A COMPARISON OF TWO METHODS OF VEGETATION ANALYSIS OF THE WET FYNBOS IN THE KIRSTENBOSCH NATIONAL BOTANICAL GARDENS.

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ABSTRACT

For the purposes of comparison, floristic data collected in the wet Fynbos were subjected to two vegetation analysis techniques : the Braun-Blanquet classification method, and the Bray-Curtis Ordination technique.

Neither method proved entirely satisfactory, and this is ascribed to the method of plot selection, and to the extreme heterogeneity displayed by the vegetation.

I. INTRODUCTION

Kirstenbosch National Botanical Gardens are situated on the south-eastern slopes of Table Mountain, and fall within the demarcated Table Mountain National Monument. The study area covers approximately I,3ha. and is situated to the east of that section of the gardens normally frequented by visitors. It is roughly rectangular in shape and each boundary is either a road or a fire break. Apart from the natural fynbos vegetation the area also supports a number of exotics (Quercus robur, Acacia spp., Albizia lophantha, Pinus pinaster, Briza maxima and Rubus pinnatus).

The original intention of the project was to monitor the regeneration of the plant species present in the area after a fire, thus assessing the impact of a fire on an example of mature wet fynbos and on the habitat.
However, when an attempt was made to burn the area the vegetation failed to ignite because the wet summer of 1976/77 had prevented the vegetation from drying out. The lack of wind and the high moisture content of the vegetation (65%) and the soil (70%) therefore prevented a clean burn, except on the perifery where the vegetation had previously been slashed to increase the width of the fire break.

As the original objectives failed, and because much floristic data had already been gathered, it was decided to test the data by subjecting it to two different analysis techniques, a Braun-Blanquet classification, and an ordination technique.

The essence of the Braun-Blanquet approach is founded on three basic concepts.
1. Plant communities are conceived as types of vegetation, recognised by their floristic composition. The full species composition of the communities better express their relationships to one another and to their environment than any other characteristic.
2. Some species are more sensitive expressions of the relationships than others. For practical classification and an indication of the environment the approach seeks to use those species

whose ecological relationships make them effective indicators.
3. These diagnostic species are used to organise communities into an hierachial classification of which the association is the basic unit. This hierachy is invaluable for thr understanding and communication of community relationships that it makes possible.

A point to be emphasized is that Braun-Blanquet has never adopted an organismal concept of the plant community. His views come very close to the intergrational concept of Goodall and Rowe (van der Maarel, 1975). Most Braun-Blanquet followers are aware of the continuities between stands as well as between types. There is also a profound awareness of the temporal changes in the community structure and composition, which can be found already in the earliest papers by Braun-Blanquet.

The essence of the ordination approach is found in the following concept of vegetation structure.
Gleason and Ramesky (in Whittaker, 1970) working independently first proposed the individualistic hypothesis of vegetation structure. This hypothesis holds that no two communties are identical in floristic composition and cannot readily be delimited as clear cut units. No discontinuities in compositional variation occur, except where there are discontinuities in the physical environment. The technique of ordination if founded on this theory.

Ordination is the uni- or multidimensional arrangement of stands so that a statement of stand position, relative to the axis or axes of the model, conveys the maximum amount of information about its composition. It is an ecological tool for summarizing and ordering information about the distribution and relative abundance of plants. Rewarding use can be made of ordination as a framework for potential environmental correlations, as the complexity of the environmental conditions determining the distribution may be measured better indirectly through studying plants, than by direct measurement of the environmental conditions (Morris, 1967).

PLATE I : This photograph is fairly representative of the vegetation of the area. The dense, low, scrubby elememt, consisting of various Erica species and Passerina species predominates the vegetation, while scattered larger trees such as Maytenus oleiodes, as seen in the photograph, occur throughout.

In the foreground is an area which was cut down in preparation for the burn, and the

PLATE II : This photograph is a close-up of the low(less than 2m tall) scrubby element. There is a large amount of plant debris around, and some of the bushes appear to be dying, for example the Erica hispidula on the left of the photograph.

II. HISTORY

The area was previously under a Pinus pinaster plantation, but was cleared about 30 years ago, and since then has been allowed to revert back to natural vegetation, while being protected from fire. The area is however clearly very much disturbed; with a number of paths through the area, and there are also many exotics and weed species throughout.

III. PHYSIOGRAPHY

The study area is situated on the slopes of Table Mountain, at an altitude of 160m above sea level. The aspect is south-east throughout the area, and the slope is moderate, from 8,5 to 16 degrees.
Geologically the area consists of Table Mountain Sandstone overlying Basement Granite. The soil is very shallow, varying from 20 to 40cm.
To the west of the area is a small stream which descends from Window Gorge.

IV. CLIMATE

The study area is situated in the winter rainfall region, which is characterised by hot dry summers and cool wet winters. The average annual rainfall in this region is approximately 1413,7 mm. Table I shows the average monthly rainfall for the area.

TABLE I : Average monthly rainfall (mm) in the Kirstenbosch area.

Month	Jan.	Feb.	Mar.	April	May	June
Mean rain- fall (mm)	33,6	26,7	35,8	109,6	200,5	237,7

Month	July	Aug.	Sep.	Oct.	Nov.	Dec.
Mean rain- fall (mm)	238,2	211,7	139,3	91,2	56,6	33,0

Evapotranspiration figures were taken from Thornwaite and Mather for Table mountain House. Potential evapotranspiration figures are given as 685mm per annum with an annual precipitation of 1459mm. There is an overall annual water surplus of 792mm with a defecit occuring in January, February and March.

Additional moisture is received from the frequent mists which occur in the area (Marloth, 1903; Nagel, 1956).

Temperature data for the Kirstenbosch area is summarized in Table II.

TABLE II : Temperature data ((^{0}C)) for Kirstenbosch Station
(From Climate of South Africa, Weather Bureau 1953)

No. 20/779 Kirstenbosch Period 1915-1950
Lat. = 33^{0} 59' S; Long. = 18^{0} 26' E; H = 88m.

Month	Mean of Daily Max.	Mean Monthly Max.	Extreme Daily Max.	Date	Mean of Daily Min.	Mean Monthly Min.	Extreme Daily Min.	Date	Max.+ Min. 2	Range Max. - Min.
I	24,4	32,3	38,3	1924	15,1	11,0	9,0	1938	19,7	9,3
II	25,0	34,3	38,6	16	15,2	11,5	7,2	28	20,1	9,8
III	23,8	33,1	37,5	43	14,4	10,6	6,8	29	19,1	9,4
IV	21,3	33,4	36,8	33	12,6	6,8	6,2	17	17,2	8,7
V	19,1	28,2	33,6	32	10,7	6,9	4,4	36	14,9	8,4
VI	17,4	24,6	28,7	22	9,4	5,8	3,3	31	13,4	8,0
VII	16,4	24,8	31,8	34	8,7	5,2	1,8	26	12,6	7,7
VIII	16,9	26,1	31,8	36	8,8	4,5	1,4	22	12,6	8,1
IX	17,8	26,7	32,2	43	9,6	5,4	2,8	28	13,7	8,2
X	19,6	28,8	33,4	22	10,8	6,8	3,9	34	15,2	8,8
XI	21,6	29,9	36,0	31	12,6	8,0	6,0	28	17,2	9,0
XII	23,4	31,7	36,4	41	13,9	9,7	6,8	26	18,7	9,5
Year	20,6	-	38,6	1916	11,8	-	1,4	1922	16,2	8,8

As can be seen from the table an extreme summer maximum temperature of $38,6^{0}$C. has been recorded. An extreme winter minimum of 1,4°C. has been recorded. The monthly mean is 5°C. There is a small daily fluctuation throughout the year of 7,7 to 8,9°C.

The prevailing winds in this region are the south-easterlies and the north-westerlies, with the latter usually bringing the precipitation.
The study area is situated on an exposed slope.

V. METHODS

As the original aim of the study was to monitor the vegetation regeneration at two week intervals after fire, ten 10 x 10m permanent plots were simply chosen to cover as representative an area as possible. The plots were then divided in to quarters to fascilitate the ease of sampling. A further 12, 5 x 5m plots were laid out at the edge of the sampling area, and between the permanent plots. The sampling intensity amounted to 10% of the area. (See Figure I).

The floristic data collected included; cover and abundance values, sociability values, an evaluation of the condition of the vegetation and density values.

The environmental data collected included; geology, rock cover, soil depth, litter, aspect and slope. These are all represented on the Final Phytosociological Table, table III.

Scales used in the data collection.

1. Cover-abundance scale. (Werger, 1974).

r very rare, and with a negligable cover (usually a single individual).

\+ present but not abundant and with a small cover (less than 1%).

1 numerous but covering less than 1% of the quadrat, or less abundant and covering 1 to 5% of the quadrat.

2 very numerous and covering less than 5% of the quadrat, or covering 5-25%, regardless of the adundance.

3 covering 25-50% of the quadrat area independent of abundance.

4 covering 50-75% of the quadrat area independent of abundance.

5 covering 75-100% of the quadrat area independent of abundance.

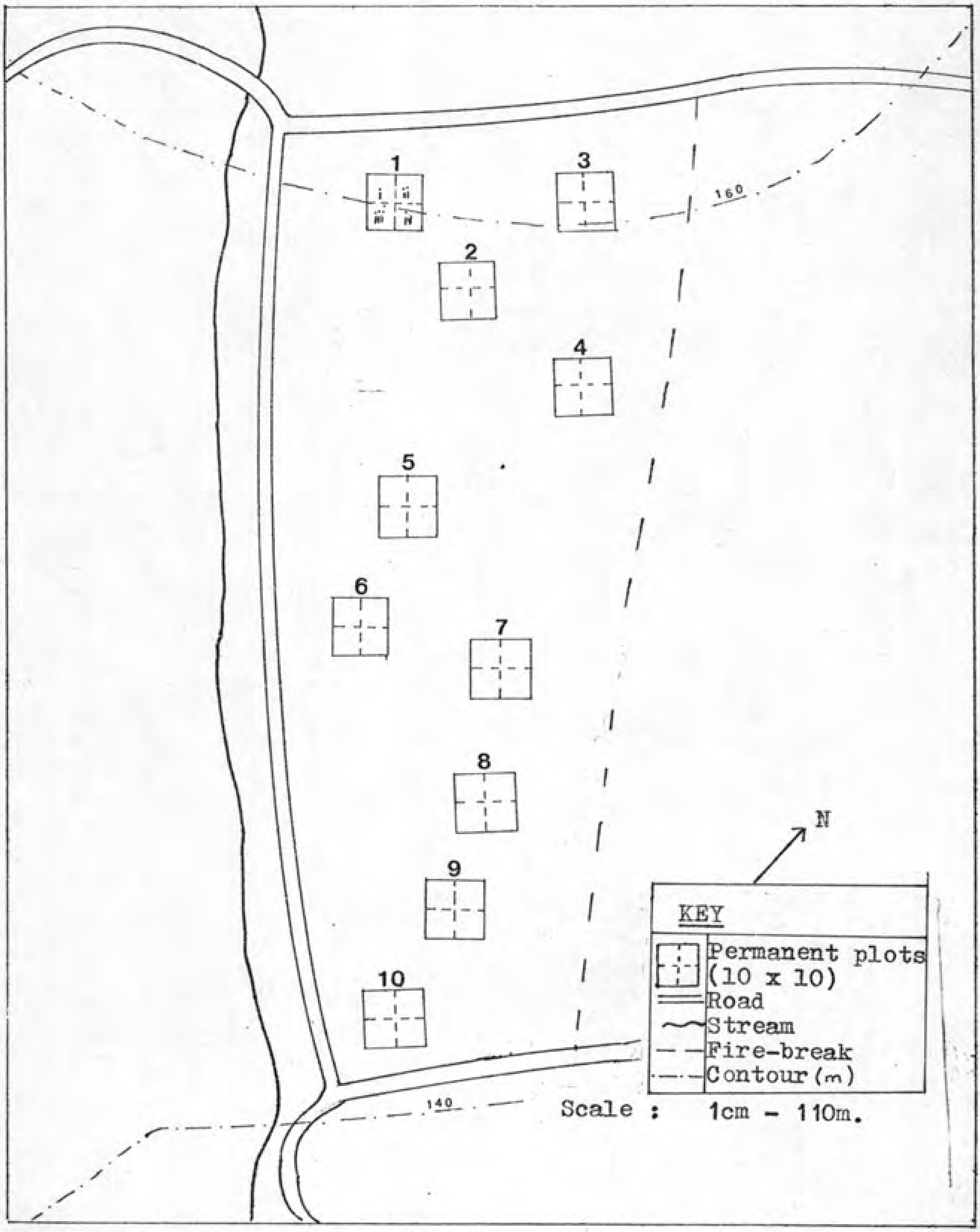


FIGURE I. Showing the layout of the permanent plots, and their division into quarters.

In addition to these values a (+) is used to account for species not within the plot, and within a 1m strip around the plot.

2. Sociability scale (Werger, 1974).
1 Single individuals.
2 Individuals grouped or tufted together.
3 Individuals occurring in troops, forming small patches or cushions.
4 Individuals occurring in small colonies, extensive patches, or forming carpets.
5 Indivuals occuring in extensive crowds or pure populations.

Any sprout coming out of the soil is regarded as a separate individual, regardless of subterranean connections.

3. Condition scale.
1 75-100% of the individuals healthy (without dead branches and leaves).
2 50-75% of the individuals healthy.
3 25-50% of the individuals healthy.
4 5-25% of the individuals healthy.
5 0-5% of the individuals healthy.

The data were then processed by two methods, the Braun-Blanquet and the ordination techniques.

Synthesis of the data into a Phytosociological Table - the Braun-Blanquet classification technique.

The field data are entered into a matrix in which the rows represent species and the columns, relevés. When this matrix is completed the result is called the 'raw table'. The next step is a visual study of the association between species. The rows and columns are rearranged successively until a clear pattern of mutually discriminant noda of species-relevé groups is obtained. The finalized phytosociological table displays the main sythetic characters of the community and it includes environmental data, and it can include information such as sociability.

Usually the Final Phytosociological Table is summarized by a Roman Table which is placed on the right of the table.

The presence of each species within each community is rated on a five point scale. A Roman numeral indicates the percentage of relevés within each community in which the species occurs.

I = 1 - 20%
II = 21 - 40%
III = 41 - 60%
IV = 61 - 80%
V = 81 -100%

Each community is thus reduced to a column, and it is easy to assess which species are faithfull to the various communities.

<u>Ordination of the data</u>; using the Bray-Curtis technique with the coefficient of dissimilarity.
To construct the ordination diagram the coefficients of dissimilarity between every possible pair of stands are calculated using the cover-abundance values for each species within the stands. This value is expressed as a percentage for each of the two stands.
The formula used to calculate the dissimilarity coefficients is as follows:

$$C_{(1,2)} = 100 - \frac{2w}{a + b} \times 100\% \quad \text{(for stands 1 and 2)}$$

a = the sum of the cover-abundance values of the species in stand 1.
b = the sum of the cover-abundance values of the species in stand 2.
w = the sum of the lowest values recorded for the species common to both stands.

(There are numerous techniques for ordinating phytosociological data and extracting ecological relationships. Comparisons of the different techniques indicate that Bray-Curtis ordination using the dissimilarity coefficient is the best general method (Gauch and Whittaker, 1972) or at least the best method when dealing with a high species diversity (Kessell and Whittaker, 1976).)

A matrix is constructed of the coefficients for each stand pair. The coefficients for each stand are totalled and the stand with the highest sum is considered most dissimilar from all others, and it is used as an end stand for the first axis. The other end stand of the first axis is that stand most dissimilar from the first chosen end stand. The length of an ordination axis is made proportional to the coefficients of dissimilarity between the two end stands. The other stands are located between the end stands by drawing arcs proportionate to their dissimilarity from each of the end stands. Arc intersection above and below the line between the end stands are projected onto the line to locate the other stands. When stands are located along the first axis there may be stands close together which are actually dissimilar, a second axis can then be constructed to separate these. A third axis can also be extracted to further elucidate the situation.

A computer program from the 'Cornell University Program Package', was modified for use on the Univac 1100, and was used to compute the values discussed above. Using these figures, both two dimensional and three dimensional ordinations were constructed.

VI. RESULTS AND DISCUSSION

The Braun-Blanquet results will first be presented, and the effectiveness of the technique discussed, and then the ordination results will be presented and discussed, and finally the two sets of results will be compared.

1. *Braun-Blanquet*.

The final results are given in the finalized phytosociological table (*Table III*). On examination of the table it is evident that there are no distinguishable communities because there are too many species which are either common throughout or too scarce to give satisfactory noda.

There are however certain groups of species and relevés which seem to show some tendency to be grouped. These are designated simply as *'groups'*.

A. The *Willdenowia luceana* group.

Willdenowia luceana occurs in nine relevés. In most of these it has a relatively high cover value, and this seems to correspond with little or no rock cover. In these relevés it forms part of the ground cover under species such as *Erica hirtiflora*. *W. luceana* seems to be a fairly gregarious species, with a sociability rating of 4 throughout the area. In relevés 4 and 40 only one layer of vegetation occurs, approximately 0,5m high, with *W. luceana* forming almost pure stands. It is difficult to ascertain whether the plants are actually 'individuals' as defined earlier, or whether one clone has expanded to form the 'mat'.

TABLE III

FINAL PHYTOSOCIOLOGICAL TABLE OF KIRSTENBOSCH AREA

					A						B						C					D									E													F										ROMAN TABLE					
RELEVE NUMBERS	26	22	40	41	3	43	4	44	27	51	50	45	19	28	29	17	12	23	18	30	31	9	10	36	11	32	46	21	14	34	35	52	33	8	6	39	47	2	20	15	24	1	16	13	5	49	42	25	38	7	48	37	Sociability	Condition	A	B	C	D	E	F
ASPECT	SOUTH EAST THROUGHOUT																																																											
SLOPE	MODERATE 8,5 - 16,5° THROUGHOUT																																																											
GEOLOGY	TABLE MOUNTAIN SANDSTONE																																																											
SOIL DEPTH	20 to 30 cm THROUGHOUT																																																											
LITTER	4	4	3	4	3	2	3	3	1	2	2	2	3	3	2	2	2	2	2	4	3	4	4	3	2	3	3	3	3	2	2	3	2	4	3	5	5	3	2	2	2	3	2	2	3	4	3	1	4	4	3	4								
ROCK COVER	1	2	0	0	2	1	1	1	1	1	1	3	2	3	2	2	4	2	2	+	2	0	1	0	1	2	2	3	1	2	3	1	+	0	3	0	0	2	1	2	2	2	3	2	2	+	1	2	4	0	+	+								
NUMBER OF SPECIES	32	19	17	20	4	11	10	19	24	26	16	29	22	18	21	20	27	20	14	24	22	15	15	14	15	18	21	11	17	15	18	17	15	15	12	10	19	11	19	12	15	9	6	8	14	9	18	12	12	11	11	13								
Distinguishing species of *Willdenowia* group (A)																																																												
Willdenowia lucaeana	+	1	4	+	2	(+)	3	(+)																																													4	3	V					
Distinguishing species of *Acacia - Kiggelaria* group (B)																																																												
Acacia longifolia	+								2	2	2	+	1		+		1										3		1										+						+								1	1		V	I		II	I
Kiggelaria africana									1	r	2	1	+	+													+																							+	1		2	1		V	I		II	I
Asparagus scandens				(+)		+			1	1	+	+	+				+																											+									1	1	II	V	I			I
Knowltonia capensis									1	+	1	1	1		+					+														+																			1	1		V	I	I	I	
Olea africana									(+)	+	+	+																																									1	1	I	IV		I	I	
Chironia baccifera	r								+	1		2								+														+																			1	1						
Olea capensis											+	+	+									+																												+			1	1		IV		I		I
Rapanea melanophloeos									r	+		+						+				+												+																+			1	1		III		II		
Diospyros whyteana									(+)	+		+																																									1	1			IV		I	I
Osyris africana		1	r	1						+	1	(+)							+																		+	1		1	+												1	1	II	III	I			II
Podalyria calyptrata	(+)	1							r	1	+							1			+																2													2		2	1	1	II	IV	I	I		I
Distinguishing species of *Virgilia-Chrysanthemoides* group (C)																																																												
Chrysanthemoides monifera														+	+	+	+	r	r																												+						1	2			V			I
Virgilia oroboides	+	+												+	+	r	3	+	r																											2		+					1	1	II		V			I
Hypochoeris radicata	+	+												+	+	+	+	+	+							+																		+		+		+			+		1	1	II		V		I	II
***Passerina-Maytenus* group (A-D)**																																																												
Passerina vulgaris	1	+	+				+		r	+		3	+		r	r	2	+	+	+	2	2	1	3	+		+		1			+	r						+	+								+			1		1	3	III	V	V	IV	III	II
Maytenus oleiodes	r		r			r		2	(+)			3			r	1	2			r	2	1	+	3	+								+																				1	1	II	III	III	V	I	
Asparagus asparagoides	+							+	1	+		+			+		+		1	+	+	1	+		+	+																											1	1	I	IV	III	V		
Phylica stipularis	r								1	+		+		2			+			+	+		+		+	+			1									+	+														2	1	I	IV	II	IV	I	I
Chasmanthe aethiopica									+	+			+	+	1		+		+		+	+					+							1											+								1	2		IV	III	III	II	I
Auercus robur			r	1				+			r					+			1	1	+	1	1		1								1																		+		1	3	II	II	II	V	I	
Dolichos gibbosus	1								1			+			+	+		1		1							+															+						+					1	1		III	III	I	I	I
Distinguishing species of *Phylica-Erica hispidula* group (E)																																																												
Phylica imberbis													+	1	1											+	+	+	+	+	+	+	+						+														1	3		II	II		V	I
Erica hispidula	r	+	1				+								r		1	+								+	+		2		+	2								1	1												2	3	III		III		III	I
***Aristea-Ficinia* group (B-E)**																																																												
Selago serrata												+	+					+			1		+		+	+	2			+	1	+		+	+										1					+			1	1		III	I	III	IV	I
Wachendorfia paniculata		+								+		2				+	+	+	+				+		+		1		+			+			+				+								+						1	1	I	III	III	II	III	I
Aristea thyrsiflora												2					1				+	1	+							+	+		+	2																+	2		1	3						
Myrsine africana	1		r						r		1	2	+	+		+			+	+	1	1	1		+	1	1		+						+		1								+		1		1			+	2	3	II	IV	III	V	III	II
Ficinia acuminata				+				+		1	1	1				+	1	4		+	2				1	1				1	1	1	1	+		+	+	1											+						I	IV	III	III	IV	II
Generally occurring species																																																												
Pteridium aquilinium	1	2	+	2	2	2	3	1	1	1	3	2	+	2	1	2	+	3	4	3	4	2	2	1	+	3	2	2	1	2	3	1	1	1	1	1	1	2	1	1	1	3	2	2	2	+	+	1	+	1	1	2	3	4-5	V	V	V	V	V	V
Erica hirtiflora			+	1		3	+	2	1				2	2			2		3	2	1	3	1	1	1	2	2	2	3	3	3	+	1	1	2	1	2		3	2	2	3	3	3	2		+	1	2	3		2	3	3	IV	III	III	V	V	V
Blaeria ericoides	2	3	1	r	2	1	3	1		2			1			3	2		2		2	4	3	1	+	2	+	2	3	2	2	2	3	1	2	2	4	3	2	2	2	2	2	2	2	1	+	2	2	1		2	2	1	V	III	III	IV	V	V
Briza maxima	+	+	+		+	+	+		r		+		+		+	+		+		+		+	+	+	+		+		+		+		+	+	+		+	+	+		+	+	+	+		+			+				3	4	V	III	III	II	IV	IV
Rhus tomentosa	r		r	1						1	2	2	1		1		2	2	3	+	1	3	3	3		1			1	+	+		+	+			1		1		+			+	+	1					+	1	1	1	II	V	IV	V	IV	III
Asparagus thunbergianus	4		(+)	+		+		+	2	+	1		+	1	1						1			+		1	+			1			1				+										+				2	+	1	1	IV	V	II	II	III	II
Stoebe cineria		+						+	r	+		1	+				2	2						1	2			1	2	2	2	+	+				1		+			+					r	2				+	1	1	II	V	II	II	IV	II
Pentaschistis angustifolia	1			1		+	+					+	+	1							1			+	+	+		+		+	+	+					+	+	+		+						2					+	1	4	III	III	II	III	III	II
Ficinia filiformis	(+)	1	+	r			1		r			+	1	+	+		+	1		1	1	+		+		+	1	+		+	1	1	1		+	+	+	+	+		+	1				+	+	+	+			r	3	1	IV	IV	IV	IV	V	IV
Cassytha ciliolata			+					+	1	+	1	+	+				+	+				+	+	3		+	1	1	1	1	1	+	+			+			+	1	+		1	1				+	+			+	2	1	II	V	II	IV	IV	III
Pelargonium cucullatum	1	1	+			1	1	+	1	1		1			+	2	1	+	+	+				1	+	+	+	1		1		+	+	+	+	+	+	+	+	+	+	+					1	+	+	1		1	1	1	IV	III	V	III	V	IV
Erharta aphylla	2	r	2		1		+	+	+	3	3	4		2	2	4	1	+	1		1	1					1	1	1	+	2		2	1					+	1	2		+	+	1			3		+			1	1	IV	V	V	II	IV	III
Restio cuspidatus				+	+		+									1		2															1	+		+	+					+			2		3						1	1	III	II		I		I
Secamone alphinni										3																																														III				
Metalasia muricata								1		2																																											1	1	I	II		I		I
Oxalis purpurea								+		+								+																												+			r		+		1	1	I	II			II	II
Senecio rigidus								+				+					+			+																		+															2	1	I	II	I	I		I
Helichrysum auriculatum												+	+																																								1	1		III				
Rubus pinnatus				+													+																													+							1	1	I		I			I
Diospyros glabra				+											r	r														+																	+						1	1	I		II		I	I
Acacia melanoxylon			r														+							+										+	1	2									1					2			1	1	I		I	I	II	I
Pelargonium capitatum																																	+		+																		1	1					II	
Aristida capensis						3																														+																	1	1	I					
Rhus lucida				+																																													+				2	1	I					I
Anapalina revoluta																					+					+					+	+																					1	4				I	III	
Phylica viridis							+													+	1																																1		I			I		
Protea laurifolia/neriflora			+		+		+																																								+						1	3	II					I
Rasmathus rotundifolius														+																																							1	3			I			
Lichtensteinia lacera												+															+				+																						1	1	II			II		
Peucedanum galbanum																																				+																	1	3						I
Cliffortia polygonifolia																+																						+															1				I			I
Ficinia bulbosa																																						+															2	1						I
Watsonia pyramidata																																						+															1	3						I
Schoenoxiphium lanceum																+											+																										1	1			I			
Homoglossum watsonium																+																																					1	1			I	I		
Gladiolus blandus																												+									+																1	1			I			
Eriospermum lanceaefolium														+																																							1	4					I	I
Clutia pulchella											+					+			+																	+									+								1	2			I			I
Hermas villosa																+				+																									+								1	2		II	II			I
Bobartia indica																						+						+								+				+		+											1	1			I	I	II	I
Blechnum australi														+																																							1	1			I			
Psoralea aculeolata																					+						+								+																		1	1				I	II	
Brabejum stellatifolium																																														+							1	1						I
Polygala myrtifolia																																								+													1	1						I
Plagiochloa uniola																													+																							+	1	1			I			I
Erica imbricata																																											1										1	3						I
Stenotaphrum secundatum																																															1										I			I
Acacia saligna															+																													+									1	4					I	
Digitaria sanguinalis																											3													+													1	1						I
Ursinia anthemoides																																																		+			1	1						I
Pinus pinaster																		+																					+														1	1	I		I			I
Leucospermum conocarpodendron																		+											3					3						+										2			1	1			I		II	I
Eragrostis curvula																																															+					+		1						I
Pelleas viridis	+																	+			+																												+				2	1	I		I	I		I
Erica plukenetii	+								+																																												2	1	I	II				
Halleria lucida			+						+												+																+															+	1	1	II	III	II	I		
Asparagus africanus										1	1					1		+																			+																1	1	I	III	II	I		
Roella ciliata				+																																																	1	1						I
Zantedeschia aethiopica						3																																															1	1	I					
Senecio littorea	1																																											(+)									1	1	I					I
Cassine peragua	+																																																				1	1	I					
Microanthus junceus	1																																																				1	1	I					
Agapanthus africanus	r																																																				1	1	I				I	
Erica phylicaefolia	r																																																				1	1	I					I
Ixia polystachya	r																																																				1	1	I					
uraltia heisteria																			r									+			+	+				1											+						1	1			I		I	I
harta erecta	r	+														4																																					2	4	II		I			

B. The *Acacia longifolia* - *Kiggelaria africana* group.
This group contains most of the larger 'scrub forest' trees such as *K. africana*, *Rapaneae melanophloeos* and *Olea capensis* in the tallest stratum - 4m high.
Generally the lower strata are composed of species found in groups (A-D), (B-E) and in the group of species common to the whole study area. Some of the shortest plants, such as *Chironia baccifera* and *Knowltonia capensis*, are confined to this group.

C. The *Virgilia oroboides* - *Chrysanthemoides monilifera* group.
This group is made up of three species, *V. oroboides*, *C. monilifera* and *Hypocoeris radicata*.
V. oroboides forms the upper stratum, 5m in height. The next next stratum, from 1,5 to 3m is shared by *C. monilifera* and a member of the next group, (A - D), *Maytenus oleiodes*.
The lower layers and the ground stratum are comprized of *Erica spp.*, *Passerina* spp. and various herbs, grasses and restios.

A - D. The *Passerina vulgaris* - *Maytenus oleiodes* group.
The group D is distinguished by the lack of species limited to groups A, B and C.
The entire group consists of species which form the shrub layer in the former groups, for example *P. vulgaris* and *Phylica stipularis* , and various ground stratum species such as *Chasmanthe aethiopica*.

E. The *Phylica imberbis* - *Erica hispidula* group.
P. imberbis and *E. hispidula* show a common distribution, and together with *Erica hirtiflora* make up the upper stratum in the low shrub (approximately 1,5m tall) vegetation which predominates the area.

B - E. The *Aristea thyrsiflora* - *Ficinia acuminata* group.
This group has a faily wide distribution and forms the lowest stratum of vegetation in the groups already described; mostly geophytic and herbaceous species.

F. This group can be termed a depauperate group - it contains only those species which occur throughout the area.

From the preceeding results and discussion of the phytosociological method, it is apparent that the Braun-Blanquet technique is not very successful in gaining an understanding of this vegetation.

This is probably due to three basic factors.

1. The extreme heterogeneity of the vegetation.
2. The method of site selection.
3. The size of the plots.

According to the Braun-Blanquet method, selected, representative, homogenous plots of certain minimal size are sampled in the phytocoenoses (stands) of the vegetation to be surveyed. This was not the method of sampling used in this project.

First consider site selection.
This is generally carried out subjectively, so that the stands which are possible examples of the association are selected. Stands which are obviously heterogenous in habitat, structure, or floristic composition might logically be expected to represent parts of two or more units, and Werger (1974), emphasizes that they should be avoided as their information cannot be used to describe a single unit. He thus advocates a subjective site selection which will avoid heterogenous plots. Werger also states that there is no fundamental reason against random sampling, but warns that much of the information collected will be useless.
In this study, the site selection, as mentioned before, was not subjective in that homogenous plots were not sought. The plots were sited in a manner which would ensure coverage of as large, and as representative an area as possible. The layout of the plots is given in Figure I.
By not subjectively chosing communities, and them sampling them, much of the data collected are indeed of little use in this study from the Braun-Blanquet point of view, as the plots were usually heterogenous.

What precisely is homogeneity ?
A large number of definitions are given in the literature, but the one most generally accepted is that of Dahl and Hadac (1949)- " a plant species is said to be homogenously distributed within

a certain area, if the probability of finding an individual of the species within a test area of given size is the same in all parts of the area ".
As demonstrated by the great number of species limited to a few relevés in this study , the area is extremely heterogenous, and to obtain homogenous plots would have required much smaller, or alternatively, much larger plots. As Rommel has pointed out, homogeneity is a matter of scale (in Werger, 1974).

Minimal plot size was not calculated, and an arbitrary value of 10 x 10m, divided into four 5 x 5m squares, was decided upon. For the original purpose of the study - to monitor vegetation regeneration after a fire - the plot size was not of critical importance; but in this vegetation survey application, it has proved to be so.

Thus for the Braun-Blanquet method of vegetation description to succeed, subjective sampling, selective sample size and homogenous plots are essential. A similar conclusion has been reached by Mc Kenzie and Moll working in the Kalahari Desert (pers. comm.).

2. Ordination.

Using the values produced by the computer, a two dimensional ordination of the stands positions relative to each other, was constructed. This can be seen in Figure II.
The projection of selected species and environmental data onto this diagram, showed no clear patterns, and it was decided to construct a three dimensional ordination. This can be seen in Figure III.
When selected species were projected onto this diagram certain weak patterns or associations could be seem.
As the environmental data, such as aspect, slope, litter, rockiness, soil type and soil depth, were more-or-less constant throughout, no patterns were evident when these factors were plotted onto the three dimensional ordination.

Delimitation of groups of associated species.

Examination of the ordination diagram reveals that there are four poorly defined groups of associated species.

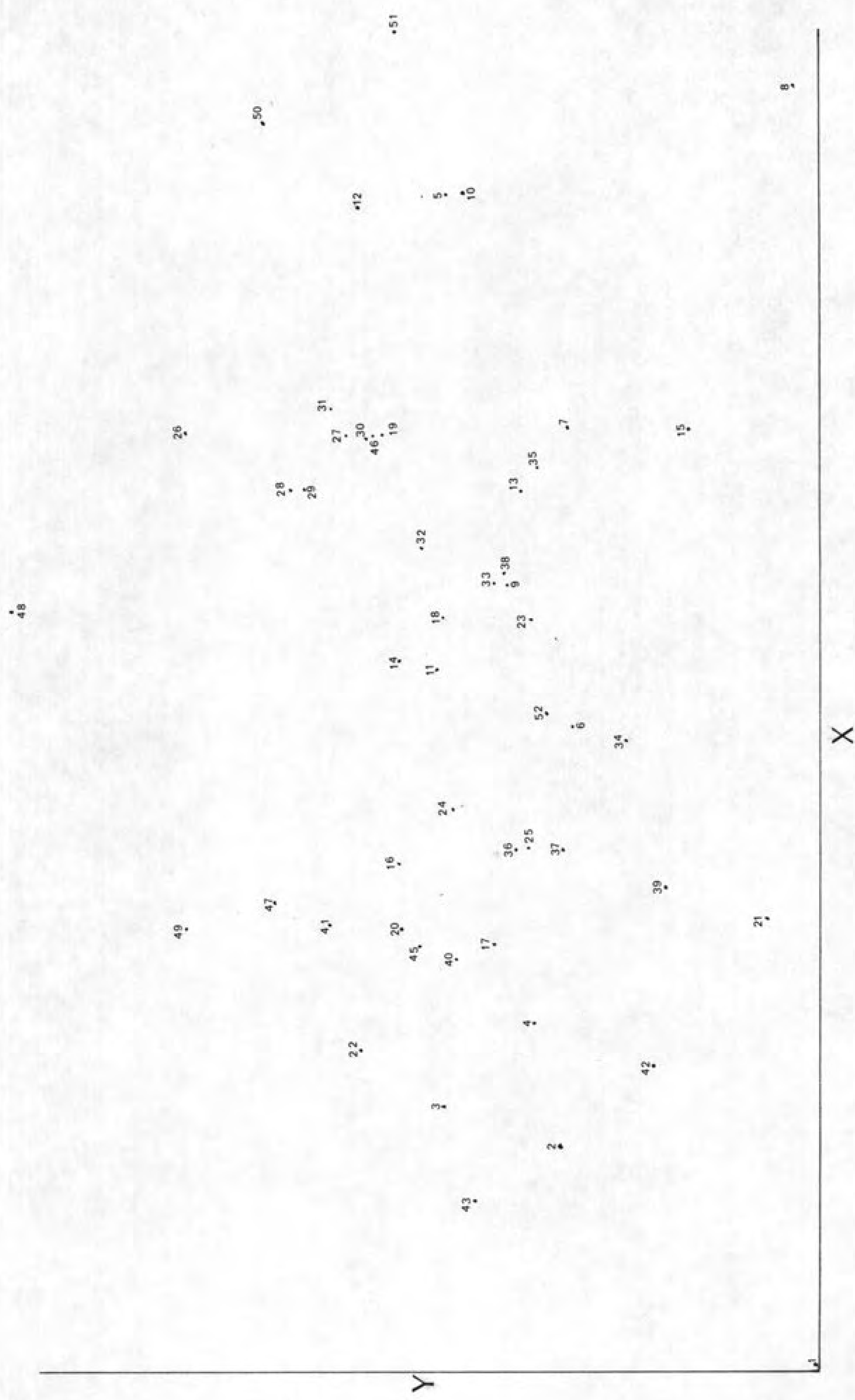
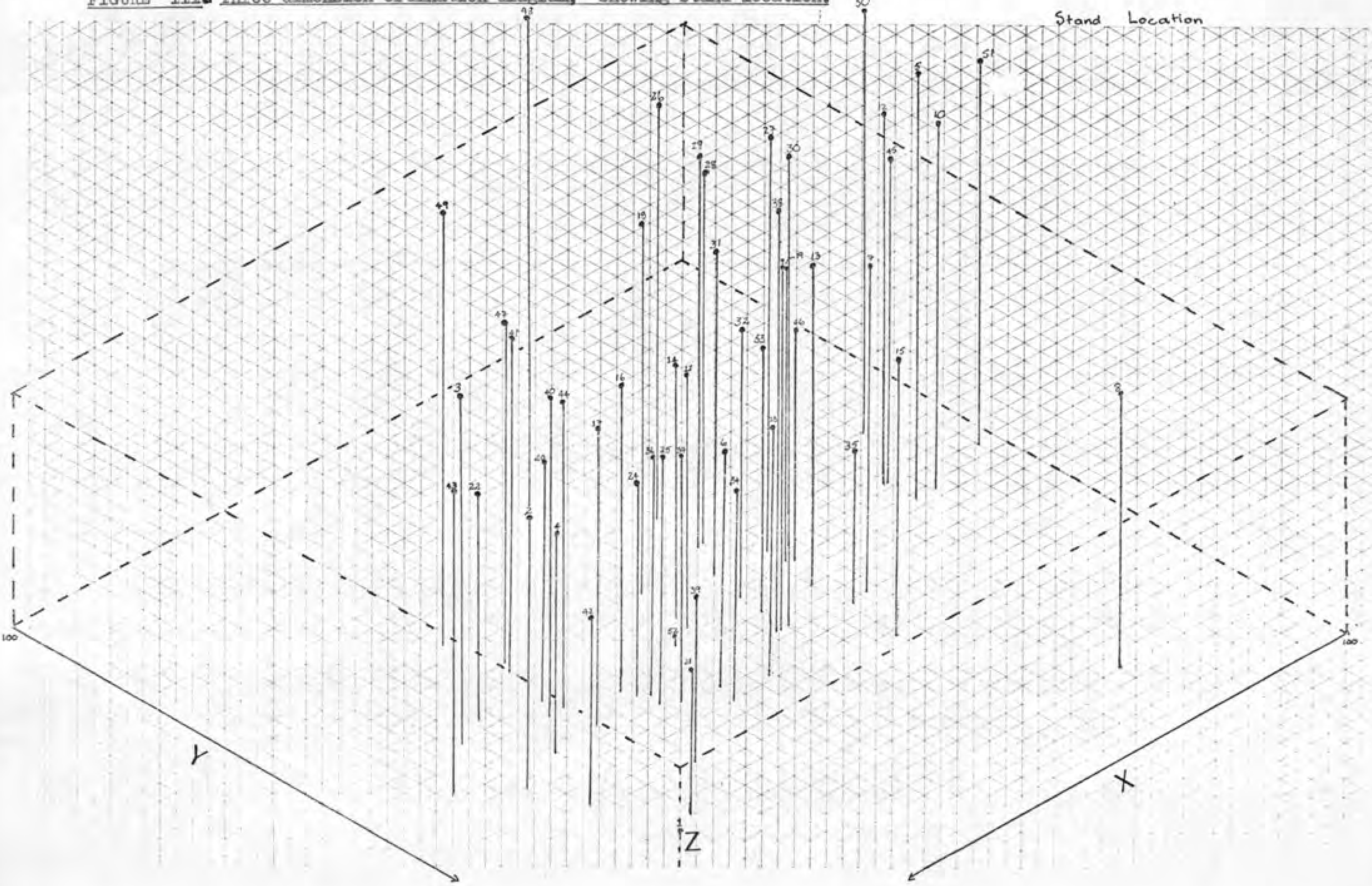


FIGURE II. Two dimensional ordination diagram, showing stand location.

FIGURE IIIa Three dimension ordination diagram, showing stand location.



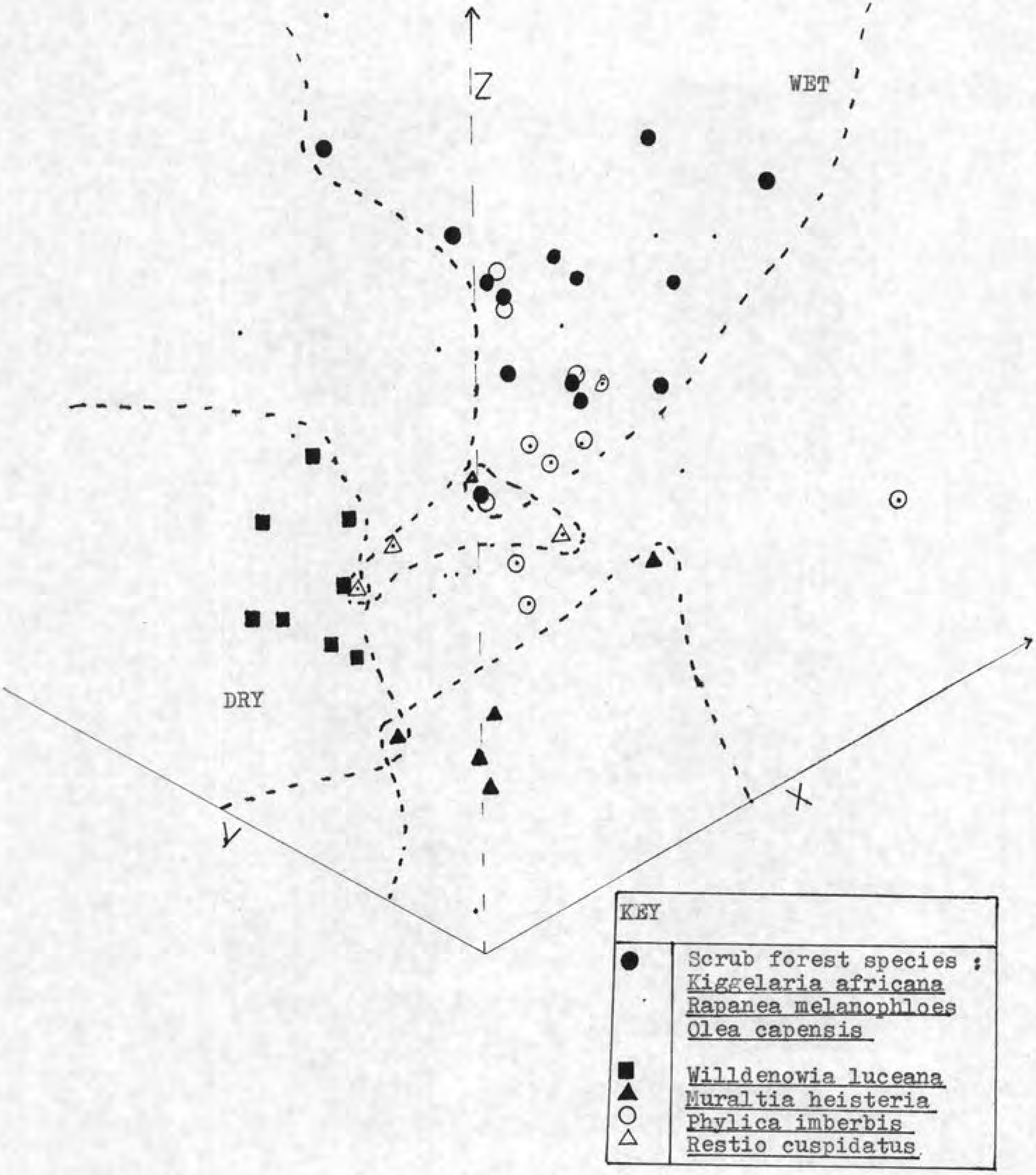


FIGURE IIIb. Ordination diagram showing the pattern in the vegetation. There could be a moisture gradient, from wet, in the scrub forest group, to drier in the W. luceana group.

Willdenowia luceana group.
The stands containing the species W. luceana are grouped together to the left of the diagram. These plots also contain species such as Passerina vulgaris and Maytenus oleoides, but they are also found in plots which form part of other groups.

Muraltia heisteria group.
M. heisteria occurs in a number of plots which are clumped together at the bases of the diagram. Species such as Erica hispidula and Phylica imberbis are also found in these stands, they they also occur in other stands belonging to groups characterized by Restio cuspidatus and scrub forest species, respectively.

Restio cuspidatus group.
The stands which contain R. cuspidatus occur towards the centre of the diagram. Virgilia oroboides shares these stands and is also found in stands belonging to the next group.

Kiggellaria africana group.
These stands form the upper right corner of the diagram. The species which are found in these stands are generally scrub forest species, such as Kiggelleria africana, Rapanea melanophloeos, Diospyros whyteana, Olea capensis, Podalyria calyptrata, and the exotic Acacia longifolia.

Examination of the distribution of species which occurred in more than 80% of the plots simply indicated that these species are dispersed throughout the area. An interesting case is that of Erica hirtiflora, this species is confined to plots which occur on the periphery of the diagram.

To fascilitate group distinction, a three dimensional model of the three dimensional ordination was constructed, using thin sticks with plasticine balls on the ends to indicate the position of the stands in space. The distributions of certain of the species discussed above, such as Kiggellaria africana, Restio cuspidatus, Muraltia heisteria and Willdenowia luceana were represented using smaller balls of plasticine, which were then placed onto the larger ones .
Of particular interest here is the distribution of Muraltia

heisteria. The stands containing this species are all clumped together in one region of the model, except for stand 35, which is located to the right of the group. However it shares same vertical plain with the rest of the group, and thus shows some affinity with the resr of the group.

Correllation with environmental factors.
Using the weak groupings which could be distinguished on the ordination diagram, it is possible to postulate a moisture grsdient across the diagram: starting at the bottom left hand corner of the diagram with the relatively dry, well drained Willdenowia luceana group, and progressing through the slightly wetter Restio cuspidatus group, to the wetter 'scrub forest' group, the Kiggellaria africana group.
This water gradient was not apparent from the environmental data collected on the site, but more detailed, microclimatic, studies, would probably have yielded more information.

The ordination technique has enabled a pattern to be observed in the vegetation, and it has also allowed limited correlation of this pattern and environmental conditions, even though this correlation is simply a postulation.
The large number of species with either an extremely restricted, or a very wide, distribution range, makes the establishment of further gradients impossible.
This could be due to the heterigeneity of the plots - the ordination technique requires homogenous plots for optimal efficiency (Bray and Curtis, 1957).
The heterogenous nature of the vegetation becomes even more apparent when study of the ordination diagram and model reveals that plots, which originally formed one large plot before subdivision into quarters occured, are often widely separated; for example plots 5, 6, 7 and 8, all part of the original plot Four. (See Table IV in Appendix)

VII. DISCUSSION

Neither the Braun-Blanquet, nor the ordination technique proved entirely seccessful in this study.
The major groups on the Final Phytosociological Table, and the groupings on the ordination diagram co-incide to a certain

extent, but with the aid of the ordination technique some ecological correlations could be made.
The slightly more meaningful results achieved using the ordination technique are in keeping with the observation made by van der Maarel (1975), that the efficiency of the ordination method tends to supercede that of the Braun-Blanquet method with increasing age of the vegetation. In this study we are dealing with 30 year old fynbos, which shows signs of senescence; there is a large amount of plant debris on the soil surface, and many of the plants are in a poor condition as can be seen on the Final Phytosociolocical Table.

VIII. CONCLUSION

From the preceeding discussion it can be concluded that, for the purpose of adetailed study of a small area of heterogenous vegetation, neither the ordination nor the Braun-Blanquet technique appears ideal. The former seems slighly superiour in that it allows formulation of environmental relationships.

The importance of sample size and of the subjective siting of the plots to achieve homogenous plots, to the successful application of both techniques, have been cleary demonstrated.

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APPENDIX

TABLE IV

Listing the original plot numbers, and the corresponding numbers of the relevés on Table III

Original plot number	Relevé number
1	3i
2	3ii
3	3iii
4	3iv
5	4i
6	4ii
7	4iii
8	4iv
9	5i
10	5ii
11	5iii
12	5iv
13	6i
14	6ii
15	6iii
16	6iv
17	7iii
18	7iv
19	8ii
20	8iii
21	8iv
22	9i
23	9ii
24	9iii
25	9iv
26	10i
27	10ii
28	10iii
29	10iv
30	1i
31	1ii
32	1iii
33	1iv
34	2iii
35	2iv
36	1*
37	2*
38	3*
39	4*
40	8*
41	9*
42	10*
43	11*
44	12*
45	2i
46	2ii
47	5*
48	6*
49	7*
50	7i
51	7ii
52	8i

*Temporary plots marked by an asterisk.