the raw table. Columns and rows are then rearranged so that those which are positively associated or negatively associated, are grouped. Successive rearrangement should result in specific species-plot combinations. This table sorting is completely subjective but may be placed on an objective basis by the use of numerical grouping techniques. In the present study the results of a numerical grouping technique were used to group plots. Species were subjectively grouped. Sorting of the raw table was accomplished by using the computer. For this purpose a simple computer program was written. Sorting using this program may be either objective or subjective (Campbell, 1974b).

Although some workers leave out plots which they consider unrepresentative of any noda, all the plots have been used in the present study. It is felt that with further work in the studied forests, the affinities of any such plots will be shown.

b. Ecological confirmation of table pattern

The groupings of plots and species are a result of mere shuffling. The biological reality of the plot groupings can be confirmed by ensuring that the noda consist of plots which are ecologically similar. The usual procedure is to place the ecological data collected in each plot at the top of the phytosociological table. Because of the large amount of phytosociological and environmental data resulting from the present study, the results have been placed in separate tables.

c. Constancy and Fidelity

The final table allows easy assessment of noda or community characters such as dominant species, ~~and~~ character species and differential species. Constant species are those which occur in a high percentage of the plots of a community. Differential species are those species which distinguish one community from a floristically related community but are present in still other communities. A character species is a special case of a differential species. Besides distinguishing one community from another, it is also generally restricted to this community. Faithfulness to a community is known as fidelity. Apart from being determined by restriction to a nodum it can also be based on cover abundance values.

In the present study there has been no attempt to distinguish character species, as any species which is found in only one of the communities studied, may occur in many unstudied communities. All species characteristic of certain communities are therefore referred to as differential species. Dominant species have been regarded as those which have a high cover-abundance value as compared to other species in the community. A species is referred to as having its optimum in a community when it has higher cover values in this community as compared to other communities.

3.1.4 Conclusions

The end product of the Braun-Blanquet method is a classification based on total floristic composition. The basic unit of classification is the association which is a plant community with a definite floristic composition, a uniform physiognomy and uniform habitat conditions (Schröter and Flahault, 1910, qouted by Werger, 1974). Associations may be sub-divided or grouped to give hierarchical structure to the classification. As this is the first study in the Cape forest vegetation, the data available is considered insufficient to give syntaxonomical rank to the eight communities recognised. One of these communities is divided into two facies while several are combined into larger groupings. Each community is characterised floristically, environmentally and structurally.

3.2 NUMERICAL CLASSIFICATORY AIDS

3.2.1 Group average sorting based on a Czekanowski coefficient similarity matrix

There are a multitude of different techniques available for the grouping of data. Association analysis (Williams and Lambert 1959) has been widely used but suffers from the fact that it operates only on ~~the~~ presence and absence data and more important is the fact that it is a monothetic system, each group being defined by the presence or absence of a specified attribute (species). Misclassification is therefore possible when there is a chance absence of the specified species from plots in which these species would be expected to be found. The problems involved in association analysis are too great for it to be considered as a useful technique. A polythetic grouping method, in which grouping is by overall similarity, has been used in the present study. In polythetic systems there is less chance of misclassification. Various methods were actually used but it was found that the strategy of group-average sorting, using the Czekanowski coefficient (C_z), was most suitable.

In this method a similarity measure is calculated between each plot. The plots were then grouped according to the group average sorting strategy. In the present study C_z was used (Field and McFarlane, 1968). This is $C_z = \frac{2w}{A + B} \times 100$ where C_z is the percentage similarity between the two plots being compared, A and B are the sum of the quantitative measures of the species of the two plots being compared and w is the sum of the lesser quantitative value for each species. In the present study the Braun-Blanquet cover-abundance values were converted to purely numerical values and these were then used to calculate the similarity matrix. The conversion used was as follows: (r)=1; r=1; (+)=2; + = 3; 1=4; 2a=6; 2b=8; 3=12; 4=16; 5=20.

Two prpperties of C_z need to be considered. Firstly, this coefficient is abundance weighted and therefore more abundant species may dominate the analysis; information of less abundant species being lost. This is especially illogical when one considers that it may be the rare species which are selective of environmental conditions and therefore better indicators of certain habitat conditions (Day, Field and Montgomery, 1971). To prevent the effect of the more abundant species being weighted, abundance values are often standardised by square root or log transformation (Field, et al, 1968). This has the effect that the higher values are deweighted. Standardisation would not appear necessary when using the Braun-Blanquet cover abundance scale as this scale tends to be logarithmic, the importance of more abundant species already being lowered (cf. Field, 1970). For example a species covering 100% of a plot will get a value of five, while a species which covers one percent of a plot, and has therefore a one hundred times smaller percentage cover, gets a value of one which is only five times smaller than the value of the first species.

The second property of C_z is its assymetrical nature. This means that only joint presences of species are considered when calculating the similarity between two plots. The logic behind assigning more importance to joint presences than to joint absences is that in joint presences the environmental conditions which are required by the species are met in both plots whereas in joint absences there could be a host of environmental conditions excluding growth of the species. This is illustrated by the fact that "no plant ecologist would say that Fynbos and Bushveld vegetation were similar, because both lacked the species found in swamp forest" (cf. Field, 1969). Symmetrical coefficients such as the information statistic suffer from the problem that equal importance is placed on joint absences and joint presences (Field, 1969).

Like other sorting strategies group average sorting operates on a n x n similarity matrix where n is the number of plots to be classified. In group average sorting the most similar plots are first grouped. The similarity coefficients of the plots of such a group are then averaged so that in further grouping when the next most similar plots are grouped, the newly formed groups are regarded as single plots (Hall, 1969). The results can be represented in a dendrogram which shows the pattern of grouping and the linkage level at which plots are grouped. A computer program was available for the numerical analysis using Czekanowski coefficient and the group-average sorting strategy.

3.2.2 Average member comparisons.

The presentation of the results of group-average sorting represents a simplification of the many relationships occuring between plots and sets of plots. The multidimensional similarity relationships are represented in two dimensions in a dendrogram. Some distortion is therefore inevitable. By using the method of average member comparisons all the relationships between a set of plots and other plots or sets of plots may be investigated. In this method an average member is calculated for the set of plots under consideration by averaging the abundance values for all the plots in the group. This average member can then be compared, by means of C_z, with each plot within the set, with plots outside the set or with other sets of plots. By such comparisons one can show internal trends in a set and external trends outside a set. It is also a usefull method for showing plots which represent transitions between groups and showing ecoclines (Hall, 1970).

4 RESULTS AND DISCUSSION

4.1 RAW DATA

The data collected from the 39 plots and the similarity values calculated between each plot are shown in Appendix 3 and 4 respectively.

4.2 PLOT GROUPINGS

Figure 4.1 shows the plot groupings produced by the numerical classificatory system based on group average sorting and C_z.

Groups F, G and H appear to be the most distinct groups. These represent the scree forest or MAUROCENIA COMMUNITY, the

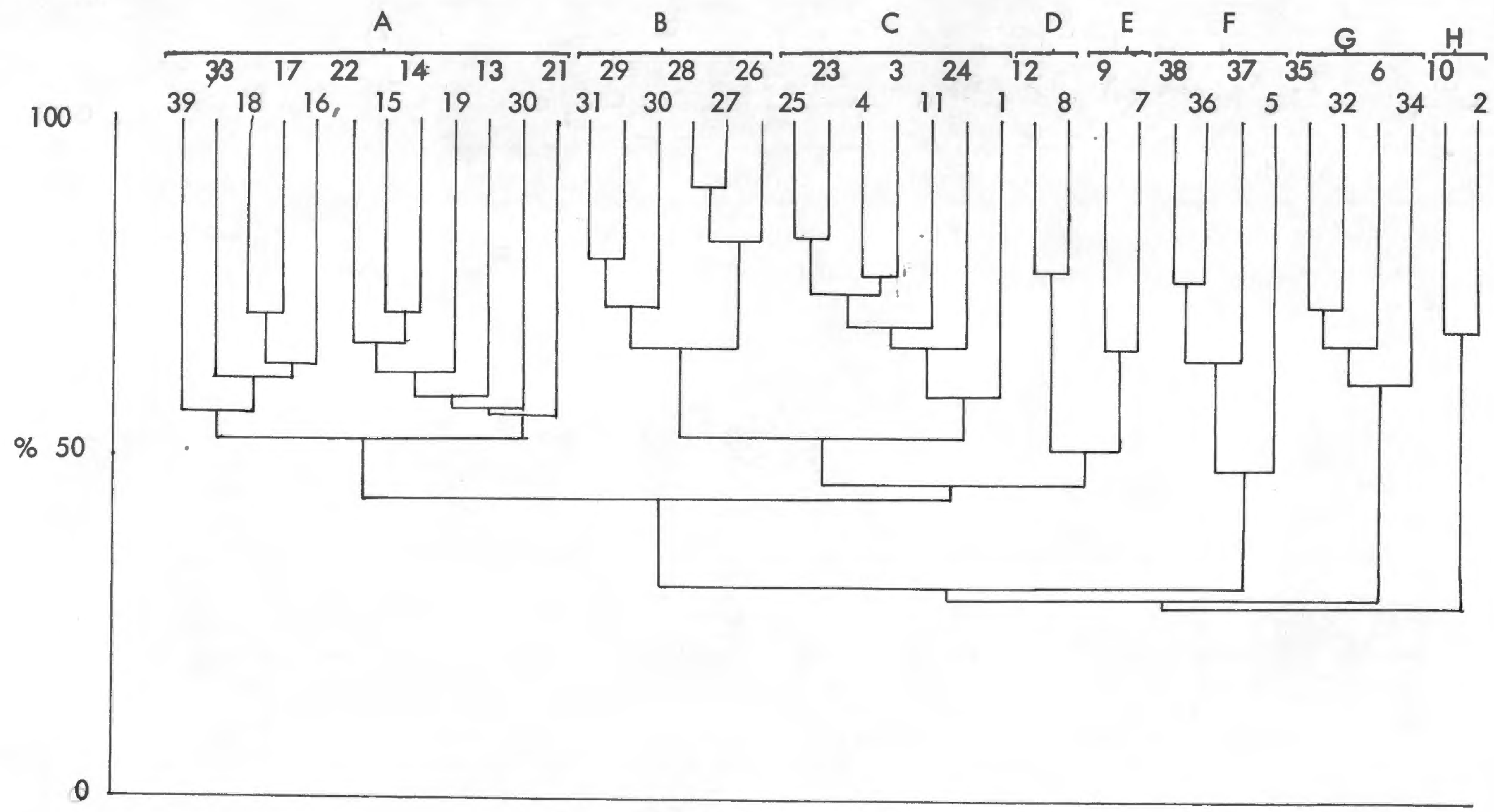

Fig. 4.1 Dendrogram showing group average relationships between plots. The scale shows percentage similarity as given by the Czekanowski coefficient. Plot numbers are shown at the top of the dendrogram. The letters A-H indicate the eight main groups recognised.

Table 4.1

The final phytosociological table.

	VIRGILIA COMMUNITY				MAUROCENIA COMMUNITY				PODOCARPUS - SCUTIA GROUPING																												CUNONIA COMMUNITY		sociability
									LINOCIERA - GREWIA COMMUNITY												CELTIS COMMUNITY		SCOLOPIA COMMUNITY		CURTISIA GROUPING														
																									CURTISIA-LINOCIERA COMMUNITY							CURTISIA-HARTOGIA COMMUNITY								
																																RAPANEA Facies			CUNONIA Facies					
Plot number	34	35	32	6	38	36	37	5	39	33	18	17	16	22	13	15	14	19	20	21	8	12	7	9	25	23	4	3	24	11	1	27	28	26	31	29	30	2	10	
Virgilia oroboides	2b	4	3	3																																				1
Rubus fruticosus	1	1	2a	+	r			(+)																																1
Grass K6	2a	r	r																																					2
Achyranthes aspera		+	+																																					2
?Rhychosia capensis	+	r																																						2
Solanum mauritanicum	r	r																																						1
Podalyria calyptrata	+																																							1
Phytolacca ?americana	+																																							2
Maurocenia frangularia					3	2a	3	2a							(+)					+																				1
Asparagus aethiopicus					1	1		1			+			+	r					+		r		+	r	+														1
Pleopeltis macrocarpa					+	+	+	+																	(r)													+	+	2
Cluytia pulchella					1	+		(+)													r			(+)									+	+						2
Herb K1-4B					+		+																																	1
Maytenus oleoides					2a																																			1
Podocarpus latifolius									1	3	1	2a	3	+	1	1	1	+					(+)	(+)	3	+	+	(+)	2b	1	+			(+)	(+)	+	(+)	2a		1
Maytenus acuminata										1			1				r	+	2a		+	2a	2a	+	1	1	1	1	1	(r)	2a				(r)			1	+	1
Olea capensis	+		+						3	2a	3	2a	+	+		1		1			1	+	2b	2b	3	3	2a	3	4	5	2a	1	1	1	2b	2b	1	1		1
Olinia cymosa								(+)						2a		4	3	2b	3	3	3	2b	r		1	2a	2a	2b	3	+	(r)	(+)			1	(+)	+	(+)		1
Apodytes dimidiata				+				(+)			1	+	+	(+)			r			+		2a	(r)	1	1	(+)	+	1			1					+		2a		1
Secamone alpinii			+					(+)	2a	2a	+	1	+	+	+	1	+	+		+	+	+		+	1	1	1	1	+	1	1	+	+	+	+	+	1	1	+	1
Scutia myrtina								1		1	+	1	2a	1	1	+	2a		+	1	+	+	1	+	(+)	1	+	+	1	+		+	+	+	+	+	+	+	r	1
Asparagus scandens			+			+	+		r	+	+	+	1	1	+	1	2b	+	+	+	r				1	1	+	+	1	+	r	+	+	+	+	+	+	r		2
Ehrharta ?capensis																			+					+	+	+												+		2
Asparagus africanus														+													1													1
Carex aethiopica																			+										+											2
Linociera foveolata								1		2a	2b	2a	1	1	2a	+	2a	2a	+	4					+	+	1	+	+	+	2a									1
Grewia occidentalis									r			1		r						+																				1
Stipa dregeana var. elongata										+								r	+																					2
Herb O11-1																	+																							1
Rhus ?lucida										+																														1
Populus canescens																			r																					1
Celtis africana																					2a	2a																		1
Schoenoxiphium lanceum																		1			+	1	1	+	1	+	+			2b	+					(+)	+	+	+	2
Scolopia mundii																							5	2b	+	1	1	(+)	(+)	1							+	(+)		1
Asplenium lanulatum																									+	+	+	(+)		+	+									1
Ocotea bullata																									+	2a			(+)	1	1					+	+	1	(r)	1
Grass K4-4E																									+		+													2
Curtisia dentata																									+	2b	2a	2b		2a	2b	(+)	+	1	2b	2a	1	(+)	(+)	1
Hartogia capensis																													1		(+)	3	3	3	3	2b	3	1		1
Dryopteris inaequalis																												+								(+)	+			2
Cunonia capensis																														+	2a				1	1	3	5	5	1
Blechnum attenuatum var. gigantum																																						+	+	2
Ilex mitis																																						(+)	(+)	1
Zantedeschia aethiopica					(r)										r																							r	+	1
Todea barbara																																							+	1
Fern K5-5C																																						+		1
Herb K5-7E																																							(r)	1
Diospyros whyteana	3	2b	2a	2a	(+)	+	1	4	+	+	+	1	1	1	+	1	1	+	1	+	1	1	1	1	1	1	2a	2b	1	2b	2a	+	1	1	1	1	1	+	+	1
Rapanea melanophloeos	2a	4	3	2a	+	+	+	+	1		1	2b	3	3	1	2a	2b	+	1	+	2b	+	3	4	1	(+)	1	1	(+)	1	2a	3	3	2b	1	1		1		1
Cassine capensis	1	r	+	(+)	3	3		2a	3	3	2b	3	2a	4	4	2a	3	2a	3	(+)			+	2b	1	1	3	2a	2a	1		2a	2a	1	1	2a	2a		(+)	1
Knowltonia capensis		+		r		+	+	+		+	(+)	+	+	+		r	+	+	+	+	+	(r)	+	+	+	+	+	+	+	+	+	+	+	+	(+)	+				2
Canthium ventosum	+	+	2a	+				(+)	2a	2a	2a	1		2a			+	1	1	+	+	+	+	+	1	1	+	1	2a	1	1	+	1	+	1	+	1	1	(r)	1
Kiggelaria africana	2a	1	1	3	+	1	2a	+						r		(+)	+				2a	1	1		+	+	1		+		2a	2a	2a	1		+	+	+	+	1
Asplenium adiantum-nigrum					(+)	+	+																+	+	+	+	(+)	+	+				+	+	r	(+)				2
Halleria lucida	2a		+	2a																	2b	2a	3	(+)	1	(+)	+	1	(+)		1								(+)	1
Blechnum australe		+	+	(+)																				(+)	+	+	+	+	+	+		+	+		(+)	+	+			1
Leidesia procumbens	1	+	+	+				(+)													r					+				+		+		1				+	(r)	1
Oxalis sp.	+	+	+	+													r																	+		r,	(+)	+	+	1
Maytenus heterophylla	r		1	1						r	1	+						r						(+)																1
Canthium mundianum			+	(+)	2a	2b	3	1	1			3		+	+	1	+	+	+	+	2a	2b	1	1	+	+				(+)										1
Olea africana					3	4	2b	+	+		2b	3	2b	1				+	3	+																				1
Asplenium K5-5E								+																														+		1
Pellaea pteroides					(+)													+																						1
Stachys aethiopica																								r																1

VIRGILIA COMMUNITY and the CUNONIA COMMUNITY. In Figure 4.1 plot 5 in the first of these groups only links to the other members of the group at a low similarity value. If one considers the similarity matrix (Appendix 4) it is found that this plot is somewhat intermediate between the core-like members of group F and the plots 21 and 22 which are situated in Orange Kloof. The CUNONIA COMMUNITY is not as distinct as it would appear on the dendrogram. Figure 4.2 shows the results of average member comparisons comparing the average member of this community with other plots.

INSERT FIGURE 4.2

The plots of groups B, C, D and E are the most similar to the average member of group H, the CUNNONIA COMMUNITY. If one considers the phytosociological table (Table 4.1) it can be seen that plot 10 is sufficiently different from the plots of other groups to be placed in a group of its own. However, plot 2 is rather intermediate between this plot and the plots of the above-mentioned groups. It is felt that with further sampling plots similar to plot 10 will be found and as they would be so distinct, they should be placed in a separate group. For convenience plot 2 is placed with 10 although it is probably unrepresentative of the CUNONIA COMMUNITY as represented by plot 10.

After considering results from average member comparisons and by looking at the phytosociological table it was decided to give hierarchical structure to the classification of plots by grouping various sub-groups. The final grouping arising after considering the results of numerical aids is shown in Figure 4.3. The order of the groups has been largely determined by the relationships between the groups. For instance, group B1 is placed next to group H because of their similarity. This grouping has been used in the construction of the phytosociological table.

INSERT FIGURE 4.~~4~~3

4.3 FLORISTIC ~~DESCRIPTION OF THE~~ CHARACTERISATION AND STRUCTURAL DESCRIPTION OF THE VARIOUS GROUPINGS.

Table 4.1 shows the final phytosociological table. In the description of the groupings which follows the basic units are referred to as communities. The classification which has been proposed should be a working hypothesis for further work in the

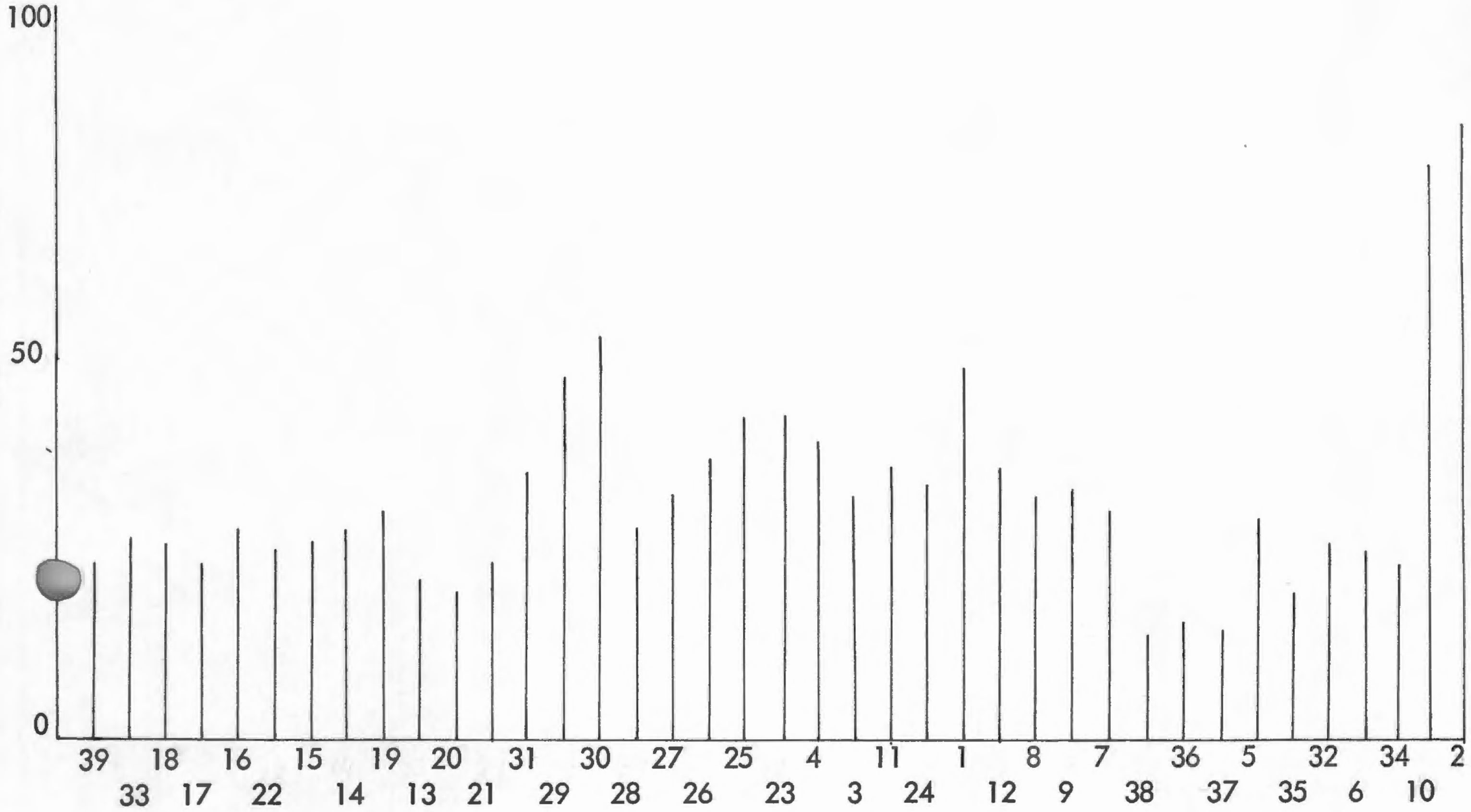

Fig. 4.2 Average-member comparison. The graph shows the percentage similarity of plots to the 'average member' formed by plots 2 and 10. The sequence of plots and groups is that shown by the dendrogram in Fig. 4.1 .

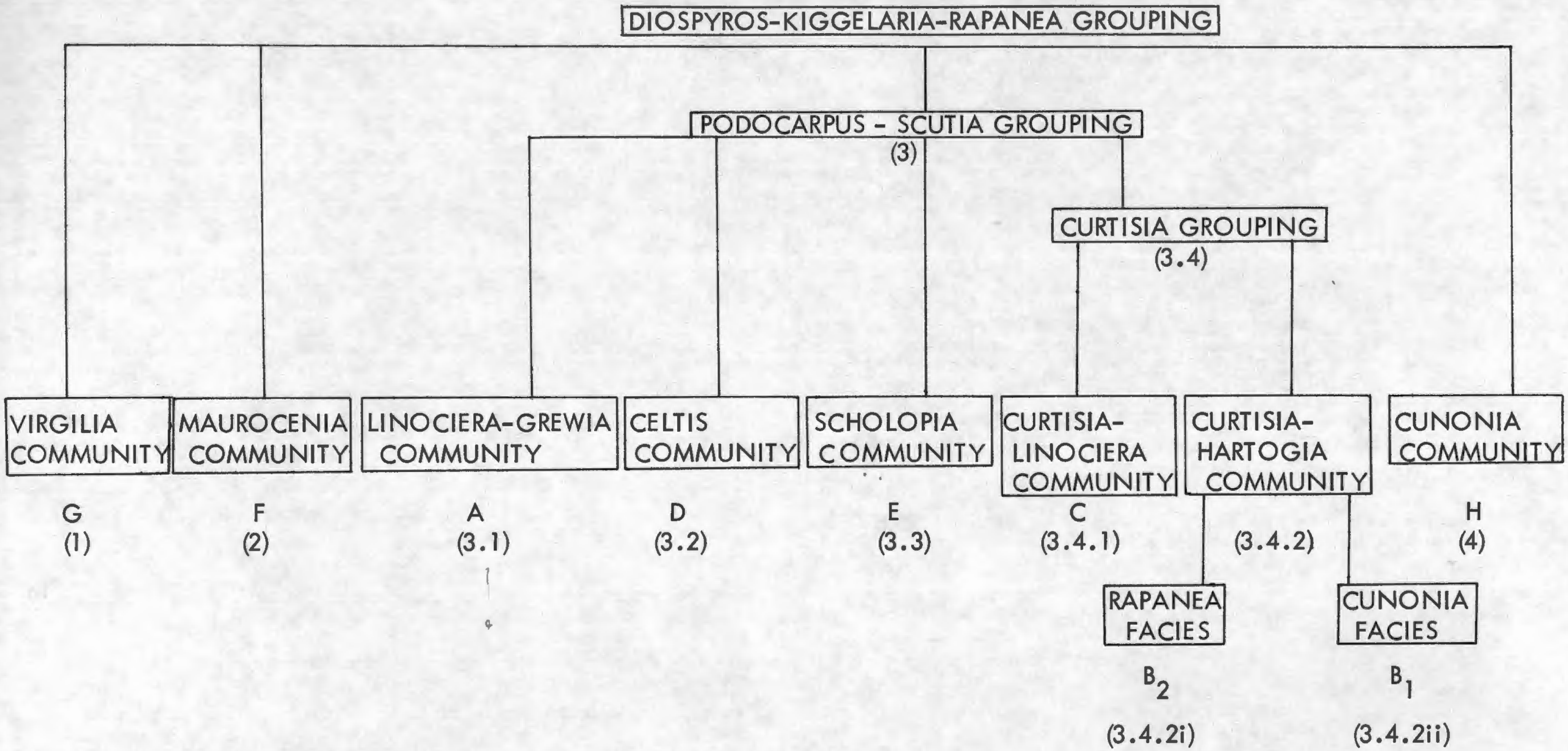

Fig. 4.3 The final plot groupings. The plots of each group are shown in Fig. 4.1. The various groupings have been named according to their differential or dominant species. The alphabetic codes used in the dendrogram are shown togethe r with the numerical codes used for each group.

Cape forest vegetation. Future work will show whether the communities recognised can be extrapolated to other areas of the forest where plots were not taken. The groupings and communities have been named after the differential or dominant species.

DIOSPYROS - RAPANEA - KIGGELARIA GROUPING

This is the large 'group' comprising all the communities delineated. With further work in the forest vegetation, other communities may be included in this group. Diospyros whyteana is found in all the plots comprising this group. Other tree species of high constancy include Rapanea melanophloeos, Kiggelaria africana, and Canthium ventosum. The most constant ground layer species is Knowltonia capensis.

1. VIRGILIA COMMUNITY

The differential and dominant species of this community is Virgilia oroboides. It is also found in all four plots representing this community. Rubus fruticosus, although not restricted to this community, is also a differential species. Species with high cover values and a high constancy are D. whyteana, Rapanea (both of which appear to have an optimum in this community) and Kiggelaria. Halleria lucida has high cover values in some of the plots.

This community has a 8-10m high canopy and a 15m high emergent layer consisting of Virgilia. The ground layer has a relatively high projected cover (P.C.) of about 15 percent. This is probably due to the fact that light has little difficulty in penetrating the canopy and emergent layer.

2. MAUROCENIA COMMUNITY

Maurocenia frangularia has a high constancy and high cover values in this community and although it is not exclusive to this community, it is a differential species. Asparagus aethiopicus, another differential species, appears to have its optimum in this community. Pleopeltis macrocarpa is a differential species of this and the CUNONIA COMMUNITY. Apart from Maurocenia, other species with high cover values are Cassine capensis, Olea africana (the dominant species) and Canthium mundianum. Plot 5, which has been recognised as a peculiar plot, contains, or has in its close vicinity, a number of species found in other forest areas but not in any other plots of this community (e.g. Olinia cymosa, Apodytes dimidiata, Scutia myrtina, Linociera foveolata and C. ventosum). The MAUROCENIA COMMUNITY consists of low trees of about 8m.

3. PODOCARPUS - SCUTIA GROUPING

This major grouping which comprises the remaining plots excluding the two of the CUNONIA COMMUNITY, has as differential species, amongst others, Podocarpus latifolius, Maytenus acuminata, Olea capensis, Olinia, S.myrtina, Apodytes, Secamone alpini and Asparagus scandens. These species are, however, not completely constant within this grouping and may not be exclusive to this grouping. There are many other differential species, but these are even more restricted to certain communities within the major grouping (e.g. Linociera, Curtisia dentata).

3.1 LINOCIERA - GREWIA COMMUNITY

Linociera and Grewia occidentalis are the differential species of this community. The former is the more important as it has a high constancy unlike the latter. Linociera is not restricted to this community also being found in the CURTISIA - LINOCIERA COMMUNITY for which it is also a differential species. However, it appears to have its optimum in the LINOCIERA-GREWIA COMMUNITY. Cassine capensis would also appear to have its optimum in this community. It is the dominant in most of the plots. Apart from C. capensis, other species which may have high cover values are O. africana, Rapanea, C. ventosum, P. latifolius, Olinia and O. capensis.

Within this community it is obvious that there is some pattern, but it is felt that the quadrat size was too large to show this pattern. Olea africana and Maurocenia frangularia occured on rockier sites. On sites with deeper soils, these species were absent. Canopy height was generally greater on the latter sites (c. 15m as opposed to c. 12m). The canopy layer was usually the only distinct layer.

3.2 CELTIS COMMUNITY

The two plots representing this community were located by random means. This is important as Celtis africana, is an extremely rare tree at Kirstenbosch, a few trees having been recorded. As such these plots, which are situated a few yards from each other are probably not representative of many areas in Kirstenbosch as they both have C. africana as a dominant species. However these plots are distinct from others in that Halleria and C. mundianum have high cover values. To a lesser extent this is also the case with Kiggelaria. Olinia is the dominant species. Rapanea and M. acuminata may also attain high cover values. Notably absent from this community is Cassine capensis and P. latifolius.

In this community Olinia forms an emergent layer of 15m. The canopy is 10-13m high. A subcanopy with a P.C of 25 percent and a height of 7-10m can also be distinguished. There is minimal ground layer.

3.3 SCOLOPIA COMMUNITY

The differential species of this community is Scolopia mundii as it has its optimum in this community. This species, O. capensis and Rapanea all have high cover values in this community. Other species which may have high values are Halleria, Cassine capensis and M. acuminata. Apart from the closed canopy (12m), a subcanopy layer was also recognisable (6-10m with a P.C. of 25 percent). A 20m individual of O. capensis was an emergent in one of the plots.

3.4 CURTISIA GROUPING

The differential species with the highest constancy is Curtisia dentata. Ocotea bullata and Hartogia capensis are also differential species.

3.4.1 CURTISIA - LINOCIERA COMMUNITY

Differential species of this community are Linociera and Asplenium lanulatum. This latter species is restricted to this community. Ocotea may be considered to be a differential species but it is neither constant nor exclusive to this community. O. capensis would appear to have its optimum in this community. To a lesser extent this is also the case with Diospyros whyteana, but it has a greater optimum in the VIRGILIA COMMUNITY. Apart from O. capensis, other species which attain high cover values are Olinia, Curtisia and Cassine capensis. The canopy height of this community appears to depend on the exposure of the site (15-20m).

3.4.2 CURTISIA - HARTOGIA COMMUNITY

Hartogia capensis is the differential species of this community for although it is not exclusive to this community, it is here that it has its optimum. It is also the dominant species. Apart from this species, other species which may have high cover values are *Cassine capensis*, *Rapanea*, *Curtisea*, *O. capensis*, *Cunonia capensis* and *Kiggelaria*. *Halleria* is notably absent from this community. Two facies of this community have been recognised.

3.4.2.i CURTISIA - HARTOGIA - RAPANEA FACIES

In this facies *Rapanea* has higher cover values as compared to its values in the other facies. This is also the case with *Kiggelaria*. *Rapanea* together with *Hartogia* is the dominant species. *Cunonia* is absent. The canopy in this community is about 12-14m high with a P.C. of 75 percent.

3.4.2.ii CURTISIA - HARTOGIA - CUNONIA FACIES

The differential species of this facies is *Cunonia capensis*. The canopy is generally higher than that of the other facies (15-17m) and has a greater P.C. (85-90 percent).

4 CUNONIA COMMUNITY

The most important differential species of this community is *Cunonia* as it attains extremely high cover values (75-90 percent). This species dominates the community. Other differential species are *Ilex mitis*, *Blechnum attenuatum*, *Zantedischia aethiopica* and *Todea barbara*. It is felt that a characteristic of this community is the low number of species. Plot 2, which has been recognised as an intermediate plot has more species common to other forest types than plot 10. The canopy of this community is extremely high (25-30m) and has a high P.C. (85-90 percent).

4.4 ENVIRONMENTAL CHARACTERISATION OF THE VARIOUS GROUPINGS

The environmental data collected from each plot is shown in Table 4.2. The important habitat characteristics of each grouping are as follows.

DIOSPYROS - KIGGELARIA - RAPANEA GROUPING

The forest areas studied and collectively termed the DIOSPYROS - KIGGELARIA - RAPANEA GROUPING as opposed to the Fynbos areas in the immediate surroundings, have been protected from fire and exploitation and they generally occur in areas with more mesic conditions.

1 VIRGILIA COMMUNITY

Virgilia, the dominant and differential species of this community, suggests the main habitat characteristic of this community. This species is a light demanding pioneer species growing abundantly in heavily exploited and burnt forest sites (Phillips, 1928; Phillips 1931; Von Breytenbach, 1965). This community therefore represents a seral forest type and is actually a result of past exploitation in the area (pers. comm. J.A.Marais, Kirstenbosch Gardens). That forest has been able to develop in this area as opposed to nearby Fynbos areas is probably due to the fact that aliens are continually removed by the Kirstenbosch staff and especially due to the fact that the area is protected from fire. The soils are also better than those in the Fynbos areas and even better than those in much of the forest areas. They are relatively deep, contain more clay and have more structure than most other forest soils.

2. MAUROCENIA COMMUNITY

This community is characterised by large boulders which cover more than 90 percent of the ground. As such they provide fire protection, and some species can make use of percolation water running under the talus (Daubenmire, 1974). The importance of the boulders can be seen towards the south of the talus, where Fynbos vegetation is found as soon as one moves onto less rocky soil. It has been noted that plot 5 is a peculiar plot in this community. When one consults the environmental data available , it appears that this peculiarity may be due to the fact that the boulder size at this plot is smaller than that at the other three plots. It has been noted that plot 5 appears intermediate between plot 21 and 22, of the LINOCIERA - GREWIA COMMUNITY at Orange Kloof and the core-like members of the MAUROCENIA COMMUNITY. The relationships between the Orange-Kloof community and the MAUROCENIA COMMUNITY is probably caused by the high rock cover at some of the plots in the former community. Maurocenia, a characteristic species of the scree forest, is found in plots 13 and 21 in Orange Kloof both of which have a high boulder cover (c. 60 percent). O. africana, another characteristic species,was found in many more plots in Orange Kloof, but was generally restricted to those with a high boulder cover.

[I dont agree with this anymore (B,C)]

3 PODOCARPUS - SCUTIA GROUPING

This group includes all the forest studied excluding seral communities (VIRGILIA COMMUNITY), scree forest (MAUROCENIA COMMUNITY) and very wet forest (CUNONIA COMMUNITY).

3.1 LINOCIERA - GREWIA COMMUNITY

No direct environmental data characterises this community. However, this community is found on an exposed slope within Orange Kloof and at an altitude (c. 500m) where the effect of mists is minimal. The only other communities having these characteristics are the two communities considered above. Considering the exposure and the lack of mists, this forest probably represents a very dry forest type. Evidence for this can be seen if one considers plot 19, which was taken from the stream in the Orange Kloof study area. If this had been a wetter forest one would have expected this plot to have affinities with plots in Skeleton Gorge (especially those of the CUNONIA COMMUNITY, the very wet forest). Further evidence for this community being a very dry type is the fact that Grewia occidentalis and Linociera, the differential species of this community, are supposedly indicators of dry forest types. Other species of this community which fall into this catagory are Cassine capensis (which attains its optimum in this community), Maytenus heterophylla and Rhus lucida (cf. Phillips, 1928; Von Breitenbach, 1965; Von Breitenbach, 1972; Taylor, 1955). There is also a notable lack of ferns in this community. This may indicate a dry soil. It was noted that wetter forest types with more affinities to the forest in Skeleton Gorge, occur in the gorges of ~~the~~ Orange Kloof.

It has been stated that there is a relationship between this community and the MAUROCENIA COMMUNITY. This is probably mainly due to the high boulder cover in both communities. Both communities are also situated on open slopes at an altitude where the effect of mists is minimal. The LINOCIERA - GREWIA COMMUNITY is, however, not a true scree forest, the boulder cover usually being less than that of the MAUROCENIA - COMMUNITY.

Within the LINOCIERA - GREWIA COMMUNITY floristic pattern is associated with soil depth and boulder cover. On sites with deep soils and low boulder cover one gets tall (15m) forest while on rocky sites one gets lower forest (12m) with species such as Maurocenia and O. africana. In plot 14 where the canopy was disturbed, there was a very high ground layer P.C (c. 50 percent).

3.2 CELTIS COMMUNITY

The two plots representing this community were taken from very protected areas next to Skeleton Stream on a moderate slope. The absence of P. latifolius and Ocotea saplings, which are present in most other areas of Skeleton Gorge, and the extremely small number of herbaceous ground layer species may be due to disturbance, as the two plots are situated on the much-used Skeleton Gorge path. However, it is felt that this habitat type should have the potential for the development of a specific forest type as there are very few areas where a moderate slope is combined with minimal exposure. The only other plots which had the above habitat characteristics, were the two of the CUNONIA COMMUNITY. These, however, differ in that they were taken from the actual Skeleton Stream. The unique ecological conditions of these plots may account for the floristic characteristics mentioned in the previous section.

3.3 SCOLOPIA COMMUNITY

This community is environmentally characterised by rocky shallow soils on steep north-east facing slopes. Conditions are therefore relatively unfavourable. The aspect indicates that this is a dry forest type. However, it is not as dry as the LINOCIERA - GREWIA COMMUNITY as mists are an added source of precipitation, and as it is found in Skeleton Gorge ~~and~~ it is therefore somewhat protected.

3.4 CURTISIA GROUPING

From the environmental data in Table 4.2, this initially appears to be a grouping with a rather wide range of environmental conditions. This is not the case as this forest type probably represents the climax type of all the better forest sites. Therefore, it excludes seral communities (VIRGILIA COMMUNITY), scree forest (MAUROCENIA COMMUNITY), very dry forest (LINOCIERA - GREWIA COMMUNITY) dry forest (SCOLOPIA COMMUNITY) and very wet forest (CUNONIA COMMUNITY). It also does not include the CELTIS COMMUNITY. The reason for this is at present not apparent. Within the CURTISIA GROUPING there is a range of sites: dryer sites with relatively deep soils; wetter sites with shallow soils and wetter sites with relatively deep soils.

3.4.1 CURTISIA - LINOCIERA COMMUNITY

This community is ecologically distinct from the other community of the CURTISIA GROUPING by the fact that the latter is on soils derived from T.M.S. and granite, while this community is on soils derived from T.M.S. With respect to either soil depth or exposure and aspect, or both, the sites of this community are less favourable than those of the other community of the CURTISIA GROUPING.

Plots 23, 24 and 25 are on a relatively open east-facing slope and are therefore more exposed and drier than other plots taken from Skeleton Gorge (excluding those with a north-east aspect - dry forest SCOLOPIA COMMUNITY). These plots are also situated at a low altitude as compared to other plots in Skeleton Gorge, and the effect of mist may be less. However, they are more favourable in terms of soil depth, having a deeper soil than most other plots in Skeleton Gorge (excluding some of those of the following ~~CURTISIA COMMUNITY)~~ community). The other plots of this group, i.e. 1,3,4, and 11 are favourably situated in that they are in very protected areas of Skeleton Gorge. However, the soils are very shallow and in most cases there is also a high boulder cover.

All the plots of this community are on steep or very steep slopes.

3.4.2 CURTISIA - HARTOGIA COMMUNITY

As has been stated above, the soils of this community are derived from T.M.S. and granite. This is the only community having soils with a granitic origin. As such, the soils are generally deeper and have a higher clay content than the soils of other communities. The soil factor may explain the notable absence of Halleria from this community. The two facies of this community can be ecologically distinguished on exposure.

3.4.2 i CURTISIA - HARTOGIA - RAPANEA FACIES

This facies is found on south-east facing slopes, c. 30m from the forest margin, in more exposed sites than those of the second facies. This probably results in a drier site, which will explain the absence of ~~CUNONIA~~ cunonia from this facies and the high cover values of Rapanea, which also has high values in the VIRGILIA, LINOCIERA - GREWIA and SCOLOPIA COMMUNITIES, all of which are dry forest types. The latter community is also found near the forest margin.

3.4.2 ii CURTISIA - HARTOGIA - CUNONIA FACIES

This facies is found in more protected areas than the first facies. As the soils are also relatively deep and have a certain amount of clay, the sites of this community probably represent the optimal sites for forest growth. The only unfavourable character is the steepness of slope.

4. CUNONIA COMMUNITY

The plots representing this community were taken from the Skeleton Stream in very protected areas, which probably ~~only~~ get only a few hours sunlight every day. This forest is therefore a very ~~wet~~ moist type. However, there is almost no soil at any of these sites, the ground surface being covered by small to medium sized boulders. Plot 2 has been noted to be rather unrepresentative of the CUNONIA COMMUNITY. This can be ecologically explained by referring to the field sheets where it was noted that although the sample was taken from within the stream there were small "islands" in the stream. These supported species not found in plot 10, where only the stream was sampled.

A simple summary of the environmental characteristics of each grouping or community is shown in Figure 4.4, while Table 4.3 is a summary of the floristics and environmental characteristics of each community or grouping.

4.5 SEEDLING STUDIES

In all except three plots the number of seedlings for each tree species was recorded on the following scale: 1 = 1 to 5 seedlings in the plot or a seedling in the vicinity of the plot; 2 = 6 to 10 seedlings in the plot; 3 = 11 to 15 seedlings in the plot. An individual of a tree species was considered to be a seedling if less than 0,5m in height. The results of the study are shown in Table 4.4.

Although this study was not very detailed, the results suggest that there will be no future drastic change in ~~thf~~ the forest floristics except for those of the VIRGILIA COMMUNITY. Of the

Other important habitat characteristics

* Serel community
** moderate slope

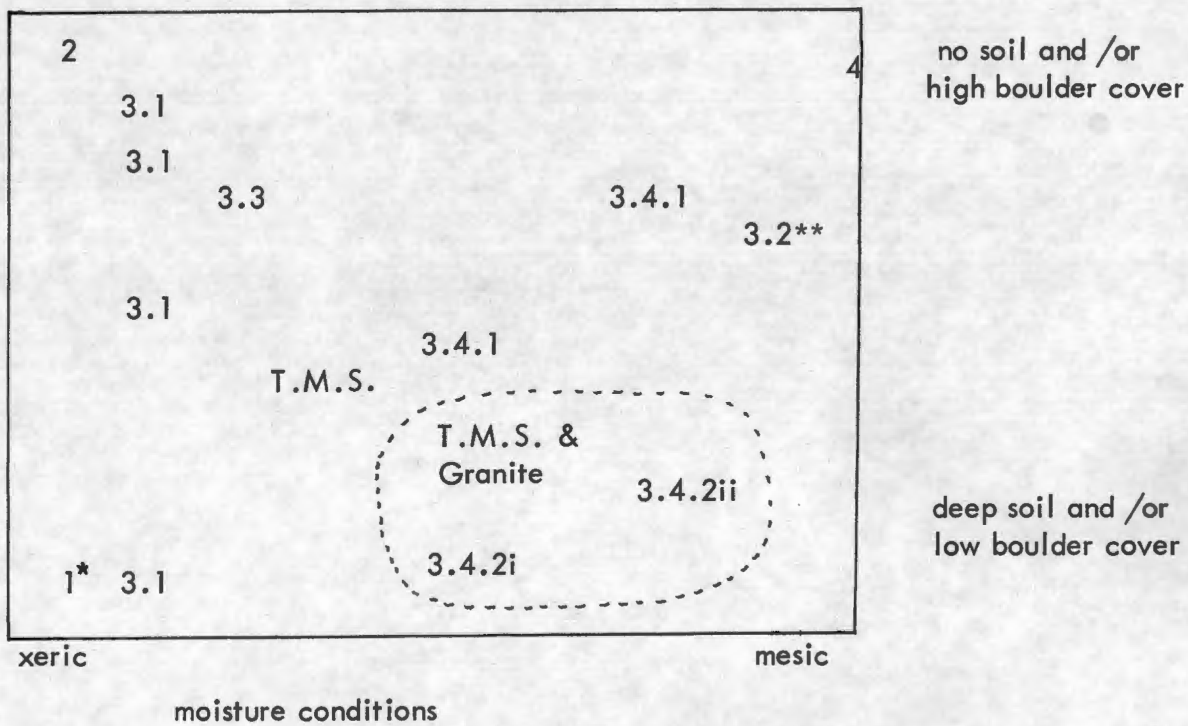

Fig. 4.4 A summary of the environmental characteristics of each recognised grouping. Each community is identified by the symbols used in the text.

TABLE 4.3 THE IMPORTANT FLORISTIC AND ENVIRONMENTAL CHARACTERISTICS OF THE COMMUNITIES THAT WERE RECOGNISED

NAME OF FOREST TYPE	ENVIRONMENTAL CHARACTERISTICS	FLORISTIC CHARACTERISTICS (d = differential species ; D= dominant species; o= species attaining an optimum in a community)
1 VIRGILIA COMMUNITY	SERAL COMMUNITY	Virgilia oroboides (d)
2 MAUROCENIA COMMUNITY	SCREE FOREST	Maurocenia frangularia (d), Olea africana (d,D,o), Asparagus aethiopicus (d,o), Canthium mundianum (D,o)
3.1 LINOCIERA-GREWIA COMMUNITY	VERY DRY FOREST	Linociera foveolata (d,o), Grewia occidentalis (d), Cassine capensis (D,o)
3.2 SCOLOPIA COMMUNITY	DRY FOREST	Scolopia mundii (d,o), Rapapea melanophloes (o)
3.3 CELTIS COMMUNITY	MOIST FOREST MODERATE SLOPE ? DISTURBANCE ?	Celtis africana (d), Halleria lucida (o), Canthium mundianum (o).
3.4.1 CURTISIA-LINOCIERA COMMUNITY	MEDIUM-MOIST WITH DEEP SOILS (Plots 23,24 & 25) OR MOIST WITH SHALLOW SOILS (plots 1,3,4 & 11)	Linociera foveolata (d), Asplenium lanulatum (d), Olea capensis (D,o)
3.4.2 CURTISIA-HARTOGIA COMMUNITY	DEEP SOILS WITH A GRANITIC ORIGIN	Hartogia capensis (d,D,o)
i RAPANEA FACIES	MEDIUM-MOIST FOREST	Rapanea melanophloeos (D,o)
ii CUNONIA FACIES	MOIST FOREST	Cunonia capensis (d)
4 CUNONIA COMMUNITY	WET FOREST	Cunonia capensis (d,D,o), Ilex mitis (d), Blechnum attenuatum (d), Todea barbara (d).

23 species which were recognised as trees 21 were recorded in this seedling study. The two species not recorded were *Celtis africana*, which is extremely rare in Kirstenbosch and *Ilex mitis* which, being found in the CUNONIA COMMUNITY, is restricted to riverine areas. Four of the five species with a high constancy *i.e.* *Diospyros whyteana*, *Rapanea*, *C. ventosum* and *Kiggelaria*, also had the most number of seedlings recorded. The other species, *Cassine capensis*, also had a relatively high recording. Species which showed regeneration only in specific communities were generally restricted, as larger individuals, to these communities. For example, a *Cunonia* seedling was recorded from a plot of the CUNONIA COMMUNITY; *Maurocenia* and *O. africana* regeneration was restricted to the MAUROCENIA COMMUNITY, while the maximum number of *Scolopia mundii* seedlings were recorded from the SCOLOPIA COMMUNITY.

The seedling study produced some interesting results in the VIRGILIA COMMUNITY, where it appears as if the floristics of the subcanopy and canopy will eventually alter. The three species which at present have high cover values *i.e.* *Virgilia*, *Diospyros whyteana* and *Rapanea*, show little regeneration. *C. ventosum* and *Cassine capensis* both have a high cover value in only one plot. For both species seedlings were recorded from the other three plots. *Apodytes*, *O. capensis* and *C. mundianum* which are at present not represented in the canopy, were recorded as seedlings. One would expect an alteration in floristics and cover-abundance values in this community as it is a seral community, and also because the ground layer is affected by alien management practices.

Generally there is a greater number of seedlings, and also a high P.C. of ground layer species, in areas which have a disturbed or broken canopy.

Table 4.4 Seedling records for a number of plots. See text for explanation of the quantitative values used. Groupings are as in Table 4.1 .

Plot number	34	35	32	6	38	36	37	5	39	33	18	17	16	13	15	14	19	8	12	7	9	25	23	4	3	24	11	1	27	28	26	31	29	30	2	10
Diospyros whyteana				2		1	1		1		1		1	2	2	2		2	1	2	1	1	1	2		3		1	2	4	4	3	1	2	1	1
Canthium ventosum	1	1		1				1		1	1		1		1	1	1	1	1	1	1	1	2	2	1	1		1	1	1	1	1	1	2	1	1
Rapanea melanophloeos				1			1	1	1		1		1		2		1		1		1		1	2			1	1		1	1	1	2		1	
Kiggeleria africana				1	1	1	1	1							1	1		1	1				1			2	2				1		3	3	1	2
Linociera foveolata								1	1	1	3	1	2	1	1	3	1					1	1	2	1	1		1								
Podocarpus latifolius										1	1	1	1			1	1					1	1	1	1	1	1	1								
Canthium mundianum			1			1			1		1			1	1	2			1	1	2	1	1													
Maytenus acuminatus																1	1	1		1	1	1	1			1	1					1			1	
Cassine capensis		1	1	1									1			1					1	1	1		1	1	1									
Apodytes dimidiata				1								1	1			1				1		1	1										1			
Olea capensis	1		1																		1	1		1	2	2			1	1	1				1	
Ocotea bullata																						1	1			1	1	1					1	1	1	1
Olinia cymosa								1								1				1		1	1	1				1							1	
Scholopia mundtii																				2	1	1	1		1		1							1		
Olea africana					1	1	1	1																												
Maurocenia frangularia					1	1																														
Halleria lucida			1																						1											
Virgilia capensis				1																																
Hartogia capensis																										1										
Curtisia dentata																														1	1					
Cunonia capensis																																			1	

5 CONCLUSIONS

5.1 THE BRAUN-BLANQUET METHOD

The Braun-Blanquet method was found to be entirely suitable for the scale of the survey and the amount of detail required.

Because of the subtle differences between communities (see below), it was only difficult to decide where to place a plot, such that it would be representative of a stand of vegetation. It was felt that stratified random sampling would remove this problem, also placing the siting of plots on a more objective basis. However, by such sampling there is the chance that heterogeneous areas may be sampled. This sampling represents a waste of time and effort. Furthermore, more time would be required for the siting of plots. Therefore, it is suggested for future work, that plots are sited subjectively.

A sample size of $100m^2$ is felt to be sufficient for primary survey work in the Cape forest vegetation. A problem at Orange Kloof, where sampling intensity was relatively high, was that plots were too large to be sensitive to micro-pattern. It is felt that if sample size was decreased, the plot would not contain a representative sample of the community. The detection of such detailed pattern is not an aim of the Braun-Blanquet method which was, however, suitable for a general description of the Orange Kloof forest. If such detail is required, a plotless sampling method (eg. Williams et al., 1969) may be suitable. The primary aim in the South-Western Cape should be a description and classification of vegetation at a semi-detailed level. More detailed work, such as the study of forest micro-pattern, should only follow once the semi-detailed description is complete.

In the previous Braun-Blanquet surveys undertaken in South Africa the aim has often been to describe and classify communities which were obviously different structurally and floristically. In the forest studied it was difficult, if not impossible, to merely describe the different communities prior to the survey. Structurally most of the forest studied is very similar. This reflects the fact that the forest is also floristically very similar. In the majority of cases, the communities recognised have been delineated on subtle changes in total floristic composition. It is very seldom that there are species which are exclusive to any of the recognized communities. That the communities recognized are only slightly different in floristics and structure has an effect on the Braun-Blanquet method and results in the following ways:

(1) As has been stated, it is difficult to site plots subjectively such that the area sampled is floristically and structurally characteristic of a stand of vegetation. Structurally most of the forest is similar, and floristically the subtle changes in species composition do not allow prior insight into what are the limits of a certain stand of vegetation or where a representative sample may be sited. The third criterion for siting plots, that which states that a plot should be environmentally homogeneous and environmentally representative of a stand of vegetation, is the only one which can be practically used in the study area. Therefore the suggestion for future study is that plots are sited according to environmental characteristics, the hypothesis being that environmental homogeneity and representativeness imply floristic and structural homogeneity and representativeness. An aim in siting plots should therefore be to sample a wide range of habitat types.

(2) Because of the subtle differences between communities, the necessity of using cover-abundance is shown. Presence and absence data would not have been sufficient to delineate communities in the present study.

(3) The clarity of the phytosociological table is determined by the floristic distinctness of the communities recognised. For example, the VIRGILIA COMMUNITY, MAUROCENIA COMMUNITY and to a lesser extent the CUNONIA COMMUNITY were easily recognised prior to the survey. They therefore come out as distinct noda in the phytosociological table. The remaining communities are distinguished in the field by subtle differences. Therefore these communities are not clearly distinguished in the phytosociological table.

(4) The need of a total floristic list can be seen as the communities have really been distinguished on total floristic composition.

Not much environmental data was collected from each plot but it is felt that it was sufficient, as it was possible to ecologically characterise the different communities. However, actual measurement of soil moisture conditions would be useful for further habitat characterisation of the communities.

5.2 NUMERICAL CLASSIFICATORY AIDS

The group-average sorting based on the C_z similarity matrix and obtained from Braun-Blanquet cover-abundance values appears suitable as a method of plot grouping. The importance of this technique is that it suggests possible groupings which will be the most sound with respect to the numerical criteria used by the technique. The numerical criteria of the above technique would appear suitable to differentiate between floristically slightly different plots and to group floristically similar plots such that the resulting classification is subjectively acceptable. I feel that the importance of such a technique is not the increase in objectivity, but the suggestion of possible groupings which may not have been considered in a purely subjective grouping of plots. The method of average-member comparisons is of use when one wishes to examine some of the relationships between plots or sets of plots as the dendrogram resulting from the group-average sorting is a two-dimensional simplification of the multi-dimensional similarity relationships between plots or sets of plots.

5.3 FOREST ECOLOGY

In the study area a number of communities were recognised. These have been structurally, floristically and ecologically characterised. These forests are relatively poor in species, only 70 species being found, of which only 23 were tree species. This may partly explain the fact that the different communities are often distinguished on subtle floristic differences. The tree species found are species with a wide distribution and furthermore, except for *Ocotea bullata* and perhaps *Olea capensis subsp. macrocarpa*, they are pioneer species in various other forest areas. However, in this area most are climax species.

Environmentally the communities can be characterised by past history (VIRGILIA COMMUNITY), soil origin, soil depth, soil rockiness, soil moisture and exposure. The floristic and environmental characteristics are summarised in Table 4.3.

6 SUMMARY

The Braun-Blanquet method has been used to delineate, describe and classify various communities from forest areas in Orange Kloof and Kirstenbosch.

The applicability of the Braun-Blanquet method is considered. It was thought to be completely suitable in the present study and is suggested as the method for future semi-detailed work in similar forest vegetation.

The usefulness, of a numerical grouping technique is considered. The technique used and which appears suitable is that of group-average sorting based on the Czekanowski coefficient. Average member comparisons were used to reveal some relationships which had been lost in the overall picture obtained by group-average sorting.

Eight communities were recognised. These were described in terms of structure, floristics and habitat. The communities are environmentally characterised in terms of exposure, soil condition and past history. Floristically the studied forest is poor and many of the communities are distinguished on subtle differences in total species composition. Structurally the forest is very similar, a common feature being the absence of a ground layer.

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APPENDIX 1. THE AREAS FROM WHICH PLOTS WERE TAKEN

(r) indicates that the plot was sited by stratified random sampling.

Skeleton Gorge.

- Skeleton stream: 2, 10.
- Below contour path: 23(r), 24(r), 25(r).
- Above contour path:
  - Less protected areas: 26(r), 27(r), 28(r),
  - Very protected areas:
    - Next to Skeleton Stream: 1, 8(r), 11, 12(r).
    - At forest edge: 9.
    - Others: 3, 4, 7, 29, 30, 31.

Open slopes above Kirstenbosch.

- Rocky scree: 5, 36, 37, 38.
- Deep soils: 6, 32, 34, 35.

Orange Kloof: 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 33, 39.

APPENDIX 2. THE MODIFIED Ec2 FORM FOR THE RECORDING OF HABITAT AND STRUCTURAL CHARACTERISTICS

ADDITIONS TO FIELD DATA SHEET Ec2

1 Name..

2 Relevé N$^{\underline{o}}$......Date..............Region.......................

3 Locality..Altitude.............

4 Formation...

5 Brief description of vegetation.......................................

....

....

6 Dominant species..

....

....

7 Geology...

8 SITE DESCRIPTION

9 Slope......................Aspect........................

10 Exposure...................Relief........................

11 Drainage...................Litter........................

12 Boulders...................Stones........................

13 Biotic influences...

....

....

14 SOIL TYPE

15 Total depth................Organic material..................

16 Fauna activity.............Flora activity....................

17

Profile depth	pH	HCl	Colour	Texture
...........m.	....	......	....	....
...........m.	....	......	....	....
...........m.	....	......	....	....
...........m.	....	......	....	....

18 Relevé area..............m^2 Total cover............%

19

Vegetation strata	Height m	% Cover
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....

20 Notes...

....

....

....

....

SPECIES LIST FOR APPENDIX 3
(= : ?)

1 OLEA CAPENSIS
2 OLEA AFRICANA
3 LINOCIERA FOVEOLATA
4 CANTHIUM VENTOSUM
5 CANTHIUM MUNDIANUM
6 OLINIA CYMOSA
7 MAUROCENIA FRANGULARIA
8 CASSINE CAPENSIS
9 HARTOGIA CAPENSIS
10 CUNONIA CAPENSIS
11 VIRGILIA OROBOIDES
12 HALLERIA LUCIDA
13 CURTISIA DENTATA
14 PODOCARPUS LATIFOLIUS
15 SCOLOPIA MUNDTII
16 SCUTIA MYRTINA
17 MAYTENUS HETEROPHYLLA
18 MAYTENUS ACUMINATAS
19 OCOTEA BULLATA
20 KIGGELARIA AFRICANA
21 DIOSPYROS WHYTEANA
22 CLUYTIA PULCHELLA
23 RAPANEA MELANOPHLOEOS
24 APODYTES DIMIDIATA
25 SECAMONE ALPINI
26 KNOWLTONIA CAPENSIS
27 ASPARAGUS SCANDENS
28 ASPARAGUS AETHIOPICUS
29 ASPARAGUS AFRICANUS
30 SCHOENOXIPHIUM LANCEUM
31 CAREX AETHIOPICA
32 ACHYRANTHES ASPERA
33 EHRHARTA =CAPENSIS
34 GRASS K6
35 LEIDESIA PROCUMBENS
36 DRYOPTERIS INAEQUALIS
37 ASPLENIUM ADIANTUM-NIGRUM
38 ASPLENIUM LANULATUM
39 PLEOPELTIS MACROCARPA
40 TODEA BARBARA
41 BLECHNUM ATTENUATUM VAR. GIGANTUM
42 BLECHNUM AUSTRALE
43 RHUS =LUCIDA
44 STACHYS AETHIOPICA
45 OXALIS SP.
46 ZANTEDESCHIA AETHIOPICA
47 RUBUS FRUTICOSUS
48 ASPLENIUM K5-5E
49 GREWIA OCCIDENTALIS
50 HERB K5-7E
51 FERN K5-5C
52 CELTIS AFRICANA
53 HERB O11-1
54 STIPA DREGEANA VAR. ELONGATA
55 SOLANUM ~~AURICULATUM~~ MAURITANUM
56 POPULUS CANESCENS
57 PHYTOLACCA =AMERICANA
58 PELLAEA PTEROIDES
59 =RHYCHOSIA CAPENSIS
60 PODALYRIA CALYPTRATA
61 MAYTENUS OLEOIDES
62 HERB K1-4B
63 GRASS K4-4E
64 ILEX MITIS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1	2.	1	3	2.			2-	1	2-		5	+			1	+	2.	3	1			+	3	4	3	1	1	1	2-	1	2-	+	2.	+					3
2					+											2-	3	2-	+	3	+	1														4	2-	3	+
3	2.		+	1	1						+		2.	2.	+	1	2.	2-	2.	+	4	1	+	+	+								2.						
4	1	1	1	+	0	+	+	+	+	.	1	+		+			1	2.	1	1	+	2.	1	2.	1	+	+	1	+	1	1	2.	2.	+	+				2.
5					1	0	1	2.	1		0	2-	+	+	1		3		+	+	+	+	+		+							+				2-	3	2.	1
6	.	0	2-	2.	0		.	3			+	2-		3	4				2-	3	3	2.	2.	3	1		0		0	+	1								
7					2.								0								+															2.	3	3	
8			2.	3	2.	0	+		2-	0	1		4	3	2.	2.	3	2-	2.	3	0	4	1	2.	1	1	2.	2.	2.	2.	1	+	3	1	.	3		3	3
9	0	1																						1		3	3	3	2-	3	3								
10	2.	5								5	+																		1	3	1								
11						3																										3		2-	4				
12	1		1	+		2.	3	2-	0	0		2.											0	0	1							+		2.					
13	2-	0	2-	2.						0	2.												2-		+	1	0	+	2.	1	2-								
14	+	2.	0	+			0		0		1		1	1	1	3	2.	1	+			+	+	2-	3	0			+	0	0		3						1
15		0	0	1			5		2-		1												1	0	+					+									
16		+	+	+	1		1	+	+	.	+	+	1	2.	+	2.	1	+		+	1	1	1	1	0	+	+	+	+	+	+		1						
17						1			0								+	1	.													1	.	.					
18	2.	1	1	1			2.	+	+	+	.	2.		.		1			+	2.			1	1	1						.		1						
19	1	1								.	1												2.	0	+				+	+									
20	2.	+		1	+	3	1	2.		+		1		+	0							.	+	+	+	1	2.	2.	+	+		1		2.	1	1	2.	+	
21	2.	+	2-	2.	4	2.	1	1	1	+	2-	1	+	1	1	1	1	+	+	1	+	1	1	1	1	1	+	1	1	1	1	2.	+	3	2-	+	1	0	+
22					0			.	0																	+		+								+		1	
23	2.	+	1	1	+	2.	3	2-	4		1	+	1	2-	2.	3	2-	1	+	1	+	3	0	0	1	2-	3	3	1		1	3		2.	4	+	+	+	1
24	1	2.	1	+	0	+	.		1			2.		.		+	+	1			+	0	0		1				+										
25	1	1	1	1	0			+	+	+	1	+	+	+	1	+	1	+	+		+	+	1	+	1	+	+	+	+	1	+	+	2.						2.
26	+		+	+	+	.	+	+	+		+	.		+	.	+	+	0	+	+	+	+	+	+	+	+	+	+	+		0		+		+	+	+		
27	.	.	+	+				.			+		+	2-	1	1	+	+	+	+	+	1	1	1	1	+	+	+	+	+	+	+	+			+	+		.
28					1				+			.	.					+			+	+	+		.											1		1	
29				1																		+																	
30	+	+		+			1	+	+	+	2-	1							1				+		1				0	+									
31																				+				+															
32																																+			+				
33		+							+											+			+		+														
34																																.		2.	.				
35		+			0	+		.		.	+												+			1	+					+		1	+				
36			+																										0	+									
37			+	0			+		+														+	+	+	+		+	0		.					+	+	0	
38	+		0	+							+												+		+														
39		+			+					+															.											+	+	+	
40										+																													
41		+								+																													
42			+	+		0			0		+												+	+	+		+	+	+	+	0	+			+				
43																																	+						
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45		+				+				+				.												+			.	0		+		+	+				
46		.								+			.																									.	
47					0	+																										2.		1	1			.	
48		+			+																																		
49																	1				+	.																	.
50										.																													
51		+																																					
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57																																		+					
58																			+																			0	
59																																		+	.				
60																																		+					
61																																						2.	
62																																					+	+	
63				+																					+														
64		0								0																													

APPENDIX 3

rows = species see attached list

columns = plots

APPENDIX 4

nxn Similarity Matrix (%)
n= no. of a stand

	1	2	3	4	5	6	7	8	9	10	11	12
	13	14	15	16	17	18	19	20	21	22	23	24
	25	26	27	28	29	30	31	32	33	34	35	36
	37	38										
2	54.255											
3	62.570	38.974										
4	65.946	42.786	77.083									
5	32.099	31.461	40.237	41.143								
6	37.662	24.706	31.056	33.533	34.722							
7	47.778	32.653	48.128	51.813	32.941	35.802						
8	50.932	36.158	47.619	50.575	37.086	40.559	56.805					
9	44.318	37.500	56.831	58.201	40.964	34.177	67.391	49.697				
10	36.242	64.242	21.795	28.395	23.022	22.901	22.930	28.986	23.529			
11	59.140	45.545	69.430	65.327	38.636	27.381	43.299	40.000	48.421	25.767		
12	50.323	42.105	49.383	51.190	37.241	37.956	52.761	77.778	46.541	28.788	35.503	
13	29.412	23.684	37.762	46.980	44.444	18.644	26.389	27.200	38.571	17.699	38.667	26.891
14	41.916	30.601	50.575	58.889	47.134	30.872	41.143	56.410	45.614	20.833	44.199	44.000
	64.122											
15	39.456	31.902	54.545	53.750	43.796	26.357	38.710	58.824	43.709	17.742	48.447	47.692
	57.658	71.831										
16	43.038	33.333	49.697	50.292	41.892	22.857	43.373	38.095	51.852	17.778	40.698	34.043
	50.820	57.516	55.639									
17	44.444	31.633	48.128	53.886	43.529	29.630	40.426	41.420	53.261	12.739	45.361	38.037
	58.333	61.714	54.194	66.265								
18	44.720	32.768	58.333	51.724	43.709	27.972	34.320	30.667	54.545	14.493	51.429	33.333
	56.000	51.282	50.000	62.585	71.006							
19	49.333	34.940	57.325	57.669	44.286	22.727	40.506	53.237	48.052	23.622	52.439	51.128
	52.632	62.069	64.000	54.412	56.962	58.993						
20	31.515	25.414	48.837	50.562	41.290	21.769	34.682	46.753	40.237	14.085	37.989	41.892
	48.062	63.750	55.714	50.331	58.960	49.351	60.140					
21	33.333	24.419	45.399	42.604	53.425	24.638	28.049	46.897	36.250	15.038	36.471	44.604
	50.000	60.927	54.962	43.662	51.220	53.793	59.701	55.034				
22	40.936	29.947	51.685	61.957	52.174	27.451	44.693	47.500	56.000	14.865	45.405	42.857
	65.185	71.084	63.014	66.242	68.156	63.750	63.087	59.756	59.355			
23	62.500	50.000	76.382	74.146	42.857	29.885	53.000	48.619	61.224	29.586	74.757	49.143
	37.179	50.267	51.497	43.820	45.000	51.934	55.294	45.405	45.455	54.450		
24	46.995	43.216	70.526	62.245	35.838	23.030	46.073	50.000	49.198	23.750	60.914	43.373
	38.095	58.427	60.759	52.071	46.073	54.651	55.901	53.409	45.509	52.747	69.951	
25	61.856	51.429	73.632	73.430	38.043	31.818	54.455	48.087	60.606	29.240	69.231	51.977
	37.975	48.677	50.888	54.444	48.515	53.552	54.651	43.850	40.449	49.741	82.243	70.244
26	46.154	43.023	49.080	50.888	38.356	37.681	45.122	48.276	48.750	28.571	47.059	34.532
	36.667	49.087	48.855	46.479	45.122	42.759	41.791	32.215	32.857	47.742	50.000	49.102
	46.067											
27	44.156	40.000	48.447	51.497	40.278	38.235	44.444	51.748	49.367	24.427	47.619	36.496
	37.288	49.664	51.163	51.429	44.444	43.357	45.455	36.735	36.232	54.902	47.126	50.909
	44.318	79.710										
28	45.570	34.483	52.121	52.632	37.838	34.286	46.988	48.980	55.556	22.222	44.186	34.043
	36.066	47.059	48.120	51.389	45.783	43.537	42.647	35.762	32.394	53.503	47.191	53.254
	47.778	84.507	90.000									
29	61.818	51.934	66.279	66.292	38.710	31.293	45.087	41.558	53.254	32.394	63.687	40.541
	38.760	48.750	50.000	46.358	47.399	53.247	48.951	35.443	37.584	48.780	63.784	61.364
	62.032	68.456	68.027	68.874								
30	49.102	59.016	51.724	53.333	28.025	21.477	33.143	34.615	38.596	45.833	55.249	33.333
	30.534	38.272	43.662	31.373	34.286	35.897	42.759	28.750	26.490	38.554	53.476	51.685
	50.794	62.252	63.087	62.745	75.000							
31	54.194	42.105	65.432	57.143	30.345	23.358	39.264	40.278	46.541	25.758	61.538	36.232
	36.975	44.000	49.231	41.135	42.945	50.000	49.624	39.189	37.410	46.753	58.286	56.627
	53.107	70.504	68.613	69.504	79.730	69.333						
32	35.928	28.415	36.782	38.889	33.121	71.141	40.000	42.308	43.275	25.000	37.569	34.667
	29.008	38.272	38.028	36.601	38.857	37.179	35.862	26.250	26.490	45.783	38.503	35.955
	38.095	49.007	53.691	50.980	37.500	34.568	34.667					
33	43.038	33.333	49.697	56.140	32.432	14.286	33.735	31.293	43.210	19.259	44.186	28.369
	57.377	54.902	46.617	62.500	62.651	61.224	58.824	50.331	38.028	56.051	46.067	57.988
	53.333	39.437	40.000	40.278	43.709	37.908	43.972	28.758				
34	34.568	23.596	30.769	30.857	36.842	65.278	34.118	38.411	27.711	21.583	28.409	31.724
	17.460	26.752	27.737	22.973	24.706	23.841	24.286	19.355	15.068	26.087	26.374	24.277
	27.174	42.466	38.889	35.135	28.387	24.204	24.828	61.146	18.919			
35	28.205	20.930	26.994	28.402	32.877	63.768	32.927	31.724	36.250	18.045	29.412	21.583
	13.333	30.464	21.374	28.169	23.171	17.931	19.403	20.134	18.571	30.968	25.000	22.754
	23.596	41.429	46.377	42.254	29.530	21.192	23.022	72.848	14.085	58.904		
36	17.834	15.029	25.610	35.294	54.422	21.583	27.879	28.767	36.025	16.418	21.053	28.571
	44.628	39.474	33.333	36.364	53.333	41.096	35.556	52.000	36.879	44.872	30.508	27.381
	30.168	36.879	31.655	39.161	30.667	19.737	22.857	25.000	29.371	19.048	19.858	
37	23.288	16.049	20.915	23.899	42.647	25.000	27.273	34.074	22.667	14.634	18.750	31.008
	25.455	26.950	28.099	31.818	42.857	28.148	29.032	34.532	32.308	28.966	25.301	22.930
	27.381	30.769	28.125	33.333	25.899	14.184	20.155	24.113	13.636	19.118	21.538	67.176
38	9.877	13.483	15.385	25.143	48.684	18.056	20.000	19.868	28.916	15.827	12.500	20.690
	38.095	29.299	24.818	25.676	41.176	31.788	27.143	41.290	26.027	34.783	20.879	17.341
	20.652	23.288	19.444	25.676	20.645	14.013	13.793	19.108	18.919	17.105	13.699	76.190
	61.765											
39	35.211	29.114	48.322	46.452	34.848	22.581	36.000	33.588	47.945	15.126	48.718	30.400
	56.604	48.175	51.282	42.188	61.333	67.176	55.000	44.444	34.921	59.574	44.444	48.366
	47.561	38.095	38.710	39.063	45.926	35.036	46.400	37.956	59.375	25.758	17.460	40.945
	24.138	36.364										