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NUMERICAL CLASSIFICATION OF 'MIXED SCRUB' VEGETATION ON ALDABRA ATOLL

by D. McC. Newberry and M. G. Hill

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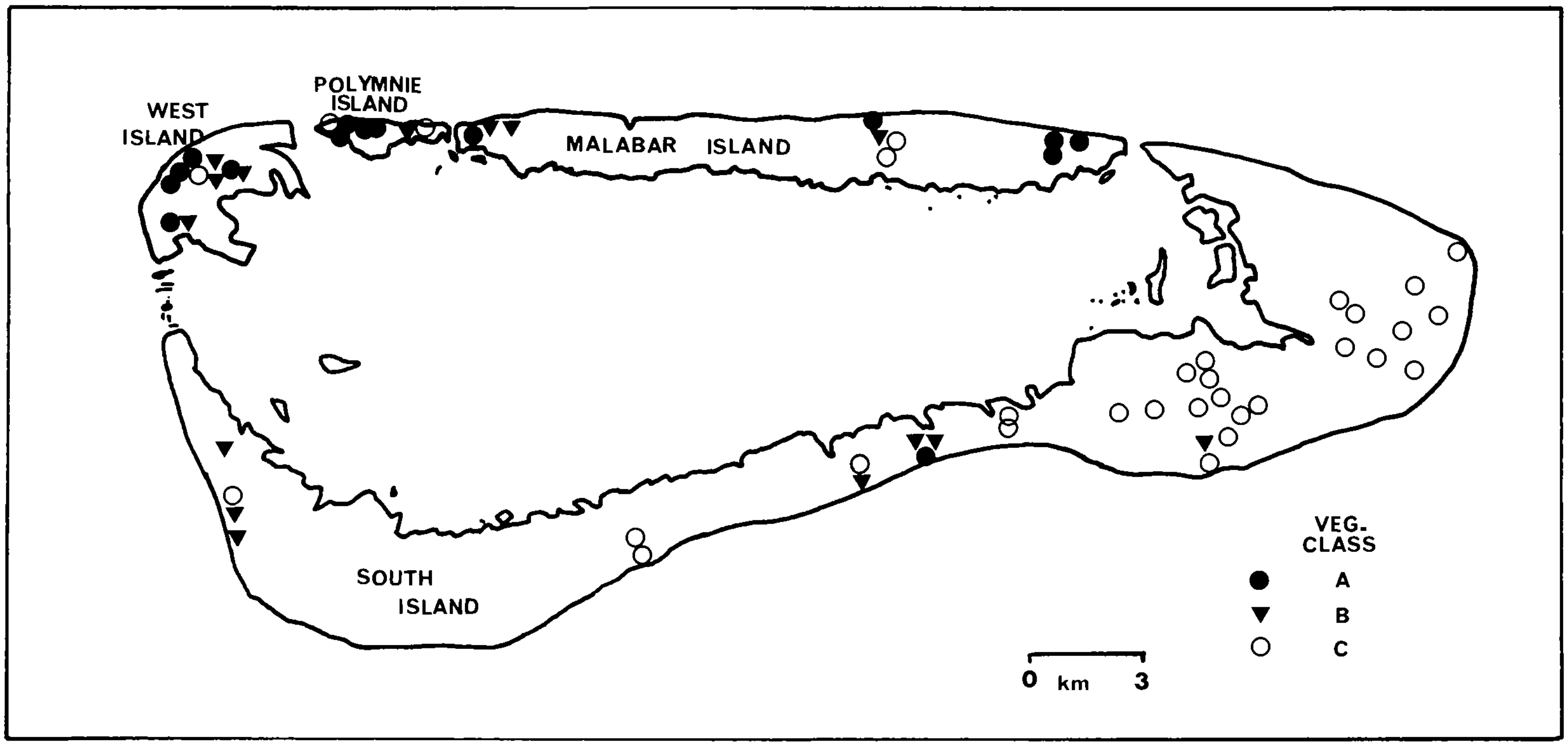

Fig. 1. Aldabra Atoll showing the position of Sixty-one sites given in three classes of mixed-scrub vegetation.

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INTRODUCTION

Previous qualitative descriptions of the vegetation of Aldabra Atoll (46° 20' E, 9° 24' S) defined three major woody vegetation types: (a) mangroves, (b) *Pemphis acidula* scrub, and (c) 'mixed-scrub' (Fosberg, 1971; Hnatiuk and Merton, 1979; Stoddart and Wright, 1967). Mixed scrub varies considerably in its floristic composition over the whole atoll but has received little detailed analysis.

This paper reports the results of a classification of mixed-scrub which formed part of a survey of the status of infestation of the coccid, *Icerya seychellarum* (Westw.) in 1976/7 to 1978 (Hill and Newbery, 1980).

METHODS

Between 4 December 1976 and 25 February 1977 the percentage cover, density and height of each woody taxon were recorded in 61 sites representative of Aldabra's mixed scrub (Fig. 1). Although convenience of access largely determined the areas sampled, vegetation adjacent to paths was avoided.

The ground area covered by woody living and dead vegetation was recorded for each site. Where the vegetation was stratified the total percentage cover of all the species in a site exceeded the ground cover.

The topography of the sites was recorded in three classes described by Stoddart *et al.* (1971): (i) champignon, (ii) pavé, and (iii) platin limestone coral. Position of each site in relation to the sea coast and the '8 m ridge' (Stoddart *et al.*, (1971) which is prominent along some of the atoll's rim, was noted.

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RESULTS

The percentage cover data for 56 woody taxa (Appendix 1) plus two partly woody ground layer taxa were classified by a polythetic divisive procedure. This method separates groups of sites on the basis of a reciprocal averaging ordination of species and sites (Hill, 1973; A.J. Morton and J.W. Bates, pers. comm.).

The mixed-scrub sites were clearly divisible into three main classes (A, B and C) and nine subclasses (Fig. 2). The mean percentage cover of each taxon in each subclass is recorded in the appendix.

Sites in classes A and B predominated in the north and northwest of the atoll (Fig. 1) whilst those in class C were in the south and southeast. For those taxa which had a mean percentage cover exceeding 5% in any subclass, eight were common to all three main classes, four to A alone, three to B alone and seven to C (Table 1).

The mean density and percentage ground cover of living woody vegetation were greater in classes A and B than in C (Table 2), and the vegetation in class C sites was taller and had a greater percentage of dead material than A or B.

Four of the nine subclasses are specialized vegetation types: (i) A2, coastal *Casuarina* woodland; (ii) A3, *Scaevola* dominated coastal scrub; (iii) C3, *Thespesia-Lumnitzera* very open low-lying vegetation around lagoon inlets in SE., and (iv) C4, Takamaka grove, dominated by *Calophyllum*. These have been recognized by Hnatiuk and Merton (1979) and Fosberg (1971). (Full taxonomic nomenclature is given in the appendix).

The remaining five subclasses are floristically more diverse and represent the bulk of the inland mixed-scrub of Aldabra. From notes on the position and topography of the sites it is possible to distinguish some factors associated with the subclasses.

(a) A1. Dense, tall mixed-scrub in the north and northwest on champignon, inland of the '8 m ridge'.

(b) B1. Dense, tall mixed-scrub in the north and northwest on pavé on, and inland of, the ridge.

(c) B2. Shorter, open mixed-scrub on pavé on the ridge in the south.

(d) C1. Open mixed scrub on pavé and platin in the south and southeast.

(e) C2. Open, tall mixed-scrub and woodland on platin in the east.

Table 1 shows that A1 and B1 are distinguished from C1 and C2 by the higher cover of *Acalypha claoxyloides, Pemphis acidula, Sideroxylon inerme* and *Tarenna supra-axillaris* and by the absence of very low cover of *Ochna ciliata, Apodytes dimidiata, Canthium bibracteatum* and *Guettarda speciosa*. *Maytenus senegalensis, Mystroxylon aethiopicum* and *Polysphaeria multiflora* were present with appreciable cover in most of the sites of these subclasses.

Subclass A1 differs from B1 because it has much higher cover of *Tricalysia sonderiana* and *Allophylus aldabricus,* but little *Euphorbia pyrifolia* and *Dracaena reflexa* (Table 1). The percentage cover of *Acalypha claoxyloides* was much higher, and of *Tarenna supra-axillaris* much lower, in A1 than in B1. Subclass C1 has a greater cover of *Maytenus senegalensis* and *Guettarda speciosa* than C2 but much less *Canthium bibracteatum* and *Terminalia boivinii* than C2.

Classification imposes artificial divisions on the floristic structure of the vegetation where they might not exist in the field. The above subclasses may be expected to form a continuum. The distribution of the sites with respect to the first two components of an ordination (Orloci 1966) show very close agreement with the arrangement of the sites in the classification (Fig. 3). Subclass A2 sites have been removed as a first ordination showed that they were well separated from the rest of the sites. Axes I and II accounted for 18% and 12% respectively of the total variance. One simple interpretation of these axes is that II follows a northwest to southeast gradient (-ve to +ve Fig. 3) and I a topographical gradient from champignon to platin (+ve to -ve). Axis I may also be confounded with the effects of salinity since coastal sites are grouped in the bottom left of Fig. 3.

DISCUSSION

The aim of the vegetation sampling was to assess the population of the coccid, *I. seychellarum,* on Aldabra and the use of the classification has aided the interpretation of coccid data (Hill and Newbery, 1980).

As the sites were (a) not strictly randomly located, (b) did not cover all the mixed-scrub of Aldabra (notably the NE of South Island), and (c) may be considered insufficient in number, the classification presented here has limitations. However, the results are clear. Since numerical records of the floristic composition of mixed-scrub have not been published before and Aldabra's vegetation has not received quantitative treatment we consider it important to present our findings fully. These data may form a basis for further study of the vegetation but need improvement and expansion. Our classification does not include grasses and herbs since coccids are restricted to woody plants.

Stoddart *et al.* (1971) have described the marked change in topography across the atoll, from a predominance of champignon in the north-west, through pavé, to platin limestone areas in the south-east. Topography also changes from sea-coast to lagoon, with the 8 m ridge providing a mosaic of small, soil-filled pockets. The classification emphasizes the influence of topography in the differences between vegetation classes and subclasses both within and between islands of the atoll. To speculate any further on the reasons for the differences in floristic composition would be dangerous without experimental evidence on the response of different tree taxa to different edaphic regimes. Two other major factors change between the NW and SE of the atoll: (i) There is a greater density of Aldabra's main herbivores (tortoises and goats) towards the eastern end and (ii) there is greater exposure to SE trade winds in the dry season along the south and south-east coast compared with the more sheltered islands in the north-west (Hnatiuk and Merton, 1979). There is some indication that rainfall may differ across the island, but evaluation of this awaits full analysis of data collected between 1975 and 1979.

Sites were chosen to be representative of different vegetation found in different parts of the atoll. It is therefore not surprising that the classes in Fig. 2 are so well defined. Had more sites been placed on the borders of different vegetation types (if such types really exist) a less clear subdivision of the sites would have resulted. However, the classification did permit the comparison between 30 sites in classes A and B in the north-west with 31 sites in class C in the south-east, and identified the main differences in floristic composition.

Ordination of the sites suggests that the mixed-scrub forms a continuum across the atoll and explains the difficulty presented to previous workers to subdivide it beyond the more obvious specialized subclasses shown above (Hnatiuk and Merton 1979). The ordination showed no discrete groups of sites. The first three axes removed only 40% of the total variation, and this indicates that several important factors influence floristic composition. Further studies of mixed-scrub would be more effectively analysed as a continuum rather than by classification, which met our rather restricted aims in studying the coccid distribution.

SUMMARY

Sixty-one mixed-scrub sites on Aldabra Atoll have been numerically classified into three main classes and nine subclasses, and these are associated with differences in topography and position on the atoll. Ordination of the sites suggests that the vegetation is more realistically viewed as a continuum.

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Table 1. Mean percentage cover of woody taxa in eight subclasses (A1-C3) that exceed 5% cover in any subclass.
(for taxon authorities see Appendix)

Taxa	A1	A2	A3	B1	B2	C1	C2	C3
Maytenus senegalensis	8.1		5.3	14.7	11.1	15.9		
Acalypha claoxyloides	30.5	60.0		5.7				
Pemphis acidula	9.4			12.6				
Polysphaeria multiflora	8.8			8.2	9.8	13.9	22.7	
Tarenna supra-axillaris	5.9			19.3				
Sideroxylon inerme	9.8			10.1				
Mystroxylon aethiopicum	17.7			21.6		16.0	8.7	
Terminalia boivinii	6.3			17.5			5.6	
Tricalysia sonderiana	6.8							
Allophylus aldabricus	5.1							
Casuarina equisetifolia		62.5						
Scaevola taccada			15.6					
Euphorbia pyrifolia				7.1	10.8			
Dracaena reflexa				6.0				
Colubrina asiatica					10.3			
Ochna ciliata						7.0	15.1	8.4
Apodytes dimidiata						10.4	6.5	
Guettarda speciosa						6.5		
Canthium bibracteatum							6.1	
Pandanus tectorius								6.0
Thespesia populneoides								10.4
Lumnitzera racemosa								5.3

Table 2. Mean density, percentage of ground covered by living and dead vegetation and mean and maximum height of woody vegetation in 9 subclasses of Aldabra mixed-scrub.

Vegetation class	Density (400 m^{-2})	% cover		height (m)	
		alive	dead	mean*	max.+
A1	277	91	2.2	1.5	3.4
2	152	84	2.5	1.5	8.6
3	113	58	4.5	1.0	2.6
B1	298	90	2.9	1.8	2.7
2	189	62	2.5	1.3	2.3
C1	141	73	3.5	1.5	2.6
2	129	70	1.3	1.8	2.8
3	41	42	9.0	2.2	2.8
4	76	87	13.3	4.2	9.0

*mean of all taxa in site

+the mean of the three tallest taxa

Appendix. Percentage cover of taxa averaged for the sites in each of the vegetation subclasses A1 to C4 (C4 consists of 1 site and its values appear below the table)

	A1	A2	A3	B1	B2	C1	C2	C3
Acalypa claoxyloides Hutch.	30.5	60.0	2.1	5.7	3.4	1.2	1.6	.
Achyranthes aspera L.	0.4	.	0.6	0.3	.	.	.	.
Allophylus aldabricus Radlk.	5.1	1.0	.	4.0	0.3	0.7	0.5	0.8
Apodytes dimidiata E. Mey. ex Arn.	0.9	.	.	4.4	2.4	10.4	6.5	2.5
Asparagus umbellulatus Bresler	0.1	.	.	.	.	.	.	.
Azima tetracantha Lam.	2.0	.	1.9	1.1	0.1	0.5	.	.
Caesalpinia bonduc (L.) Roxb.	0.4	.	.	.	.	.	.	.
Calliandra alternans Benth.	.	.	.	.	.	.	0.7	.
Canthium bibracteatum (Bak.) Hiern	1.3	.	.	2.1	.	1.0	6.1	0.2
Capparis cartilaginea Decne	1.7	1.0	0.6	.	0.3	0.1	0.8	.
Casuarina equisetifolia L.	.	62.5	1.5	.	.	.	.	.
Clerodendrum glabrum E. May. var. *minutiflorum* (Bak.) Fosb.	1.3	.	.	1.4	1.6	1.0	.	.
Colubrina asiatica (L.) Brongn.	.	.	0.9	.	10.3	0.1	.	.
Deeringa polysperma (Roxb.) Mog.	0.6	.	.	0.2	.	0.8	.	.
Dichrostachys microcephala Renvoize	2.3	.	.	0.8	.	.	.	.
Dracaena reflexa Lam. var. *angustifolia* Baker	1.8	.	.	6.0	.	0.1	.	.
Erythroxylon acranthum Hemsley	1.3	.	.	2.4	0.4	1.4	0.4	0.7
Euphorbia pyrifolia Lam.	3.0	.	4.8	7.1	10.8	0.9	1.1	.
Ficus avi-avi Bl.	0.1	.	.	1.2	0.4	0.2	.	.
Ficus nautarum Baker	0.1	.	0.1	0.2	.	0.6	.	3.3
Ficus reflexa Thunb.	1.6	.	.	1.2	0.7	0.3	0.2	0.1
Flacourtia ramontchii L'Her. var. *renvoizei* Fosb.	.	.	.	.	.	2.9	4.9	2.3
Guettarda speciosa L.	.	.	.	0.5	4.8	6.5	.	3.7
Grewia salicifolia Schinz	.	.	.	.	.	0.1	.	.

Appendix (continued)

	A1	A2	A3	B1	B2	C1	C2	C3
Jasminum elegans Knobl.	0.7	.	.	2.1	0.1	0.1	0.7	.
Lumnitzera racemosa Willd. var. *racemosa*	.	.	.	.	.	.	.	5.3
Maerua triphylla A. Rich. var. *pubescens* (Klotzsch) De Wolf	.	.	.	0.1	.	.	.	.
Malleastrum leroyi Fosberg	.	.	.	.	.	0.1	0.1	.
Margaritaria anomala (Baill.) Fosb. var. *chelonephorbe* (Hutch.) Fosb.	.	.	.	.	0.4	.	.	.
Maytenus senegalensis (Lam.) Exell	8.1	0.5	0.2	14.7	11.1	15.9	4.5	1.2
Mystroxylon aethiopicum (Thunb.) Loes.	17.7	0.5	.	21.6	4.1	16.0	8.7	2.0
Operculicarya gummifera (Srague) Capuron	.	.	.	.	0.1	.	2.0	.
Ochna ciliata Lam.	0.9	.	0.1	3.2	2.4	7.0	15.1	8.4
Pandanus tectorius Park.	.	.	0.1	0.2	.	2.3	0.2	6.4
Paretta verdcourtiana Fosb.	1.0	.	0.1	0.6	.	0.1	0.1	.
Pemphis acidula Forst.	9.4	.	4.9	12.6	.	2.3	.	.
Phyllanthus casticum Soy. Will.	0.9	.	.	.	.	0.3	.	.
Plumbago aphylla Bojer ex Boiss.	.	15.0	27.9	0.6	0.1	.	.	.
Polysphaeria multifora Hiern	8.8	.	0.2	8.2	9.8	13.9	22.7	2.6
Premna obtusifolia R.Br.	.	.	.	0.1	.	.	.	.
Scaevola taccada (Gaertn.) Roxb.	1.8	.	15.6	0.2	2.5	0.5	.	.
Scutia myrtina (Burm.f.) Kurz	0.8	.	.	0.2	0.1	0.2	.	.
Sideroxylon inerme L.ssp. *cryptophlebium* (Baker) Hemsl.	9.9	1.3	.	10.1	4.3	3.0	0.1	0.3
Solanum indicum L. var. *aldabrense* (C.H. Wright) Fosb.	0.2	.	.	0.4	0.4	0.4	.	0.1
Sophora tomentosa L.	0.3	.	.	.	.	.	.	.
Stachytarpheta jamaicensis (L.) Vahl	.	.	5.3	.	1.2	.	.	.
Tarenna supra-axillaris (Hemsl.) Bremek.	5.9	3.0	.	19.3	1.1	0.9	.	.
Tarenna tricantha (Baker) Bremek.	2.1	3.0	0.1	0.8	4.1	3.0	1.7	0.4

Appendix (continued)

	A1	A2	A3	B1	B2	C1	C2	C3
Terminalia boivinii Tul.	6.3	.	.	17.5	.	1.4	5.6	1.1
Thespesia populnea (L.) Sol. ex Correa	2.9	.	.	.	.	.	.	.
Thespesia populneoides (Roxb.) Kostel	.	.	.	.	.	0.2	0.4	10.4
Tournefortia argentea L.f.	.	.	2.7	0.6	0.1	.	.	.
Triainolepis fryeri (Hemsl.) Bremek.	0.3	.	.	0.1	.	.	0.3	.
Tricalysia sonderiana Hiern	6.8	7.5	.	2.7	0.3	0.2	3.4	.
Vernonia grandis (DC.) H. Humb.	.	.	.	.	0.4	.	.	.

Subclass C4:

Calophyllyum inophyllum L. var. *takamaka* Fosb.	86.7
Canthium bibracteatum	5.0
Flacourtia ramontchii	5.7
Ludia mauritiana Gmel.	5.7
Mystroxylon aethiopicum	13.3
Ochna ciliata	11.7

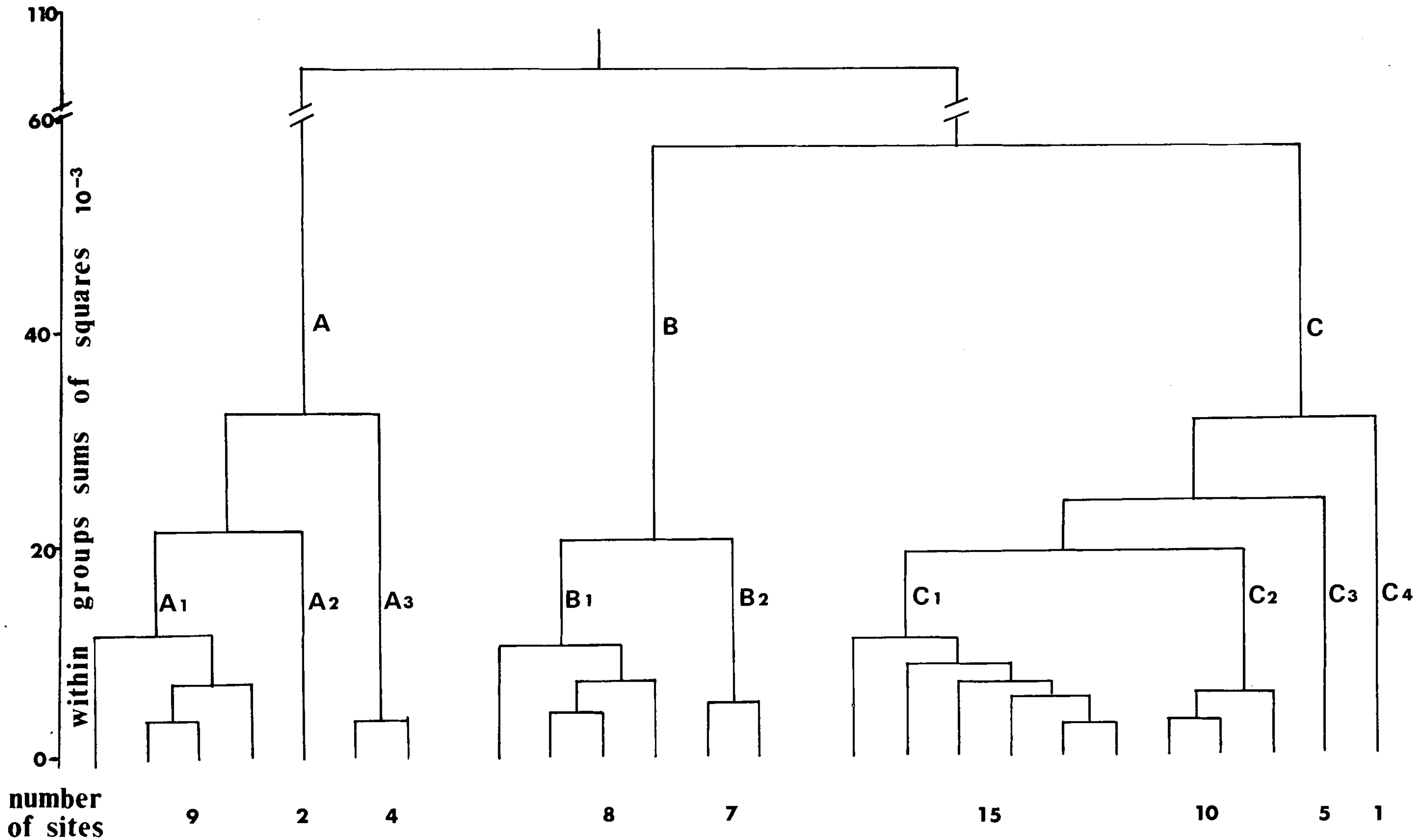

Fig. 2. Polythetic divisive classification of sixty-one mixed-scrub sites on Aldabra Atoll.

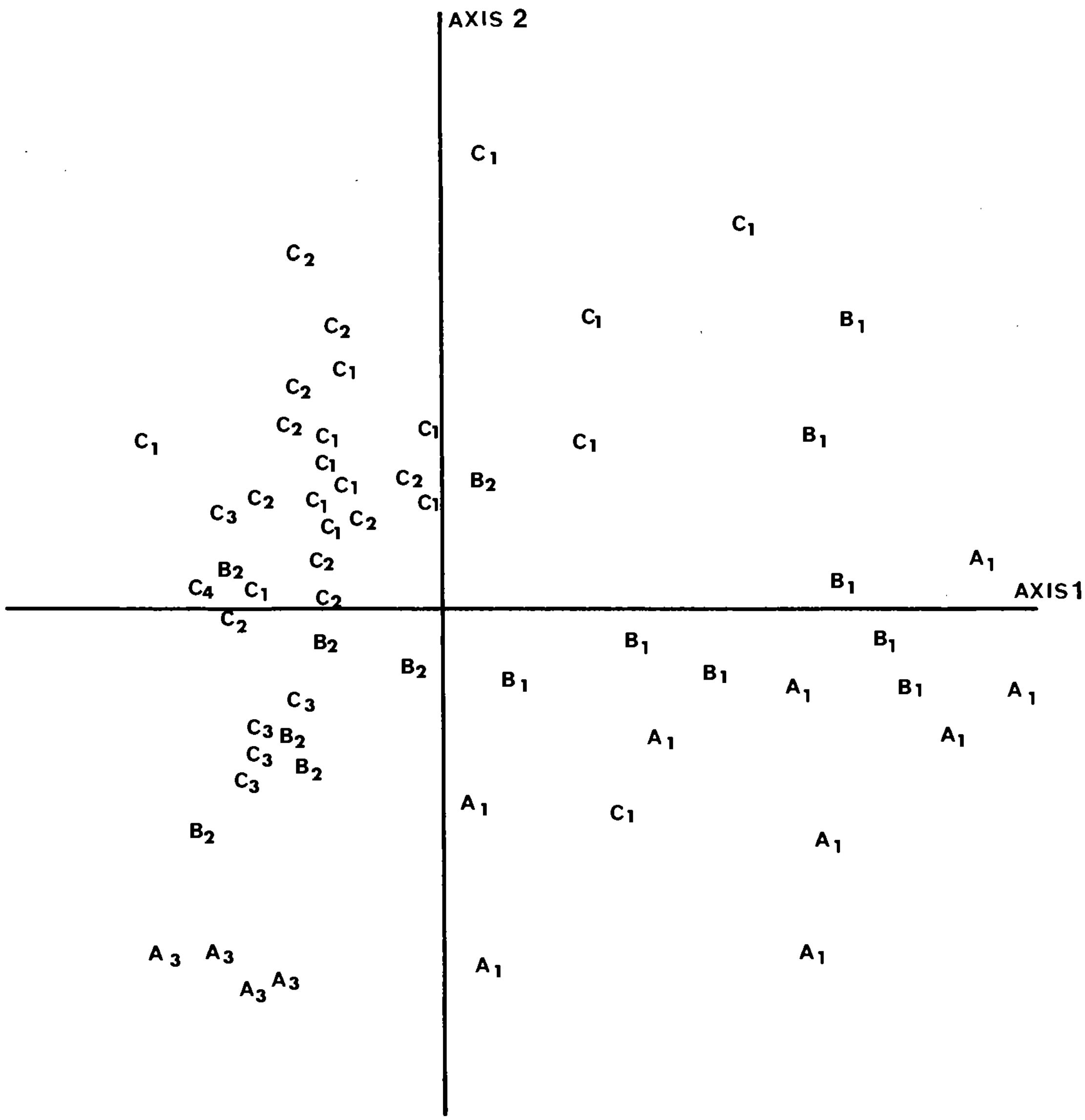

Fig. 3. Principal components ordination of sixty-one mixed-scrub sites on Aldabra Atoll.