I [

ORDINATION OF

NIGERIAN GUINEA SAVANNA

PLANT COMMUNITIES

A thesis submitted for the

degree of

Doctor of Philosophy

in the University of Oxford

by

G. 0. OSAN0T0, B.Sc. (A.B.U.), M.Sc. (Wales), M.I. Biol.

Wolfson College,
Oxford,

May 1980.

CONTENTS

		Page No.
Acknowledgements		i
Abstract		ii
List of Floristic Plant Community Tables		iii
List of Illustrations		viii
CHAPTER 1	BACKGROUND CONCEPTS OF THE SAVANNA	1
1.1	Introduction	1
1.2	The historical development of the Savanna Concept	3
1.3	The ambiguity and imprecision of 'Savanna' as an ecological term	10
1.4	The Nigerian 'savanna'	10
1.5	Nigerian climatic continua and Keay's (1949-1959) Vegetation Zones	10
CHAPTER 2	SOME EXAMPLE PHYSIOGNOMIC SCHEMES OF 'SAVANNA' VEGETATION CLASSIFICATION	17
2.1	A possible substitute ecological term: 'CERRADO' instead of 'SAVANNA'.	19
CHAPTER 3	HISTORY AND CULTURE OF USE AND DISUSE WITHIN THE ZONE	22
3.1	Shifting pastoral land use	25
3.2	Rotational fallows	28
3.3	Vegetation Clearing in the usage of land	33
3.4	Forestry land use in the 'Savanna'	38
CHAPTER 4	ANALYSES OF THE NIGERIAN 'NORTHERN GUINEA SAVANNA' PLANT COMMUNITIES	42
4.1	A review of previous numerical floristic compositional community analysis in the Northern Guinea Savanna	49
4.2	Literature review of the approaches to the plant community	54
4.3	Definitions of Plant Communities	60
4.4	Community Classifications by Cluster Analysis	64
4.4.1	Introduction	64
4.4.2	The Cluster Analytic technique used	68
4.4.3	The Cluster Analytic procedures	69
4.4.4	Plant community interpretations from the cluster dendrograms	74

KASHIM IBRAHIM LIBRARY RECEIVED

CHAPTER 5		FIELD METHODS	76
	5.1	Introduction	76
	5.2	The climate	76
	5.3	Stratification by air photographs	81
	5.4	Stratification and sampling of representative domains in the Zone	89
	5.5	The twelve domains or strata surveyed within the 'Northern Guinea Savanna'	94
	5.5.1	The locations of the studied domains	97
CHAPTER 6		FIELD SAMPLING FOR FLORISTIC AND ENVIRONMENTAL DATA	107
	6.1	Introduction	107
	6.2	Floristic data collection from the domains	110
	6.3	Synthetized synoptic floristic table matrices	113
	6.4	The application of Cluster Analysis to floristic and environmental data matrices	114
CHAPTER 7		ORDINATION	161
	7.1	Introduction	161
	7.2	Literature review of the definitions of ordination	164
	7.3	Literature review of ordination techniques	166
	7.4	My application of Rao's Canonical Factoring Analysis as an ordination technique	172
	7.4.1	Factor Score Co-efficient Matrix	178
	7.4.2	Eigenvalues and proportion of common variance	179
	7.4.3	Graphical representation of RCFA Ordination axes	198
	7.5	Plant community interpretation from RCFA	200
CHAPTER 8		FIELD DESCRIPTIONS OF SOIL SAMPLES	207
	8.1	Physico-chemical laboratory analyses of soil samples	207
	8.2	Other evaluated environmental properties made in the quadrats sampled	209
	8.3	Categories of environmental factors evaluated, their codings and meanings	213
	8.3.I	Physico-chemical edaphic factors	213
	8.3.II	Geological Factors	214
	8.3.III	Biological Factors	214
	8.3.IV	Vegetation Factors	215

CHAPTER 9 DISCUSSIONS AND CONCLUSIONS 304

Plates, Descriptions with Ecological Comments and Appraisals. 346

APPENDICES

APPENDIX A: SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA

MATRIX I: From Galma 'Fadama' 361

MATRIX II: From Zaria - Dambo 'Kurmi' 362

MATRIX III: From the Galma Irrigation Scheme Centre 363

MATRIX IV: From Upland Kako Village to Galma 'Fadama' 364

MATRIX V: From Selected Upland Sites on the Galma Basin 365

MATRIX VI: From the Dumbi to Kako Transect on the Galma Plains 366

MATRIX VII: From the Dumbi Inselberg and Rocky Hills 367

MATRIX VIII: From the Mairabo Plantation Reserve 368

MATRIX IX: From the Kabama Plantation Reserve 369

MATRIX X: From the Guga Plantation and Enclaves 370

MATRIX XI: From the Guga Non-Plantation Reserve 371

MATRIX XII: From Kuyello Rural Area Composite Survey 372

APPENDIX B: THE RAW PHYSICO-CHEMICAL LABORATORY RESULTS OF SAMPLED SOILS

Fadama 1: Augured Soil Samples 373

Dambo 2: Augured Soil Samples 374

Kako 4: Augured Soil Samples 375

Upland 5: Augured Soil Samples 376

Plain 6: Augured Soil Samples 377

Rocky 7: Augured Soil Samples 378

Kabama 9: Augured Soil Samples 379

Guga 10: Augured Soil Samples 380

Guga 11: Augured Soil Samples 381

Kuyello 12: Pit Soil Samples 382

APPENDIX C: THE IDENTIFIED FLORA: SOURCES, NOMENCLATURES, AND AUTHORITIES 383

BIBLIOGRAPHY 390

ACKNOWLEDGEMENTS

This work was carried out under the Federal Republic of Nigeria Government Scholarships Programme, supplemented by a study fellowship award by the Ahmadu Bello University, Zaria, Nigeria. I thank the two Organizations for the financial support.

I thank my supervisor, Dr S.R.J. Woodell and my field supervisor in Nigeria, Professor B.J. Harris; Professor F.R. Whatley for my admission into Botany School, Oxford; Dr H.C. Dawkins, H. Wright, Esq., E. Evans, and the Oxford Computing Laboratory staff, for their consultative and technical help during data analyses.

I am grateful to Dr Ango Abdullahi, Director, Institute for Agricultural Research, Samaru, for making my field work in Nigeria possible; to the Soil Survey Section of the Institute where I organized my field data; to Professor P. Greig-Smith who stimulated my interest in quantitative approaches to ecological research and remained a reservoir of quantitative ecological knowledge which I have tapped freely during this work.

I thank the unknown farmers in whose lands I have made floristic records and soil auger samples and from whom I received useful information during ground surveys. The Forestry Division and the Irrigation Section of the Kaduna State Ministry of Natrual Resources have made official records available for my examination, for which I thank them. I am grateful to my typist, Mrs G. Ilott, for her patience and understanding.

Mrs (Dr) Marion Osanoto, my devoted wife, my son and daughter, Yetunde and Olugbemi have demonstrated their wonderful understanding, moral support, and amazing co-operation when I left them for two years in Nigeria because of the Ordination of Nigerian Savanna Plant Communities. I am impressed by and thankful to them.

ABSTRACT

This thesis is an attempt to provide an objective quantitative ecological interpretation to the trends and aggregations of the flora within representative portions of the so-called Nigerian Northern Guinea Savanna Zone, using ordination and classification. The aim of the investigation was to test the homogeneity of the plant distribution on which the delineation of the ecological zone had been established.

My field surveys were preceded by preliminary stratifications of the environment into relatively homogeneous domains, partly based on geomorphological differences in the environment, using aerial photographic interpretations, and partly based on visible distinct forms of land use. 419 species were encountered in 714 quadrats.

I used a standard agglomerative Cluster Analytic technique available in the Oxford University Computing Laboratory to sort plant communities from the floristic data matrices which I had already arranged into sets of synoptic matrices. The Cluster Analytic results were cross-checked with Rao's Canonical Factor Analysis which I introduced into synecological investigations as an ordination method from the Statistical Packages for the Social Sciences of Nie, et al (1975).

Fifty relatively distinct communities of different sizes and four sub-communities were detected by the two multivariate analytic methods. The communities represent relatively distinct floral assemblages. Nine primary factors controlling floral distribution, apart from the climate, were identified, largely by quantitative methods.

I conclude that the 'Northern Guinea Savanna' has no ecological homogeneity apart from climate, and its use alone as a reason for delimiting the zone from the rest of the Country's vegetation is inconsistent with the very bases of ecology. I suggest 'cerrado' as a comprehensive substitute for "the catachrestic word, savanna, which is applied to nearly every type of tropical vegetation from swamps to

LIST OF FLORISTIC PLANT COMMUNITY TABLES

		Page
I.1	Table 1: Vetiveria nigritana - Paspalum orbiculare - Mimosa pigra Community of thickets on oxbow lake-like depressions within the 'fadama'.	252
I.2	Table 2: Nelsonia canescens - Borreria verticillata - Paspalum orbiculare Community 'fadama' weeds of arable lands in fallow.	253
I.3	Table 3: Borreria verticillata - Sporobolus pyramidalis - Nelsonia canescens Community of forbs and grasses on damp, flat lower middle slopes of the 'fadama'.	254
I.4	Table 4: Ageratum conyzoides - Centella asiatica - Paspalum orbiculare Community on the outer zones of the 'fadama'.	255
I.5	Table 5: Guiera senegalensis - Sporobolus pyramidalis - Andropogon pseudapricus Community of an indistinct 'fadama' - 'upland' zone of geomorphological intergradation.	256
II.1	Table 6: Centella asiatica - Leucas martinicensis - Paspalum orbiculare Community flanking local marshes at the heads of 'kurmis'.	257
II.2	Table 7: Paspalum orbiculare - Borreria verticillata - Centella asiatica Community of weeds in damp arable crops under annually farmed lands.	258
II.3	Table 8: Mimosa pigra - Paspalum orbiculare - Euphorbia heterophylla Community of weeds associated with crops.	259
II.4	Table 9: Paspalum orbiculare - Panicum subalbidum - Melochia corchorifolia Community of weeds along the middle slopes of the 'kurmi' depressions.	260
III.1	Table 10: Panicum sulbalbidum - Digitaria ciliaris - Setaria pallide-fusca Community of aquatic weeds controlled by flooding and standing water.	261
III.2	Table 11: Digitaria ciliaris - Cyperus rotundus - Eleusine indica Community of weeds on poorly drained sandy 'fadama' alluvial terrace.	262
III.3	Table 12: Eriochloa nubica - Panicum subalbidum - Cyperus pustulatus Community - of semi-aquatic weeds under mechanized irrigation.	263
IV.1	Table 13: Digitaria ciliaris - Imperata cylindrica - Paspalum orbiculare Community of weeds in 'upland' arable crops and post-harvest farmlands on level edges of 'fadamas'.	264

IV.2 Table 14: Paspalum orbiculare - Borreria verticillata - Centella asiatic Community of weeds in Oryza sativa arable crop on the 'fadama' near old agricultural villages. 265

V.1 Table 15: Loudetia simplex - Terminalia avicennioides - Elionurus pobeguinii - Cochlospermum tinctorium - Ctenium newtonii - Dyschoriste perrottetii Community on uncultivated gullied upland sites. 266

V.2 Table 16: Pennisetum pedicellatum - Vernonia perrottetii - Eragrostis tremula - Leucas martinicensis - Borreria verticillata - Digitaria ciliaris - Brachiaria stigmatisata - Oldenlandia herbacea Community of weeds in current croplands and post-harvest damp farmlands. 267

V.3 Table 17: Ageratum conyzoides - Pennisetum pedicellatum - Jussiaea suffruticosa - Cynodon dactylon (Super-) Community combining weeds of arable crops under different crops in various hydrological states. 268

V.3.i. Table 17, Segment 1: Ageratum conyzoides - Jussiaea suffruticosa - Sacciolepis africana - Centella asiatica (Sub-) Community of weeds on current farmlands associated with monocultures of Saccharum officinarum on flat 'krumi' valleys. 268

V.3.ii. Table 17, Segment 2: Ageratum conyzoides - Nelsonia canescensis - Ethulia conyzoides - Paspalum orbiculare - Eragrostis pilosa (Sub-) Community of weeds on current farmlands associated with monocultures of Sorghum vulgare on damp uplands. 269

V.3.iii. Table 17, Segment 3: Cynodon dactylon - Imperata cylindrica - Pennisetum pedicellatum - Ageratum conyzoides (Sub-) Community of weeds in current farmlands associated with mainly mixed crops. 270

V.4. Table 18: Sporobolus pyramidalis - Anogeissus leiocarpus - Piliostigma thonningii Community of uncultivated relics of 'kurmi' woodlands on streamsides. 271

VI.1 Table 19: Digitaria ciliaris - Dactyloctenium aegyptium Community of weeds in current arable lands after a few weeks of cultivation or weeding following the first few rains. 272

VI.2 Table 20: Pennisetum pedicellatum - Mitracarpus scaber - Paspalum orbiculare Community of weed regrowths on recently fallow farmed lands often with remnants of old crops. 273

VI.3 Table 21: Brachiaria stigmatisata - Borreria verticillata - Paspalum orbiculare Community of forb-grasslands mixed with scrublands on old cultivated heavily grazed lands. 274

VI.4	Table 22: Cochlospermum tinctorium - Annona senegalensis - Elionurus pobeguinii Community of open scrubs and shrublands with forbs and grasses on seemingly uncultivated plains.	275
VI.5	Table 23: Fadogia agrestis - Cochlospermum tinctorium - Annona senegalensis - Guiera senegalensis - Elionurus pubeguinii - Sporobolus festivus Community of dwarf shrubs, grasses and forbs on shallow soil deposits over lateritic ironstones.	276
VI.6.	Table 24: Annona senegalensis - Cochlospermum tinctorium - Piliostigma thonningii - Guiera senegalensis - Andropogon gayanus - Terminalia avicennioides Community of open woodlands on uncultivated granitic rocks and tree-shrublands on old farmed lands.	277
VII.1	Table 25: Cissus rufescens - Borreria radiata - Andropogon gayanus - Anogeissus leiocarpus - Milletia thonningii - Bombax custatum Community of granitic Inselberg fringing woodlands.	278
VII.2	Table 26.1: Dissotis - Achyranthes aspera - Brachiaria lata - Milletia thonningii - Acacia ataxacantha Community of slopes of Inselbergs.	279
VII.3	Table 26.2: Cissus rufescens - Borreria radiata - Andropogon gayanus - Discorea bulbifera Community of the sub-summits rocky, very steep slopes of Inselbergs.	280
VII.4	Table 27: Afrotrilepsis pilosa - Borreria radiata - Schizachyrium exile - Triumfetta pentandra - Sporobolus festivus Community of Inselberg Crests and granitic rock pools.	281
VIII.1	Table 28: Eucalyptus camaldulensis - Imperata cylindrica - Dyschoriste pedicellata Community in Forestry Plantations.	282
VIII.2	Table 29: Eucalyptus teriticornis - Brachiaria stigamatisata - Sporobolus pyramidalis - Dyschoriste pedicellata Community in forestry plantations.	283
IX.1	Table 30: Eucalyptus camaldulensis - Cassia rotundifolia - Brachiaria stigmatisata - Isoberlinia doka Community under plantations established during 1971 to 1977.	284
IX.2	Table 31: Eucalyptus camaldulensis - Brachiaria stigmatisata - Borreria verticillata - Cassia rotundifolia - Zornia glochidiata Community of forest plantations established in 1968 and 1969.	285
IX.3	Table 32: Eucalyptus citriodora - Cassia rotundifolia - Brachiaria stigmatisata - Blepharis linariifolia - Stylochiton lancifolius - Isoberlinia doka Community under 1968 and 1969 plantations.	286

IX.4 Table 33: Eucalyptus teriticornis - Cassia rotundifolia - Fimbristylis ovata - Guttenbergia nigritana Community continuum under forest plantations established from 1968 to 1977. 287

X.1 Table 34: Eucalyptus camaldulensis - Eucalyptus citriodora - Andropogon gayanus - Pennisetum pedicellatum Community in plantations established in 1971 and 1972. 288

X.2 Table 35: Isoberlinia doka - Pennisetum pedicellatum - Dichrostachys glomerata Community of agricultural regrowths in the Enclaves of Reserves. 289

X.3 Table 36: Hyparrhenia rufa - Piliostigma thonningii - Brachiaria jubata Community on flat 'kurmi' of stream valleys and their adjoining gullied bluffs in uncultivated forest reserves. 290

X.4 Table 37: Ctenium newtonii - Elionurus pobeguinii - Isoberlinia doka - Isoberlinia tomentosa - Dichrostachys glomerata - Monotes kerstingii Community on summits of flat-topped mesas of lateritic ironstones. 291

XI.1 Table 38: Dyschoriste perrottetii - Andropogon gayanus - Dichrostachys glomerata - Zornia glochidiata - Isoberlinia tomentosa Community associated with largely bare, dry, eroded, lateritic ironstone mesa summits and sub-summits. 292

XI.2 Table 39: Dyschoriste perrottetii - Zornia glochidiata - Eragrostis turgida - Digitaria gayana - Microchloa indica Community associated with sheet erosion on middle slopes and shallow soils underlain by quartzite and schist. 293

XI.3 Table 40: Dyschoriste perrottetii - Andropogon gayanus - Eragrostis turgida Community associated mainly with rill erosion or small dissected drainage channels on middle slopes. 294

XI.4 Table 41: Andropogon schirensis - Elionurus pobeguinii - Monotes kerstingii Community on uncultivated, dry, deep, red slopes. 295

XI.5 Table 42: Eragrostis turgida - Sporobolus pyramidalis - Andropogon gayanus Community on uncultivated, nearly level, 'Kurmi' valleys. 296

XII.1 Table 43: Loudetia simplex - Isoberlinia doka - Monotes kerstingii Community on uncultivated lateritic ironstone mesa tops. 297

XII.2 Table 44: Monotes kerstingii - Monocymbium ceresiiformis - Isoberlinia doka Community associated with uncultivated severely gullied stream heads having exposures of lateritic ironpan. 298

XII.3 Table 45: Isoberlinia doka - Monotes kerstingii - Loudetia simplex - Uapaca togoensis Community associated with uncultivated to hardly cultivated ironstone mesa - fringing alluvial deposits. 299

XII.4	Table 46: *Andropogon gayanus* - *Andropogon pseudapricus* - *Isoberlinia doka* - *Borreria radiata* - *Butyrospermum paradoxum* Community regrowths on old farmed, currently abandoned, arable lands with rubbles of ironstone, quartzite, or schist.	300
XII.5	Table 47: *Pennisetum pedicellatum* Community of cleared and abandoned 'Model Farm Settlement Scheme'.	301
XII.6	Table 48: *Hyptis specigera* - *Pennisetum pedicellatum* - *Ageratum conyzoides* Community of agricultural regrowths on farmed fallows on flat plains.	302
XII.7	Table 49: *Hyptis specigera* - *Ageratum conyzoides* - *Lactuca glandulifera* - *Imperata cylindrica* Community of 'weeds' on current *Oryza sativa* farmlands.	303
XII.8	Table 50: *Hyparrhenia cyanescens* - *Mitragyna inermis* - *Hyparrhenia rufa* Community of uncultivated 'fadama'.	303

LIST OF ILLUSTRATIONS

		Page
1	Manual ridging and furrowing under the Dumbi Inselberg. May 1978	324
2	The useful trees retained in farmed lands and current farm lands are not indicators of soils. May 1978.	324
3	Mangi, a permanent but recently established agricultural village at the foot of the Dumbi Inselberg. May 1978.	324
4	An example of the so-called 'Savanna Parkland' near Zaria City with Adansonia digitata, Ceiba pentandra and Parkia clappertoniana.	324
5	Manual ridging and furrowing with different types of hoes for various kinds of soils. April 1978.	325
6	Manual 'shaduf' irrigation in the dry season along River Sayen Dumbi. Crops: Allium cepa and Lycopersicum esculentum. February 1978.	325
7	Harvested Sorghum vulgare being prepared for manual threshing, storage or markets. October 1978.	325
8	Extensions of the Dumbi Inselberg and arable land cleared again with fire before the next tillage. January 1978.	325
9	A view of arable lands from the top of Kufena Inselberg on 30th March 1976.	326
10	A repeat view of the arable lands from the same top of Kufena Inselberg on 15th May 1976.	326
11	Arable lands of the professional 'peasant' farmers at different floristic cover stages on the same day. May 1976.	326
12	A harvest of Capsicum in operation on the upland plains. November 1978.	326
13	Mixed cropping at an early stage under the professional (or 'peasant') farmer. Domain 6, June 1978.	327
14	The same mixed crops in Plate 13 during August 1978.	327
15	A monoculture of Arachis hypogea on a well-drained, loose, friable, sand loam soil on the upland plain. September 1978.	327
16	A monoculture of Sorghum vulgare on a fresh upland plain. July 1978.	327
17	Oryza sativa in the inundated 'Fadama' of the Galma Irrigation Scheme Centre. August 1978.	328

18	Saccharum officinarum on damp cultivated 'kurmi' with some of its major weeds. September 1978.	328
19	Post-harvest weed regrowths on the upland plains. December 1978.	328
20	Sorghum vulgare on the fresh upland plains and its attendant weeds. September 1978.	328
21	"What is a weed but a plant whose virtues have not yet been discovered," said Emerson, according to Griffith-Jones (1977). Post-harvest beautiful weeds of recently harvested crops. October 1978.	329
22	Arable land in its second year fallow, dominated by Pennisetum pedicellatum. November 1978.	329
23	An arable land in its first year fallow with a mixture of weeds. November 1978.	329
24	Arable land in third year fallow outside Zangon Aya. February 1978.	329
25	Khaya senegalensis pollarded for browsing by cattle, sheep and goats near Fulani shelters. March 1978.	330
26	Khaya senegalensis recently felled. Mortars are produced from its heavy boles; fuel from its branchlets; timber from its trunk. January 1978.	330
27	Shifting Fulani pastoralists en route to a new site on the Galma Basin Upland Plains. March 1978.	331
28	Rainy season pastoralists' 'rugas', or shelters, in Guga Forest Reserve Enclave. August 1978.	331
29	Scattered trees in the current fallow land. Grazing cattle and sheep and old termite hill surrounded by locally bare land. July 1978.	331
30	A temporary cattle, sheep and goats open shed on the Galma Basin upland. February 1978.	331
31	An incidental Fulani pastoralist settlement on the Upland Plains. June 1978.	332
32	Gully erosion in Guga Forest Reserve, partly due to grazing by goats and domestic phytophagous ungulates. September 1978.	332
33	Herders and farmers live in close co-operation, mainly on the flat plains and on ridged and furrowed farmed lands where there is less danger of erosion.	332

34	Intercalation of ground cover by vegetation and bare diffused tracks. October 1978.	332
35	A close look at a cause of accelerated erosion in the cerado. August 1978.	333
36	Sheet erosion in a Fulani pastoralist's so-called 'farm'. August 1978.	333
37	Habitat degradation through overstocking with herds by pastoralists in Guga Forest Reserve. August 1978.	333
38	A panorama of the Mairabo Eucalyptus Plantation Reserve from Tukur Tukur granite hill top. July 1978.	334
39	A total collapse of indigenous undergrowths under the introduced exotic Eucalyptus spp. in Mairabo Forest Plantation Reserve. 11th July 1978.	334
40	Isoberlinia doka and Isoberlinia tomentosa shrubs in the nominally reserved non-plantation in Guga Forest Reserve. February 1978.	334
41	The ground covers under an eight-year-old Eucalyptus camaldulensis plantation stand. Kabama, July 1978.	335
42	Eucalyptus tereticornis woodland in Kabama Plantation Forest Reserve. June 1978.	335
43	Competition between arable land use and exotic forestry land use.	335
44	A nine-year-old Eucalyptus citriodora plantation with its undergrowths in Kabama Forest Plantation Reserve. June 1978.	335
45	'Fadama' swamp forbland of sedges and grasses. May 1978.	336
46	A relatively natural 'Fadama' woodland and an inundated 'Fadama' terrace grassland. August 1978.	336
47	The Kabama water course below the Kabama Forest Plantation Reserve. June 1978.	336
48	The Galma Irrigation Scheme Centre. Site of my Domain III. May 1978.	336
49	Borassus aethiopum, scattered Parkia clappertoniana, Butyrospermum paradoxum and Ficus gnaphalocarpa on a post-harvest Sorghum vulgare farm. January 1978.	337
50	Securidaca longepedunculata on gullied concretions of lateritic ironpan. November 1978.	337
51	River bank sheet erosion in co-operation with termite-induced bared land. August 1978.	337
52	My soil profile descriptive equipment in the field within the 629 quadrats distributed in the first eleven domains or strata from Fadama I to Guga XI. cf. the pits dug for the other 85 quadrats around Kuyello, Plates 53 and 54.	338

53	A mixture of Monotes kerstingii, Uapaca togoensis, and Loudetia simplex co-abundant wooded grassland on the colluvial deposits below an ironstone mesa. January 1977.	338
54	Hyparrhenia cyanescens 'Fadama' grassland along River Damari and the grey 'fadama' soil. January 1977.	338
55	A lateritic ironstone mesa in Guga non-plantation Forest Reserve with some of its characteristic species. March 1978.	339
56	Some characteristic species of cracks among granitic boulders of rocky hills. July 1978.	339
57	Bombax custatum, etc., on a rocky hill. January 1978.	339
58	A panoramic view from the crest of the Inselberg. July 1978.	340
59	The Dumbi Inselberg rock pools and crevices in which Afrotrilepis pilosa, Sporobolus festivus, etc., grow. July 1978.	340
60	The Dumbi Inselberg fringing woodland and the effect of past cultivation.	340
61	Another side of the Inselberg fringing woodland with a recent tree clearance using more drastic equipment, and the remains of the diminishing wood. July 1978.	340
62	An example of an abrupt landscape change from the uplands to a stream-bank. June 1978.	341
63	Dichrostachys glomerata on the sub-summit of an eroded ironstone mesa. July 1978.	341
64	Parkia clappertoniana in a Sorghum vulgare farm on the edge of the 'Fadama'. May 1978.	341
65	A roadside erosion along a major road. August 1978.	341
66	Complexities and Complications (1):a combination of cultivated arable land, burning, dry season effect, grazing cattle, and physiognomic variation in a 'fadama'. January 1978.	342
67	Complexities and Complications (2): concentrated assembly of Phragmites karka on the depression to the 'Fadama', yet the species was encountered once in the total of 714 quadrats sampled. May 1978.	342
68	Complexities and Complications (3): an arable land just cultivated with Sorghum vulgare before my visit for a holistic flora survey in the systematic manner. May 1978.	342
69	Complexities and Complications (4): Perhaps an 'atypical' colony of Adenodolichos paniculatus. August 1978.	342

70	An example of an erosion-complex with the multiple 'causes' which could possibly be attributed to one 'cause'. August 1978.	343
71	The bases of Tamarindus indica, Sclerocarya birrea and Cussonia barteri trees raised above the general bare surroundings is possibly related to overgrazing. August 1978.	343
72	Nearly vertical erosion scarps plus collapsing, retreating and under-cutting of soils from the roots of standing shrubs. October 1978.	343
73	A spectacular erosion located along a recently constructed highway. November 1978.	343
74	A gully along an ephemeral drainage channel with a mixture of moist sites flora and those of dry sites. November 1978.	344
75	Stream below a Eucalyptus plantation incised to the granitic bedrock. August 1978.	344
76	Sheet erosion in Guga Non-Plantation Reserve. Balanites aegyptiaca and Dyschoriste petrottetii appear to endure the overgrazing. September 1978.	344
77	An ephemeral stream which flows intermittently following each torrential rain. August 1978.	344
78	An isolated Dyschoriste perrottetii on a dry bare eroded ferruginous soil. September 1978.	345
79	A demonstration of drought-enduring power and sympathetic distribution of Dyschoriste perrottetii with another drought-enduring species, Dichrostachys glomerata, under multiple stress. March 1978.	345
80	A demonstration of the power of resurrection and of the intra-species gregariousness possessed by Dyschoriste perrottetii. May 1978.	345

CHAPTER 1 BACKGROUND CONCEPTS OF THE SAVANNA

1.1 INTRODUCTION

The most up to date attempt to define or describe the 'savanna' of West Africa ecologically was made by Kowal and Kassam (1978). It reads: "Ecologically, the varied assemblages of vegetation within the regions between the humid equatorial High Forest and the Desert bio-climates of Trans-Saharan Africa are described as Savanna."

Obviously, this so-called ecologically described 'savanna' based on climate is a geographical description of a geographical region. It is not an ecological definition based on a botanically defined vegetation per se.

Phillips (1959) described 'savanna' physiognomically as "the natural vegetation in these regions is dominated by grassland with varying densities of scattered trees or shrubs". Phillips was perhaps neither right nor wrong. The generalised physiognomic description however depends on which habitats were inspected. The range of the 'savanna' vegetation-complex varies from barelands to grasslands, woodlands and even to what several physiognomic descriptions by several authors have variously described as 'riparian', 'fringing', 'gallery' or 'riverine' "forests" (Keay 1960, Clayton 1958, Nielsen 1965, Wickens 1976), along riversides in the 'savanna' zone of Nigeria and of the Sudan Republic.

It is not only that there is no distinctive physiognomic uniformity throughout the 'savanna'; seemingly similar edaphic habitats were described as carrying "valley grassland", "valley moist woodlands" and "fringing woodland" following surveys made in several forest reserves in the "savanna" of northern Nigeria (Howard 1964). Similarly, Brand and Brammer (1956) identified four structurally distinct grassland

types on the Ghanaian savanna swamps, viz: "high swamp grassland", "tall swamp grassland", "medium swamp grassland" and "short swamp grassland". The same physiognomic groups do not seem to always occupy similar habitats either; for Alford et al (1972) identified "montane", "riparian" and "swamp" "forests" on non-cultivated areas of the Nigerian 'savanna'.

Physiognomic descriptions or definitions, like Phillips, attempting to model the totality of this vegetation-complex into a succinct unit-range, is in practice hardly a beneficial over-generalisation. Greig-Smith (1964) pointed this out that "physiognomy is the criterion least susceptible to any quantitative approach and must usually rest on verbal descriptions.... It enables quick crude subjective verbal concepts to be made", based on what the observer considers the conspicuous appearance of the vegetation seems to look like.

An objective ecological interpretation of the 'savanna' therefore requires starting by simplifying the geographical 'zone' down to its component units followed by submission to mathematical or computational tests for trends and discontinuities, based, first, on its botanical compositions per se. Thereafter, the relationship between the plant populations or communities and their biotic and their abiotic environments, with which they are in constant dynamic interactions, can be elucidated.

The evolutionary history of the concept of the 'savanna', plus the multiple meanings it has been given by different authors will now be reviewed. The serious linguistic confusions with which the word 'savanna' is beset will be pointed out. Its geographical implications will be indicated. Its near-meaninglessness as an appropriate ecological term will be indicated, using the guidelines available from the literature, some of which dates back to the 19th century. A substitute ecologically usable term, which does not carry the multiple connotations which 'savanna'

now bears, will be suggested to replace the ubiquitously used word; its long establishment as a possible natural world vegetation climax type notwithstanding.

1.2 THE HISTORICAL DEVELOPMENT OF THE SAVANNA CONCEPT

The essence of the logic used in the early ecological delimitations of global vegetation zones, including the savanna, was intricately inter-woven with the climatic abstract ideals which Whittaker (1953) termed "the Clementsian's influential monoclimax climatic theory" and its equivalent "vegetation zonality" hypothesis by Schimper (1903).

By the former theory, vegetation grows like an organism into a climax, the adult stage, passing through a successive successional developmental or infantile stages. According to Clements (1905), Weaver and Clements (1929) "Climate is the master factor of the natural elements controlling plant life, determining plant distribution and structure (and) a climatic region has but one potential climatically controlled climax into which all successions of the region irrevocably lead whether they start from open water or solid rock". By an "intelligent as distinct from empirical description and diagnosis of plant communities" (Watt 1970), world vegetation has therefore been delineated into named climatic regions, each with a possible single vegetation climax as an extension of the monoclimax climatically controlled vegetation theory.

The Schimperian hypothesis of "vegetation zones" or "floristic realms" (Walter 1973) contests that "the widespread assumption that the distribution of plant species is directly dependent upon the physical conditions prevailing in the habitat is incorrect (but that) usually one particular extreme factor is of direct importance". According to

Walter (1973) "the climate exerts that direct influence (so that) in a floristically uniform area, the structure of the vegetation is determined by the environment and primarily by climate".

In the idealised scheme of world climatic distribution and classification by Koppen-Geiger (1936), "tropical savanna" is represented as "tropical wet and dry, Aw" bounded by "tropical rainforest or tropical constantly wet, Af", and the "hot tropical desert or low latitude arid desert, BWh;" lying approximately between latitudes 5° and 15° along both sides of the equator. Walter (1971) defined "natural savanna" as "an homogeneous plant community in which two competitors, woody plants and grasses, grow more or less widely apart on a grassy background" since "savanna represents very definite vegetation types on a transition to arid zone".

The description of the savanna as an homogeneous plant community is questionable, and it is in this phrase that Walter's main weakness lies. It may be possible, with certain limitations, to establish degrees of correlations between any two stands of vegetation, but no two spots are strictly homogeneous in their flora. The synthesis of plant communities depends on the analyses of several small-scale samples representing the different strata of the vegetation. And though different ecologists with different methods do arrive at different community limits, it is hardly possible to find an homogeneous area of vegetation of the size of the savanna indicated by Koppen-Geiger (1936). Even a large area that is physiognomically homogeneous in its grass cover will be quite likely heterogeneous for trees.

The prevalent views suggest that savanna is used in the geographical sense as a climatic natural region with little or no reference to flora. A "natural region is an area which possesses within its borders a comparatively high degree of uniformity of relief, climate, and vegetation,

and to some extent, a uniformity in human activities" according to the geographical definition by Moore (1974).

However, there are suggestions that savannas were not natural regions but that the areas were formerly covered with forests from which tropical grasslands and woodland mosaics are the rudiments derived by some pervasive forces variously ascribed to climatic, anthropozoic or edaphic pressures, either as unique or as interactive vegetation determinants.

Grisebach (1872) attributed savanna existence to alternation of wet and dry seasons outside the equatorial region: "The equatorial belt with a continuous rainfall is covered by rainforest bordered to the north and south of the equator by marked seasonal rainfall in which grasslands become dominant." Schimper (1903) suggested that "savanna originated under a sharply defined wet and dry season" (because) a "quite rainless dry season of five months alternating with a continuously raining wet season is a climate hostile to woodland".

Schimper and von Faber (1935) identified two savanna formations: "Savanna woodland appears under a summer rainfall with a long dry season. Trees are small, evergreen, in open formation, with a ground layer of tropical bunch-grasses. They occur on Brazilian and African plateaux and North Australia." On the other hand, real "savanna is a moist tropical grassland, with or without trees, and may owe its origin to fire or to adverse soil conditions or both". The latter is "pantropical" according to Schimper and von Faber.

Bews (1929) believed that "tropical high-grass savanna is a derivation from forest destroyed by fire (while) tropical bunch-grass savannas are essentially occupying areas where climatic factors are not suited to maintainance of closed forest". Savanna was however ascribed to "curious" "peculiar" "special" soil features by Warming (1892). That savanna could

have originated from destruction of forest by fire was "totally inadmissible" to Warming (1892). Warming and Graebner (1918) also saw "partly geological, partly climatic" reasons for "scarcity of trees in the savanna" of Brazil.

Meyers (1936) saw the savanna as a grassland vegetation with both climatic and pyrophytic causes and concluded that "the savanna is thus of climatic origin associated with alternating wet and dry seasons (and) the vegetation is a fire climax".

Some authors, however, either did not subscribe to the climatic or fire-caused savanna nor to the 'hostility of the savanna to woodlands', or they put less emphasis on them. Willian (1940) for example asserted that "Brachystegia woodland savanna is definitely a secondary vegetation which has successfully asserted itself and assumed a degree of stability on degraded and impoverished soils". Beard (1953) commented that the savanna vegetations of northern tropical America "are juxtaposed with a great variety of forest types" which suggests that the 'homogeneity of physiognomy' and the 'grassy' vegetation are not distinctive features of savannas.

On the African savanna, Moreau (1933) postulated a change from forest vegetation into savanna as a change in sympathy with a long-term climatic change and wrote of "a continuous evergreen forest, stretching from the West African forest belt to East Africa which may well have persisted until comparatively recent times, probably as late as 12,000 years ago". Then "with the adverse dry conditions came the retreat of the forest (so) the evergreen forest declined in extent and at the present time it is but isolated patches of montane forests like so many islands in a sea of savanna".

Richards (1973) proposed a much more recent biotic derivation of savannas from the tropical rainforest following "civilized man's arrival with far higher technical and cultural level, his armoury of power saws and

bull-dozers". Richards (1973) speculated that "if it had been possible to photograph the earth from a satellite 150 or 200 years ago, one of the conspicuous features of the planet would have been a green belt, the wet evergreen tropical rainforest, stretched almost unbroken 10 degrees or more north and south of the equator over the humid tropical lowlands of Central and South America, Africa, South-East Asia and the Islands of Indonesia, when small groups of hunters and food-gatherers were the only inhabitants".

The South African environmentalist, Whyte (1951) described and attributed the initiation of the African savanna to "destruction of virgin forest by the custom of native hunting and farming tribesmen which combine periodic bush burning with shifting cultivation, promoting erosion, increasing dessication, shortage of water and a general sinking level of ground water table. As a result the vegetation deteriorates from its natural climax forest type to a degenerate forest, the 'savanna', with poor and sparse grass flora containing remnants of the original flora".

An obviously unintelligible definition of the savanna was given by Troll (1935): "savanna is all the hygrophilous plant communities in the tropics", distinct from "steppes" which are his "xerophytic communities in the tropics". It is unintelligible because of the insusceptibility of the term 'hygrophilous' to easy definition.

Jaeger (1945) conceived the savanna in purely climatic terms with little reference to vegetation. Two macro-climatic savannas were formulated by rules set on the number of rainy months per annum: "the humid savanna is a climatic zone of tropical summer rain with an annual dry period of two months and a half to five months"; and "dry savanna is a zone with a period of seven and a half to ten months of annual rainlessness". An application of this proposed definition would mean that the Nigerian Guinea savanna should be described as dry savanna, see Figs. 1, 2 and 3.

However, the basis on which the West African savanna zones have been recognised were more closely connected with the three climatic zones proposed by Chevalier (1900). The West African savanna zone was partitioned by east-west lines arranged roughly parallel to the equator. They were named Guinea, Sudan and Sahel from south to north corresponding to the gradual transition to sub-Saharan scrubs from the mixture of deciduous forests, close and open woodlands with mosaics of gramminoid, herbaceous, shrubby and woody physiognomies in the Guinea savanna zone. According to Chevalier (1900) each zone was supposed to have "its distinctive climate and flora" but they have been further partitioned into sub-regions or "vegetation zones" with "modifications and amplifications" first by Keay (1949a, 1953, 1959) and later by Clayton (1957), Figs. 1 and 2.

Although Morris (1970) described the "present boundaries between savanna and forest" in terms of "sharp" "abrupt" "clear-cut" boundaries, such readily distinguishable divisions are seldom reported. For example, Lely (1925) suggested that "though divisible into main types" the savanna types were"so blended that the differences are often unrecognisable". Lely (1925) also commented that "savanna is very topographic" and suggested linkages in the distribution of "forests" and "inferior bushlands" with physiographic gradations.

Whittaker (1975), surprisingly, being one of the major exponents of continuity in vegetation, made an enumeration of different "ecosystem types" in which "woodland", "shrubland", "cultivated land" and "savanna" constitute separate ecosystems; suggesting that these are mutually exclusive to one another, and that savanna is an ecosystem. A climatic regional savanna is however a composite of these ecosystems, plus other ecosystems such as forest plantations and flora areas relatively

distinguished by mutually interactive determinants like slopes and valleys.

The obvious defect in the views of the different authors is their common attempt to explain the savanna in terms of physiognomic homogeneity determined more or less exclusively by a single main causal factor, such as the climate (Schimper 1903, Schimper and von Faber 1935, Meyer 1936, Moreau 1935, Walter 1973); fire (Bews 1929, Willian 1940); topography (Lely 1925); or the action of civilised or uncivilised man (Whyte 1951, Richards 1973).

Even with the emphasis on physiognomy, the structural complexities of the vegetation in the area called savanna in Nigeria does not justify the general reference to it as 'tropical grassland'. The climate provides a basic scheme by which simplistic climatic regions have been delineated everywhere, eco-geographically, before they are subsequently linked with the vegetation. However, such delineations are only hypothetical approximations for physiognomically and floristically diverse regions having broadly similar climatic characteristics. Idealised climatic regions are not delimited with vegetation as the criterion and the forcing or super-impositions of vegetational homogeneities on them will inevitably meet with discrepancies. Savannas thus contain large- and small-scale structural and floral distributional variations from one part to another, which can only be explained by several determinants, some of which are independent and mutually exclusive while others are complex, interrelated and overlapping.

1.3 THE AMBIGUITY AND IMPRECISION OF 'SAVANNA' AS AN ECOLOGICAL TERM

The linguistic confusions associated with the word savanna were traced by Beard (1953). He showed that the term has an ubiquitous usage and has little relationship with vegetation in its original meaning. In its subsequent adaptation as a vegetation term it was ambiguous and imprecise.

According to the historiographic research into the possible origin of the word 'savanna' in several languages, Beard reported that it is equivalent to sabanna, savana, zabana or zavana in Brazil, Guiana, Haiti and Cuba, meaning "treeless plains". The word was supposed to have been imported into Latin America from a Spanish original word sabana from which it was coined into English as savannah. In Spanish, sabana means "as flat and bare as a sheet" (Beard, 1953). In fact, sabana simply means smooth in its Spanish current usage, as I am told by a Spanish speaker, particularly soft, flat surfaces like mattresses and grassy ground. The word savanna was adopted and used "generally to designate all tropical American natural grasslands" by Beard (1953).

1.4 THE NIGERIAN 'SAVANNA'

In Nigeria, vegetation types ranging from barelands, forblands, grasslands, shrublands, woodlands to even forests along riversides, with or without grasses, natural or man-made, on rocks or in swamps, cultivated or uncultivated, are called savanna, after the Zonation of the Country's Vegetation by Keay (1949a, 1953, 1959).

1.5 NIGERIAN CLIMATIC CONTINUA AND KEAY'S (1949-1959) VEGETATION ZONES

Nigeria extends from a heavily forested marine-influenced southern



FIG.1 PROVISIONAL NIGERIAN VEGETATION ZONES ACCORDING TO KEAY 1949-59

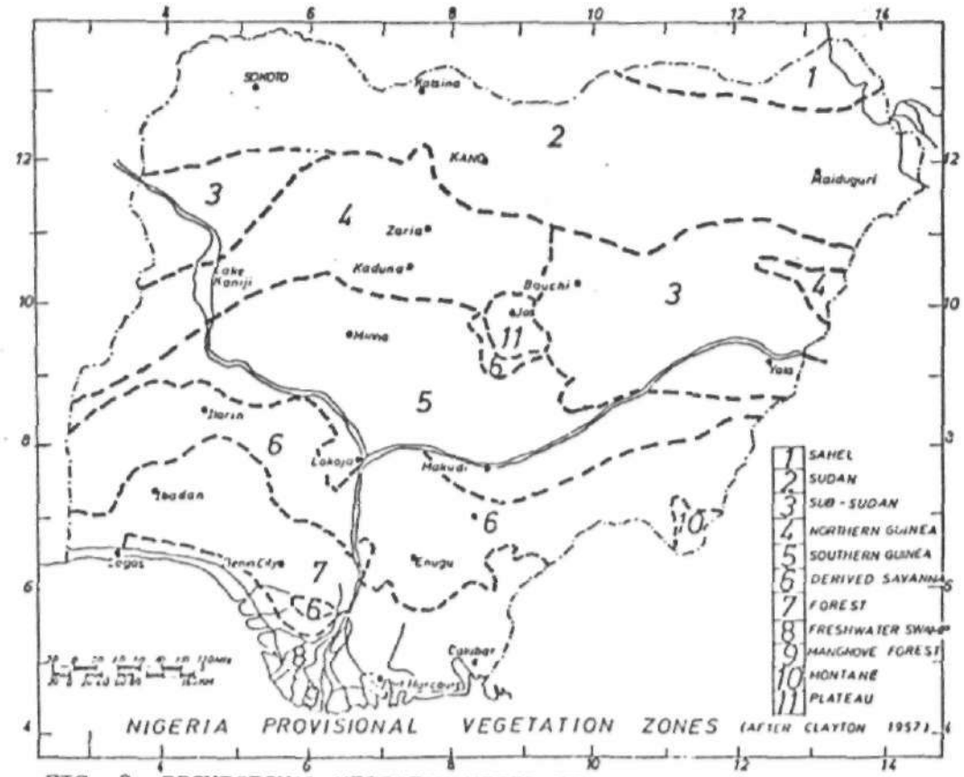


FIG. 2 PROVISIONAL NIGERIAN VEGETATION ZONES ACCORDING TO

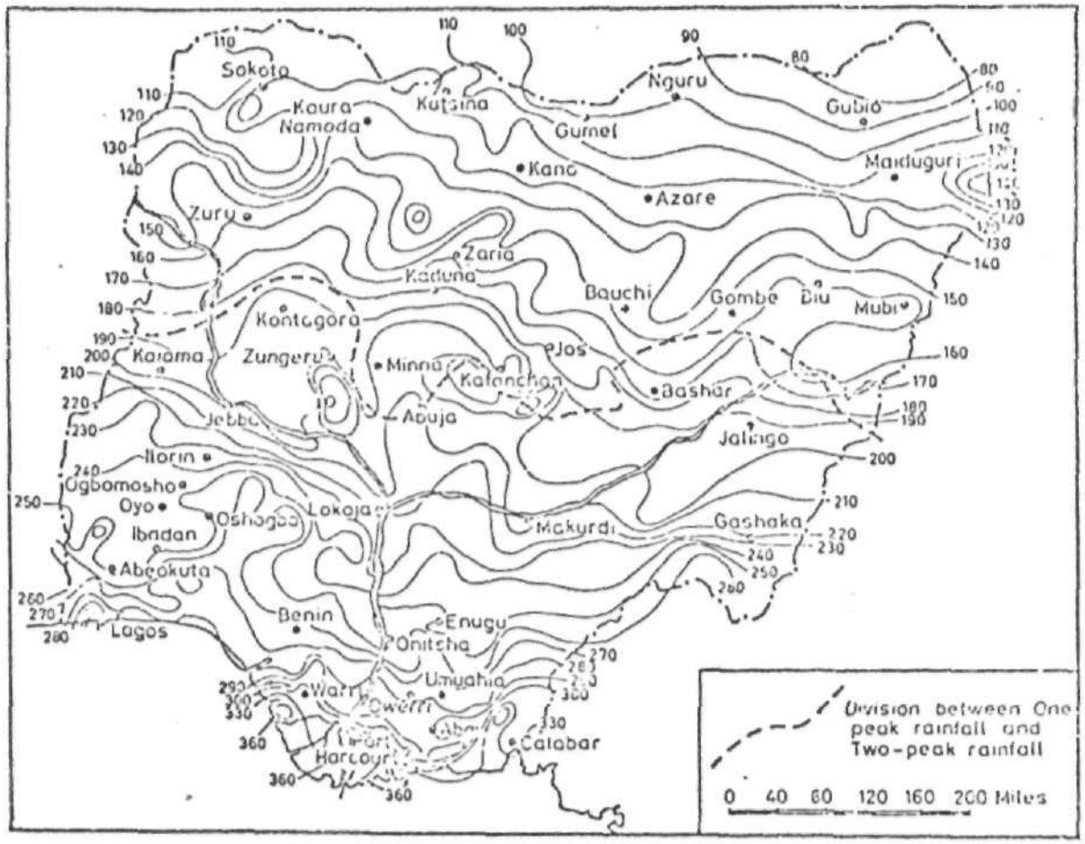


FIG. 3 LENGTH OF WET SEASON IN DAYS PER ANNUM IN NIGERIA
(After Walter 1968).

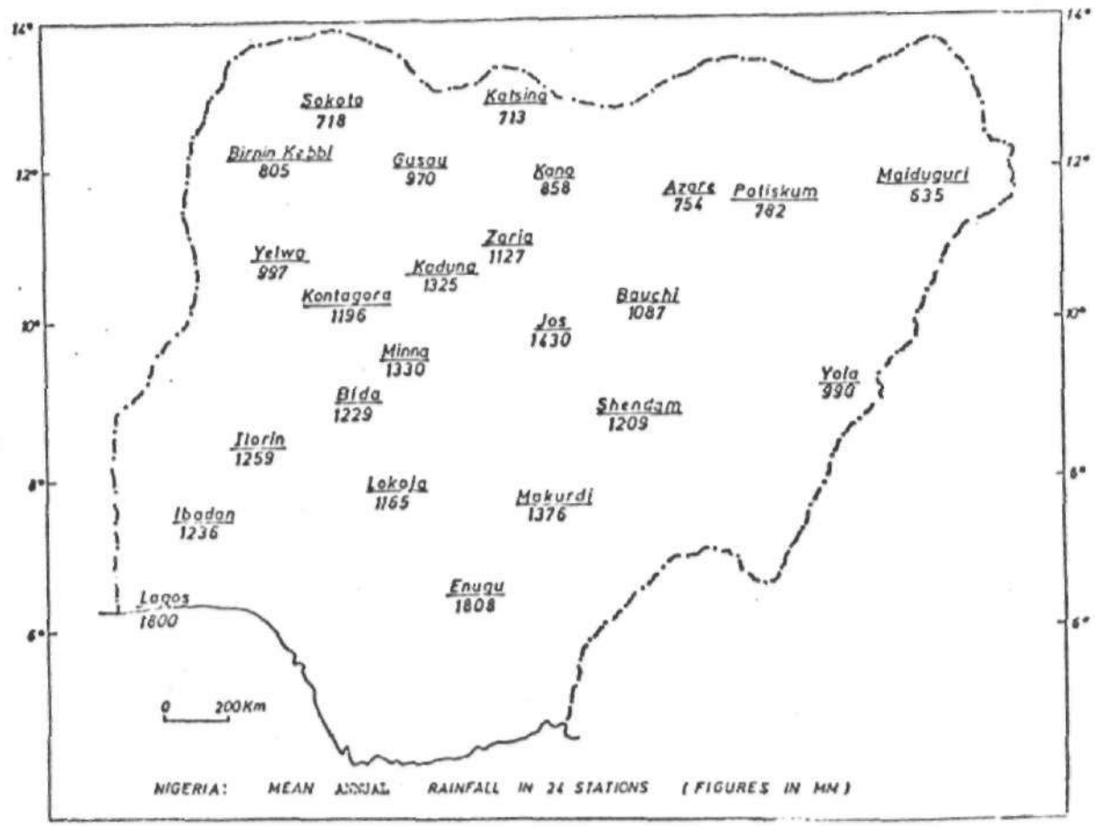


FIG. 4 MEAN ANNUAL RAINFALL IN 24 SELECTED STATIONS IN NIGERIA

coast towards the most extensive hot desert in the world, the Sahara, beyond her northern boundary. A general gradual reduction in the quantity and duration of rainfall from the coast towards the hinterland is demonstrated by rainfall descriptions and maps, e.g. Figs. 3 and 4.

According to Walter (1968), Nigeria's rainfall and average climate is a repercussion of two relentlessly counter-active wind forces. The south westerly winds from the Atlantic Ocean are moist, cool and rain-bearing. The north-eastern Harmattan winds from the Sahara Desert are dry, dessicating, dust-laden and hazy. They are mutually deactivating counter-pressures, and their oscillations across the south-north latitudinal trend determine the duration of rainfall at any given latitude within the country.

Keay (1959) divided and mapped the vegetation of Nigeria with "modifications and amplifications" of the more simplistic vegetation map by Chevelier (1900). Basically two broad groups were recognised, viz: the southern forest and the northern savanna. The forested south represents the belt little affected by the winds from the Sahara Desert, where the oscillations of the operative dynamic wind forces are least felt. The oceanic winds dominate over most of the forest area for about nine or more months per annum.

Chevalier (1900) delineated three savanna zones in West Africa as Guinea, Sudan, and Sahel, arranged in approximately east-west parallel belts to the equator. Each zone was supposed to have "its distinctive climate and flora". The Guinea savanna was characterised by more than 1000mm. annual rainfall, the Sudan savanna, 500 to 1000mm, and the Sahel savanna by less than 500mm. The delineations provided the descriptive basis for subsequent amendments. The "amplifications and modifications" by Keay (1959) as a result of which boundary adjustments and further divisions were demarcated from Chevalier's zones was a secondary development

of the process of discriminating between isohyet lines as the climatic index of a supposed climate-determined vegetation across the country.

The savanna areas coincide with the non-coastal belt in which the north-east winds restrain, neutralise and cancel out the oceanic rain-bearing winds for longer periods annually. However, the opposing wind currents dominate the north-south belts in the fashion that their severities, in terms of intensity and duration, increase in conformity with the increasing proximity to the source of either the oceanic winds or the desert winds. Accordingly, the broad climatic characteristics are a general continuum gradation following the north-south latitudinal trend, although Cocheme and Franquin (1967) affirmed that "the dynamics of West African weather is zonally oriented and directly linked to sharp discontinuity of atmospheric humidity, the movement of the Inter-Tropical Discontinuity Zone".

However, the concept of the climatic zonality was the basis of the vegetation models and interpretation by Keay (1959). The savanna was demarcated from the forest as a sub-humid to semi-arid tropical woodland and grassland region. Keay's savanna covers about three-quarters of Nigeria, occurring primarily in the former northern region of Nigeria.

Keay (1949a, 1953, 1959) partitioned the Nigerian savanna into five "provisional" zones on the basis of the amount of precipitation, the length of the rainy season, and the type of vegetation cover. Outside the "derived savanna" or forest-savanna mosaic, the wettest savanna is the Southern Guinea savanna which has about 1100 to 1600mm. of rainfall distributed in 190 to 250 days per annum. The Northern Guinea savanna has between 890 to 1400mm. of rainfall distributed in 130 to 190 days. The Sudan savanna is characterised by 500 to 1100mm. annual rainfall distributed in 80 to 130 days per year. The driest savanna, the Sahel, has less than 500mm. of rainfall in less than 80 days in a year.

The "vegetation cover" used by Keay means the structural variations of the vegetation in terms of the "approximate natural physiognomy" and "major species" constituting the "zonal vegetation".

The "zonal vegetation" was defined as "the unit of middle rank vegetation on adequately drained upland sites under given macro-climax conditions" (Aleksandrova 1973), or as "vegetation on level areas and average soils" (Walter 1971). From the species lists for the Northern Guinea savanna given by Keay (1959) "major species" appear to mean regionally ubiquitously distributed species which are seldom specific to any community.

Thus using this zonal vegetation concept with emphasis on the climatic monoclimax vegetation zones, vegetation conditioned by land use, local soil differences, topography and non-climatic causal influences do not represent the "climatic normal" (Keay 1960) or they are misplaced variant vegetations spreading outside their climatic zones.

Keay's savanna represents a sub-humid to semi-arid tropical wood-shrub-herb-grasslands covering about three-quarters of Nigeria and occurring primarily in the northern states. The wettest savanna is the Southern Guinea savanna and the driest is the Sahel. The Northern Guinea savanna occupies the centre of these five savanna belts, and presumably it is the typical Nigerian savanna. According to descriptions by Keay (1959), the Northern Guinea savanna is made up of "broad-leafed savanna woodland" as its "climax vegetation". Its "widespread and characteristic species" are Isoberlinia doka, I. tomentosa, Uapaca somon (= U. togoensis), Monotes kerstingii, Combretum binderianum and Swartzia madagascariensis.

The lack of physiognomic homogeneity, apart from the lack of floristic homogeneity, within the Northern Guinea savanna vegetation zone was pointed out by Keay when he also wrote that "streamside vegetation typical of this zone consist of dense evergreen understorey of forest climbers

and shrubs with wide spreading emergent trees of savanna species" among which were Khaya senegalensis, Vitex doniana, Raphia sudanica and the bamboo, Oxytenanthera abyssinica.

Obviously, with any further elaboration, the role of edaphic, land use, and other environmental factors within the Northern Guinea savanna zone, will assume significance and lead to an enormous increase in complexities of vegetation patterns and to the delineation of numerous plant communities in the zone.

CHAPTER 2 SOME EXAMPLE PHYSIOGNOMIC SCHEMES OF 'SAVANNA' VEGETATION CLASSIFICATION

Schemes of classification based on physiognomy have received a great deal of attention in the Nigerian Guinea savanna for various reasons. For example, physiognomic classification has been made by foresters concerned directly with prospecting for the possibilities of reserving existing wildland vegetation or to replace them with plantation reserves. Ecologists have attempted to use physiognomy as a guide to interpreting environmental features or land use potential. Some schemes of community classification employed mixed physiognomic and present land use with botanical composition criteria to supplement each other. These convey the impression of the general stature of the vegetation which is otherwise not easy to appreciate.

Numerous possible physiognomic classifications have in fact been suggested by various authors. Hopkins (1974) identified four physiognomic types, viz: savanna woodland, tree savanna, shrub savanna and grass savanna.

Alford et al (1972) designated fifteen possible basic physiognomic types for uncultivated savanna using aerial photographic interpretations to judge the continuities or discontinuities of canopy cover, stratification, floral densities, and the nature of the habitat of the vegetation stand. They recognised forest, swamp woodland, woodland savanna, parkland, shrub savanna, shrubland, thickets, tree savanna, tree/shrub savanna, low shrub savanna, clumped tree grassland, herbaceous swamp, grassland, and grass-forb.

The identities of the above are, however, difficult because of over-lapping. Perhaps the physiognomic groupings made by Clayton (1958) are ecologically more meaningful. They were based on the continuities and discontinuities of canopy closure as well as on the conditions of the pre-vailing habitats of the vegetation stands on the field, and cover both the

wildland and the used savanna. These physiognomic terms were largely adopted by the Inter-African Conference (Boughey 1965). Clayton (1958) identified:

a) Thicket as dense shrubby vegetation, often thorny, and usually more or less impenetrable; grass absent.

b) Periodic Swamp Forest which is swampy during the wet season, on flood-plains.

c) Riparian forest on damp ground which is not swampy but maintained at high moisture content by the presence of a water course.

d) Woodland with mainly trees having their crowns touching, with sparse grass, herbs and woody plants growing under.

e) Savanna Woodland which may be closed or open depending on spaces between trees.

f) Tree/Shrub savanna having both trees and shrubs mixed.

g) Tree savanna (often called Parkland) because of their discontinuous canopy.

h) Shrub savanna which may again be open or closed as gaps between shrubs vary.

i) Grassland savanna which may be climatic or edaphic in character, such as the upland and aquatic grassland.

j) Fallow regrowths on old farmed lands.

k) Farm lands with weeds.

l) Herb swamp usually dominated by sedges.

Keay (1948a, 1953, 1959), therefore, only showed the basic orientation of the Nigerian vegetation with the Country's climate. The partition provides a useful crude simple base for qualitative and quantitative analytic studies. The multiplicity of the dimensions were however subordinated to a single direction of change. A consideration of the role of edaphic, biotic, and other environmental factors within the climatic zone will assume some significance and lead to a more multi-dimensional interpretation of the vegetation distributional patterns than that outlined by Keay.

2.1 A POSSIBLE SUBSTITUTE ECOLOGICAL TERM: 'CERADO' INSTEAD OF 'SAVANNA'

I have stressed the concept of the savanna as an inappropriate, imprecise, ambiguous, omnibus term for the floristically and physiognomically heterogeneous vegetation, and that it is applied to every type of vegetation from swamps, riparian forests, grasslands to farmlands and even to barelands and woodlands on hilly or rocky surfaces. Personally, I suggest, the Portuguese word "cerado" as an unambiguous, more appropriate substitute, to the Spanish word "savanna" for a comprehensive description of the existing semi-natural vegetation in this Nigerian zone. Besides, well-known terms which seem more ecologically precise, as used in my study area, will be employed. Such words are 'Fadama' and 'Kurmi'.

The Northern Guinea savanna zone that was delimited by isohyets, represents approximately the former mid-northern Nigerian climatic-political regional middle belt. I would have preferred to call the same zone "the mid-northern latitudes 'cerado' vegetation of Nigeria" from its geographical location and the complexity of its vegetation.

"Cerado", according to Goodland (1971), means "open, half-open or dense vegetation which varies physiognomically from herbaceous, grassy, shrubby vegetation through woodland and almost forest". Conversely, 'savanna' specifically (and erroneously, in the Nigerian situation) conjures the deceptive impression of a more or less open tropical grassland or grassy-shrub vegetation or "the homogeneous plant community in which two competitors, woody shrubs and grasses, grow more or less widely apart on a grassy back-ground" (Walter 1971). But the range of vegetation implied by 'cerado' varies from anything from grassland to almost a forest and allows for an objective classification of the community gradients in order to provide a quantitative floristic classification which can be used in the comparison of the ecological relationships between different areas under different soils

and land use.

The 'savanna' and the Northern Guinea savanna zone will be largely maintained in this thesis after the series of the Nigerian vegetation zonations and nomenclatures by Keay (1949a, 1953, 1959) but it will be subject to substitution by the 'cerado' which I have proposed as an ecological alternative. Keay's approach can however be criticised, though not with the aim of destroying it.

The vegetation zonation in the north-south trend was a primary work upon which secondary and tertiary analyses can be built. The linkage of vegetation with climate (mean annual rainfall duration and quantity) was a reciprocal vegetation-climate trend whose gross mutual correlation cannot be disproved. However, it was, in my view, possibly a process of first defining the major climatic zones and then seeking the vegetation that would correspond to them. The search for the vegetation zones was found on the gross physiognomic and floristic continuum from the forested coastal latitude $4\frac{1}{2}$°N to the 14°N northern latitude national boundary with Niger near the Sahara Desert. This is a straight distance of about 900 km. across Nigeria. Regionally ubiquitously distributed species were used in the formation of the arbitrary zones. His axiom of the so-called "zonal vegetation" has been defined as "the unit of middle rank vegetation on adequately drained upland sites under given macro-climatic conditions" (Aleksandrova 1973). Alternatively, Walter (1971), like Morison et al (1948) defined "zonal vegetation" as vegetation on level areas and average soils. In my opinion the 'average soil' in the Nigerian cerado or 'savanna' is difficult to know at any season, and it seems to depend on the use for which it is intended.

In the example of his Northern Guinea savanna zone vegetation, Keay (1960) appeared to have avoided vegetation conditioned by land use or local soil differences because it does not represent the "vegetation on average soils" under the "climatic normal". Obviously, like Clements (1936), who was

obsessed with the idea of climatic climax, vegetation variations not conforming to anticipated climatic ideals were "spreading outside their zones".

The climatic zonation of vegetation must therefore be seen as a blurring of the networks of the natural intergradations in plant communities. For example, a fadama with distinct dominating thicket species plus companion species that are regularly subjected to prolonged or short-term waterlogging, have their field distributions controlled into a relatively distinct zone along the flat river beds in the Guinea, Sudan or Sahel 'savannas'. Within one locality in one of the climatic 'savanna' zones, vegetation conditioned by ironstone hardpans, unsuitable for cultivation, may lie in close proximity with plant communities consisting of weeds resulting from the consequence of agriculture as its major ecological causal factor.

Because of the multi-dimensional characteristics of plant communities and the interrelationships as well as the relative independence of their controlling factors, it is expected that all the possible factors of the environments should be considered singly and jointly in classifying communities. This expectation is of course difficult in practice and a choice of which important factors to be explored should be made in a given situation, from climate to soils, topography, edaphic properties, geological substratas to the effects of man.

Sample maps made by "reconnaisance surveys and stereoscopic interpretation of aerial photographs" to divide parts of the Northern Guinea 'savanna' zone into units of landscape or 'land systems' that have characteristic patterns of relief, soils and vegetation" (M.O.D. 1970), now suggest that the bands of vegetation surrounding water bodies belong more to a definite riparian zone than to a climatic vegetation zone. They also suggest that vegetational variations caused by man, soils or topography are more conspicuous from aerial photographs.

The idea here is to base the interpretation of the factors on the floristic communities in terms of many possible factors assessed through field work in the environment.

CHAPTER 3 HISTORY AND CULTURE OF USE AND DISUSE OF LAND WITHIN THE ZONE

Keay (1949b) explained that uninhabited lands in the Nigerian savanna "were fully occupied and had been so for centuries until the troublous times of the rising of the Fulanis which started in Sokoto in 1804 (during which) any small town or village was potentially liable to be ruthlessly raided by its enemies". According to Keay (1949b) the 'Fulani uprising' continued until the advent of Pax Britannica, and "the people were either fleeing, slaughtered or enslaved while their farmlands were transformed into dense savanna vegetation".

Smith (1955), in order "to provide a background picture for peasant agriculture" in northern Nigeria, saw the savanna as "a state whose energies were formerly focused on slave raiding".

According to my view, an equally salient historical factor responsible for the transformation of formerly inhabited farmed lands into dense vegetation was the impact of the "depopulation of primitive tribal communities" (Clark 1977) before the territorial expansion of Britain and European Countries into the zone. For the establishment of the Pax Britannica was preceded by an era of about four centuries of pre-colonial slave production from 'south of the Sahara' to the Americas. The cargoes taken in European ships to the Americas were the able-bodied young men and women from the 'south of the Sahara'. Raidings, kidnappings and warfare were the weapons used.

Clark (1977) mentioned that "slave population suffered high mortality and marriage was discouraged" so that "increase was due to heavy additional importation of slaves from Africa, particularly West Africa". Survivors of

slaves reaching the American plantations from the south of the Saharan 'savanna' zone to the coast, in chains, on foot, and on the trans-Atlantic journey on the European ships, were little fractions of the numbers taken by the violent techniques of slaving. And so the deaths were consistently replenished for four centuries from the 'savanna' in the south of the Sahara.

The centuries of selective withdrawals of those deemed fittest to survive and the sporadic recurrent threatening of the survivals must trigger off prolonged reverberations on land use and vegetation.

Putwain and Harper (1970) showed that "removal of the stresses imposed by one species could result in rapid re-imposition of stress by other species". Also Harper (1971) exemplified a variety of ways in which "the populations of aggressive exploiters of a habitat control the biological compositions of the community". Naturally interactive organisms (man and plants in this case) would exhibit the compensatory population changes such that the continuous decimation of the 'savanna' human population by slavers leading to partial population crashes would be responsible for reversal of previously tamed lands into abandoned wildlands.

The fantastic fallacy that human population had always been low in the African savanna "due to very high child death-rate" (Culwick 1963) is of course an oversight of the salient historical factors, and a distortion which made this account inadequate for utilisation for the ecological setting. Child-bearing ages of both sexes were the targets in the Trans-Atlantic slave trade. The violence, the insecurity, the unnatural selection of young fit members of the community as the result of the opportunity presented by European slave traders, must, in my view, be counted as a salient causal factor which has influenced the composition and distribution of plant communities.

Obviously the "transformation of farmlands into dense savanna vegetation" as Keay (1949b) called it, was because when the inhabitants of

a given area were reduced below a viable number in an environment, due to the European slave raiding, the remaining few had to abandon the area because they were too few in number, or they were composed of members of extreme ages, too young or too old, to tame and harness the environment. Following which, a new dynamic successional flora regrowth on old farmed and inhabited lands got established towards the climax vegetation.

Woodell (1980) pointed out that "slave trading has gone on for longer than the European slave trading, both locally and by Arabs" (personal comm.). This white-washing of the European slave trade is not necessary. It is the impact of exporting millions of captives on the land use and the associated vegetation that I refer to, not the morals or the politics of it. Local slave trading is domestic. It did not result in massive loss to the 'savanna' labour force and the taming of the environment which I expand upon using Keay's foundation. Slave trading on camel backs or on foot across the Sahara is not the same as slave trading across the ocean in huge ships into which assorted men and women were packed like sardines. Moreover, the Trans-Saharan slave trading was more connected to East Africa, while the Trans-Atlantic slave trading was more linked to West Africa, according to the historians to which I made references.

From firsthand knowledge of contemporary Nigerian practices, plant-parts from stems,roots, leaves, flowers, fruits, seeds to barks, of uncultivated plants, play profound roles in the daily domestic lives of the people, as sources of food, medicine, fuel, shelter, and utensils. Several savanna species are utilised also in industrial articles in several forms, from beverages, spices, silk, fats, oils, poisons, antidotes, mats to ropes. The plants are also instrumental even in superficially unconnected crafts and trades like iron-smelting or pottery.

Some major events in the Country's historical development can in fact nearly only be meaningfully interpreted from a plant distributional viewpoint.

The movement into the Nigerian savanna by Fulani pastoralists, according to the historical narrations (Meck 1925, Niven 1950, Bartlett 1956, Osae and Nwabara 1968) started in the thirteenth century from their original West African habitat on the Senegal Valley and the edges of the Sahara Desert. The subsequent invasions of the present Nigerian Guinea savanna states (Kaduna, Niger, Kwara, Benue, Gongola) during the 1800s, if given the correct interpretation, were neither mere "plans for the foundation of a Mohammedan theocracy from a religious zeal" as explained by Meek (1925), nor was it simply one of those aspects of "tribal coups and punitive raidings" catalogued by Niven (1950). The pastoralists could not have been any more particularly ferocious or fanatical than the other inhabitants. It was an effort to take control of the land for grazing across the greener Nigerian savanna.

3.1 SHIFTING PASTORAL LAND USE

The pastoralists are unsettled, rural in their habitat, and landless by their dependence on shifting inhabitation from one uncultivated land to another (Plates 25, 27 to 37). According to their own explanations (personal comm.) their domestic mammals prefer different parts of the environment at different times of the year, and they try to place each species of their animals in the particular environment to which each is most closely adapted and in which it is most free from disease during the changes in the savanna seasons. In short, each of their major domestic mammals has its ecological environment, exhibiting local habitat preferences which in the rainy season consist of three rough strata that may be defined in terms of their vegetational, hydrological, geological and topographical characteristics. Cattle characteristically prefer the fadama, sheep characteristically prefer the mesic uplands, and goats characteristically prefer the xeric mesas.

Bartlett (1956) pointed out that "Nomadic herders rely solely upon natural vegetation for their livestock's fodder, and neither sow pastures nor store forage". And by an estimate, "In Nigeria, over four-fifths of all cattle are owned by pastoral Fulani" (de Leeuw, 1965) and these are concentrated almost entirely in the savanna. Their unsettled ('nomadic') life constitutes their method of responding to the seasonal variations in the floristic composition of vegetation which forms their principal occupational need.

The methods of responding to the seasonally changing flora includes raising a mixture of animals concurrently (cattle, sheep, goats, chickens, and guinea fowl); the acquisition of minimum loads; seasonal sedentary life with 'backyard' farming of annual crops (Sorghum, Pennesetum, Vigna, Lagenaria, Cucurbita, Ipomea batata) during the rainy season. Their houses consist of disposable thatched shelters or huts (rugas), instead of real houses. Rainy season shelters are thickened with plant stems, built on the drier uplands, often on flat-topped porous ironstone mesa or on summits of the topographic undulations of the so-called 'catenae'.

Dry season shelters are more rudimentary, made of Sorghum straws into conical, much more temporary 'nests', and often installed near the fadama.

Baxter (1975) wrote concerning shifting pastoralists that "making new camps is a source of personal satisfaction to pastoralists". When asked why they move, I was given the reasons as: (a) the animals prefer different environments at different seasons; (b) the low-lying sites are unsuitable for the ruga because of inundation; (c) because the open cattle 'sheds' become soiled by the droppings from the animals; (d) because palatable forage grows on the uplands during the rainy season; (e) because the owner of the present site upon which they settle during the dry season wants to farm the site of old animal sheds in the rainy season.

According to Horowitz (1975) "The ecologic divisions between herder and farmer stand in a close relationship to ethnic segmentation". He reasoned that "historically the farmer had a long occupancy of the area as millet farmers before the Fulani appeared in the early part of this century with their herds of cattle, goats and sheep" and this "results in violence at decisive points over the land". This seems to be more of an ethnologist's imaginary view (see Plate 33).

Similarly, Gulliver (1975) imagined that the relationship between farmer and pastoralist is "a response to the internal context of the socio-cultural system of the people and the factors underlying the tenacity with which the pastoral Fulani have maintained their ethnic and social separateness under the ecological and social pressures".

Firstly, the advent of the Fulani pastoralists into the Nigerian Guinea savanna in this century is not supported historically. Osae and Nwabara (1968) explained that Fulanis were offsprings of Berber fathers who were herdsmen from the desert. The men travelled with their herds until they found the fertile lands of the savanna, which was attractive, and they settled down first on the Senegal Valley. Cut off from their womenfolk, the herdsmen intermarried with the West Africans. That the Fulanis have been components of the savanna zone before A.D. 1000 was suggested. But they remained in rural, unsettled, relative social isolation, shifting after pasturage and water according to the demands of their special trade. They remained obscure until their animals multiplied and more grazing land was needed.

There seems to have been a long history of Fulani-dependent economy, e.g. milk, meat, cattle, plus sheep, goats, and fowls, were, and are, sold to the non-pastoral population. Pastoralism also provided the hides from the cattle, sheep, and goats, for the leather tanners, and manure for the farmers. Besides, the pastoralists were also dependent upon the surpluses

of the farmers' articles, which they do not produce effectively or adequately.

Secondly, the fact that the lines dividing arable lands from pastoral lands are very thin at particular seasons, suggests that the supposed inter-ethnic or inter-occupational tensions or hostilities are imaginary. The grazers are dispersed around farming settlements. Following the harvest of the final crops from the farm, the farmer turns over his land to the grazer. Post-harvest residues are browsed by the cattle, sheep and goats, and the animals in turn manure the farm with their dung (Plate 33).

Agricultural and pastoral land users therefore communally use the arable lands, and this must have been a long-term more or less symbiotic inter-dependence on one another for centuries.

3.2 ROTATIONAL FALLOWS

The major land use form in the Nigerian savanna has been agricultural though the origins of agriculture in Africa south of the Sahara had been a matter of dispute among botanical historians. Murdock (1968), for example, has argued that "the Mande-speaking peoples of the middle Niger domesticated a number of indigeneous plants, including several millets during the fifth millennium B.C." Vavilov (1950) however thought Ethiopia to be the centre of the domestication. Hugot (1968) believed, on the other hand, that agriculture "diffused from Egypt and Maghreb to South of the Sahara between 6500 B.C. and 2500 B.C."

Agriculture in Africa south of the Sahara was thus estimated to have been in existence as early as between 6500 B.C. and 2500 B.C. by Hugot (1968). Other opinions even suggest a much longer period of the impact of agriculture in the West African savanna: "Certainly agriculture was being practised in the savannas north of the tropical rain forest by the third and second millennia B.C., if not before, although it is not clear how widely they were

According to various postulations on the origins of crops, Oryza glaberrima, Gossypium sp., Sorghum vulgare, Pennisetum spp., Musa sp., Coffea spp., and Discorea spp., were first domesticated from wild plants in Africa south of the Sahara in the first millennium B.C., before further dispersals added to the number of crops (Griggs 1974). Purseglove (1976) also suggested that the area could be the true origin of other crops "if we realise that current claimed centres of origins of certain crops may be centres of cultivation, migration, selection or hybridization and not necessarily the true home of the crops".

Aspects of the state of the vegetation and land use probably conditioned by agriculture before the advent of Pax Britannica were described by a number of explorers, though their descriptions were often shadowed by the relationship of plant distribution with vegetation in England.

Mungo Park, in his diary for 24 July 1796, wrote of "a large town called Kabba, situated in the midst of a beautiful and highly cultivated country, bearing a greater resemblance to the centre of England than what I should have supposed had been the middle of Africa. The people were employed in collecting the fruit of shea trees (= Butyrospermum paradoxum) from which they prepare the vegetable butter" (according to Miller, 1954).

Apparently observed in its usually highly cultivated state in the rainy season (Plates 11, 15 and 16), Clapperton (1829) described the area between Zaria and Kano as "The land everywhere looked beautiful, the trees full of foliage, such as the butter tree (= Butyrospermum paradoxum) or dorowa (= Parkia clappertoniana) and the tamarind (= Tamarindus indica). The country at present looks like some of the finest in England. All around is green and beautiful with only trees here and there".

Of the farm lands, Cailie (1830) said "I was astonished to find agriculture in such a state of achievement in the interior of Africa.

Their land is carefully cultivated like ours".

The descriptions of Barth (1857) described how the regionally ubiquitous useful trees also changed in composition over the landscape: "The dorowa (= Parkia clappertoniana) which had formed the principal ornament of the landscape gave place entirely to other trees, such as the tall rimi (= Ceiba pentandra), the kuka (= Adansonia digitata), and the deleb palm (= Borassus ethiopum), but beyond the village of Doka, the dorowa (= Parkia clappertoniana) which is the principal tree of the provinces of Katsena and Zariya again come prominently, while the butter tree (= Butyrospermum paradoxum) and the alleluba (= ? Cordia africana), afforded a greater variety to the vegetation" (Kirk-Green 1962).

Wallace was the second in command to Lord Lugard in the colonial conquest of northern Nigerian savanna zone, according to Niven (1959). Wallace (1896) wrote: "Economic trees are left standing in the fields. The shea-butter (= Butyrospermum paradoxum) from which a good fruit is obtained as well as a large quantity of vegetable butter for cooking and lighting and many other purposes, locust bean tree (= Parkia clappertoniana) from which a large quantity of food is obtained, the gambier (= Acacia arabica) the fruit of which is used for tanning hides, the tamarind (= Tamarindus indica); its fruit is greatly praised; numerous plum trees (= ? Vitex doniana) growing in both towns and in fields, the valuable kuka (= Adansonia digitata), for it yields fruit and capital fibre, its leaves used for nutritious soup; silk worms feed on tamarind trees. In addition to the above trees, there are numerous and extensive forests of gum trees, valuable from the commercial standpoint" (Wallace 1896).

The technical changes in the evolutionary history of world agricultural implements and of the techniques of farming reviewed in detail by Grigg (1974) has pointed to the inappropriateness of the concept of 'shifting cultivation' and the idea of a 'digging stick' as an agricultural implement in most areas of the so-called West African savanna (cf. Nye and Greenland, 1960).

Grigg pointed out how every culture was more or less based on agriculture during the first and early millennia B.C., mostly from "archaeological evidence". He suggested that "the great divide in the history of agricultural technology came in the middle of the nineteenth century"; that it was the industrial and the subsequent agricultural "revolutions in England during the seventeenth to early nineteenth centuries that created the great gulf in the agricultural implements and techniques between the present agricultures of Asia, Africa, Latin America, and Western Europe"; that it was not until the inter-war period (from 1914 to 1945) that "the tractor replaced simple iron and horse plough tools in North America, Australia and Europe"; and that "many implements and techniques of farming were known all over the world in the early centuries of the Christian period, if not before".

According to Grigg (1974) for example, "The hoe and machete were adapted by the Indians", while "the hoe and spade plus primitive harrows, rakes and forks were particularly important in northern China". And in "the Old World farming techniques" by the early Christian period, and possibly earlier, Grigg included "green manuring" and "the spreading of animal manure on the farms as distinctions of agricultural management in the south of the Sahara.

He also suggested that "Much of the early farming in the south of the Sahara took place in semi-arid areas, and the value of an alternating fallow to conserve soil moisture was well known"; that "double cropping" was practised, but only in the irrigated valleys; that "the shaduf were used for the irrigation by the early centuries of the Christian period"; and that "terracing of steep slopes was also practised" (Plates 6, 11).

Iron tools have served their attendant benefit on agriculture too. According to the Encyclopaedia Britannica, the "guinea" was "a gold coin at one time current in the United Kingdom. It was first coinced in 1663,

in the reign of Charles II, from gold imported from the Guinea Coast of West Africa by a company of merchants trading under charter from the British crown - hence the name".

Specialist iron smelters have therefore, for a very long time, provided iron-working tools for agriculture and the crop distribution. As can be implied from the diversity in the shapes and forms of the most important Nigerian savanna agricultural implement, the hoe, the people have used it for centuries in working the land. They knew about the complexities of the environment and diversified their technological implement and methods for dealing with the edaphic variables. Intuitive evaluations of the changeable soil physical characteristics led to the modifications of the hoe for ridging, furrowing, and weeding. Knowledge of the deterioration in soil chemical properties and falls in agricultural productivity following repated cultivations led to 'rotational fallows', not 'shifting cultivations'.

The farmers do not shift, they are sedentary in permanent settlements and cultivate the land in the neighbourhood of their towns or villages (Plate 9). Fallow cultivation is commoner on land farther away from the towns. Morgan (1969) distinguished among a number of agricultural types in tropical Africa and concluded that "true shifting cultivation is rare, found only in parts of Ivory Coast and the Cameroons and only where human population densities are low". He pointed out that "rotational fallows are created and unwanted trees are not allowed to re-establish themselves". Rotational fallow in the Nigerian Guinea savanna is a method used in maintaining soil fertility, often coupled with manuring of land by the farmer inviting or welcoming the pastoralist to graze in his post-harvested farm, and making payments for the cattle manure. From the figures quoted by Richards (1970) "for every acre under cultivation, another fifteen to twenty acres must lie fallow while the soil slowly recovers its fertility under shifting cultivation". This means that shifting cultivation methods require the use of great areas of

land by one farmer, and it is hardly practicable in a thickly populated country.

Axes and cutlasses are also iron tools used in conjunction with the hoe. Abandoned iron-smelting spots are still common in the Nigerian savanna fields. That they were abandoned was probably due to a technological stagnation brought about as a reversal of technology during the Pax Britannica when manually produced iron tools were replaced by tools from mass production.

3.3 VEGETATION CLEARING IN THE USAGE OF LAND

Agricultural and pastoral land uses depend very largely on family and individual labours. Each user observes the peculiarities of the land and clears it as rationally as his means permit. There are thus considerable ranges in the practices of preparing the land for pastoral and agricultural uses. In contrast, land use in the forms of forestries or irrigation schemes arise from governmental authority and the economic factor determining approaches to the clearing and maintenance of land are less restrictive.

The smallholder farmer removes unwanted plants from his farmland by tedious, time-consuming, back-breaking manual labour, using the hoe and a few implements; cutlasses and axes. When possible, in the dry season, he saves his energy by partly using fire in clearing the land for the next growing season (Plates 8 and 66). Fire is the sole method of clearing lignified old grasses by herdsmen. The recurrence of fires and their side effects on the soils and vegetation in the savanna and in other tropical areas have been the subject of separate studies by several authors (e.g. Hopkins 1963 and 1965, Daubenmire 1968, Boughey 1971, Ross-Innes 1971).

The use of fire in the tropics was once considered "primitive" (Bartlett 1956). However, the Fulani pastoralists use it on the unfarmed

savanna to replace old lignified grasses with young succulent, preferentially grazed, vegetation regrowths to their phytophagous domestic ruminants. Smith et al (1960) had noted that "postburn plants are preferred by herbivores who seek out burned sites and unerringly select the more palatable and apparently more nutritious forage". Hopkins (1963) also saw that "growth is produced sometimes very rapidly regardless of the soil moisture content and the occurrence of precipitation" after a savanna fire and suggested that "the removal by fire of the plant tops triggers latent primordial regions to initiate new growths" or "the pre-rains vegetation flush" (Hopkins 1970).

Records of ground temperatures at Olokemeji by Hopkins (1965) indicated that soil surface temperatures invariably exceeded 538°C, both in early and late dry season burnings. Ground level temperatures of 715°-850°C were recorded in similar experiments in the Sudan vegetation by Masson (1961). The figures suggested that fired soils under agricultural or pastoral lands are purified or sterlized by the high temperatures experienced. Hill (1971) believed that "big game in Africa may prefer the emerging growth of postburn sites, not only because it is more palatable but because there are reduced numbers of ticks, mites, and flies in the open burned sites". Nye and Greenland (1960) also stated that "following the fire, the land is at its cleanest and makes the task of weeding a relatively light one".

The documented studies suggest that floristic changes to fire vary with the type of vegetation, soils, moisture, fire frequencies, burning times, climatic and topographical effects. Daubenmire (1968) pointed out the beneficial fertilizing effects of the ash from burning prior to planting: "The blanket of dead and decaying vegetation contains nutrients that are largely unavailable for growth until released slowly and incompletely by decay, or rapidly and more completely by fire". Soils in burned grasslands

usually have slightly higher pH values, more available nitrogen than comparable unburned areas also, according to Daubenmire. And Metz, et al (1961) said that "mineral salts of Ca, P, K, and Mg often increase in the soil with burning".

Vogl (1974) suggested that "grassland fires sometimes create disturbed sites or pioneer conditions that permit invasion by opportunistic species such as annuals or short-lived perennials". Ramsay and Ross-Innes (1963) suggested that "because of disturbance by fires, and other agents, grassland diversity is commonly assured by heterogeneous mixtures".

Conversely, Lloyd (1971) followed the changes in the availability of nutrients in the soil under grassland and tall herbaceous communities subjected to sporadic burnings in Derbyshire, England. He reported that fire in a plant community causes alterations in the chemical status of the community and in the availability of nutrients in the soil: "Substantial losses of nitrogen, phosphorus and potassium occur in the smoke." A 70% N loss, 40-45% K loss, and a 25-40% P loss were reported from monitoring the nutrient content of vegetation at seasonal intervals after fires between 1968 and 1970. "The only nutritional responses to burning detected in the communities are short-lived increase in phosphorus concentration in plant tissues," therefore "the effects of fire in respect of plant nutrition are unimportant in the ecology of the communities relative to damage caused to the plants and alterations in the physical environment" Lloyd concluded.

That burning is an important factor in causing fluctuations in the floristics of some of the plant communities in the Northern Guinea savanna, through causing considerable changes in micro environments, is probable. Shrubs and forbs are however often uprooted, cut or axed down by the farmer. Stems which are used for domestic fuels are extracted before the rest is

spread along the furrows which are the next growing ridges. They are either left to decay in the ridges to be moulded over them, or they are cut. A huge annual conflagration lapping over the savanna in an uncontrolled blazing bonfire under a "slash and burn shifting cultivation" was however hardly observed in my study area. There is, therefore, an element of over-statement in the assertion that "the vast regions of savanna that occur in Africa are fire climaxes" (Nye and Greenland, 1960).

The hoe is sized and shaped differently for from light hoeing to heavy cultivation (Plate 5). The nature of the land and the types of crop for which it is designed determines the differences in ridging and furrowing which is part of every 'normal' cultivation in the area. Ridges are low and furrows are shallow on upland plains designed for shallow rooting crops: Sorghum, Pennisetum, Arachis, Vigna, Capsicum, etc. (Plates 12, 15, 16). Ridges on alluvial fadama and moist uplands designed for tuberous crops (Discorea, Colocassia) and for hydrophytic crops (Oryza, Saccharium) are higher and bigger with deeper furros (Plates 13, 14). Hoe sizes increase from upland friable soils to fadama heavy soils (Plate 5).

Norman (1968) had pointed out the prevalence of intercropping in the zone, and has suggested the reasons for it: "Mixed cropping or inter-cropping in which two or more crops are grown together in the same farm and in the same season is the common practice of the smallholder farmer." Inter-cropping was found in 81% of farms in the Northern Guinea savanna around Zaria, and the possible reasons, according to Norman (1968) are: Intercropping is an implicit within year type of rotation; it is an insurance policy against fluctuations in security; and it is a method of meeting the limiting factors of production: land, labour, capital and management (see my Plates 13 and 14 and the associated descriptions).

Ramsay (1968) quoted figures purporting to be the arithmetical proportion of land surface area of the savanna shared by each land use type:

1.	Uncultivated bush	45.8%
2.	Non-reserved forest	31.2%
3.	Bush fallow	9.3%
4.	Agricultural land under crops	6.8%
5.	Land under tree crops	0.0%

Ramsay's land use terminologies are in themselves undefined and are confusing, and I consider the figures relating to agricultural land under crop highly improbable. According to Ramsay, "the main agricultural system of the country is still of the peasant subsistence farming based on shifting cultivation". However, I maintain that the country's agricultural system is based on the "rotational fallow system" suggested by Morgan (1969). Thus 'bush fallow' and 'agricultural land under crops' are both arable lands. Ramsay and de Leeuw (1964) reported that their "survey was carried out in the dry season ...." In the dry season, farmers who depend on rain-fed crops on uplands had harvested their crops and would have gone into subsidiary dry season occupations. This practice would produce the temporary 'bush fallow' and the appearance of 'uncultivated bush' during the post-harvest dry season.

The implications of my suggestion mean that 61.9% of the Nigerian Guinea savanna can be described as agricultural lands (with or without standing crops), which is more convincing to me in the light of my seven years of touring experience in the Northern Guinea savanna as a field ecologist. It may be asked "When does bush become cultivated?" There is no easy answer because many features need consideration, jointly, or in isolation. My approach is described under my "Categories of environmental factors evaluated".

The 31.2% 'non-reserved forest' constitutes the primary grazing grounds and forms the source from which firewood hewers and collectors of natural

plant amenities derive their needs for the domestic and commercial purposes. But the forest reserves deserve special explanations and ecological investigations as a major and expanding form of land use.

3.4 FORESTRY LAND USE IN THE 'SAVANNA'

British occupation was established over northern Nigeria under Lord Lugard in 1900 according to Niven (1950), and a Forestry Department was established in the Nigerian savanna in 1903. The citations of forest reserves whose boundaries were described and gazetted started.

Lely (1925) described in detail 120 commercially valuable and exploitable trees from the zone. The actual plant communities were, however, either "forests or "inferior bushlands" which "though divisible into types, were so blended that the differences were unrecognizable".

But Ojo (1973) suggested that "the need for exotics is greater in Nigeria than in any other countries" and pointed out that "the trend is from natural forests to plantations of exotics because the indigenous forests lack uniformity in size and quality and contain few trees of economic value per unit area". Ojo (1973) identified four reasons for "the need for exotics":

1. "because the indigenous forests lack uniformity in size and quality of trees and contain few trees of economic value per unit area";
2. "introducing exotics enriches the local flora";
3. "all the important exotics in Nigeria show the quality of resistance to disease and other unfavourable, environmental factors";
4. "Superior growth rate and production has been the chief incentive for planting exotics in preference to indigenous species".

These are largely fallacies from an ecological viewpoint (Plates 38 to 44).

According to the Forestry Divisions at National and State-divisional

levels, "indigenous trees are either "notoriously slow in their growth rates" (Forestry, Lagos 1962-1968), or they have "crooked shapes" and so they are "worthless as timber, pole or protective trees" (Mohamed 1978). Therefore, both the National and divisional levels decided that "exotic species which provide more rapid growth, suitable wood for specific purposes, would be established". Lagos (1965) for example stated that "the estimated cost in this programme for the year is £7,500". By 1978, a grand total of N17,166,111 (approximately £13,732,888) was recommended for an "Arid Zone Afforestation Project Proposal" in the Report of the National Committee on Arid Zone Afforestation (Abdullahi, et al (1978). There are two forms of forest reserves in the zone subsequently: the 'superior', deliberately introduced exotic tree species rigorously established in cultivated habitats or plantations, and which cannot establish themselves in the wild in spite of their privileged intensive care. 119 alien species have been officially recorded as having been propagated and perpetuated into quasi-naturalised plantations in the savanna (Mohammed 1978, personal comm.). Accidental or privately introduced exotic herbaceous ornamental flowering herbs, not included, have actually established themselves in the wild (e.g. Catharanthus roseus, Coreopsis tinctoria, Zinnia sp.) as imported weeds. The propagation and perpetuation of the apparently superior exotic species (e.g. Eucalyptus spp., Gmelina arborea, Azadirachta indica, Cassia spp., Tectona grandis, Pinus caribaea, Callitris spp., etc.) into woodlands start from centrally irrigated nurseries in polypots where special seed selections lead to special selection of seedlings. The land clearing on the field is done either by labour-intensive hand work or by mechanical tractors, using 'contractors' to remove stumps of all potentially competitive plants from deep depths. The plants are established in the field at the time they should receive the maximum benefit of the rains in their first critical season of growth. Maintenance continues with thorough harrowing to keep the

ground completely clean and cultivated; fertilizer is applied round each tree, particularly superphosphate and borate.

The second type of forest reserves, the 'inferior' indigenous type, have none of the superiority artificially imposed upon them, but they have been gazetted and their boundaries drawn. They grow without management under perpetual disturbances on land not considered suitable for agriculture. They form the major sites for firewood fetching and are the pastoralists' main grazing grounds, as well as the sites for composite uses.

The Forestry Department is apparently solely concerned with the exploitation rather than investigating the reserves. Any student of ecology recognises that a single or multiple change, such as the introduction of exotic species, could trigger off negative or positive reactions in the rest of the floristics in the environment. The possible impacts of these alien species on the Guinea savanna zone receive their first known holistic floristic surveys, analyses and their interpretative implications in this thesis.

Attention has so far been directed mainly towards a subjective physiognomic classification of tree communities. My use of an intensive investigation of the herbaceous component of the flora is likely to result in a more reliable description and sub-division of the 'Nigerian Guinea savanna' than has formerly been available.

Clayton (1957) has summarised the fact from his large-scale and intensive knowledge of the Nigerian Guinea savanna vegetation that "most of the Nigerian vegetation are seral communities, not easily amenable to the remote sensing techniques by aerial photograph interpretations". He concluded that "It remains to be seen whether some rational scheme of classification can be evolved for this very diffuse nodum". It is my belief that field surveys on the ground, sampling and identifying the floristics in diverse land use areas, including vegetation in superficially

unused states, as well as vegetation in weedy man-made successional stages, coupled with the quantitative assessment of the associated environmental factors, and with the application of the now available appropriate objective floristic and environmental analytic techniques, will provide far reaching results in the clarification of the "very diffuse nodum".

A legitimate criticism could be that I am undertaking an over-ambitious study for my thesis. However, a synecological study often requires a holistic integrative approach. Land use studies also require extensive studies as Clark (1977) pointed out that "the student of ecological land use finds himself compelled, whether he likes it or not, to assemble information from diverse fields ....". Dobbs (1969) also believed and stated that "there are types of ecologists who deal with tiny aspects of ecosystems of few controlled factors from which confident assertions are made (but) it requires extensive field studies to deal with the infinitely complex world outside the laboratory and to make suggestions in terms of an environment, taking into consideration the multiple factors in operation". Salisbury (1959) similarly stated that "Often in the past it has been found convenient to consider the habitat factors in separate categories, the historic, the climatic, the edaphic and the biotic", and warned that "there is an inevitable danger in such abstraction that we underrate the degree to which these interact to effect their influences on plant life".

In the case of the 'Northern Guinea savanna' of Nigeria, it has been believed that "the detailed descriptions obtained in Europe require too much skill and too much time to be suitable for Nigerian conditions" (Clayton, 1957). Therefore, crude simple, sub-standard techniques of studying the flora-environment inter-relationships have largely appeared unrectified. Clayton's supposition requires upholding or refuting. This, in my view, can only be done by a seemingly over-ambitious concurrent study

CHAPTER 4
ANALYSES OF THE NIGERIAN 'NORTHERN GUINEA SAVANNA' PLANT COMMUNITIES

There have been few attempts to apply objective numerical analytic techniques of either ordination and/or classification to the interpretation of the Nigerian savanna flora distribution, and the plant communities therein, though the northern three-fourths of the Nigerian land area are considered as a 'savanna'.

Plant ecological work has been concerned with attempts to develop vegetation physiognomy as a tool in land classification. Physiognomy is surveyed in conjunction with the main tree species and is subjectively analysed in association with field soil surveys, using aerial photographic interpretations as a remote sensing technique to suggest which soil groups carry the densest vegetation and are of the greatest significance to growing plants. This, of course, is not surprising when one considers the vast area involved and the small number of often temporarily resident ecologists working there.

Partly due to the difficulty of identifying herbaceous-graminoid ground flora during the dry season (since the dry season is also the field survey season because of the problem of accessibility during the rainy season) and partly due to the periodicity and the great variability exhibited by the ground layer flora, practically any serious analysis had been concerned with trees. The consequences of biotic pressures through agriculture, tree felling, grazing pressures, and tree plantings all of which tend to be associated with seral plant communities in response to the dynamics of temporal vegetational changes have not been appreciated or subjected to distributional analysis.

In the "Classification and Ordination of Nigerian savanna vegetation" by Kershaw (1968a and b), based on his data from a vegetation survey in Zaria Province, his concept of the Nigerian savanna vegetation was the unmanaged wildland in forest reserves and vegetation expanses least disturbed by land

use, at least superficially. These were, for example, located in "rocky areas on sites which were irregular, steep, stony or too shallow for arable farming". The same seemingly 'true' savanna formed the basis of the numerical analysis by Ramsay and de Leeuw (1965). Lawson, Jenik and Armstrong-Mensah (1968) also made their Ghanaian Guinea savanna vegetation analysis in "Mole Game Reserve" which they said "represent a relatively well-preserved area of Guinea savanna in Ghana".

Keay, the architect of the "Northern Guinea savanna zone" concept in Nigeria illustrated "how the diverse communities within one area of one of the vegetation zones are arranged in a catenary mosaic, in order to integrate the concepts of catena and vegetation zone" within the "constitutionally reserved Anara Forest between Zaria and Kaduna" (Keay 1960).

Considering that the Northern Guinea savanna zone, as originally delineated from the other Nigerian vegetation zones with isohyet lines by Keay (1959) includes all types of vegetation, natural or man-made, with or without trees, shrublands, woodlands, grass- or herb-lands on any habitat (swampy, rocky, gully, or plain site) the subsequent subjectively chosen wooded-wildlands by every worker investigating the savanna are hardly representative of the climatic regional vegetation zone which the Northern Guinea savanna really means. The records and analyses therefore only represent localised aspects of the vegetational variation imagined to be nearest to the climax Northern Guinea savanna vegetation, rather than an unbiased random sample of the zone on its regional scale.

Keay (1949b) investigated the cornerstone ecological "example of Sudan savanna zone vegetation in Nigeria" from Zamfara Forest Reserve where it was noticed by visual observation and by the intuitive mental process of recognising character-species, that "several distinct communities are at once evident, but there is no obvious correlation between vegetation and topography except on rocky slopes and water courses". Yet the conclusion

reached in that instance was that "the concepts of the association-segregates (plant communities) and topographic catena proved valuable in the interpretation of this bewildering vegetation". Such an assignment of a common cause to several subjectively recognised distinct communities, suggests a need for a more accurate floristic description and numerical analytic comparison. For, apparently the 'bewilderment' was got round by a subjective arrangement of the vegetation dominants into "association segregates" on either "main or tributary catanae" because as pointed out "it appeared to be comparable to the association-segregation of the forests of North America by Braun (1935)" and "the importance of micro-relief in determining the mosaic arrangements of soil types and plant communities in African savanna has been emphasised by Morrison, Hoyle and Hope-Simpson (1948)".

Again, Keay (1960) re-demonstrated the marriage between "diverse communities and catenary mosaic" in the Anara Forest Reserve of his Northern Guinea savanna. A wedlock was suggested with the conclusion that "the paper shows how the diverse communities are arranged in a catenary mosaic and how they are affected by fires and native farming, and so integrates the concept of catena and vegetation zone".

Fire or 'native' farming should probably be regarded as ecological factors in themselves and an objective numerical analysis would probably indicate that the seral communities on habitats affected by decisively intensive or non-intensive sporadic land use practices, including agriculture, afforestation and grazing, are to be jointly considered in the interpretation of the floristic distributional studies in the Guinea savanna zone.

Contrary to the notion of causal factors culminating in a constant catenary explanation of all plant communities, Bird (1957) demonstrated instances in which the composition of vegetation provided a sequence which

reflected "local soil catenas" from a study of an Hertfordshire woodland. Bird also pointed out in other cases that "relationships between the composition of the vegetation shows little relation to the soil catena because of structural variations due to human interference", which he named coppicing, silvicultural treatment, long abandoned clearing, illumination, recolonisation and natural regeneration communities.

The concept of the soil catena was suggested by Milne (1935, 1947) in East Africa for soil survey classification and mapping to mean "a sequence of soil types repeated in similar sites, or topographic situations, within a region". Although Milne (1947) illustrated examples with soils and vegetation under "natural or semi-natural conditions" and could show some sequential changes reflecting the soil catena on soils occurring on similar parent material, he also saw other changes in vegetation which "bear no relation to soil catena" and followed with alternative investigations for other causes or factors, particularly biotic. The adoption of the concept of "tropical soil-vegetation catena and mosaics" was only an "impression based on ideas gradually developed with the experience acquired on African journeys" (Morrison et al 1948). While the catenation or seriation idea may partly explain undisturbed physiognomic distribution, they obviously do not wholly solve the problem of plant communities based primarily on species composition and those which are mainly in successional series as it is the situation in the Nigerian Guinea savanna, in my view.

That soil catenas are also linked with drainage, nature of underlying rock materials, or their joint effects, each of which may differentially or collectively influence plant community patterns may be inferred from the three forms of soil catenae postulated by Clarke (1954), viz:

"simple or drainage catena on regions of uniform rock material where variation of soil are related to surface topography and drainage conditions of soil";

"geological catena in regions of varied parent rock material with soil types related to geological outcrops"; and
"mixed catena in which soils are partly related to topography and partly to geological features".

It is apparent, therefore, that differences in plant distribution in the Northern Guinea savanna in relationship with the catenary or topo-sequential arrangements of soils will change in species composition under the variations of simple drainage, as a result of the effect of the degree of slope on which they were formed, but also with the geology on which the soil minerals are dependent as well as the host of soil properties (soil organic matter, soil porosity, soil reaction, soil texture) resulting in soil variants whose properties are in a 'mixed up' state.

Keay's usage of the catena was limited to the "simple or drainage" catena of Clarke (1954). The method was to decide what seemed the most rational concept which had some reasonable hope of being on the right lines (because Braun (1935) or Morrison et al (1948) elsewhere believed it was so).

Several highly correlated vegetation stands were supposedly effectively measuring the same source of variation (the simple catena) in both the Sudan savanna and the Northern Guinea savanna, obviously because of the bias to the classification of chosen sample areas based on the idea of the vegetation as it could have been under a climax. Samples were collected in "discrete vegetation units by reference to the dominant species, physiognomy and directly observable site factors because it appeared to be generally satisfactory" (Keay 1960). Analyses were alternatively subjectively based on either "distinctive physiognomy" or on "segregation of dominant species". The vegetation sample units were then forced together and forced apart into subjective communities by the a priori decision-making factor.

Fundamentally Keay's methods were geared to provide a realistic frame of reference within which the vegetation of his isoyhet delineated large geographical zones can be adequately described. The poet, Robert Frost (1934) wrote: "There are roughly zones":

> "..... That though there is no fixed line between wrong and right,
> There are roughly zones whose laws must be obeyed ...."

While samples of vegetation over a geographically wide range of latitudinal/ climatic locations may be dissimilar enough to be cut into arbitrary rough zones on the hypothesis that sites found in close proximity and under similar rainfall duration and rainfall intensity are more likely to be floristically and physiognomically similar than those on widely separated localities, introduced exotic, as well as many native species growing in the Nigerian Northern Guinea savanna indicate the species within the zones are capable of existing beyond their 'normal' distributional zones. Many environmental factors thus cause quantitative floristic distributional changes in the geographic climatically-determined rough zone.

However, the field observation and measurements which represent the possible factors affecting plant distribution, as Gittins (1969) states "is very large and the initial problem is to identify those factors which are most likely to be of overriding importance in determining the occurrence of species and kinds of vegetation". Tansley (1935) proposed "autogenic" and "allogenic" factors for two major sets of spatial distributional factors of plants. "Autogenic" are those "brought about by action of the plants themselves on the habitat"; while "allogenic" are those species distributions "brought about by external factors". Goodall (1978) suggested that "species may be positively associated because one is dependent on the other or because they are similarly affected by some third factor in the abiotic inanimate environment", or that "they may be negatively associated through mere spatial exclusion through competition, or allelopathic effects, or through differing environmental requirements".

In the "acid test" view suggested by Anderson (1965) "Plant communities may form assemblages of species separated by sharp boundaries depending on the operative determinants, their uniqueness or their continua in the environment. It may not be the qualitative presence and absence of a factor which controls plant distribution, but the quality, duration, scale, and intensity of environmental selective processes are important in determining the ultimate structure of vegetation".

Kershaw (1968) referred to "the Northern Guinea savanna of Nigeria" as representing "a situation where there is no knowledge of the affinities of the various vegetational fragments". But I think he was wrong. My childhood pleasures and youthful adventures found their expressions in climbing the hills and descending the valleys around my home to accumulate an exact knowledge of where and when to prospect for the free uncultivated edible plants in my environment in the Nigerian Northern Guinea savanna. Besides, uninhabited savanna had always been my resort for recreational observations, like most inhabitants therein. My botanical training culminating in my present ecological professional life is only a cumulative personal evolutionary trend of refining intrinsic interests and abilities by quantitative analytic scientific studies of the affinities of those various vegetational fragments.

Nevertheless, objective analytic knowledge of the plant-environment interrelationships are extremely scanty as Kershaw (1968) appeared to wish to point out, though there is an abundance of intuitive knowledge of the environment and the associated plants among the inhabitants. Ordination and classification of the plant distribution are here both employed to explore these plant-environment interrelationships, to locate the possible generalizations which may be made. Neither ordination nor classification is therefore the end in itself, as used here.

The aims of the study are to quantitatively survey the existing

variations in the floristic vegetation cover over the different edaphic and major land use strata in the Nigerian Northern Guinea savanna environments; to analyse and identify the existing plant communities through a floristically defined method; to interpret the orders or trends of the plant communities in terms of the quantitative attributes of their edaphic and land use factors or in terms of the intensities of the other major causal ecological factors in operation.

4.1 A REVIEW OF PREVIOUS NUMERICAL FLORISTIC COMPOSITIONAL COMMUNITY ANALYSES IN THE 'NORTHERN GUINEA SAVANNA'

In order to obtain the greatest possible precision about the vegetation distribution, it is perhaps necessary to base classification of vegetation upon the floristic composition of plant communities. Broadly the main schools of thought on this subject differ.

The Clementsian (American) School places emphasis upon climax communities and the role of the dominant species in the community. "Plant succession, the phenomenon in which a series of invasions occur in the same spot", according to Clements (1905) "is a directional orderly and predictable process of plant community development involving transitory changes in species structure and composition". "This process," he pointed out, "is of universal occurrence which begins with nudation brought about by production of virgin habitats or by destruction of pre-existing formation, and ends in stabilization". The monoclimax concept implies that any habitat in a given region, given enough time, will ultimately support a community which is representative of the regional vegetation, because "successional trends converge toward a similar end with regards to physiognomy and recurrence of the same genera of dominant species" within a community (Oosting 1956).

Emphasis has been placed upon the dominant species and the successional status in special habitats whose vegetation is uniquely defined by a single dominant, such as in the beechwoods and bracken communities by Watt (1934 and 1947) in Britain. The objections to the approach of identifying communities in terms of dominant species in the Northern Guinea 'savanna' is that single-species dominance and climax communities are very rare, except in artificial vegetations like in forestry plantations. It is not easily adaptable because the vegetation often has more than two or more equally abundant species in the same habitat. Besides, the 'Nigerian Guinea savanna' vegetation is largely semi-natural as a result of past and present biotic influences. A pre-occupation with climax communities could therefore involve seeking for flora communities which cannot be readily identified on the field. It is therefore considered preferable to base the classification of communities upon the visible floristic composition of the vegetation. And thus though Clements' concepts are of fundamental importance, the methodology is perhaps not practical in the 'Nigerian Guinea savanna'.

The Continental School of Braun-Blanquent (1932) based community delimitations entirely upon the floristic composition of sample quadrats (relevé) studied. Using their methodology, "objective" communities are derived by the affinities of the quadrats examined on the field. However, in order to be able to make a consistently objective reliable comparison between communities and to unify results of floristic estimates from surveys made several months and several kilometers apart, an elaborate scheme of classification and ordination are now commonly used to provide the objectivity which is not otherwise possible from personal judgement.

In addition to climate, Keay (1960) illustrated by means of physio-graphic with physiognomic profile diagrams and species enumerations from Anara Forest Reserve that the Northern Guinea sub-savanna zone can be

organised into "diverse communities" related to "catenary mosaics". Lawson et al (1968) also saw three types of broad communities in relationship with catena in the Ghanaian Mole Game Reserve, viz: "upper slope savanna" and "riverian savanna woodland" which "differed markedly in structure and species composition from the prevailing savanna type on gentle slopes". They also stated that "middle slope savanna showed a similarity in tree numbers, species composition, density, and basal area of trees, suggesting an equilibrium of vegetation and environment".

The classification procedure by Lawson et al was based on the chi square (X^2) tests of homogeneity. The chi-square technique is "incapable of indicating interrelationships among a set of samples representing more than one underlying factor, and its sorting is based on an arbitrary judgement" (Kershaw 1968a).

The delineated Keay's 'Northern Guinea savanna' of Nigeria was used by Kershaw (1968a, 1968b) as a basis for a numerical classification and ordination of the woody vegetation/environment relations. The results indicate a complexity of vegetation variation that was explained by factors other than climate. Kershaw (1968a) made his numerical classification of floristic groups or associations based on differences and/or similarities between floristic samples, using the 'normal' analysis methods of William and Lambert (1959, 1960, 1961) in which the maximum X^2 makes a subdivision of quadrats by the qualitative presence or absence of each species. Eighteen associations were sorted out from the 'Northern Guinea savanna' based on floristic similarities between points. The floristic affinities were interpreted as "broadly correlating with their topographical and geographical location" (Kershaw 1968a). His analysis with recourse to principal component plot ordination "showed that the first three axes were identified with low/high water availability, presence/absence of fossil ironstone cuirass material, and northern/southern trend respectively"

(Kershaw 1968b). These are the two cases known to me in which the application of multivariate numerical classification or classification with ordination were made specifically on the 'Northern Guinea savanna' for the purpose of identifying the floristic communities and to relate them with the environment. Many descriptions of the same area and aspects of the vegetation, without the numerical tests, are however common.

The great differences between the number of communities arrived at by Lawson et al (1968) in relationship with catena, compared with the eighteen separate communities identified by Kershaw (1968a) in the 'Northern Guinea savanna zone' appear to suggest that further investigations and analyses by different techniques are necessary. While the three communities identified by Lawson et al might represent a case of an under-division, as the authors suggested ("Some finer way of classification to cover the numerous variants occurring along the catenas will be necessary"), the divisive monothetic classification method used by Kershaw (1968a) is also known for tending to make an over-division of floristic data.

Besides, although the data for Kershaw's subdivision of plots were originally in the form of Domin abundance values, the use of association analysis automatically converts the data into qualitative presence and absence data before associating all the possible pairs of quadrats into a dichotomous hierarchy of groups characterised by the presence or absence of particular species. Greig-Smith, Austin and Whitmore (1967) used the technique to subdivide their sets of data on tropical rainforest and pointed out that "a feature is the extreme fragmentation". Noy-Meir et al (1970) pointed out that "association analysis is likely to be much more satisfactory as a classification procedure in species-rich vegetation", and even there, "like other monothetic procedures, the risk of mis-classification is considerable if the criterion species happens to be absent by chance".

Osanoto (1975) made a normal association analysis of seventy-six quadrats representing the floral data sample of the Aber Valley, Wales, much of which were special habitats with visually discernible habitat differences fairly uniquely defined by a number of main species, for they had been shaped by past land use, soil differences, topography and sub-terranean water level and were specially preserved for scientific studies and for its recreational values. An association analysis was expected to work best under such near-single-species dominated communities but it was found to "make an over-division of the floristic data matrix more than knowledge and information on the environment could account for". The end groups separated species with similar distributional patterns on similar habitats from dissimilar samples, such as the Alnus glutinosa swamp woodland from the Pteridium aquilinum fernland on the middle slopes of the mountain. It also separated the dry ericoid health from the Juncus swamp and flush sedges and from the pastures. However, with the riparian deciduous forest, mixed woodlands and stands not uniquely defined by a single dominant, the normal association analysis displayed grave weaknesses. The end groups from the monothetic divisions resulted in seventeen communities, some of which were considered totally indefensible because they were made up of as few as one, two, or three quadrats. In that instance, eight final communities were re-organised from the seventy-six samples following a re-analysis with the Reciprocal Averaging method of Ordination designed by Hill (1973).

Also, Goldsmith and Harrison (1976) believed that "association analysis may lead to mis-classification and over-simplification, because it is highly dependent upon the vagaries of a sampling design using qualitative (presence and absence) information".

Pielou (1975) used the term 'community' in terms of "pattern of species abundance as summarised by the vector of ordered relative abundances" since

"typically a community will consist of a small number of abundant species and a much larger number of moderately common and rare species" because "within a general distributional form, communities have characteristically different patterns of species abundances". Kempton (1979) also pointed out the importance of floristic analysis by quantitative values, instead of the qualitative (presence and absence) values, of species: "An aspect of community structure which has excited particular interest is concerned with the pattern of abundances of all species in the community" and "the structure of species abundance at a site may provide a better characterization of the environment than the list of named species in multi-species populations".

4.2 LITERATURE REVIEW OF THE APPROACHES TO THE PLANT COMMUNITY

The views about what constitute a plant community are probably both historic and diverse. Classification of plant communities is perhaps a tradition as Poore (1962) suggested, that "since the beginning of scientific interest in vegetation and the nature of plant communities, the majority of botanists have recognised discrete units of vegetation which they combine to form classes". Goodall (1963), however, made a counter-suggestion that "the widespread recognition does not validate the hypothesis of vegetational units any more than the once general acceptance of a flat earth proved that it was flat".

The disputes and confusions implied were, however, perhaps due to the concrete or abstract senses which the term plant community represents to different ecologists. The difficulties associated with the classification of plant distribution patterns into definite communities have been variously stated by proponents of ordination or "analysts of data taken from gradients

such as elevation, topographic-moisture, and successional factors (Robertson 1978).

According to Curtis (1959) "the stands of a community or large vegetational unit are not segregated into discrete and objectively discernible units but rather form a continuously varying series". Goodall (1954) pointed out that "no communities are strictly identical but exhibit continuous variation in detailed composition and therefore cannot be readily delimited as clear-cut units". McIntosh (1958) similarly concluded that "because vegetation changes continuously it cannot be differentiated, except arbitrarily, into sociological entities or plant communities".

Curtis (1955b) observed that "within the prairie proper there is a continuously changing series of species from those best adapted to deep mesic soil to those adapted to very dry conditions as brought about by very thin soils over bedrock". Curtis suggested that "topographic types are not themselves discrete but rather grade into one another" and the mixtures of plants are likewise not definite communities in discrete definite uniform habits.

Whittaker (1956) aligned vegetation sample plots along a linear gradient structure along the altitudinal and moisture gradients of the Great Smoky Mountains, from which quantitative floristic data were collected and analysed. Whittaker pointed out that "no clusters of species curves were found" and so species populations form a "complex and largely continuous pattern or a gradient". These views derive from the pioneer work of Gleason (1926) for long ignored because it conflicts so fundamentally with the views of Clements and his followers.

Classification into plant communities was linked with the distinct and discrete community-type vegetation concept, ordination with the continuum concept; and they were considered unreconcilable views by the

proponents and opponents of either the premises of ordination or classification. Major (1961), for example, considered classification the only appropriate way of representing plant distribution. Major's opinion was that "no compromise, bridge or amalgamation between the opposing views is apparent". Poore (1964) did not accept the continuum theory of plant distribution because "the field ecologist finds it compelling to approximate classes on combination of species which occur and occur again". Webb (1954) objected because "some system of typification and recognition of plant communities is an essential preliminary to a properly based science of vegetation".

Conversely, opponents of community types as distinct assemblages of species separate from other plant communities stressed the concept of the continuous gradation of communities through the landscape. They maintained that plant communities can only be arranged into trends, gradients, or orders along environmental factors. Thus Goodall (1954b) stated that "absolute homogeneity is unknown to vegetation". And Whittaker (1956) saw the environment as a "complex-gradient comprising gradients of many environmental factors or characteristics of environmental complexes that change together in space", and "analysis should be based on arrangement or ordination of samples in relation to the complex gradients or along axes of variation in composition of samples".

Austin (1971) suggested that the gradient approach suffers from "circularity of methodology and conclusion" and objected to the "linearity of vegetational gradients based on quadrat scores derived from estimates of species in response to subjectively estimated environmental gradients which are simple to measure". Robertson (1978) suggested that "in those instances, floral relationships between environmental variables and linear gradient structures must be successful because they were special cases where there were no discontinuities in the physical environment".

Grigal and Goldstein (1971) suggested that the "applications of both ordination and classification techniques to community data are examples of analytic modelling, the objective of which is to relate community structure to environmental influences" and recommended that they should go together.

Krajina (1961) suggested that "every science has a classification of its subjects of research and without classification (into plant communities) there can be no science of vegetation", and so "a continuum should not displace classification". And Daubenmire (1966) pointed out that "though the continuity of vegetation is admitted, there must be a framework for organising, storing and retrieving information".

Classes of vegetation therefore tend to be ordinated and continuities of plant communities with one another are being classified using samples of the occurrence in the field of species combinations from place to place. However, the proofs of the continuity of plant distribution have come mainly from undisturbed environmental gradients and where the continuity is not interrupted by land use disturbance or abrupt environmental change as Whittaker (1973) suggested: "Undisturbed communities are in general more likely continuous than disturbed ones." Goldsmith and Harrison (1976) also pointed out that "an ordination gives most satisfactory results where one or two environmental gradients have marked overall control of vegetational variation so that vegetation samples or species are arranged along axes characterised by these controlling environmental factors".

The coupling of the community classification approach with an ordination procedure is therefore considered expedient for the investigation of the mixture of the floristic continuities and discontinuities in the cerado or 'Guinea savanna' field of Nigeria in view of observable differences in the combinations of species from place to place which appear to reflect edaphic differences and differential uses of land. The exclusive analysis of plant distribution by either ordination or classification alone because

the former relates to 'continuum' and the latter to 'discrete communities' according to Egler (1962) "were extreme views concerning plant distribution" and were "basically different personality types drawn from a student body because of inherent prejudices".

It is therefore the current practice to make concurrent analyses by both ordination and classification for mutual elucidations concerning the nature of vegetation distribution in relation with the factors of the environment. Anderson (1965) suggested that "the acid test of any methodology rests on the extent to which it assists us to understand more meaningfully the ecological complexity of the biosphere (and) and the value of classification and ordination lies in their use as tools in helping to provide useful information for a particular situation; they are tools of convenience and both approaches can be, and indeed are, appropriate in certain circumstances". Whittaker (1978) suggested that "these approaches may be regarded as mutually complementary and are serving different needs rather than antagonistic and can be combined in various ways for the most effective study and interpretation of plant communities and their relation to environment". Noy-Meir and Whittaker (1978) pointed out that "there seems to be a trend of departure from the desire for an all-purpose technique of continuous multivariate analysis towards acceptance of the two groups of specialised techniques that may serve both approaches to ordering community data; ordination and classification".

"Plant communities" according to Whittaker, "are complexes of synthetic floristic aggregates now derived by numerical analytic comparisons of a large number of floristic descriptions of samples described from a geographical area, with emphasis on the determination of the character-species which more or less exhibit selective preferences for particular ranges of environment"; and "vegetation is largely spontaneous and fluctuating with respect to the selective preference of species for particular communities".

Whittaker (1956) thus pointed out that "plant societies are variable unstable combinations of species which can be grouped only conditionally into associations by analyses of the combinations and correlations among plants". Conversely, non-numerical classification into plant communities by visual inspection and subjective synthesis of quadrats into defined, discrete, recognisable, repetitive classes", according to Whittaker (1973), "are influenced by what the classifier thinks is most important and interesting about these communities" followed by "intentional definition of community-types".

It is suggested that "both the traditional phytosociological methods and the numerical methods have much in common" (Goldsmith and Harrison 1976), however I think numerical methods may make the interpretation of the observations more objective, less misleading, more explicit, consistent and unified. Ivimey-Cook and Proctor (1966), for example, believed that "association-analysis is of value in examining the consistency of evidence and conclusions in phytosociology and in detecting directions of variation overlooked by traditional methods", and "it provided a powerful tool for the detection of faithful and differential species". However, I think, Ivimey-Cook and Proctor carried the praise of association analysis too far bearing in mind my references to Greig-Smith et al (1967), Noy-Meir et al (1970), Osanoto (1975), and Goldsmith and Harrison (1976).

"The detection of directions of variation" attributed to association analysis implies some linear ranking of floristic values from one or more extremes to other extremes. Such sequencing of quadrats as "from the dry to the wet habitats" was called a "uni-dimensional ordination" by Mueller-Dombois and Ellenberg (1974). It does not, however, follow that the resulting associated quadrats from the monothetic divisive association analysis technique, or even from an agglomerative classification, is the order of groups that would come out in an ordination. Greig-Smith stated

forming a "mosaic of plant communities on a mosaic of habitats" Daubenmire (1968). Aggregates of plants whose composition are fairly reliable indicators of farming, rock types or periodic swamping in the environment may be scattered in different areas of the field within the cerado ('savanna') and still belong to the same community by virtue of their floristic similarities. Thus, Daubenmire (1968) pointed out that the term community may be used for "any assemblage of organisms, large or small, whether continuous or detached" on the landscape.

Westhoff and Maaral (1978) viewed "vegetation" as "a system of largely spontaneously growing plant populations, growing in coherence with their sites". And Daubenmire saw flora assemblages jointly promoted or jointly inhibited by the same environmental factors as belonging to the same community: "Species jointly tolerating the same rigorous habitat selection that denies opportunity to all but a relatively few of the great variety of species which can reach the habitat as disseminules belong to the same plant community", consequently, "the more heterogeneous the environment of an area, the more numerous are the kinds of plant communities it embraces".

Daubenmire's definition above, requiring physiological tests of the promotory and inhibitory effects of habitats on species, can hardly form a basis of a synecological study because of the large number of species involved in communities. But an acceptable synecological qualification of a plant community was suggested: "A plant community is a product of the environment and it is characterised by a few relatively abundant combinations of diagnostic species which are peculiar to the community and are unrepresented or are inconspicuous in other communities" (Daubenmire 1968).

The Braun-Blanquent definitions involving the "constant" species, "companion" species and "relatively characteristic" species perhaps

represents the practical position that recognises the continuities and relative discontinuities of species distributions in the field. It makes interpretations of communities in terms of possible environmental continua possible through using classification procedures as sorting techniques which create communities of similar sample quadrats defined by the possession of some species, or partition several quadrats in terms of one or more species in order to identify relatively homogeneous similar quadrats. Braun-Blanquent (1932) suggested that though the individual species react individually to variations within the same "association", some of the species making up the association have high "fidelity", high "sociability", high "vitality" within the association while other species are low in the qualities and in their quantities within the same association.

Thus Braun-Blanquent defined associations from 'diagnostic', 'constant', 'character', and 'differential' species as: "An association is a plant community with certain constants and a certain physiognomy" and that "a plant community is characterised by definite floristic and sociological features which shows a certain independence by the presence of character species which could be exclusive, selective, or preferential".

Drees (1949) made a similar community definition by character-species-combinations, viz: "A plant community is identified by its characteristic taxon combination, including one or more character-taxa or differentiating taxa"; where "character-species" are those "relatively restricted to the stands or samples of a given phytocoenon and therefore characterise it and indicate its environment".

Braun-Blanquent (1932) suggested that species react together to changes in the ecological factors so that "associations" are formed "through the groupings of species having narrow ecological amplitudes and more or less strict adaptation to given habitats". It is also emphasised that where

possible a group of character-species having relatively narrow distributions together are better for the characterization of a plant community and the environment which they indicate.

These analyses to identify the plant communities in the 'Nigerian Guinea savanna' are based on the ideas that:

1. Plant communities are types of vegetation stands, continuous or discontinuous, recognised by their floristic compositions. Communities are based on the correlations among the full species compositions of community samples, more than any other characteristics, such as physiognomy, dominant species or microhabit. So "although physiognomic communities can often be partially or wholly derived from aerial photographs" Clayton (1958), my communities are based on the agglomerative classification of floristic composition of numerous quadrats and do not derive from aerial photographs alone.
2. Among the species that make up the floristic composition of a community, some are more sensitive indicators of their habitats in the environment. The analyses seek to make those indicator species and their companion species, the diagnoses of environmental factors.
3. Characteristic, differential, or diagnostic species and their constant companions are used to classify the plant communities.
4. Apart from using floristic samples based on the complete enumeration of the species during field surveys to locate the species with relative restriction to limited habitats, or the "species possessing fidelity" (Braun-Blanquent 1932), it is also suggested that an "analytic scale" should be used for the arrangement of communities in a "sociological progression" that indicate their levels or trends of organisation. (That is, the use of quantitative species scores and ordination are jointly explored together in my plant community investigations.)

My plant communities are therefore defined as representing assemblages of vegetation samples having similarly (but not identically) distributed floral components; occupying continuous or discontinuous sites in the field; characterised by their occupation of areas of similar land use; or sites with similar physico-chemical edaphic properties; or sharing one or more of the numerous environmental properties capable of being the causal factor(s) of a relatively homogeneous set of floristic samples. When subjected to an objective analysis, members of one community have intra-group positive-definite significant correlations, and they are either negatively correlated with member samples of other communities, or they have semi-definite correlations with them.

4.4 COMMUNITY CLASSIFICATIONS BY CLUSTER ANALYSIS

4.4.1 INTRODUCTION

Subsequent to the association analysis procedure used by Kershaw (1968a) to numerically identify the plant communities in the 'Nigerian Guinea savanna', the results of the application of many computer based methods used in ecological classifications of botanical communities have been subjected to assessments in terms of "their practical utility" (Pritchard and Anderson 1971). The evidences suggest that the association analysis, a monothetic divisive technique, generally leads to over-fragmentation of communities. Community classification by an agglomerative, polythetic procedure, using the quantitative flora values observed on the field, however, have been generally praised as a "procedure for the more or less automatic recognition of communities in vegetation" (Frey and Groenewoud, 1972).

Pritchard and Anderson (1971) suggested that "association analysis is perhaps a useful method for making a first approximation to a community analysis in a little known, superficially complex, tropical environment....

but the interest in phytosociological analyses of plant communities lies in the overall facies of the communities and not in the presence or absence of any particular species". Besides, Pritchard and Anderson noted that "Ordination and cluster analysis are not competing approaches, provided the ecologist is cautious in making inferences, both can reasonably be applied in the examination of multivariate samples".

Each raw data from an ecological survey consists of estimate cover-abundance quantitative values for m observed species on N number of quadrats. They are presented as a table of N rows of quadrats with m columns of species. The amount of data is such that patterns of associations or correlations and causal factors cannot be easily detected. Numerical analysis are to summarise the floristic information in the sample.

The monothetic divisive association-analytic techniques forms 2 x 2 contingency tables for all analysed species pairs based on qualitative presence and absence. Williams and Lambert (1959) recommended omission of data for species occurring infrequently because of limitations of computer sizes. Ivimey-Cook and Proctor (1966) recommended inclusion of all species. Crawford and Wishart (1966) included only those species occurring in at least ten quadrats since "including species with few presence values results in classification of the data into a large number of small groups determined by the most infrequently occurring species". Kershaw (1968a) commented that "association-analysis fragmented the associations into a large number of apparently meaningless groups". According to Pritchard and Anderson (1971) "the so-called Association-Analysis in which communities are defined by the presence or absence of a single species is highly dependent on the vagaries of sampling, and many workers have felt the method may result in botanical over-simplification, so that nowadays polythetic methods are more usually applied". Madgwick and Desrochers (1972) therefore perhaps aptly, concluded that "it is clear the test values (by association analysis)

result in very serious over-classification".

As opposed to the qualitative differentiation of plant communities in which distinction is one of nominal rather than amount of floristic cover (as achieved through monothetic divisive association-analysis) there have been suggestions for a total abandonment of analyses which focus on nominal identifications of communities by named species from the population. Instead, attention should be focused on the overall community, using particularly species abundance which may provide a better characterisation of a community than is obtained by considering named species. Kempton (1979) for example, wrote: "The structure of species abundance at a site may provide a better characterisation of the environment than the list of named species."

Where the quantitative data on species abundance are desirable to the derivation of communities, the association analysis procedure fails. Quantitative floristic cover values may in fact be regarded as redundant for an association analysis as the technique fails to make use of quantities in the data analysed.

Agglomerative classificatory procedures, e.g. by Cluster Analysis, have been particularly favoured by investigators who have cause to believe that the quantitative data on species abundance might be more useful in detecting the directions of floristic variations as well as providing a sorting tool by which the plant communities sharing the same diagnostic or differential species are organised from a matrix of floristic data.

Cluster analysis could be agglomerative in the sense that it "proceeds by successive fusion of quadrats (or species) having the most similar distributional patterns" (Goodall, 1978) as opposed to classification techniques which proceed as successively divisive techniques. It could also be a polythetic procedure in the sense that many species are jointly taken into consideration simultaneously in the agglomeration of communities,

proceeding from single quadrats, considering which other quadrat is most correlated to it, then which third quadrat is most correlated to the two, and thus proceeds to build up a cluster of quadrats around that which was first selected. The quadrats with the highest correlation with one another are thus successively amalgamated into communities.

"Cluster analysis seeks to divide the quadrats (and by inference, the region surveyed, into groups of high internal similarity with respect to the species used" (Pritchard and Anderson, 1971). Araoz, Sarmiento and Monasterio (1971) pointed out that "techniques of clustering are also being increasingly utilized in the resolution of classificatory problems in different fields of biological research" apart from in phytosociological or plant community differentiations from field data matrices".

Hall (1970) was convinced that analysis by cluster analysis was an appropriate "computer-based method for showing continua and communities in ecology where there are records of some parameter of abundance of the species occurring at a set of chosen sample sites in the area under study in spite of an extensive pattern of intergrading zones between communities". In my experience, however, as will be observed in some of my Normal or Q-cluster dendrogram results in conjunction with my ordination of the same sets of data, the "showing" of "continua" ascribed to cluster analysis by Hall should probably not be interpreted too literally. The showing of the overall "continua" (trends) may often require to be rechecked by an ordination method, even with the application of a very effective agglomerative cluster analytic technique such as the technique employed on the sets of my synoptic floristic raw data and refined environmental data matrices here.

The correlation among the quadrats (and quadrat sites) are, however, based on relative abundances in each case. Quadrats with similar environments are thus most likely brought together into relatively compact hierarchical subsets of less diverse members, shown by the linkages in a dendrogram.

4.4.2 THE CLUSTER ANALYTIC TECHNIQUE USED

The Cluster Analytic strategy used in sorting the Nigerian Northern Guinea savanna plant communities from my matrices of quantitative floristic raw distributional data is one of the forms of the revised versions of the "Cluster Analysis" programmed into the Oxford University Computing Libaries by Andrew (1975). The statistics and the calculations for plotting the resulting dendrograms were also outlined by Andrew (1972).

Everitt (1979) has pointed out the fact that "the number of cluster analysis techniques has increased dramatically over the last ten to fifteen years" and that they are being used in "the process of allocating entities to initially undefined classes so that individuals in the same class are, in some sense, similar to one another". It is not my purpose to mingle with the cluster-mathematical experts in the revisions and debates over those existing cluster analytic techniques, nor those being developed. While the discordant views among the cluster-specialists continue, a pragmatic means of objectively assessing the relative partitions of my data matrices into satisfactory ecologically meaningful communities were considered found in the average-linkage hierarchical representation of data sets into cluster dendrograms, based on the formulae for that purpose by Andrew (1975). Neither was a proliferation of classification techniques attempted, but the same procedure formed the unified computational analysis for each set of the separate observations from the different representative areas of the Northern Guinea savanna examined on the field.

4.4.3 THE CLUSTER ANALYTIC PROCEDURES

Given a sample of N quadrats whose similarities are measured by the quantitative values of m species, the objective of Andrew's cluster analysis is "to find to what extent the individuals (quadrats) may be grouped together in g (less than N) relatively distinguishable, homogeneous groups". The clustering process proceeds by scanning the whole data matrix table which may consist of the estimate scores of species per quadrats (the quadrats being assemblages of species with different cover abundance values), or of scores representing various intensities of environmental properties. The relationships between all the possible pairs of individuals to be grouped or partitioned into classes are examined. Subsequently, individuals are clustered into groups because their correlation exceeds some set levels.

The measure of similarity or "estimates of resemblance" employed by Andrew (1972) varies considerably, but in general they are more or less the same with those reviewed by Sokal and Sneath (1963) and Blackith and Reyment (1971). They include the correlation coefficient, squared Euclidean distance, standardised squared Euclidean distance, non-metric coefficients and the information statistic. The general statistical basis is the coefficients of correlation among the quadrats (or items to be clustered) or measures of distance between them. The simple coefficient of correlation between quadrats x and y (I have modified Andrew's symbols in the interest of consistency with the symbols I employed in my ordination formulae but the meanings remain the same with Andrew's) is:

$$r_{xy} = \frac{\sum_{i=1}^{N} (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\left[\sum_{i=1}^{N} (x - \bar{x})^2\right]\left[\sum_{i=1}^{N} (y_i - \bar{y})^2\right]}}$$

where xi = ith observation of quadrat x

yi = ith observation of quadrat y

N = number of quadrats to be analysed.

$\bar{x} = \sum_{i=1}^{N} \frac{x_i}{N}$ = mean of quadrat x

$\bar{y} = \sum_{i=1}^{N} \frac{yi}{N}$ = mean of quadrat y

rxy = the correlation coefficient between quadrats x and y.

The advantage of using a correlation coefficient as opposed to an association analysis as the basis of a cluster analysis should be stressed because of their significance to quantitative data. Whereas correlation coefficients quantitatively relates two variables, association analysis, based on chi square, treats data as qualitative, present or absent. The correlation coefficient relates the quantitative measures of abundances of the species in one quadrat to the quantitative values of the other. Values of environmental scores representing the intensities of environmental properties, or factors, were also examined using the correlation coefficient basis of cluster analysis. The correlation of quadrats may thus be used to indicate possible causal factors acting at different levels of intensities.

A negative correlation between two quadrats indicates a degree of oppositeness in the species compositions within them. Strong correlations among quadrats are indicated by high correlation coefficient r-values approaching +1.00 or -1.000. All the possible pairs of values of the correlation coefficients computed may in fact be examined for concomitant significant positive and negative correlations and the quadrats which mutually show high values or highly positive significant correlations can be jointly interpreted in terms of the environmental properties to which they were associated in the field, which is presumably opposite to those quadrats having significant negative correlations. Thus Kershaw (1973) suggested that "such positive and negative correlations lead to separation of groupings which typify different communities".

The clustering process in which the quadrats are progressively combined into few and large groups by the distribution of the several variable species in order to identify groups or classes of similar quadrats within the set of sample data matrix are called agglomerative as opposed to divisive ones in which the samples are successively sub-divided into progressively smaller groups. Either case requires that a restriction is made that no individual may belong simultaneously to more than one group. An exclusive hierarchical structure is therefore imposed on the quadrats by the progressive grouping of those having the most qualitative and quantitativel similar species distributional scores. The quadrats (or environmental) matrix are thence progressively grouped together such that their clustering patterns are represented by a dendrogram of fused quadrats indicative of their grouping patterns.

The clustering which proceeds with a restriction that no individual quadrat may belong to more than one group obviously forces ecotone intermediate or hybrid quadrats into a number of definite class- or community-clusters. Jardine and Sibson (1968) suggested that "a cluster method which transforms a similarity matrix into a hierarchic dendrogram should be regarded as a method whereby inequality is imposed on a similarity coefficient", and that "single linkage is the only method satisfying all the criteria reasonable for any transformation to satisfy". Jardine and Sibson (1971) devised a number of non-hierarchic methods which allow varying degrees of overlap. Williams, Lance, Dale and Clifford (1971), however, questioned the need for cluster methods to satisfy all of Jardine's and Sibson's proposed criteria. Williams, et al, suggested that "in practice single-linkage did not provide solutions which investigators found useful". Instead, "a more pragmatic approach to clustering" was suggested by Williams, et al. Everitt (1979) suggested that "the single-linkage method provided by these two authors is applicable only to small data sets and the solutions given are generally .. extremely difficult to interpret".

The conclusions reached by Everitt (1979) states that: (1) no single method of cluster analysis is best in every situation; (2) the mathematically respectable single linkage is, in most cases, the least successful; (3) average linkage clustering do fairly well overall.

Thus though five possible measures of the distance criterion are available to choose from the family of Cluster Analysis Library by Andrew (1975) and include: complete-link clustering, centroid linkage cluster analysis; within-group heterogeneity, single linkage cluster analysis; and average linkage cluster analysis, the last named method of analysis was chosen, because in addition to its overall efficiency, as reported (Everitt 1979), it enables it to handle a relatively very large data set, which may be regarded as a distinct advantage in the situations connected with aspects of tropical vegetation analyses. Besides, the purpose of a community classification, the practical objective is the production of a summary dendrogram in which all the potential quadrats that are likely to be indeterminable on an ordination scatter diagram due to factorial complexities should be defined in terms of their average nearest neighbours with which they are more closely linked instead of forming interlocking overlaps as is the potential result in single linkage cluster analysis.

Measures of similarities or dissimilarities between the clustered items introduced in Andrew's Cluster Analysis may be computed through a number of alternative methods, from which just the "mean trait distance" strategy will receive my exclusive attention because of its applicability to plant community analysis. For example, one of the alternative cluster analytic procedures via "the average Euclidean distance technique" may well be an advantage to a taxonomist more than to an ecologist as it accentuates the extreme differences imposed by single characters and results in over-fragmentations of community groups, similar to an analysis by a monothetic classificatory technique.

In order to be able to represent the multi-dimensional space over which the objects being cluster-classified are distributed, in nature, along a perpendicular axis, Andrew (1972) considered that the "measures of distance between their paired coefficients of correlation" should be used to locate the "average absolute distance between the points", using their "mean trait distance":

$$d_{ij}^{(m)} = \frac{1}{p} \cdot \sum_{k=1}^{p} \cdot \left[x_{ik} - x_{jk} \right]$$

where $d^{(m)}$ = mean trait distance

i, j = individuals being cluster-classified (quadrats)

p = number of sample points

x = quantitative values of traits (e.g. species)

k = constant multiplier.

Using the mean trait distance (mtd) is the same as using the average of the absolute differences between the quantitative values of quadrats along the vertical axis. Thus if two quadrats differ widely in the quantitative values of one species component but they are identical in another, then $d^{(m)}$ is their average difference.

The clustering which proceeds by the average linkage clustering means that the average distance between subgroups is computed by the arithmetic mean of the distances between the quadrats. Subsequently, those subgroups which have the lowest average distance are first linked together, and so on, such that each new group is represented by a point which is the mid-point between the successively amalgamating quadrats. The quadrats which coalesce early at the successive nodes therefore tend to be those having the highest within-cluster estimated correlations, and within-group homogeneity.

The agglomerative hierarchical process proceeds to cluster the N quadrats into an n-1 single group, pairing one individual quadrat with one or more individual quadrats at each step until all the subgroups form one large less homogeneous group, but containing local optimal hierarchies of

coalescing quadrats.

A separate programme for the clustering sequences exists and the computational procedures for the accretion of the clustering units into the hierarchical clusters into a dendrogram form is relatively straightforward. But it requires data manipulations in the case of very large data because of limitations imposed by computer core store.

4.4.4 PLANT COMMUNITY INTERPRETATIONS FROM THE CLUSTER DENDROGRAMS

The whole procedure may be described as an agglomerative polythetic hierarchical clustering classification technique, although other ecologists have been tempted to refer to such refined, sophisticated forms of classification techniques as a "uni-dimensional ordination" because with this system (cluster analysis) the "clustering tendencies of stands can be shown geometrically", and because "in addition to cluster recognition, it can serve to identify trends in vegetation variation, which may lead to explanations in terms of environmental gradients" (Mueller-Dombois and Ellenberg, 1974).

Pritchard and Anderson (1971) have similarly implied that the line which divides hierarchical clustering procedures from ordination techniques is a thin one: "Both methods share as their first step the summarisation of inter-quadrat relationships in a table of dissimilarity coefficients". However, clustering analyses were obviously linked more with classifications than with ordinations: "Cluster analysis seeks to divide the quadrats into groups of internal similarity with respect to species or characters used" (Pritchard and Anderson, 1971).

All the given N quadrats (or environmental observations) to be clustered are each initially regarded as a single individual which can be successively amalgamated in (N-1) steps till all have been combined into a single cluster. The points are then grouped or clustered progressively.

A diagramatic representation of the complete hierarchical clustering process from the N single quadrats to the complete cluster containing the N quadrat members constitutes the dendrogram for the set. The dendrogram thus represents a single cluster with different stages of fusion by those which are the nearest neighbours, exhibiting varying degrees of inter-cluster distances along the vertical axis.

A cluster analytic procedure which compresses the members of a community into one relatively distinct compact hierarchic cluster unit in the dendrogram is the ideal for an analysis of the communities from the set of quadrats. The interpretation of communities from the dendrogram, in principle, simply consists in seeking for clusters which are compact and well defined in the resulting complete cluster summary. For these tend to be the quadrats having the minimal intra-group floristic variations, qualitatively and quantitatively. Pritchard and Anderson (1971) pointed out, for example, that "hierarchical processes in the form of dendrograms does not provide a means of identifying natural partitions (but) the most commonly used rule seeks large proportionate changes in inter-cluster distance at successive nodes of the dendrogram".

Correlations among quadrats in the cluster analysis should arise because the quadrats contains qualitatively and quantitatively similar floristic contents within them, either because the quadrats derive from similar causal effects in the field, or because the species within the quadrats are to some extent measuring the same relatively similar environmental feature, or because the species in them exhibit some co-response to a common environmental factor in their field sample-sites.

CHAPTER 5 FIELD METHODS

5.1 INTRODUCTION

Fig. 1 indicates the vegetation zones defined by Keay (1949-59) on the basis of climate. Fig. 2 shows Clayton's revision in which he subdivided some parts of Keay's "Northern Guinea savanna", thus giving six savanna zones instead of Keay's five.

It must be pointed out first, that both authors seem to agree that the area around Zaria constitute the centre of their climatic-determined "Northern Guinea savanna zone" or my 'Mid-northern latitudes cerado vegetation of Nigeria' which I suggest is determined by a multitude of factors from climate to soil differences, topography, geology, and most important, by historic and current land uses.

Secondly, their zones correspond well in the general outlines and distribution of climatic parameters, as exemplified by the length of wet season in days per annum, Fig. 3, after Walter (1968) and by the quantitative mean annual rainfalls for 24 illustrative locations from the coastal latitudes to the northern limits of Nigeria, Fig. 4, after Kowal and Adegboye (1972).

5.2 THE CLIMATE

Since the area around Zaria constitute a central area of the Northern Guinea savanna zone, as pointed out above, the zonal climatic regime will be described using data from the Institute for Agricultural Research meterological office, Ahmadu Bello University, at Samaru. I have compiled the monthly rainfall figures from fifty-five years' records (1924-1978) based on this source (Fig. 5) and it will serve to indicate the mean weather variations in the zone.

Samaru (11° 10'N : 7° 39'E) is situated some 13km. to the north-west of Zaria on the main Zaria-Sokoto road. It lies at about 2,250 ft (= 686m.) above mean sea level on an undulating plain. It has been the

YEARS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL (IN)	TOTAL (MM)	MEAN (IN)	MEAN (MM)
1924				1.52	3.64	5.78	12.75	10.16	10.91	1.56			46.32	1197	3.86	98.06
1925			2.39	1.01	1.97	7.44	11.32	11.35	4.70	3.52	0.40		44.50	1130	3.70	94.19
1926				0.42	3.88	9.29	12.10	14.16	6.55	1.50			48.88	1237	4.05	103.03
1927				2.24	6.04	6.17	5.47	14.39	12.17	2.15			50.57	1285	4.21	107.04
1926	0.02		2.07	2.21	7.17	9.66	8.28	9.18	8.56	1.55			48.70	1262	4.14	105.19
1529			0.50	0.06	8.30	4.37	11.23	14.01	10.15	2.32			50.94	1294	4.24	107.82
1930				1.33	4.55	3.53	6.98	16.43	6.22	0.18			41.23	10 47	3.43	87.27
1931				2.48	5.86	8.28	11.41	9.59	9.30	0.18	0.06		47.16	1198	3.93	99.82
1932		0.42		2.55	8.92	9.93	5.48	8.82	8.78	2.29			47.17	1198	3.93	99.84
1933	0.01			0.97	3.91	9.18	12.97	13.82	10.65		0.12		51.64	1312	4.30	109.30
1934				2.89	7.10	5.57	7.13	13.36	4.19	2.15			42.29	1077	3.53	89.77
1935			0.35	0.37	4.20	9.14	5.38	13.96	5.73	0.10			39.23	996	3.26	83.03
1936		0.03	0.02	2.54	5.96	4.38	10.45	8.19	12.86	1.12		0.16	45.54	1157	3.79	96.39
1937				0.86	4.36	5.05	8.02	10.97	9.45	0.04			38.70	983	3.22	81.91
1938			0.03	2.66	5.33	7.07	5.48	9.43	8.41	0.47			38.88	987	3.23	82.25
1939		0.24	0.59	0.48	6.29	5.27	6.16	11.25	10.46	3.63			44.46	1129	3.70	94.10
1940				1.05	2.90	5.51	8.54	8.20	8.00	1.56			35.88	911	2.99	75.90
1941				1.59	6.11	5.86	7.38	10.27	9.27		0.23		40.71	1034	3.39	86.11
1942		0.34		2.08	9.65	4.42	6.58	7.95	3.65	2.17			36.84	936	3.07	77.97
1943			0.84	0.05	6.58	5.23	6.49	21.24	9.52	0.07			50.12	1273	4.17	106.08
1944			0.94	0.11	1.70	6.12	7.57	14.46	5.25	0.41			36.56	929	3.04	77.38
1945				0.80	1.64	6.32	8.39	10.71	8.57	2.50			38.93	984	3.22	81.97
1946			0.54		6.44	7.51	12.04	16.58	10.07	2.90			56.12	1426	4.67	118.78
1947			0.01	0.01	5.61	8.45	10.05	11.70	8.48	1.16			45.27	1150	3.77	95.82
1948			0.19	3.53	3.12	5.05	5.31	8.34	9.77				35.31	897	2.94	74.73
1949			0.39	0.11	4.98	5.23	5.52	16.35	6.22	0.09			38.53	969	3.24	82.60
1950				0.85	3.11	4.92	9.90	8.52	7.61	0.66	0.02		35.39	899	2.94	74.90
1951			0.10	1.10	5.53	4.13	8.72	11.06	11.26	3.75	0.01		45.67	1160	3.80	96.66
1952			0.14	0.13	5.09	6.27	13.02	8.04	9.00	1.82			43.51	1105	3.62	92.09
1953		0.33			10.07	5.97	11.56	8.76	8.92	0.30			45.87	1166	3.82	97.13
1954		0.48	3.11	2.55	8.65	6.76	6.61	16.42	12.32	1.28	0.76		58.74	1482	4.88	123.48
1955			0.03	1.47	2.98	7.18	12.46	13.11	13.05	2.68			52.97	1345	4.41	112.12
1956		0.28	1.32	1.76	1.73	3.97	9.65	7.63	8.61	3.55			36.50	927	3.04	77.25
1957				2.04	10 49	5.98	10.04	12.40	10.39	3.59			54 91	1395	4 57	116 27
1958	0.04			1.30	3.47	7.45	5.10	6.63	10.13	0.87			35.99	889	2.91	74.06
1959			0.27	1.87	4.66	6.65	6.23	10.84	11.32	0.03			41.87	1064	3.48	88.62
1960				2.09	1.17	7.21	8.24	9.66	13.35	0.25			42.97	1094	3.58	90.95
1961				1.70	2.27	8.19	5.68	4.81	9.52				32.45	824	2.70	68.66
1962				1.96	2.25	7.32	9.95	12.57	14.92	2.31	0.77		51.26	1302	4.27	108.50
1963				1.14	2.87	8.84	5.78	10.88	8.44	5.43			42.58	1081	3 58	90.93
1964			0.18	1.22	1.84	6.87	11.51	8.91	10.26				41.54	1055	3.46	87.92
1965			0.01	0.82	0.82	11.66	6.97	3.76	5.86	0.59			38.49	978	3.20	81.47
1966			0.02	3.86	5.06	5.40	6.51	14.95	11.71	2.93			52.46	1333	4.37	111.04
1967			0.26	1.86	3.29	7.19	9.76	3.79	11.60	0.13			38.10	968	3.17	80.64
1968			0.01	3.38	5.65	4.92	10.13	11.85	5.48	0.25			41.71	1059	3.47	88.28
1969		0.01		1.70	4.50	7.29	17.53	9.20	3.54	4.11			47.96	1218	3.99	101.51
1970			0.27	0.07	5.17	4.13	10.20	10.35	6.88	0.26			37.33	948	3.11	79.01
1971			0.14		4.60	1.23	9.09	11.76	0.30	0.30			34.82	884	2.90	73.66
1972			0.01	2.02	6.02	3.77	6.79	12.60	3.36	0.95			35.52	902	2.97	75.60
1973			0.04	0.85	1.85	7.55	7.55	8.96	11.62	0.78			38.35	974	3.19	81.16
1974			0.66	1.18	1.33	9.89	9.92	12.95	9.72	3.98			49.63	1119	3.84	97.91
1975			0.01	2.38	5.12	5.33	11.93	4.48	8.35	0.33			38.93	989	3.24	82.39
1976				3.39	5.34	8.15	8.91	7.41	7.52	5.39			47.10	1196	3.92	99.69
1977					3.08	4.80	2.32	11.92	7.84	0.17			29.35	746	2.44	62.12
1978			0.05	3.06	7.63	6.48	5.72	12.79	8.15	1.33			45.21	1148	2.45	95.67
TOTAL	0.07	2.13	15.29	80.57	261.53	369.20	484.23	608.37	480.08	81.47	2.27	0.46	2373.48	60305	196.15	5000.89
MEAN	0.00	0.04	0.26	1.46	4.76	6.25	8.75	11.07	8.79	1.48	0.04	0.00	43.15	1096	3.57	91.29
(mm)	0.0	1.0	7.1	37.1	120.9	161.5	222.8	284.2	221.9	37.4	1.1	0.0	1096	496	90.7	91.3

Fig. 5. Monthly rainfall figures during 1924-1978 at Samaru-Zaria. [illegible] Meteorological Office).

headquarters of the Department of Agriculture in the defunct Northern regional government since 1922, which explains the availability of the reliable long-term rainfall data as shown in Fig. 5.

Clayton (1957) pointed out that rainfall is the major climatic characteristic for consideration with vegetation patterns in Nigeria for "other elements such as temperature, sunshine, wind, etc., seem to be of little importance in distinguishing climatic regimes within Nigeria" (except in exceptional cases such as the Jos Plateau).

The mean annual total rainfall is 1,096mm. and the mean monthly is 91.3mm. The graphic representation of the annual rainfall totals at Samaru constructed from the actual rainfall figures presented in Fig. 5 is played on Fig. 6 which indicates that the annual rainfall has been extremely irregular during 1924 to 1978 in its pattern of distribution from year to year, so that the figure for mean annual rainfall is only a rough idea of the precipitation available to vegetation growth from direct rainfalls.

Fig. 7 represents the distribution of rainfall throughout the year based on the calculated mean rainfall values for the 55 years. It indicates that the rainfall is a one-peak type with the maximum monthly mean falling in August. Most of the rain is, however, spread between June and September, and this is readily apparent from the averaged distribution figures in Fig. 5 as well as in the monthly mean rainfall graphic representation in Fig. 7. 1089mm. out of the 1096mm. (= 99%) of the annual mean rainfall occurs from March to October.

The climate thus has two distinct seasons: the rainy wet season and the rainless dry season, corresponding to April to October and November to March approximately (Fig. 5 and Fig. 7). The figures also indicate that the beginning of the rainy season and the beginning of the dry season are quite variable, though the termination of the rainy

season is relatively abrupt and tends to occur in mid-October.

Mean values of Relative Humidity records (9.00 a.m. daily) indicate fluctuations similar to rainfall figures. The average for April to October is 68, and 35 for November to March. The low Relative Humidity for the November-March period is related to the persistent Harmattans. The lowest temperatures are recorded in December during the peak of the Harmattan winds, the mean minimum being 59°F (= 15°C), while the mean maximum temperature is highest in April at 96°F (= 35.5°C).

Special attention to Fig. 4 will, however, suggest that the mean annual rainfall is not an effective justification for the delineation of a eries of south-north isohyt-vegetation zonal boundaries, although the climate appears to allow for broad generalisations to be made about the south-north general continuum. The general pattern may conform to the hypothesis that length of rainy season and mean annual rainfall decrease from south to north, zonally orientated, as a result of the action and counteraction between the rain-bearing south-westerly winds and the dry dust-laden north-easterly Harmattans. But Kowal and Adegboye (1973) noted "anomalies" and "deviations from the average in the length of the rainy period and the availability of water" which did not conform with latitudinal expectations.

Mean annual rainfall in Kaduna, for example, is 89mm. more than at Ibadan, (Fig. 4). Yet Kaduna is in the Northern Guinea while Ibadan is in the Rain Forest zone of Keay (1959) and of Clayton (1957). Thus Clayton (1957) suggested that "the annual rainfall and its pattern of distribution at any station in Nigeria is most irregular from year to year, so that the mean annual rainfall can give only a rough idea of the suitability of a station for a possible vegetation".

It has been suggested that it is the severity of the dry and rainy seasons which controls the vegetation: "The difference between these

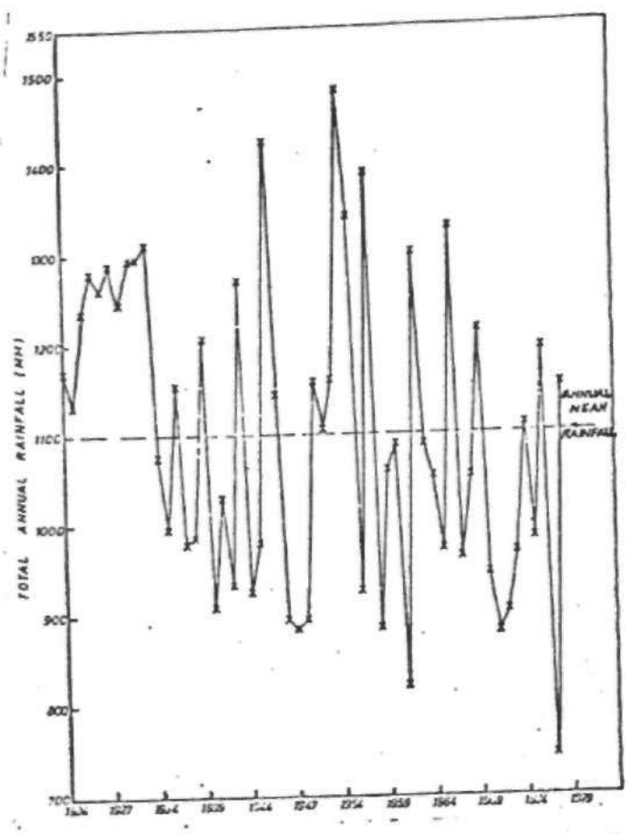


Fig. 6. Graphic representation of the total annual rainfall at Samaru (1924-1978). Based on data compiled in Fig. 5.

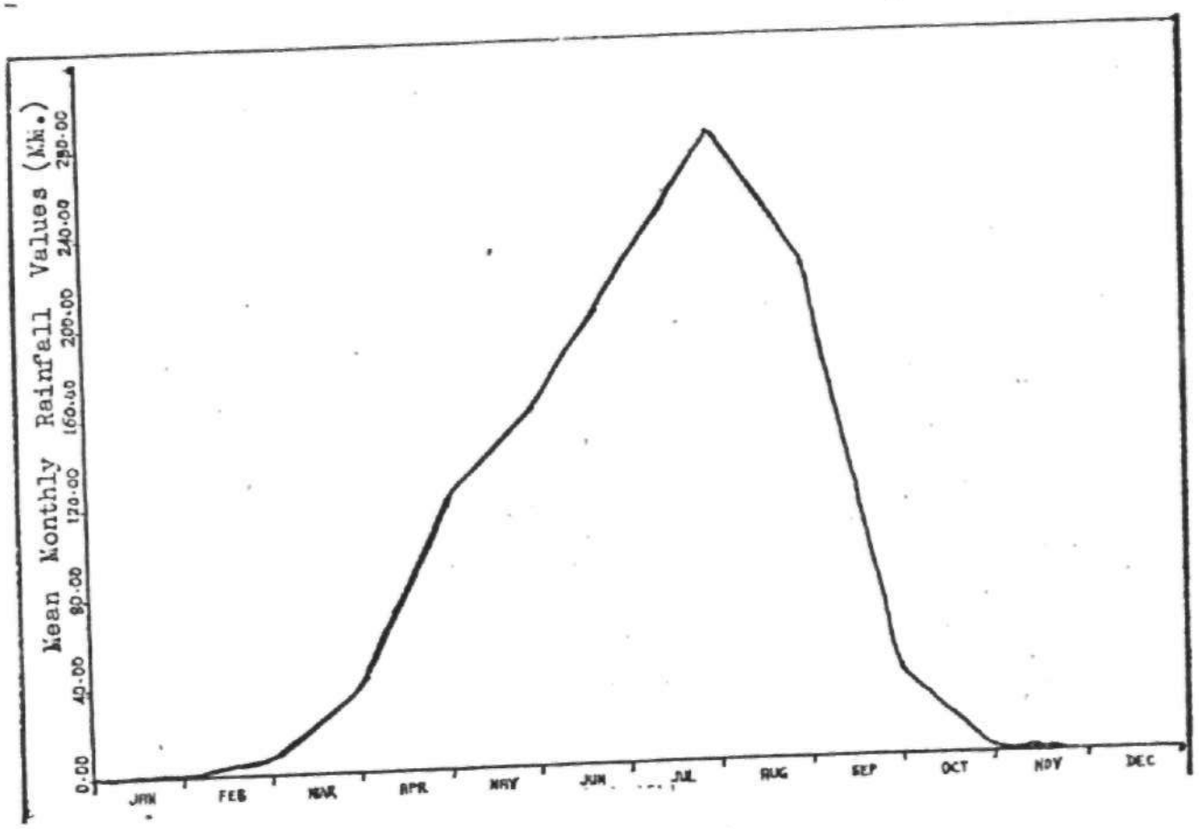


Fig. 7. Graphic representation of the mean monthly rainfall at Samaru based on the mean monthly values as compiled in Fig. 5.

climates is readily seen when the severity of their dry seasons is compared" (Clayton, 1957). Hore (1972) stated that "Zaria" (in the centre of the Northern Guinea zone of Nigeria) "possesses a tropical continental climate" and pointed out that "the continentality of its climate is more pronounced during the dry season, especially in January when the seasonal character of the rainfall assumes various changes in the colour of the vegetation from lively green foliage in the wet season to the dead-like brownish colour of the foliage in the dry season".

The final view of Clayton which came during the last stages of his field work in Northern Nigeria is therefore worthy of particular notice: "The classification of ecological units is not very consistent and many of the boundaries are somewhat arbitrary. It should be clearly understood that this (the climatic division) is only a first approximation to an ecological map. Nevertheless it will serve to indicate the general disposition of the major climatic divisions of the region." (Clayton, 1958).

5.3 STRATIFICATION BY AIR PHOTOGRAPHS

In order to provide a "practical application of vegetation survey" that will (1) "serve as an alternative to soil survey, providing a rapid inexpensive method of reconnaissance surveying"; (2) "be an aid to soil survey, enabling the greatest use to be made of air photos, suggesting which soil divisions are of greatest practical significance to growing plants which are not apparent from a soil survey alone"; (3) "be a supplement to soil survey, providing evidence on existing and potential land use, carrying capacity, grazing resources, plant successions related to erosion and conservation", Ramsay and Higgins (1966) stated that "the methods employed were largely based on greater use of aerial photographs". They stated that "these were possible through the increased coverage of the Country with modern high-quality photographs as Northern Nigeria is

very suitable for the use of air photography since the vegetation cover. over most of the Country is open savanna"

Physiographic mapping is thus now commonly used as the method of mapping vegetation and soils in semi-detailed and reconnaissance surveys. The technique depends largely on air photo-interpretation and the procedure is similar to that of the pedological air photo-analysis described by Buringh (1954) for the interpretation of aerial photographs in soil survey and land classification. It involves the classification of the terrain into "homogeneous landscape units" based on the external properties of landscape"; "where soil conditions have some visible physiographic or vegetational expression on the surface, and where the relationships between soils and the external expressions (vegetation) is more or less invariable" (Beckett, 1968).

The widespread acceptance of the physiographic or 'land system' approach to soil vegetation survey was partly a consequence of the wide range of conditions and the large-scale area usually involved. For example Kershaw (1968) distributed a total of 433 plots "more or less evenly" along the north-south distance of about 176km. "from Maska in the north of Zaria Province down to Idon near the southern limits of the Northern Guinea Savanna". Ramsay and de Leeuw (1964) procured their 401 sample plots in conjunction with "routine soil surveying" from an area of about 7020 square miles (= 18,175 sq.km.) on the Middle Gongola Valley within the Sudan and Northern Guinea zones of Nigeria. Similarly, in the Ghanaian Guinea savanna, Lawson, et al (1968) surveyed Mole Game Reserve vegetation which covers 900 square miles (= 2,300 sq.km.) land area.

Besides, for the Guinea savanna it offers the first real opportunity to approach the survey of the environment in a rational systematic and integrated fashion. It is also quick, relatively cheap and moderately accurate for surveying a wide expanse of terrain with poor access routes.

For example, Bawden (1972) estimated that "the area covered by each area" (being investigated by the Land Resources Division (LRD) of the British Ministry of Overseas Development" together cover more than 518,000 km^2 and the objective is to "describe, map and provide area estimates of the 'land form', soils, natural vegetation and pattern of present land use".

According to Bawden (1972) "areas with the same pattern of land form, soil, vegetation and climate" are defined as land systems . It has however earlier on been defined without the climate as a "land system is an area or group of areas throughout which there is a recurring pattern of topography, soils, and vegetation" made up of smaller, more homogeneous units known as 'land units' or 'land facets' according to Christian and Stewart (1953).

The "land facets" or (land units) component parts of the 'land system' have been defined as "a part of the landscape, usually with similar form, on a particular rock or superficial deposit, and with soil and water regimes that are either uniform over the whole of the facet, or, if not, varying in a small and constant way" (Webster and Beckett, 1970).

Stratification by the aerial photographic method thus depends on a first derivation of physiographic major differences in the landscape with or without brief confirmatory investigation by ground survey. Mountain ranges, flood plains, mesas, and various types of plains, are, for example, in addition to physiognomic changes with land use, identifiable with reasonable assurance.

From such reconnaissance air surveys the broad patterns of ' and systems', their topography, geological materials, soils and the associated physiognomic vegetational characteristics have been mapped into primary divisions in various parts of the Northern Guinea savanna. It is obvious, in view of the large coverage that the information could not be very

detailed in the indirect methods of relating vegetation to 'land systems' which is achieved mainly through delineation of mappable landform features, from the aerial photographs.

Without ground sampling, aerial photographic interpretations have been found to produce confused vegetation and land use results in Northern Nigeria. Vegetation patterns have been confusedly identified in most areas because "the soil-vegetation relationship has been complicated by cultivation, grazing, burning, and firewood cutting" (Ramsay and de Leeuew, 1964). Clayton (1957) also suggested that "under the influence of cultivation, the vegetation on all soil types tends to converge towards a single cultivation community". Yet such a single 'cultivation community' observed from aerial photographs might be objectively reducible into further floristically homogeneous subsets or communities of arable land weeds reflecting the different 'units' or 'facets' of the land systems, due to relative differences in the edaphic properties in the 'land system' covered by the seemingly single 'cultivation community' if direct ground surveys, complete floristic enumerations and appropriate numerical analyses are combined with aerial photo interpretations.

A possible advantage of air-photo interpretation is the elucidation of the trend of frequent cultivation to infrequent cultivations under the rotational fallow cropping of the land. Besides, a truly objective sampling method without preliminary information may require an astronomical amount of labour in collecting and analysing the data from a large area. The aerial photographs form a quite objective method of demarcating the 'domains' for detailed ground floristic survey, as pointed out by Lambert (1971).

Lambert (1971) stated thath "the main features of the vegetation cover of many parts are still so imperfectly known that a general vegetation survey of such regions remains a primary requirement". He

also suggested a need for selection of 'suitable' sampling methods in a large-scale survey to be based on "(1) type of information required; (2) economy of effort; and (3) efficiency of operation".

The aerial photographic approach which is used also currently by the Soil Survey Section, as it was used by the Land Resources Division, has brought out some salient relatively distinctive features of the environment which can be regarded as centres within plant community continuum changes along their gradients. For example, the slope gradient, slope shape, surface texture, and ground surface drainage conditions were pointed out in the north eastern state of Nigeria (de Leeuw, Lesslie and Tuley, 1972). The crests, river banks, bottomlands, plains, springs, flat pavements of ironstones associated with the land facets were also differentiated as parts of the land forms in that study. Yet the blurring of vegetation boundaries by the emphasis placed on the distribution of tree species has meant that vegetation induced by human activities has not been sufficiently treated in order to meaningfully elucidate the floristic differences created by land use on the landscapes. The land use by man has given rise to recognisable anthropogenic botanical communities in each Nigerian savanna zone.

The drawback lies in the preconceived concept of climax communities. The approach links vegetation to climate zones and fails to give adequate recognition to the fact that land use by man is the dominant ecological causal factor in the northern states of Nigeria similar to the recognition of the natural, sub-natural, semi-natural and cultivated landscapes of Westhoff (1970).

Westhoff (1970) identified four useful major categories of dynamic plant community continua on the landscape under the influence of land use. He called them (with my paraphrased descriptions): (1) the natural landscape in which flora and fauna are native, spontaneous, and vegetation is undisturbed by man; (2) the sub-natural landscape which is closely

related to the potential natural vegetation, and shares its physiognomy. However, the vegetation is not quite undisturbed because they have to a certain extent been influenced by man; (3) the semi-natural landscape in which the flora and fauna, to a large extent, are native and spontaneous, but the vegetation has been essentially changed by human influence. However, these sorts have not been artificially manured, drained, levelled down or otherwise intensively managed, and (4) the cultivated landscape in which both the composition and the physiognomy are essentially controlled by man.

There is no possibility for the integrity of the aboriginal communities to have been maintained in view of the historic and current influences of man on the plants in the Northern Guinea savanna. The natural type no longer exists in the zone. In my childhood, for an example, I learnt about the traditional iron-smelting furnaces consisting of pits and large stone camps outside the villages forming the iron-smelting spots from which metal workers produced hoe blades, cutlasses, knives, spears, arrow heads and domestic iron tools. Iron ores were mined and smelted on the field in camps settled between ironstone sources and the sources of hardwood trees. Charcoal derived from tree trunks and bellows were and are used. Reduction from ore to workable pieces of metal took days, and required continuous fuel. The camps were abandoned or dismantled after mining and smelting were completed. The fields therefore formed the centres of metal productions and involved the burning of hardwoods from trees felled from the surroundings. Obviously, the savanna vegetation has thus been profoundly modified by the use of trees for fuel in such an historic iron production in different areas.

Apart from the iron-smelters, the traditional African economies usually called 'subsistence' or 'peasant' economies such as pottery,

weaving (requiring looms), and the domestic uses of plants, depended (and still depend) for their source of power on the exploitation of the plants. A quantitative evaluation of these historic and current significant factors cannot be attempted here, but their significance suggests that the Northern Guinea savanna plant communities cannot be described as natural, and even sub-natural vegetation types are very limited on the landscapes.

The semi-natural and the cultivated vegetation of Westhoff (1970) therefore prevail while the sub-natural types are located on the rocky untillable inselbergs and hills, and similarly relatively unused areas.

Zonation by land use vegetation around towns in similar climatic regional savanna zones has been attempted by a few authors, based on aerial photo interpretations of physiognomy and only preserved tree species, particularly on the variation in tree densities or sizes. For example, Pullen (1961) described the "zonation typical of long-established settlements that surrounds Birnin Kebbi": "There is an irregular zone of several hundred meters' radius, in which trees are either absent or isolated and malformed. Further from the town the cultivated fields have an irregular scatter of trees, and this forms a wide zone which reaches as far as the uncultivated grazing land where mature trees are absent. The following are well represented: Butyrospermum, Tamarindus, Vitex, Ficus, and Balanites. Sclerocarya is poorly represented and Adansonia and Parkia are rare" (Pullan, 1961). Pullan referred to them as "parklands".

Ramsay and Ross Innes (1963) described "by ground and vertical air photographs" the so-called "parkland" of Butyrospermum-Parkia community in the Guinea savanna vegetation of Northern Ghana.

My various predecessors have contributed to the plant ecological literatures of the Soil Survey Reports at the Institute for Agricultural Research, Samaru, have generally referred to farmed savanna areas where

cultivation has been or is a dominant ecological factor as "parklands" of one form or another. Normally, only the common species of the farm trees were listed where species compositions were considered.

For example, Clayton (1963) distinguished "floodplain parkland" and "farmed parkland". Three types of "parklands" were mapped in Bornu, after one species each, viz: "Acacia albida parkland", "Adansonia parkland", and "Parkia parkland" by de Leeuw and Tuley (1972). In the discussion of vegetation around the City of Zaria, Jackson (1970) described "Ceiba parkland", and that "the land is otherwise densely farmed and natural communities are represented by the ruderals". "Natural park savanna" and "artificial park savanna" are also found in the work of Lely (1925).

As the zonation of land use depends on the use of aerial photographic interpretations and upon dependence on physiognomic descriptions, the problems encountered in delineating 'land facets', 'land units' or 'land phases' also become a vegetational problem in attempting to find the limits of each plant community. The continuum of cultivated to semi-natural vegetation ranges from over current cultivations to fallowed fields which become interspersed with coppice regrowths and shrubs and even wooded lands with long-term non-cultivation.

These land use zonations depend on a large number of indigeneous and naturalised introduced species (e.g. Butyrospermum paradoxum, Tamarindus indica, Vitex doniana, Balanites aegyptiaca, Sclerocarya birrea, Parkia clappertoniana, Adansonia digitata, Ceiba pentandra, Mangifera indica, etc.) which attain their local prominence, abundance or dominance wherever their distribution has been enhanced in farm, farmed, temporary or permanently settled agricultural or pastoral sites. Their distribution may thus be attributed to dispersion and protection by man for agricultural, pastoral or domestic needs. They have wider ecological amplitudes which are essentially anthropozoic in origin and

are characteristic of the associated land use. Such species are therefore ubiquitous in their distribution, in terms of use for edaphic indicators for they may occupy unassociated soils and sites across a wide range of geographical area.

Personally, I find it inadvisable to use the term 'parkland' for these uniquitous cultivation or pastoral plant communities. Though their relatively distinctive zonation around towns and villages has been described by many authors, they should probably be called 'tree savanna' for they bear no real structural or utilitarian relationship with the European recreational lands for which 'park' is used, and also because they are more related to "a random scatter of widely spaced trees growing in grassland, of variable heights, in which forbs and shrubs may also be found in varying numbers" described as "tree savanna" (Boughey 1956).

5.4 STRATIFICATION AND SAMPLING OF REPRESENTATIVE DOMAINS IN THE ZONE

According to Kemp (1969), "the savanna region of Nigeria covers an area of about 300,000 square miles (= 777,000 sq. km.)". The two Guinea zones of Keay are about 400km. broad, north-south wise, and occupy the central half of Nigeria that is colloquially called the "Middle Belt". It varies in land area between 300,000 to 330,000 sq. km., if an allowance is given for the differences of opinion represented in Keay's or Clayton's zonal boundaries.

The Northern Guinea zone occupies between 140,000 to 1550,000 sq.km. in land area, by my estimation, still taking the differences in opinion by Keay and Clayton into consideration. Since the official total land area of Nigeria is "over 356,669 sq. mls" (= 923,773, sq. km.) according to the Nigeria Year Book (1968, 1973) the proportion of the total Nigerian land surface area covered by the Northern Guinea savanna vegetational regional zone varies between 15.15% to 16.77%.

In earlier works, the selected sample areas were mainly decisively placed wherever the authors believed that the 'savanna' vegetation was in a near-natural condition. Kershaw (1968) surveyed several localities like erosional sites, rocky hills, granitic rocks and inselbergs, where the vegetation appeared to be in the near-natural conditions. Keay (1949b) based his example of the Sudan vegetation in Nigeria on Zamfara Forest Reserve, and in 1960, his Northern Guinea zone example was surveyed in the constitutionally reserved Anara Forest Reserve between Zaria and Kaduna. Woodell in 1978, during his supervisory field tour with me in parts of the Northern Guinea savanna of Nigeria, visited the Anara Forest Reserve with me. We observed that the soil in that reserve was largely overlaid (and probably underlaid) by lateritic ironstone boulders and bedrocks, sufficient to make tillage by hand hoes impracticable. We also noted that the patches of intermittent soil deposits over the ironstone bedrocks were too shallow to induce farmers to attempt any extensive or intensive agricultural use. The slight differences in the preferential distributions of Isoberlinia doka for the intermittent patches of soil deposits, as opposed to the Isoberlinia tomentosa which occurred mainly on the crevices of the more solid lateritic boulders, were also noted apart from the general gradual species compositional changes towards the valley lying away from the roadside. Ramsay and de Leeuw (1964, 1965a and 1965b) made their analyses of Guinea savanna vegetation surveys from little-disturbed natural-looking vegetation stands on rugged upper slopes and summits of rocky hill tops with "granites and high quartz-contents" and on 'sandstones' where the hoe is an equally ineffective agricultural tool in terms of causing agricultural disturbance to floristic distributions. In the Northern Guinea savanna of Ghana too, the vegetation as it could be, under the climax condition has appealed to workers, rather than the vegetation as it is, under the most ecologically influential factor, land use, by man. Thus Lawson, Jenik and Armstrong-Mensah

(1968) made their species enumerations in relation to the environment "from Mole Game Reserve, which represents a relatively well-preserved area of Guinea savanna in Ghana".

Clayton, in an undated departmental essay on "Some Aspects of Vegetation Survey in Nigeria" believed that "The chief difficulty in using vegetation as an indicator of soil type is that under the influence of cultivation the vegetation on all soil types tends to converge towards a single cultivation-climax community. Thus as the intensity of cultivation increases, the natural vegetation becomes increasingly insensitive to soil conditions". Subsequently, Clayton's methods were explained as "Observations are made on stands at fixed intervals .... though some judgement must be exercised to avoid completely atypical spots". The subjective "judgement" to avoid the so-called "atypical spots" often favoured by physiognomists and searchers after undisturbed natural vegetation have however been criticised by many quantitative ecologists.

McIntosh (1967), for example, pointed out that "whatever clustering of points does occur should emerge from objective data with minimal subjective manipulation before or after sampling". McIntosh also criticised "Some investigators favouring the typal or nodal approach" for appearing "convinced that such clustering would normally emerge if enough undisturbed natural landscape could be found and sampled in a way that the arrays present would all be represented in proportion to their areas occupied".

Goodall (1954b), Hopkins (1957), Mueller-Dombois and Ellenberg (1974), among many ecologists, have similarly all affirmed that no two similar plant assemblages are exactly alike. Therefore, no vegetation stand is either 'typical' or 'atypical'. Mueller-Dombois and Ellenberg (1974) pointed out that it is the "nonrecurrence of similar plant

combinations (vegetation spots or quadrats) that focuses attention on the different approaches of sampling".

Species populations are unevenly dispersed over a wide area because of their aggregative patterns, due to the heterogeneity of the environment. Several sampling methods have been suggested by ecologists who have had anlyses by classification and/or ordination in mind. Greig-Smith (1964) had pointed out that "truly random dispersal is hardly, if ever, found in nature" but that "plant individuals tend to be clumped or be continguously distributed around central points".

Willis (1973) firmly argued that "Samples must be representative of the community as a whole. This would not be so if they were all placed near one corner of the community or localised in groups here and there; neither should they be distributed in a regular manner. Exact and rigorous procedures are needed. Each sample should be taken at random for detailed analysis".

Conversely, Goodall (1952) did point out that the distribution of quadrats over an area should be such that (a) "the mean values for the whole area of the variables studied are reflected without bias in the means of the samples; and (b) as much information about their variation over the area may be retained as possible". Goodall contested at that time that a simple random distribution does not adequately meet (his) point (b). "Accordingly I advocate restricted randomisation techniques in which the area is divided into several portions and the positions of quadrats are randomised within each portion" (Goodall, 1952).

Dawkins (1970) similarly suggested that "Unrestricted randomisation is inefficient over large areas (although) theoretically, random sampling has the advantage that it carries no conscious bias and is statistically the most acceptable". Goldsmith and Harrison (1976) also stated that though random sampling is "generally considered to be the 'ideal' method

of sampling as each sample by definition must have an equal chance of being chosen .... it does not in practice achieve a random coverage of the sample area, some areas being under-sampled and others over-sampled". Whittaker (1973) observed that "though it is natural to think that samples of the set might best be taken from random locations in the landscape, formal randomisation of sample locations has been abandoned by most who have tried it".

Dawkins (1970) stated that "Systematic samples tend to produce means closer to the true mean than random samples" and suggested "records at regular intervals" and "recurrent continuous sampling with detailed list of contents" to permit calculation of growth in forest inventory. Although Dawkin's suggestion was essentially a 'time series sampling' for a 'time series analysis' attainable through recurrent continuous samplings of permanent quadrats in a forestry or conservation survey where interest could perhaps centre on statistical analyses of floristic fluctuations or oscillations that occur on a set of permanently selected sites from month to month, year to year, or from generation to generation, an alternative systematic form of survey applicable to plant community analyses over a large ground area was also put forward. Dawkins (1970) stated that "stratified random samples, if well designed, produce the lowest sampling errors of all without bias" and that it can be executed by "temporary numerous once-only cheap sampling surveys". It is also suggested that the stratified random sampling is particularly suitable in "polyspecific uneven-aged forest", which makes the method particularly valuable in land use studies by virtue of the uneven utility of the land from one area to another.

Stratification involves sub-dividing the field of study into relatively homogeneous parts and then sampling each sub-division according to its area. Goldsmith and Harrison (1976) commented that "it may be that

the imprecise nature of community boundaries may discourage the use of this method of (stratified) sampling in ecology but the advantages it offers are potentially considerable, particularly for relatively small-scale surveys of large areas". The sub-division of the area studied, according to Dawkins, constitutes a 'stratum' (plural 'strata'). Similar sub-sets of the environment were, however, suggested in the United Nations (1950) and were termed 'domains'.

According to the United Nations (1950), "Any sub-division about which the inquiry is planned to supply numerical information of known precision may be termed a 'domain' of study". Selected separate domains may represent regional areas of major, minor or mini-units which can be further broken down into sub-units in which the properties of the resulting groups become increasingly homogeneous, (according to the report) for "any responsible scientist analysing a part of the environment must always keep in mind that his results must be as useful as possible for as many purposes as may be thought of".

5.5 THE TWELVE DOMAINS OR STRATA SURVEYED WITHIN THE NORTHERN GUINEA SAVANNA OR THE MID-NORTHERN LATITUDES CERADO VEGETATION OF NIGERIA

Twelve separate surveys were executed in different representative domains or sample areas of the Northern Guinea savanna zone of Keay (1959) and of Clayton (1957). This zone corresponds to my 'Mid-Northern Latitudes Cerado Vegetation of Nigeria', the name which I suggest now in this thesis. It defines the area of semi-natural, variously managed gradients and intricate patterns of vegetation related to the composite and changeable land utilisation practices like the frequent and infrequent cultivations, improved exotic and unimproved indigenous forest reserves, unreserved grazing and fuel felling lands recurrently disturbed by man

and animals for the satisfaction of his needs for plants and plant-parts.

The chosen sites grade away (in representative areas) from near the urban centre of Zaria to the surroundings of a rural centre, Kuyello. My choice of Kuyello, for example, was a result of an invitation for an ecological-economic survey request from the Kaduna State Ministry of Economic Planning and Rural Development made to the Ahmadu Bello University, Zaria.

Nominally, the twelve representative domains surveyed are outlined as follows:

I Galma Fadama Vegetation in the Dry Season.

II Arable weeds of Zaria-Dambo Kurmi.

III Seral and weedy communities under Intensive Irrigation.

IV Kako-Galma upland and Fadama arable lands.

V Upland seral, cultivation and erosion communities.

VI Upland plains: A systematic transect survey.

VII Dumbi Inselberg and rocky hills vegetation.

VIII Mairabo Forest Plantation undergrowth communities.

IX Kabama Forest Plantation undergrowth communities.

X Guga Plantation and Farmed Enclaves.

XI Guga semi-natural indigenous reserve.

XII Plant communities from Kuyello Rural Area Composite survey.

The names are partly for my convenience in terms of their floral positions at the time of field survey or in terms of their geographical-environmental locations. More important, however, is that each of the domains also represents an area where a few major habitat factors are visually discernible as important potential centres for similarly distributed species but in which floristic continua are exhibited.

Each of my domains thus concentrates, sometimes only approximately,

on features representing a particular type of land use such as agriculture, forestry and irrigation. Approximately distinct geomorphological units of the landscapes, such as the inselbergs, plains and erosion also make up parts of the domains. Geologically different areas like the 'fadama', granitic inselbergs, basement complex rock outcrops and ironstone hills form other strata or parts of a stratum.

Although I refer to such domains as sub-regional strata within the Nigerian cerado (or 'savanna') other ecologists may prefer to call them "ecosystems". Major (1969) for example pointed out the antiquity of the ecosystem concept from various world languages. According to him "Men of cultures other than our own had the explicit idea of an ecosystem. Man as an animal has been at least a part of the wild natural scene and many of the terms in their languages succinctly encapsulate the idea of a particular kind of ecosystem" (Major, 1969). I think "terms in other languages" may "succinctly encapsulate the idea" of a particular strata or domain. However, I do not think it will serve any useful purpose to refer to any of my strata here as an "ecosystem", as Owen (1976) had implied that an ecosystem can be looked at from too many levels. "It is justifiable to regard the whole living world as one huge ecosystem, just as it is justifiable to speak of rain-forest ecosystem, an oakwood ecosystem, ... and it is perfectly correct to speak of an ecosystem centred around a single plant." (Owen, 1976).

However, as "terms in other languages" which "succinctly encapsulate the idea" of centres for relatively distinct floristic continua, I use fadama in the sense that it is used in a Nigerian language (Hausa), meaning approximately, the bottomland alluvium of large wide rivers. Kurmi is also used in its Hausa sense, meaning approximately, a narrow small river or stream-side seasonal floodplain having its own relatively distinct floristic and/or physiognomic homogeneity. English equivalents

of other Nigerian floral strata are maintained for the domains sampled.

Each area will be summarily described, and my procedures of research techniques, the floristic communities or community gradations, found will be indicated and will be related to the properties of their physico-chemical edaphic environments, in particular, and to their geological, biological and land use factors, as far as possible.

The sites cover areas of contemporary land utilisation methods ranging from the developmental intensive agriculture, with or without mechanisation, to the 'on' and 'off' cultural system of agricultural land rotation. It also covers shifting pastoral land use and permanent forest reserves, with and without intensive care. The diversity of edaphic conditions, from the inselberg and hill ranges, erosion pattern differences, localised riverine relatively recent depositional colluvio-alluvial materials to the hydromorphic soils of older alluvial deposits on floodplains of large rivers, are also represented. I do not, however, claim that the range of the land use, soils and plant communities in the whole of Keay's and Clayton's Northern Guinea savanna zone will be exhausted by these sites.

None of the individual sites is by itself varied enough to represent the zone. They are located in five relatively discontinuous areas and were separately examined in the course of field works for data collections.

5.5.1 LOCATION OF THE STUDIED DOMAINS

The basic areas in which the domains of study were located are five discontinuous sites as follows:

1 The Galma Basin complex.

2 Mairabo Forestry Plantation.

3 Kabama Forestry Plantation.

4 Guga Forestry Plantation, Forest Reserve and Enclaves.

5 Kuyello and its environ on Funtua-Birnin Gwari Road.

The locations of 1, 2, 3, 4, 5 above in relationship to Zaria are

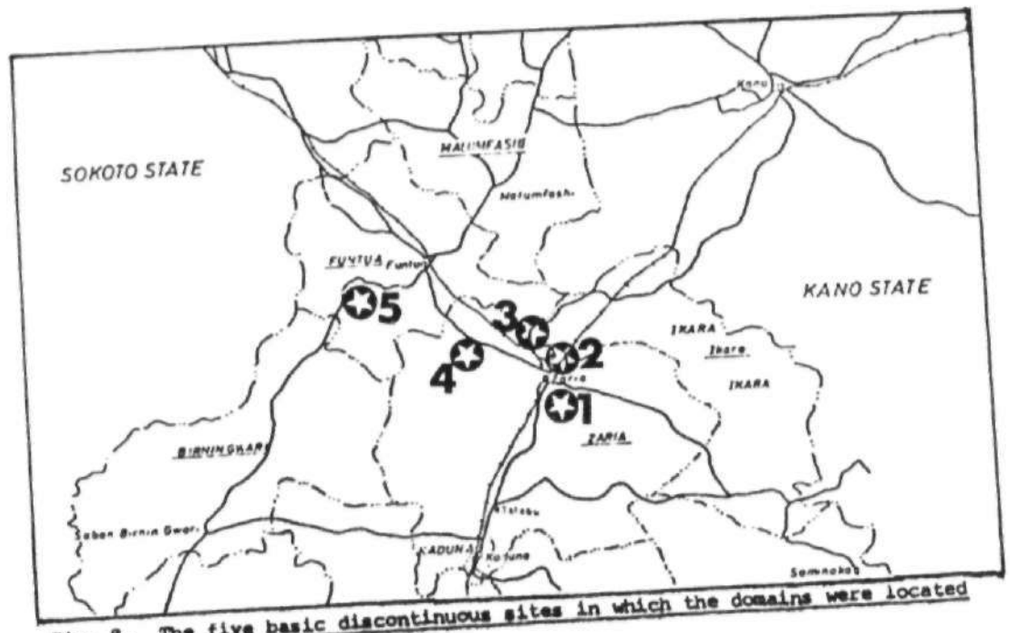
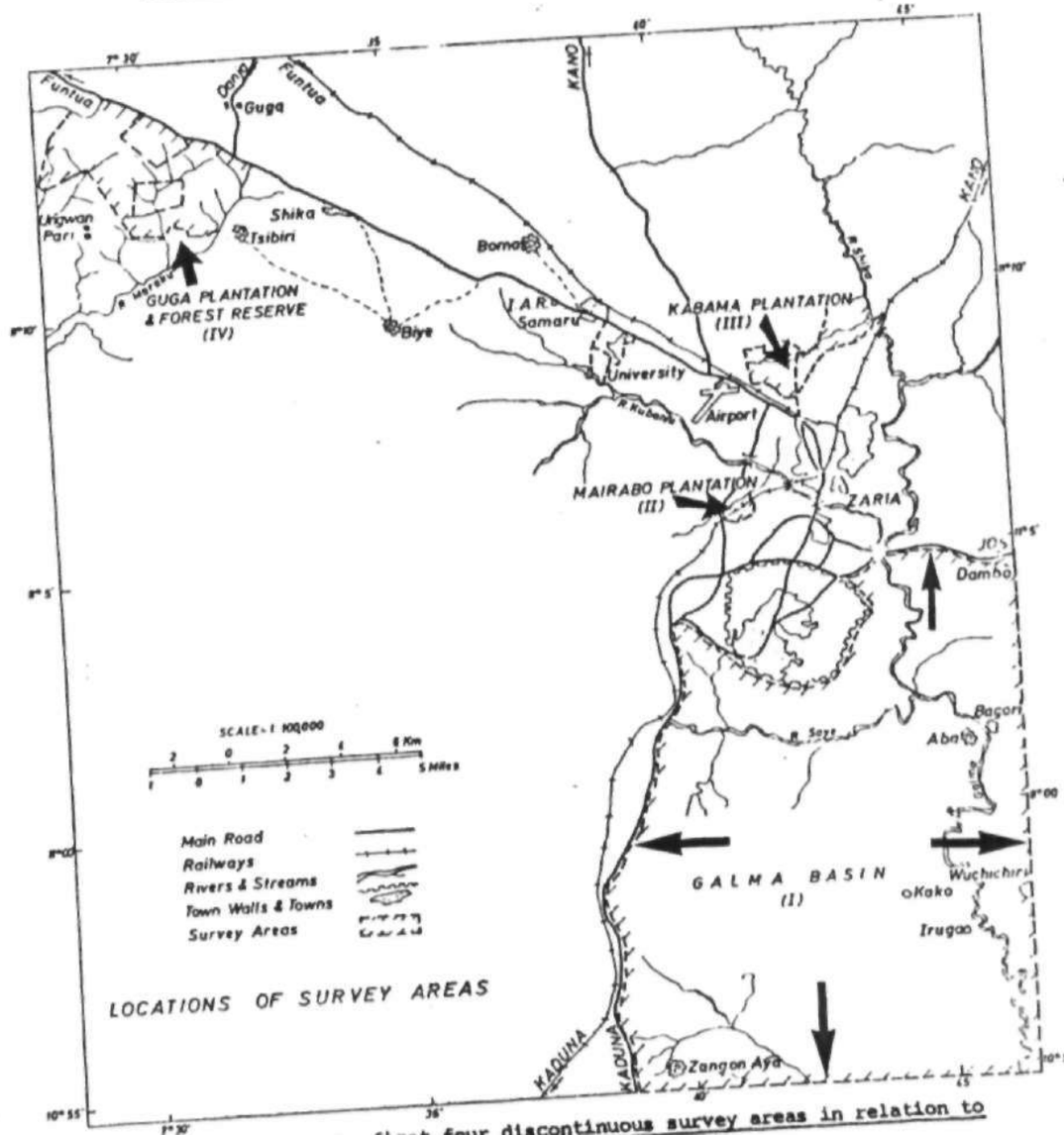


Fig. 8. The five basic discontinuous sites in which the domains were located in Kaduna State.



four discontinuous survey areas in relation to

The Galma Basin Complex is used here in a geographical sense rather than in a geological sense. For, in the geological sense, a 'basin' is "a depression of large size, which may be of structural or erosional origin" (Whitten and Brooks, 1978). In its geographical sense, a 'basin' is "the area drained by a river and its tributaries" (Moore, 1974). I use the Galma Basin Complex to include several geographically associated small land stratas, or domains, drained by one major river.

The Basin Complex is the area drained by the Galma River and its tributaries. The part of it studied was made up of about 260 km. sq. extending southwards from Zaria between 11°5' and 11°51'N, 7°39' and 7°47'E. It is bounded by the Zaria-Kaduna highway on the west, the road through Zangon Aya to the south, the straight line joining Wuchichiri to Dambo to the east and the Zaria-Pambegua-Jos road to the north as in Figs. 9 and 10. Domains I-VII are distributed on the Basin Complex to cover the strata of the landscape, the principles of which I discuss under 'Design of Ground Survey Sampling Techniques'.

MAIROBO FOREST PLANTATION was gazetted as a Native Authority Forest Reserve in 1933 as 'Zaria N.A. No. 4 Local Fuel Plantation'. It covers 177.38 acres (= 717,856.86 square meters) according communications with the Provincial Forest Office in Zaria (Mohammed 1978). It lies about 2 km. north of Zaria City, bisected by the railway and telegraph lines from Lagos to Zaria. It is bounded to the east by the 'Zaria bye-pass' highway from Kaduna to Kano and Samaru. The Mairabo stream which rises from the Kufena Inselbergs and flows into River Kubanni, a tributary of the Galma River, forms its natural northern cultline. It is surrounded by Mairabo and Tukur Tukur agricultural villages but it has special protection from the villagers and in spite of its proximity to Zaria City, it constitutes an intact plantation reserve for exotic species (Figs. 9 and 11).

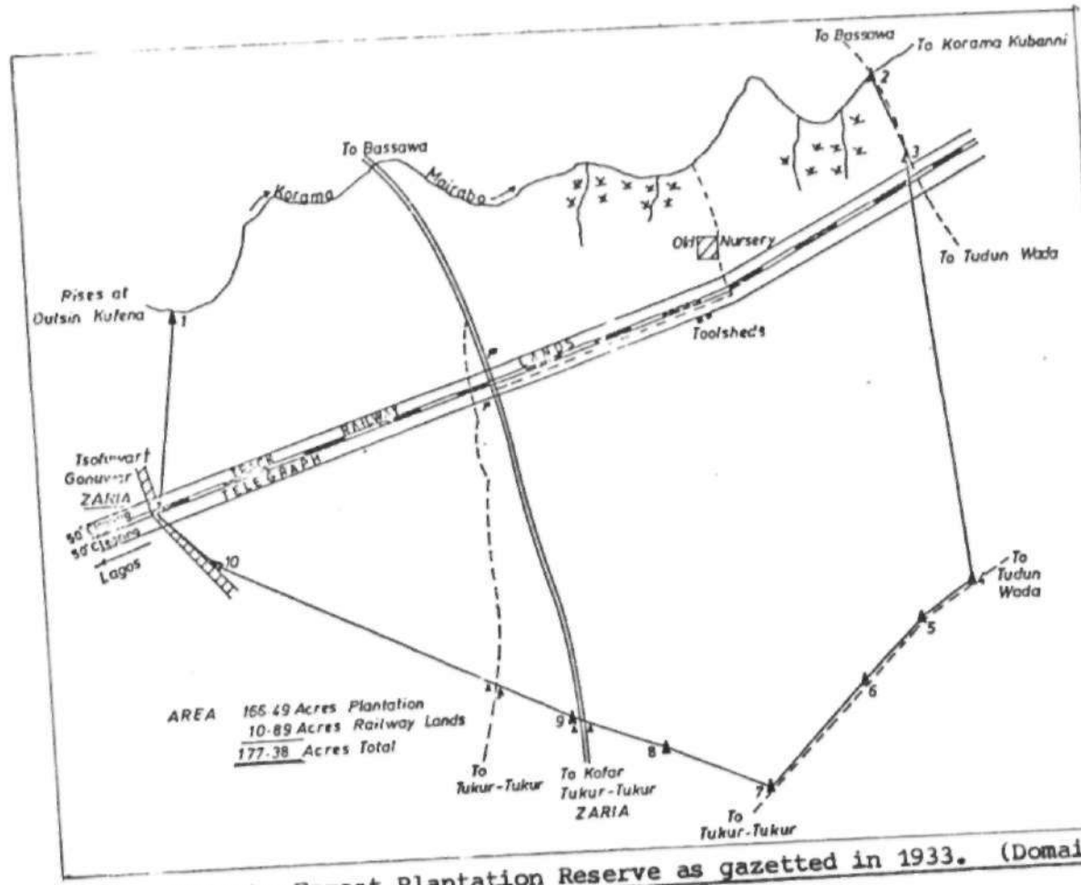
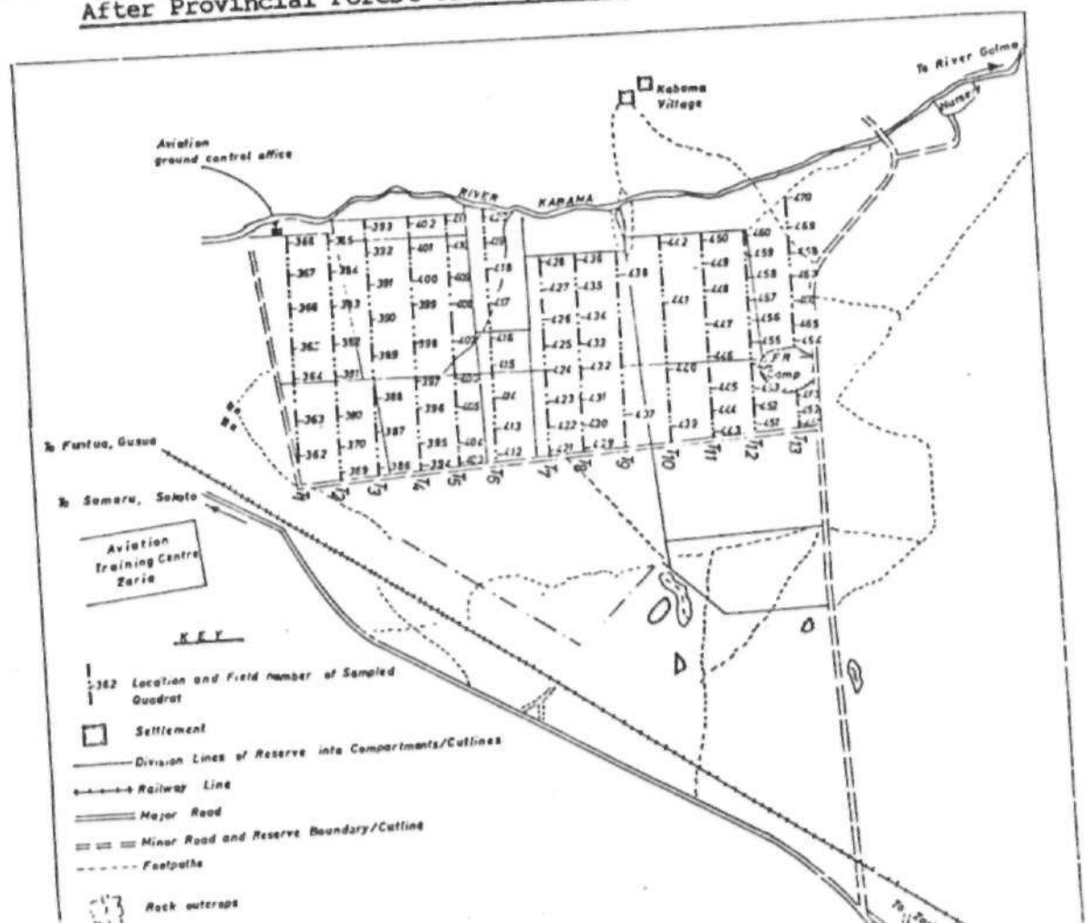


Fig. 11. Mairabo Forest Plantation Reserve as gazetted in 1933. (Domain 8.)
After Provincial Forest Office, Zaria.



KABAMA FOREST PLANTATION constitutes Zaria Native Authority Forest Reserve No. 15 as originally constituted into a Northern Regional Government Forest Reserve in 1918. It was gazetted as covering 1373.9 acres (= 5,560,173 square meters) when it came under direct control of Zaria Native Authority in 1939. Records from the Forestry Divisional Office in Zaria suggest that the introduction of exotic species started in 1967 and states that "Most of the plantable land is now planted" and that "some good thinnings have been extracted" in the 1976 entries. The Kabama Forest Reserve was thus apparently nominally reserved for a long period but it is now a plantation reserve, largely. About half of the approximately 5.5. sq. km. gazetted land area constitutes the Kabama Forest P antation.

The Plantation is located opposite the Aviation Training Centre, Zaria, and bounded northwards by the River Kabama which flows into the Galma River, before the Kabama village. Its location and environs along the Zaria-Samaru road are indicated on Fig. 12.

GUGA FOREST PLANTATION, FOREST RESERVE AND ENCLAVE was initially Zaria Native Authority Forest Reserve No. 22 located in the Giwa District of Zaria Division. I describe it in terms of plantation, reserve and enclave from the point of view of obvious land use differences, but it continuous forest reserve. According to the official citation order contained in the supplement to Gazette No. 17 published on 23rd March 1950, preserved in the office of the Divisional Forest Officer, Zaria, its location and limits were detailed as follows:

The Guga Forest Reserve is on the right hand side of Sokoto-Zaria motor road when proceeding from Sokoto to Zaria. It starts from the point where the motor road crosses the Marke Stream and terminated by where the same road is crossed by the Dangwal Stream. It is bounded on the east by the right bank of Dangwal Stream in a general south-westerly

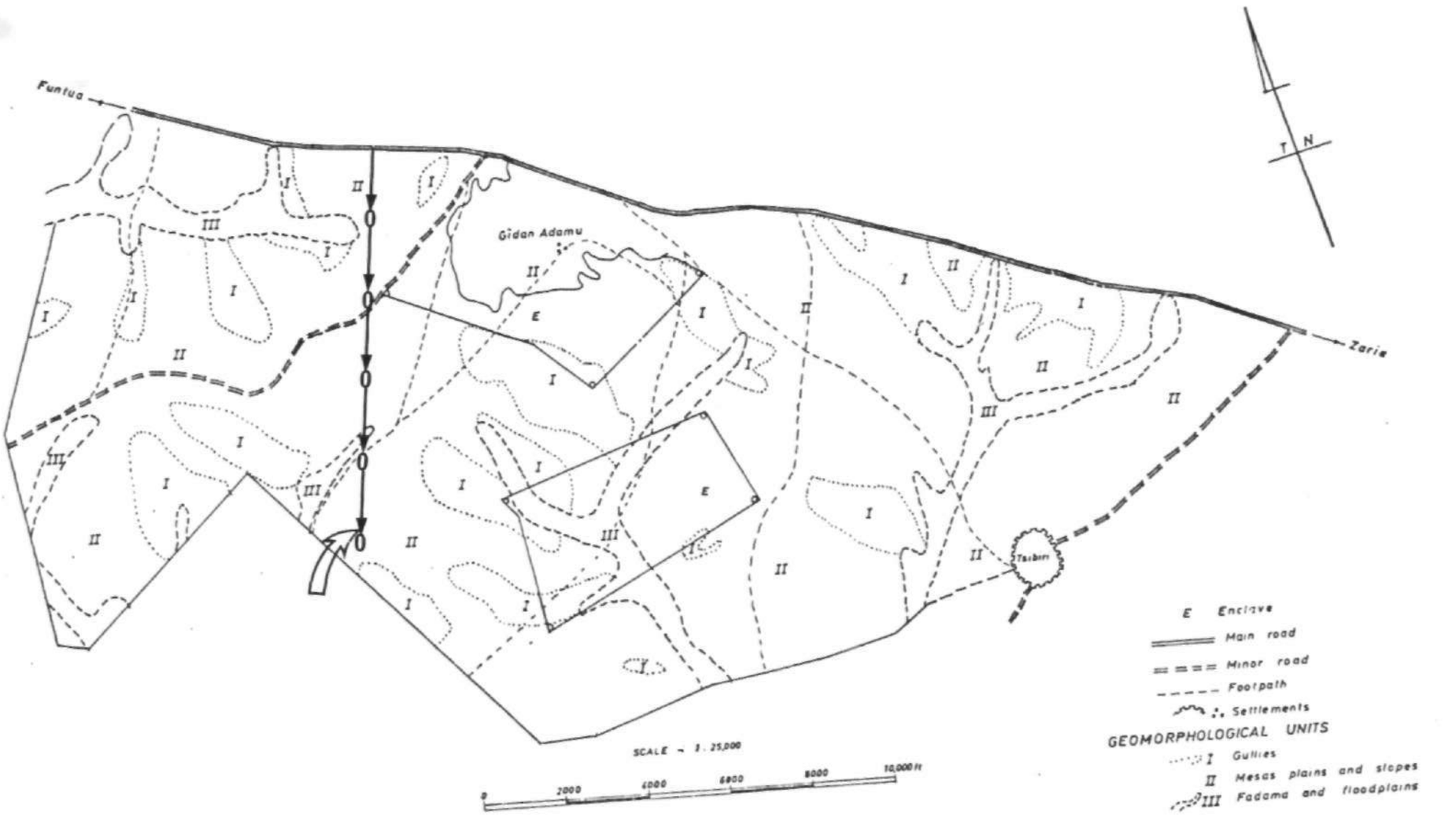


Fig. 13. Guga Forest Reserve (Domains 10 and 11). Boundaries, routes, and settlements are in accordance to the official citation order as gazetted on 23rd March 1950, after the Divisional Forest Office, Zaria. Other superimposed features are mine.

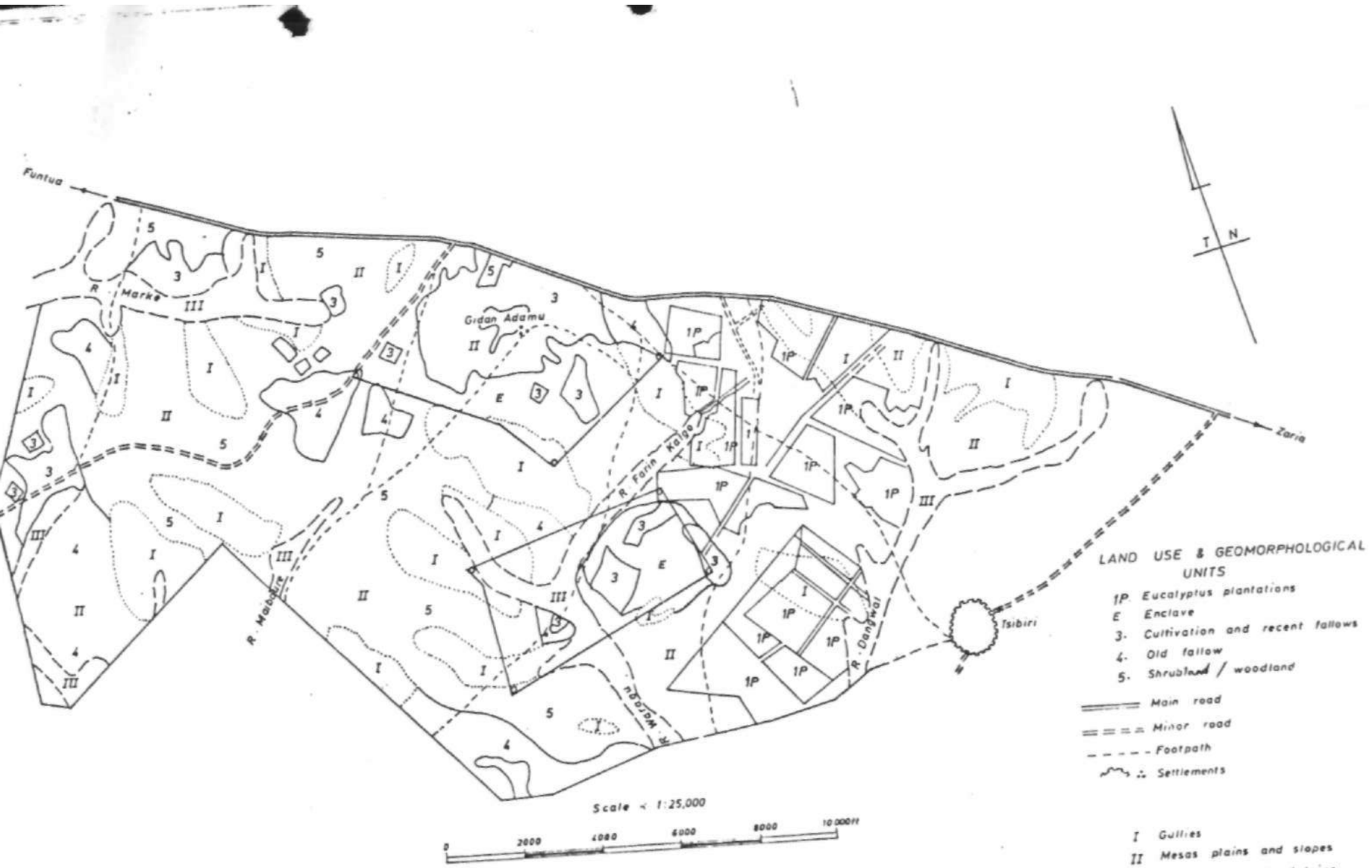


Fig. 14. Guga Forest Reserve with the landuse features superimposed on the Fig. 13 Base Map.

direction. On the south and westward it is bounded by the footpath joining Anguwan Jaula to Anguwan Tsibiri. (Anguwan means hamlet.)

Its latitudinal and longitudinal location lies approximately within 11°4'N and 7°33'E respectively, and most of it is at an elevation of above 2,200 ft (= 670m.) above mean sea level. It has a total land area cover of 18 sq. km. (See Figs. 13 and 14.)

GUGA FOREST PLANTATION by 1978 has had nine years of active planting with exotic species. The oldest stands data from 1969, and 415 hectare (= 4.15 sq. km.) have been planted in intensively cultivated areas on the River Dangwal side of the reserve.

GUGA FOREST RESERVE ENCLAVES consist of two sites (known and mapped by the Forestry management(viz: Gidan Adamu Enclave and Anguwan Jamo Enclave. The existence of the two Enclaves is connected with the principles of forestry management methods in reserves, and the historical occupation of the land. As far as possible, the Forestry demands elimination of competition from local inhabitants and their forms of land use. Human activities existing in the 18 sq. km. land before the 'citation order' were restricted to the two enclaves, where farming was permitted.

GUGA FOREST RESERVE is the remaining area of Guga under reservation but neither specially planted with trees nor farmed as in the Enclaves. Pastoral Fulani herdsmen are permitted in the enclaves although there is no special allocated area for grazing purposes. In practice inhabitations were not restricted to the demarcated enclaves because temporary erections and abandoned pastoralists' shelters were located during my surveys of the reserve although the whole Guga area was covered by the gazetted management plan. Cattle, goats and sheep were commonly seen on the field during my field work too. It formed a communal multi-purpose land use area. Firewood for domestic (and possibly for sales) and grasses for

thatching were cut (secretly) although there was one patrol guard to enforce the forestry management laws on farmers, firewood hewers or pastoralists. Fire is forbidden, but there were signs of burning, possibly intermittently, on the trees. Paths linking rugas (pastoralists' shelters) to the Enclaves and to the Sokoto-Zaria road ramify it. Uncultivated trees were de-topped to provide foliage for cattle, sheep and goats. I separate this unmanaged nominal reserve from the rest because its land use is undefinable, numerous and chaotic.

KUYELLO AND ITS ENVIRONS covers the area within and around the so-called "Farm Settlement Scheme on the Model Village of Kuyello" (Bot 1977), started by the Ministry of Economic Planning and Rural Development of Kaduna State. The domain of survey is located between kilometers 60 and 65 from Funtua to Birnin Gwari Road. It lies between latitudes 11°12' and 11°16'N and longitudes 6°55' and 6°59'E. The Dogon Dawa Forest Reserve lies on the oppsite side of the road which is the north-western limit of the survey area. The south-east boundary is formed by the River Damari. The road from Unguwan Farinbatu to Old Kuyello forms the south-west boundary and another road linking Duniya Village from near the River Damari to Kompany on the Funtua-Birnin Gwari major road forms the north-eastern end. In all, the area sampled covers approximately 36 square kilometers. See Fig. 15.

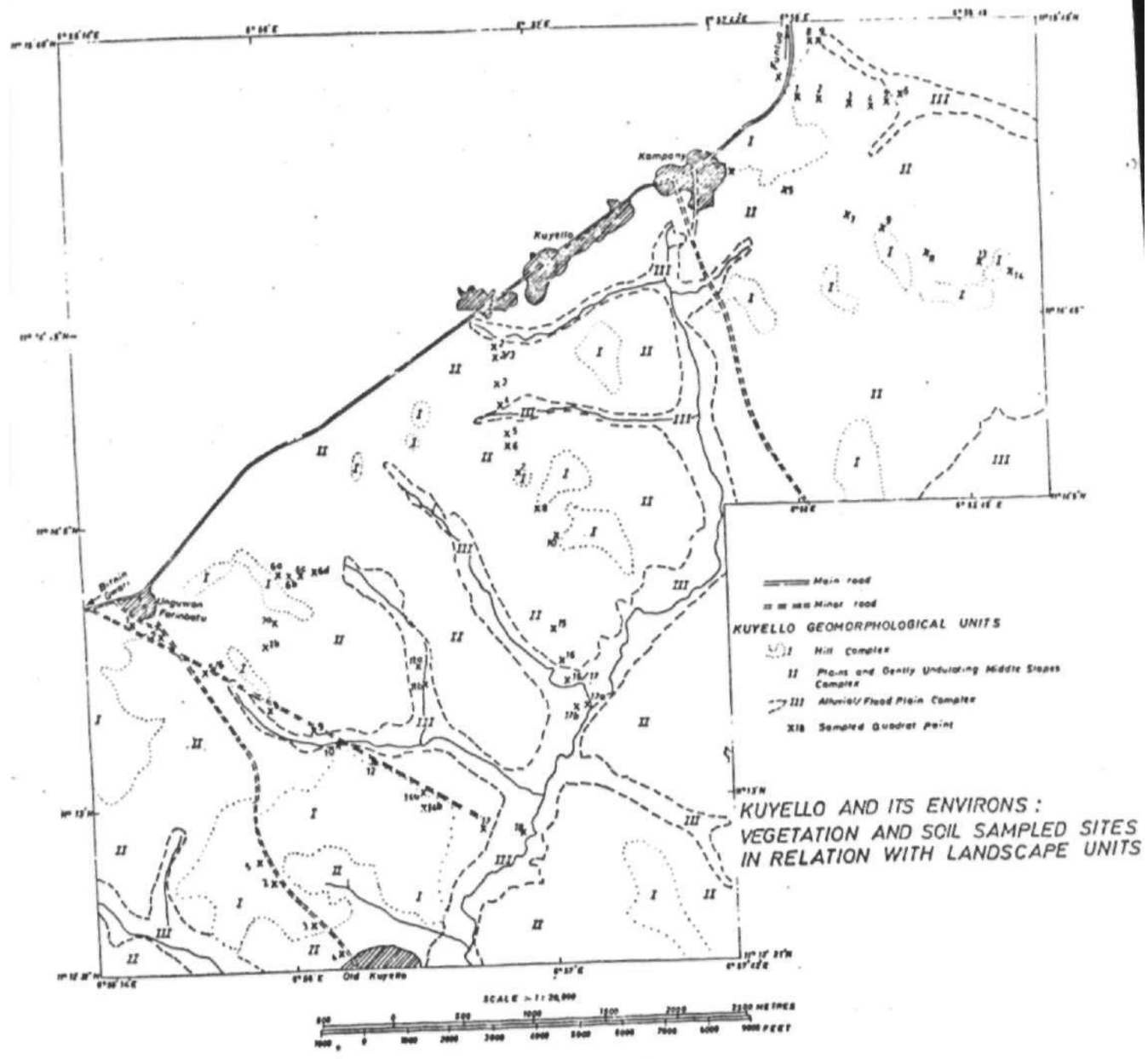


Fig. 15. Kuyello and its environs: Vegetation and soil sample sites in relation with landscape units After Valette and Osanoto (1977).

CHAPTER 6 FIELD SAMPLING FOR FLORISTIC AND ENVIRONMENTAL DATA

6.1 INTRODUCTION

Field work on domains I to XI took place over one calendar year. It commenced in January 1978 when I returned to Nigeria following my archival studies in Oxford. It terminated in December 1978 when I returned to Oxford in January 1979.

The field work on domain XII around Kuyello was, however, executed during December - January 1976/77, as a part of the routine team work executed by the Soil Survey Section of the Institute for Agricultural Research, Samaru, Nigeria. It is incorporated into this thesis because it was a floristically detailed survey made in conjunction with a semi-detailed soil survey. It is the only part of the previous vegetation surveys made by me, independently or as a member of the Soil Survey team, that falls within the 'Northern Guinea Savanna Zone'. My other surveys were made either in the "Sub-Sudan" and "Sudan zones" of Clayton (1957), either specifically for the analyses of weeds of arable crops, or as a member of a reconnaissance survey team with the I.A.R. Soil Survey Section and with the Land Resources Division (L.R.D.) of the Ministry of Overseas Development between 1972 to 1975. The L.R.D. work was then taking place in the "Southern Guinea Savanna zone" of Keay (1949-1959) on the River Benue Valley around Makurdi.

The field ecological work and the floristic analytic experience gained through the independent and team work in those so-called "sub-zones" of the Nigerian 'savanna' have contributed to what, possibly, may be thought of as my 'anti-savanna zonal concept'. It has induced me to wish to subject floristic and environmental data from the Nigerian 'typical' savanna zone to quantitative multivariate analytic techniques to test the homogeneity attributed to the regional vegetation.

Computer No. 28. **GUINEA SAVANNA: WEEDS IN ARABLE CROPS**

Location: Bizara – Gotza No. 37. | Latitude: | Longitude: | Date: 2.2.78 | STRATA: Fadama

Pt. No: 37 | Quadrat size: 10m x 10m | Size of Farm: 40 m x 50 m | No. of Crops in Farm: | No. of Samples in Farm: 2nd

Underlying rock: None. Sample bag: G.o.G. 37a | No. of previous Weedings: Fallow regrowth.

Main weeds: Borreria verticillata, Nelsonia canesc | Class: 2nd year fallow on the end of the fadama.

CROPS	Cover	Mean ht	Max. ht.	Dist. btw. crop	Dist. btw. row	Vigour
Capsicum (harvested)	–	' –	–	1½ m.	—	—

Any other note on crops

Site of quadrat was planted with peppers, Capsicum. Information based on the Fulani pastoralist met on the site.

Currently the major forb is Borreria verta but the herds of his animals will not feed on the!

WEEDS	Cover	Soc.	WEEDS	Cover	Soc.
Borreria verticillata	7	–	Laucas martinicensis	2	—
Nelsonia canescens	7	–	Triumphetta pentandra	1	—
Andropogon pseudapricus	4	–	Chrozophora senegalensis	1	–
Brachiaria stigmatisata	5	–			
Paspalum orbiculare	4	–			
Vernonia perrottetii	3	–			
Zadigofera pulchra	3	–			
Ageratum conyzoides	1	–			
Borreria radiata	2	–			
Ipomoea eriocarpa	3	–			
Eragrostis tremula	3	–			
Alysicarpus glumaceus	1	–			
Sphaeranthus senegalensis	1	–			
Urena lobata	1	–			
Polygala petitiana	1	–			
Cassia rotundifolia	1	–			
Mitracarpus scaber	1	–			
Scoparia dulcis	1	–			
Thelepogon elegans	5	–			
Crotalaria senegalensis	1	–			
Centella asiatica	3	–			
Waltheria indica	1	–			
Jussiaea suffruticosa	1	–			

Dist. from unformed land: 1km
Topographic site: 3
Degree of slope: 1
Soil depth: 0 – 3"
Aspect: —
Soil colour: Lt. Yellowish Br.
Five point-scale estimate of:
Bare area: 1
Erosion: 0
Drainage: 4
Permeability of subsoil: x Lo.
Earthworm casts: 0
Termitaria: 0
Stoniness: 0
Clay %: 10%
Silt %: Silty Loam 46%
Sand %: 44%
pH: 5.4
Organic carbon: 0.71
Extractable Na: 0.05
Extractable K: 0.16
C. E. C.: 6.6
Base sat. % 49
N.B. Galma "Fadama"

An example of the field format used in the quantitative floristic and environmental data recording under current and recent arable lands.

Comp No. 77 NIGERIAN GUINEA SAVANNA: VEGETATION – SOIL – LAND USE SURVEY

Location: Gwon Forest Reserve (Non-plantation) | Latitude: | Longitude: | Date: 1. 9. 78 | Strata: Guga XI

Quadrat size: 10m. x 10m. | Land use: grazing, fuel cutting; no cultivation | Point number: G76

Underlying rock: Schist + Quartzite on surface of soil | Soil: Dipped in G.P.S. 676a + G.P.S. G76b

Physiognomy: Open shrubland | Class: Detarium open shrubland | Canopy closure:

TREE LAYER	SCORES		SHRUB LAYER	SCORES		GROUND LAYER	SCORES		
	Cover	Ht.cl.		Cover	Ht.cl.		Cover	Ht. cl.	
Burkea africana	1	9m.	Detarium microcarp.	7	3m.	Loudetia simplex	8		
			Maytenus kerstingii	4	4	Andropogon schir.	4		
			Hymenocardia acida	2	2m.	Cienium nanum	3		
			Butyrospermum paru.	1	<1m.	Fimbristylis hisp.	2		
			Ochna afzelii	1	<1m.	Mitrachne indica	2		
			Dichrostachys glom.	2	1m.	Monocymbium cere.	3		
			Terminalia avicen.	1	1m.	Digitaria lecardi	2		
			Crossopteryx febrif.	1	3m.	Costus spectabilis	3		
			Combretum molle	1	2m.	Guttenbergia nigritana	2		
						Pennisetum pedicellata	1		
						Vernonia perrottetii	2		
						Vernonia glaberrima	2		
						Ctenitrium muricatum	2		
						Panicum maxim.	2		
						Zornia glochidiata	2		
						Cryptolepis sanguin.	1		
						Borreria radiata	1		

Accessible site 2
Degree of slope 2
Soil depth 0–30" (0–76cm)
Aspect —
Soil colour 1
Five point-scale estimate of:
Rock area: 1
Erosion: 0
Drainage: 3
Permeability: easy to augur
Earthworm casts 0
Termitaria 1
Stoniness 0
Clay % 10%
Silt % (Loamy Sand) 20%
Sand % 70%
pH 5.5
Organic carbon 0.5%
Extractable Na 0.02
Extractable K 0.05
C.E.C 1.0
Base salt % 100%

N.B. with the rainy season at its peak all the annual grasses and forbs are now out. The soil too is easily augured using the hand corina auger.

An example of the field format used in the quantitative floristic and environmental data recording under woodlands, shrublands, forblands, plantations, etc in unfarmed lands.

For my present quantitative analytic approach, the two example formats attached were designed and used in the concurrent survey of the flora and their environmental properties. The first type of format was used in areas visually discernible as current or recent arable lands under the rotational fallow farming system within the cerado (or 'savanna'). The second type of format was used in areas which were covered with trees, shrubs or forbs, for examples, in unfarmed lands on swamps or on rocks and in forest plantations or in simply legally reserved areas of the cerado.

6.2 FLORISTIC DATA COLLECTION FROM THE DOMAINS

The field method used in the floristic data collected involved the Cover-Abundance value estimation of all species present within 10m. x 10m. quadrats. A 100 meter-long chain was used for the measurements of the quadrats. The complete species enumerations were evaluated using the Cover-Abundance scores of the Domin-Krajina (1933) type of scale. These constitute the bases for the quantitative information about the species.

For the sake of consistency, I maintained the ten-point Domin-Krajina Cover-Abundance Scale (hereafter simply called Domin Scale) flora estimation method throughout the field survey. 714 temporary quadrats were examined. 419 different species were encountered over the twelve different domains. All species were identified. The I.A.R. Herbarium and the Federal Herbarium, Ibadan, were used where necessary to ensure accurate species identification. The Summary of the distribution of the strata or domains, their areas, number of quadrats sited, and number of recorded species, is as follows:

STRATUM	LOCATION	N. QUADRATS	m. SPECIES
'Fadama' I	Galma Basin	36	149
Dambo II	Galma Basin	34	119
Scheme III	Galma Basin	20	46
Kako IV	Galma Basin	23	73
Upland V	Galma Basin	56	212
Plains VI	Galma Basin	111	221
Rocky VII	Galma Basin	56	178
Mairabo VIII	Mairabo Plantation Reserve	25	110
Kabama IX	Kabama Plantation Reserve	100	185
Guga X	Guga Plantation and Enclaves	88	179
Guga XI	Guga Non-Plantation Reserve	80	174
Kuyello XII	Kuyello Environs	85	230

The strata names are those coined as job names during computations.

Phillips (1959) pointed out that "In an area where trees and grass occur together, abundance might indicate grasses as more important than the less numerous though overtowering trees", and that "cover used to indicate the area covered by species crown or the stem needs consideration for analysis of quantities".

Greig-Smith (1964) defined cover as "the proportion of the ground occupied by a perpendicular projection of the aerial parts of individuals of the species under consideration". An application of Greig-Smith's "aerial parts" as "crown cover" would indicate a few overlayering trees as having the total cover where they were in fact numerically less significant. I applied "aerial parts" as the proportion of the ground occupied by a perpendicular projection of the ground level basal stem cover for trees to avoid over-rating isolated but over-towering trees.

My ground level basal stem cover rating for trees also gave what appeared to be their true cover-proportions under locally clumped trees, under woodlands and under forest plantations, just as it did on current and old arable lands with scattered trees.

The Domin Cover-Abundance Scale has been favoured by ecologists concerned with detailed evaluation of mixed populations of species exhibiting differences in numerical abundances and in relative covers. Kershaw (1968), for example, used the Domin Scale in his survey of woody species in the "Northern Guinea Savanna" of Nigeria. Mueller-Dombois and Ellenberg (1974), however, compared the eleven-point Domin Scale with the five-point Braun-Blanquent Scale intervals. They claimed that "In species-rich herbaceous communities, estimative errors are more likely with the finer Domin Scale intervals than with the cruder Braun-Blanquent scale intervals". Such "estimative errors" will, however, probably be negligible in these surveys. Under a one-man floristic cover abundance estimation, the "estimative errors" will tend to be consistent throughout. That will in turn produce the desired relative proportional estimates of the individual species cover-abundance in the quadrats.

The Domin Cover-Abundance Scale as reported by Mueller-Dombois and Ellenberg (1974) and by Goldsmith and Harrison (1976) was slightly modified for my field and computational work, without any radical changes. The only difference I created was to convert the eleven-point score intervals to a ten-point score interval to substitute 1 and + with just 1 and to create a zero score for non-existent species during the subsequent computer-analyses as follows:

Cover-Abundance Scores		Cover-Abundance %	Species Cover-Abundance Description
Domin	Osanoto		
10	10	100%	species with complete cover
9	9	greater than 75%	species with more than 3/4 cover
8	8	50-75%	species with 1/2 to 3/4 cover
7	7	33-50%	species with 1/3 to 1/2 cover
6	6	25-33%	species with 1/4 to 1/3 cover
5	5	10-25%	species with 1/10 to 1/4 cover
4	4	5-10%	species with 1/20 to 1/10 cover
3	3	1-5%	species scattered, less than 1/20 cover
2	2	less than 1%	species very scattered.
1	1	solitary species	isolated species.
+	0	species absent	species not seen in quadrats.

6.3 SYNTHETISED SYNOPTIC FLORISTIC TABLE MATRICES

For each domain, the set of floristic data from the successive quadrats sampled on the field were synthetized into a single matrix of N quadrats and m species. The m species recorded in each set were manually reshuffled by simple numerical re-ordering. Species with the maximum absolute constancy values (A.C.V.) came first so that the rearrangement of the species from a domain reveals the relative concentration or absence of each species in the sub-set of the environment surveyed.

Westhoff and van der Maarel (1973) called such an arrangement a "phytosociological table", and they used the term "synoptic table" for such "phytosociological tables where constancy, either as a percentage or a class value, for individual synthetized sets of relevés is given". I use "synthetized synoptic floristic raw data matrix" in their sense for this arrangement of the taxonomic components of a floristic data matrix in which species that tend to recur most constantly are reflected in a synthetized set of quadrats of equal size from the field survey of a stratum or a domain of the environment.

The synthetized synoptic floristic raw data matrices for the domains are reported in the order of the job names used in the computations of the communities and community trends. They are numbered I to XII, corresponding to the order in which the twelve domains or strata examined

6.4 THE APPLICATION OF CLUSTER ANALYSIS TO FLORISTIC AND ENVIRONMENTAL DATA MATRICES

The statistical objective of cluster analysis techniques may be generalised to mean the derivation of mutually correlated subsets from a given set of quantitatively assessed variable observations. The derivation produces a reduction of the co-variance from a correlation matrix. The summary of the co-variation contents of the matrix defines the spatial relationships between entities. These entities may represent the cover-abundance values of species, or properties of the physico-chemical edaphic, biological, geological and such properties of the site of the environment sampled. I have found the same agglomerative clustering method of cluster analysis described for quadrats here to be very useful in detecting plant communities through the "ecological species groups that characterise the major gradients of variation" as proposed and used by the Finnish and Swedish schools of ecology (Pakarine and Ruuhijarvi, 1978).

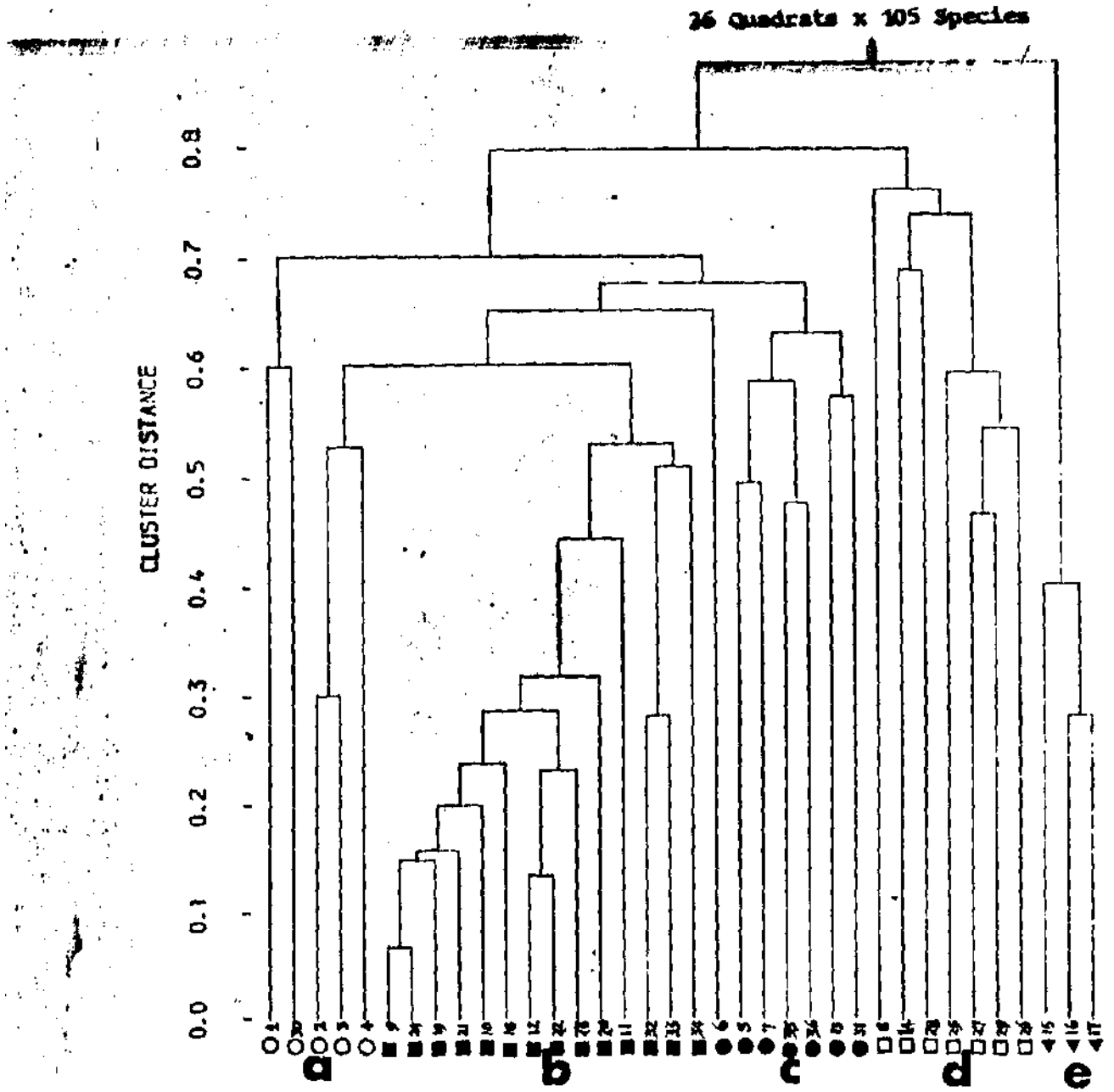
Normal analyses were quadrat-based on the Q-data matrices. Analyses of the species, physico-chemical, biological and the evaluated environmental properties were based on their R-data matrices. The results are represented by the following dendrograms.

CLUSTER RESULTS

Q-CLUSTER DENDROGRAM RESULTS

FOR SYNOPTIC FLORISTIC RAW DATA

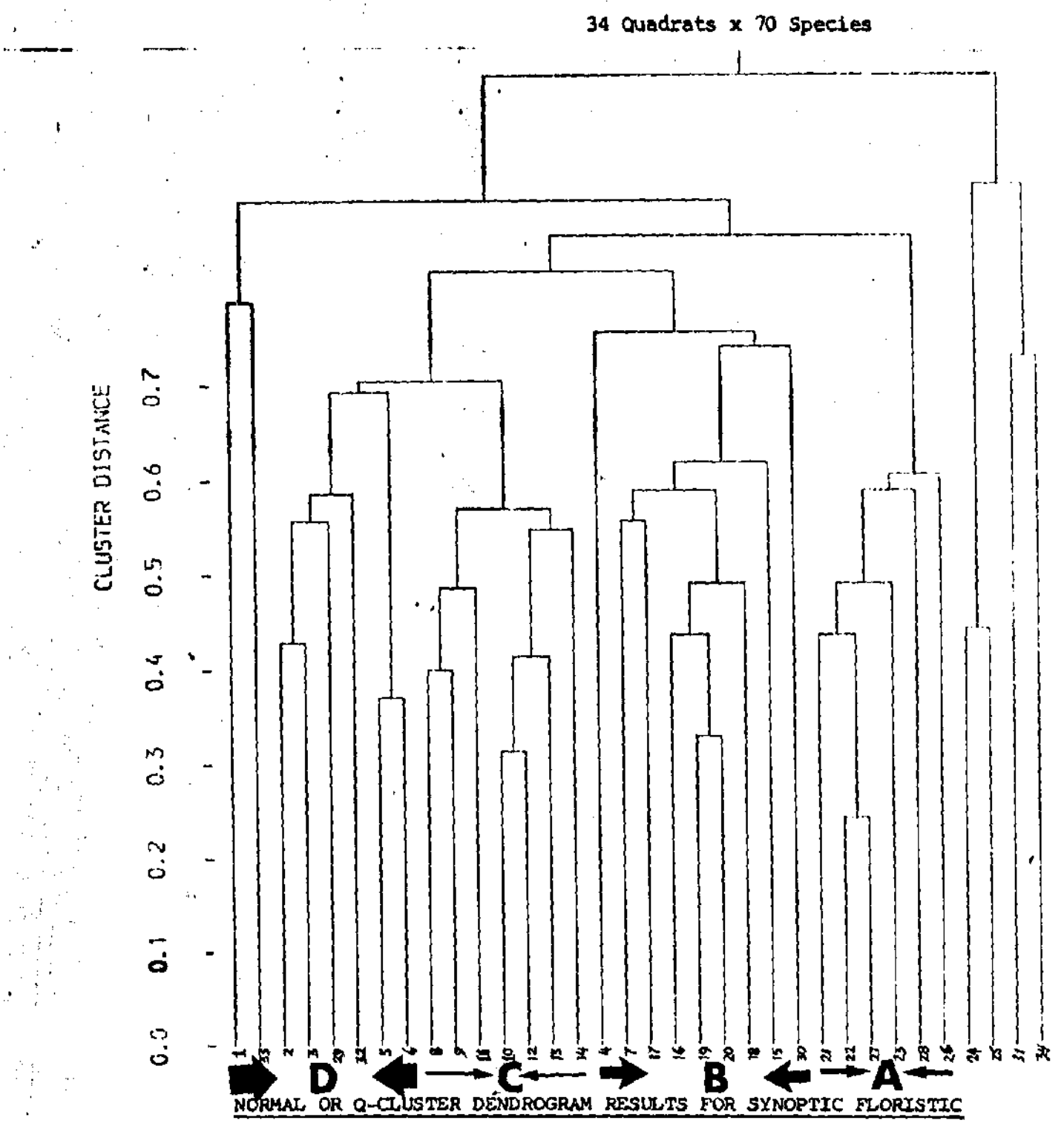
MATRICES I TO XII



NORMAL OR Q-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX I

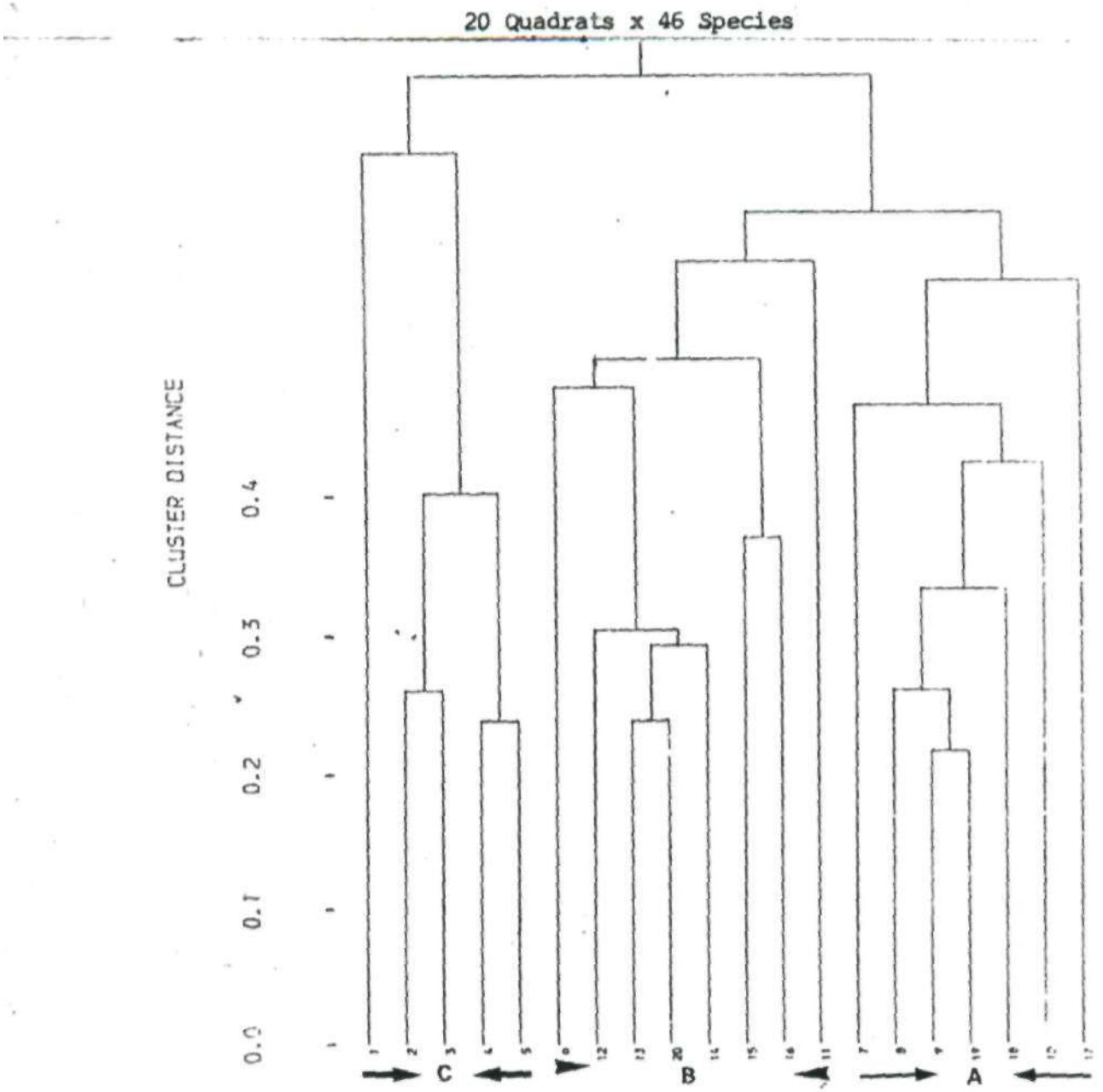
GALMA 'FADAMA' VEGETATION

See text for the explanation of relatively clustered quadrats.



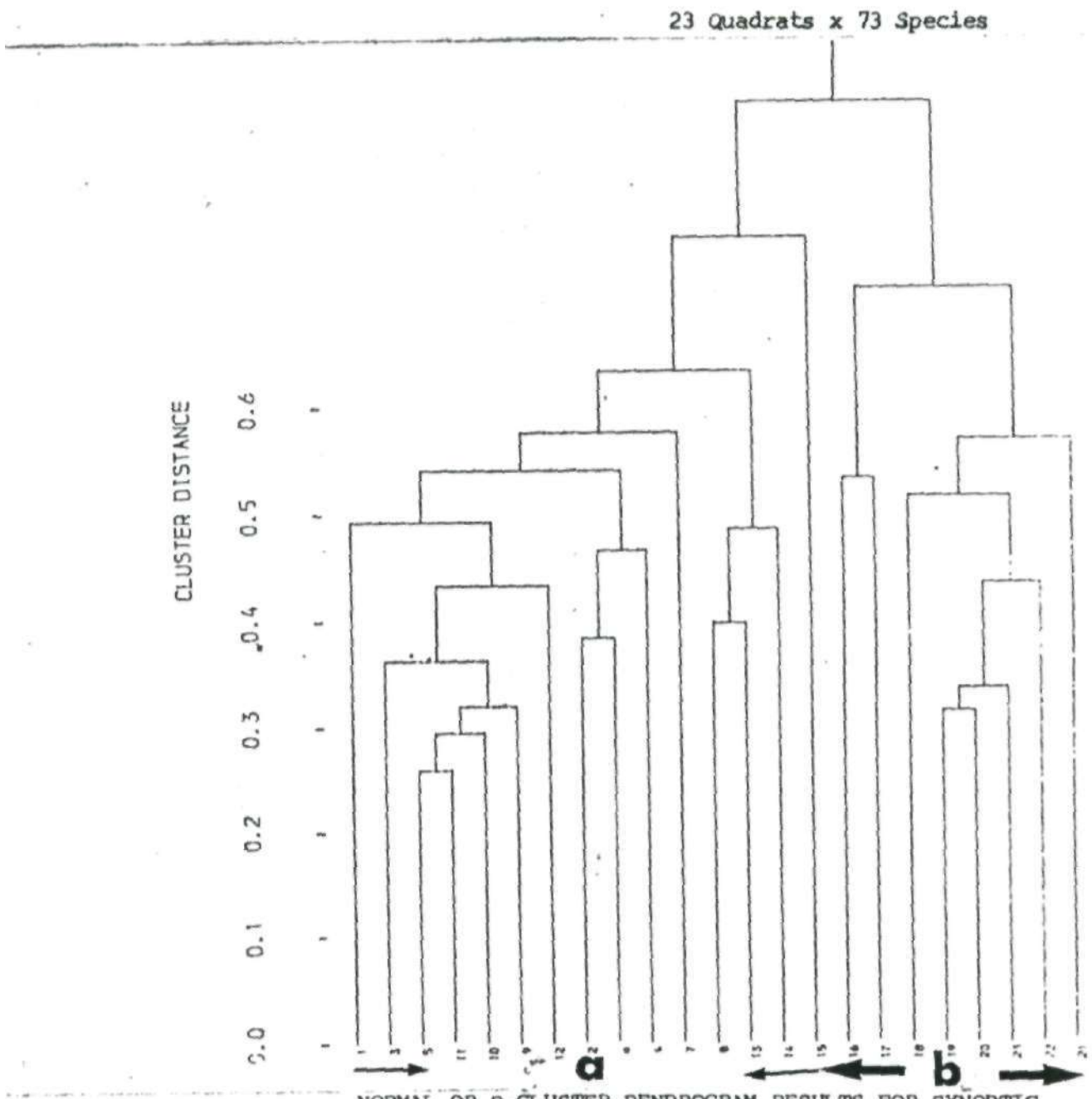
NORMAL OR Q-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX II.

ZARIA - DAMBO 'KURMI'



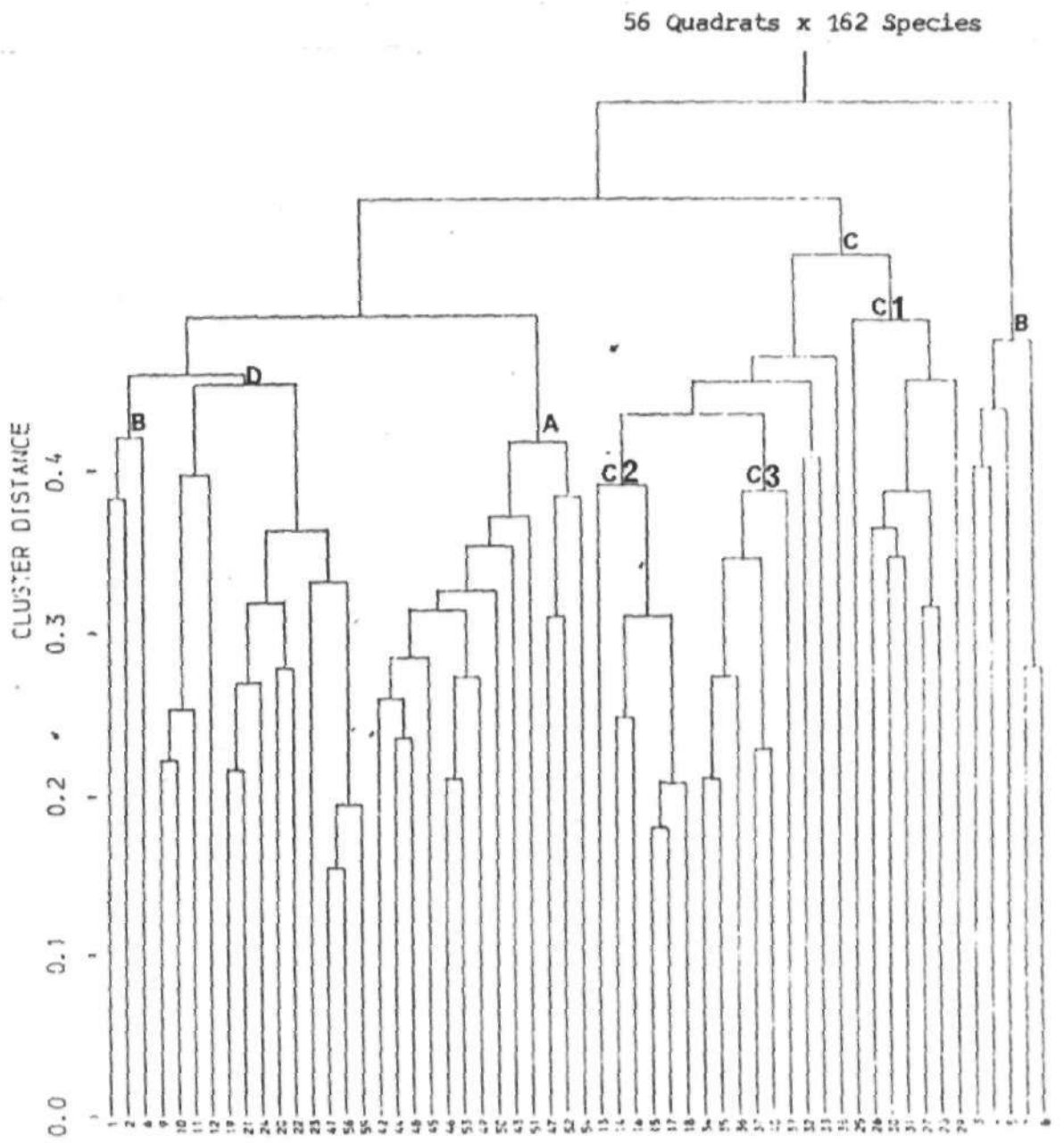
NORMAL OR Q-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX III.

GALMA IRRIGATION SCHEME SITE



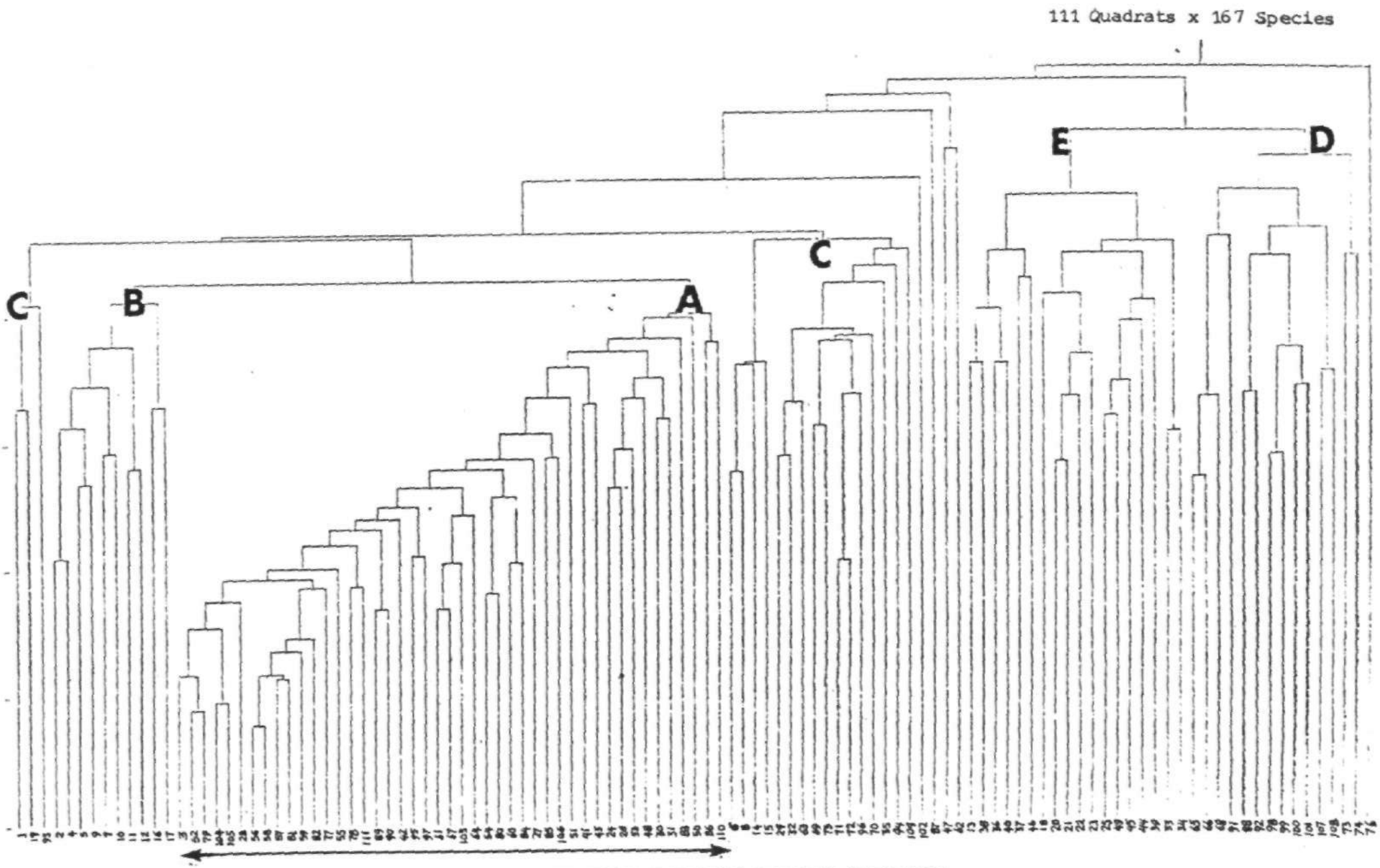
NORMAL OR Q-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX IV.

UPLAND KAKO VILLAGE TO GALMA 'FADAMA'



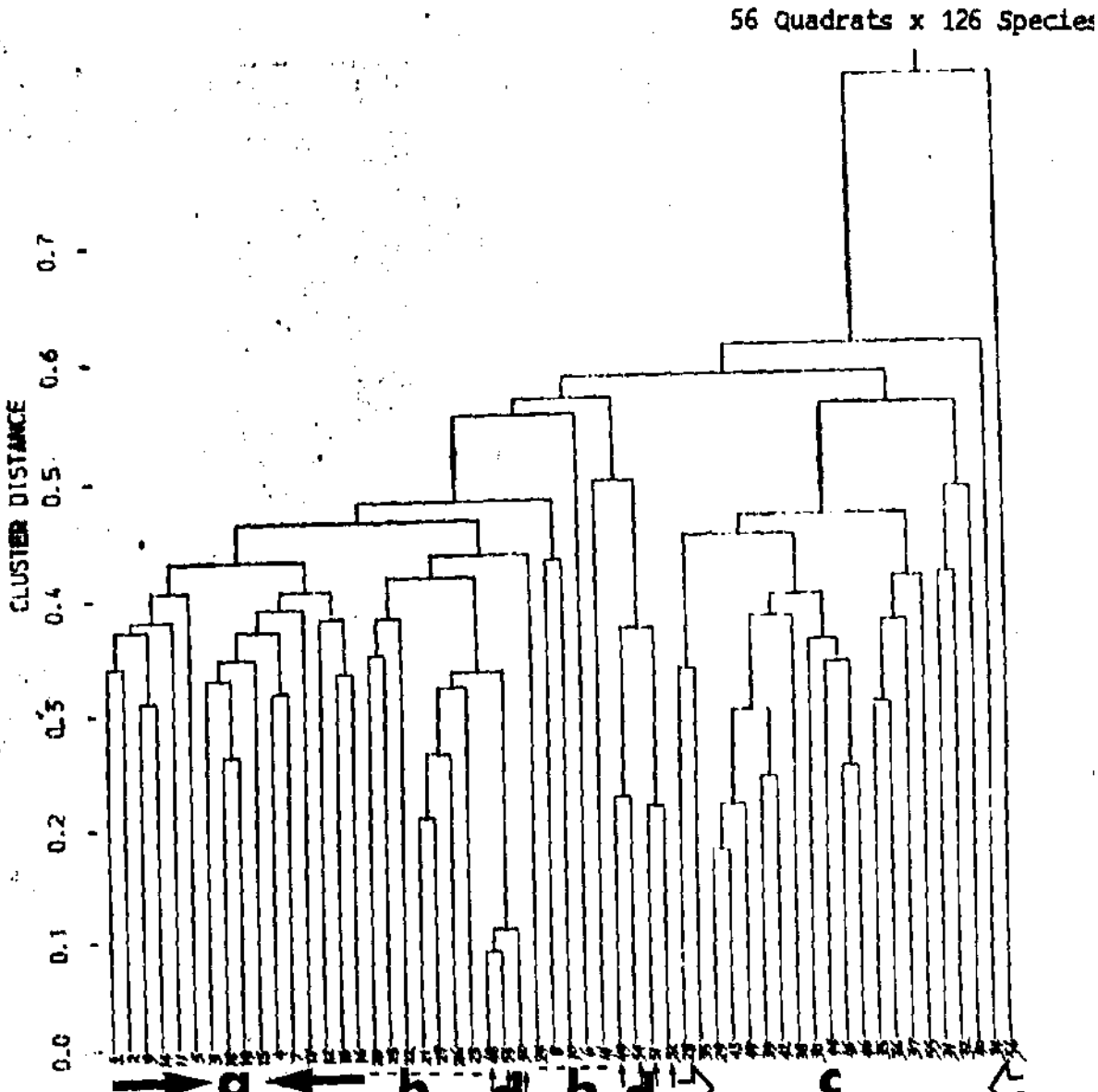
NORMAL OR Q-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX V.

SELECTED GALMA UPLAND SITES

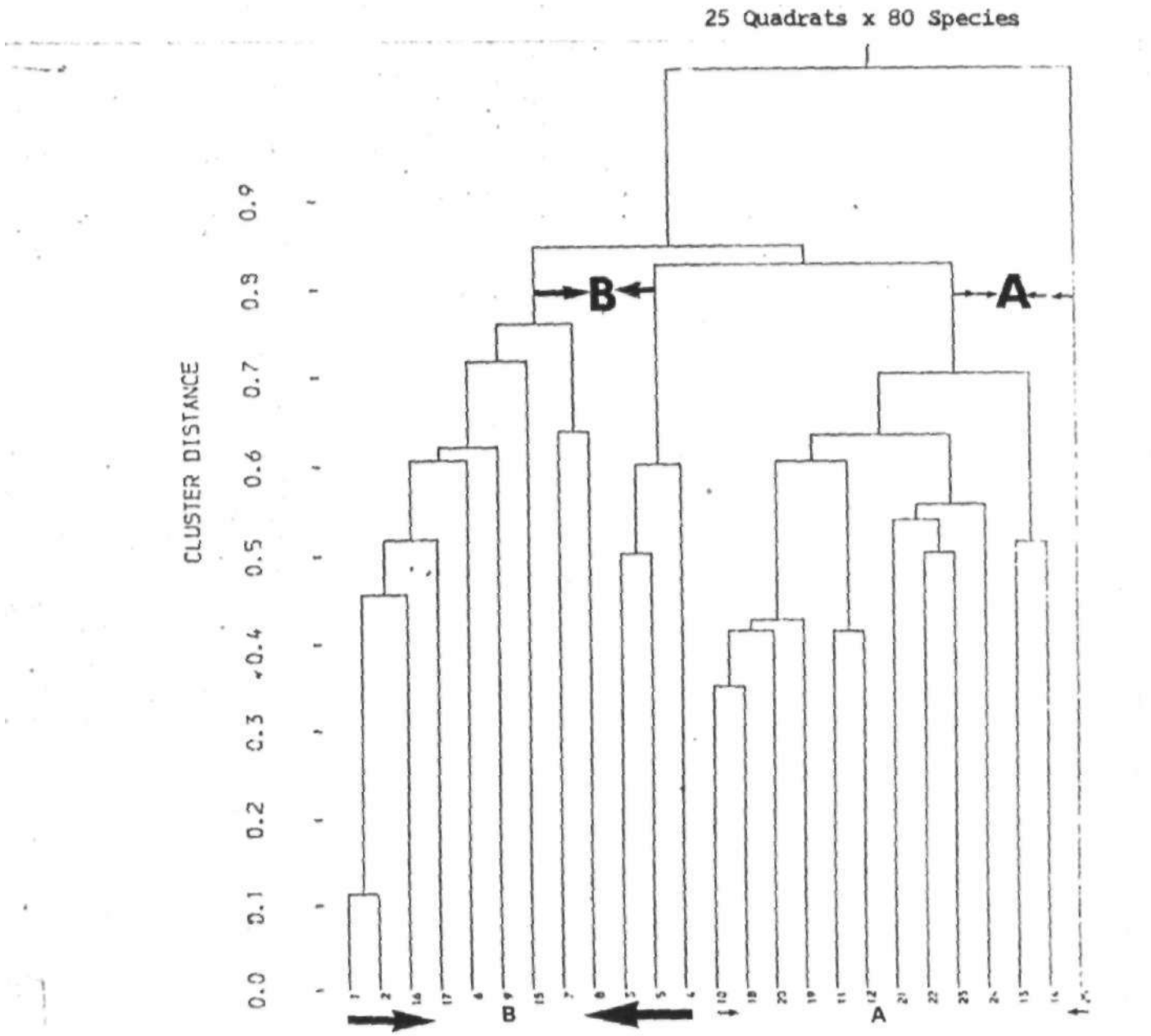


NORMAL OR Q-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX VI.

DUMBI TO KAKO UPLAND PLAINS TRANSECT.

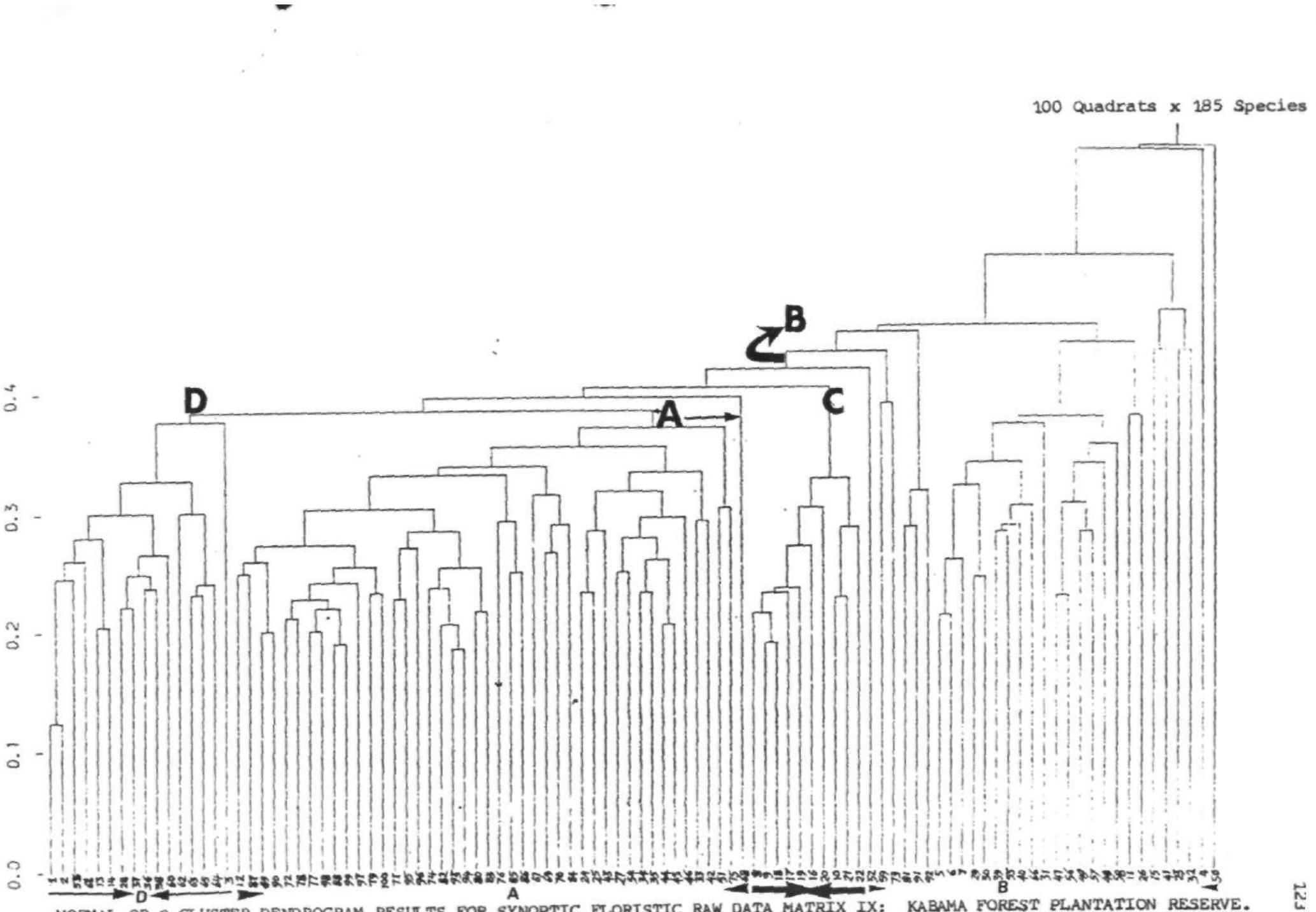


NORMAL OR Q-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX VII: DUMBI INSELBERG AND ROCKY HILLS.

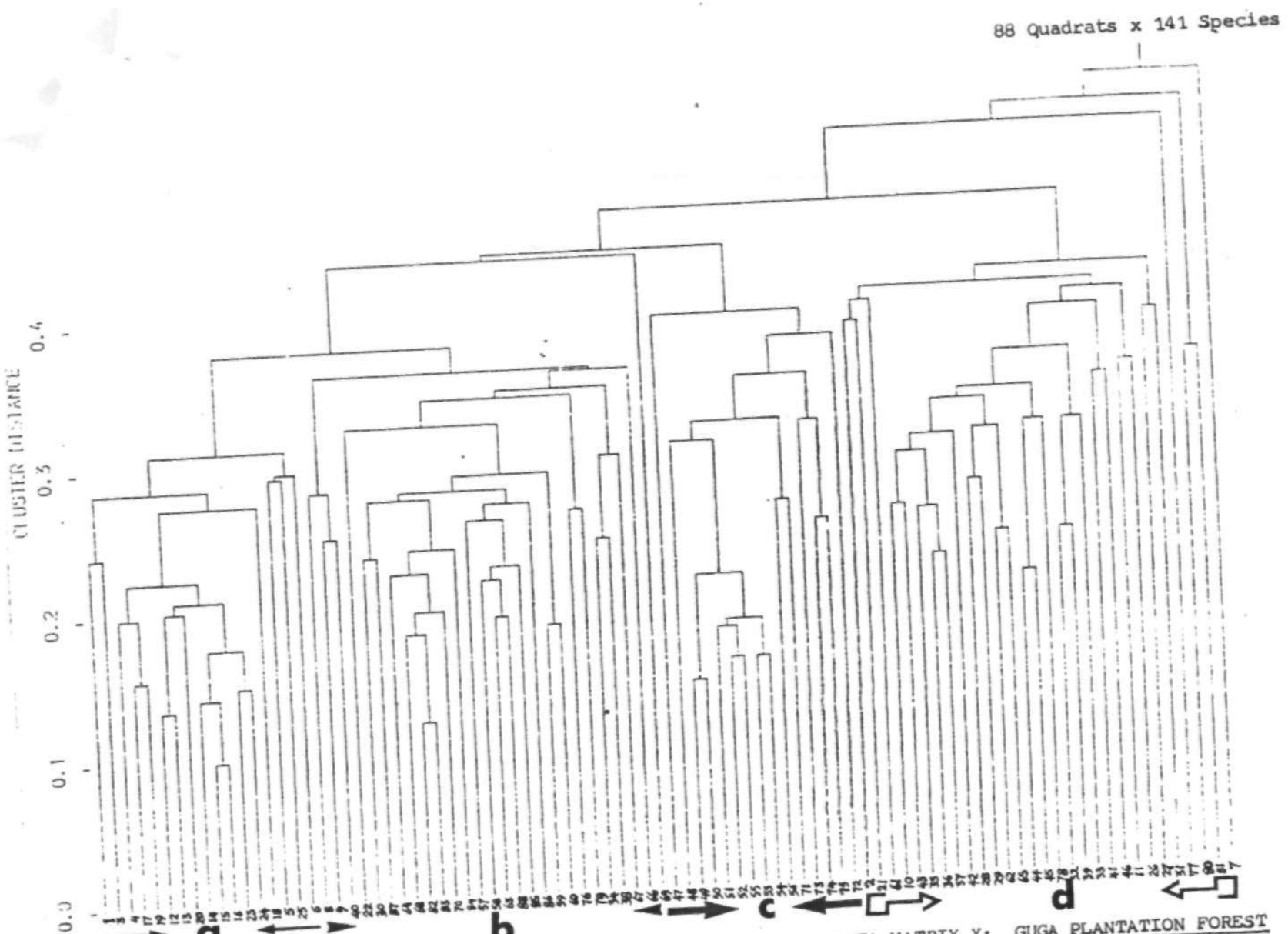


NORMAL OR Q-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX VIII.

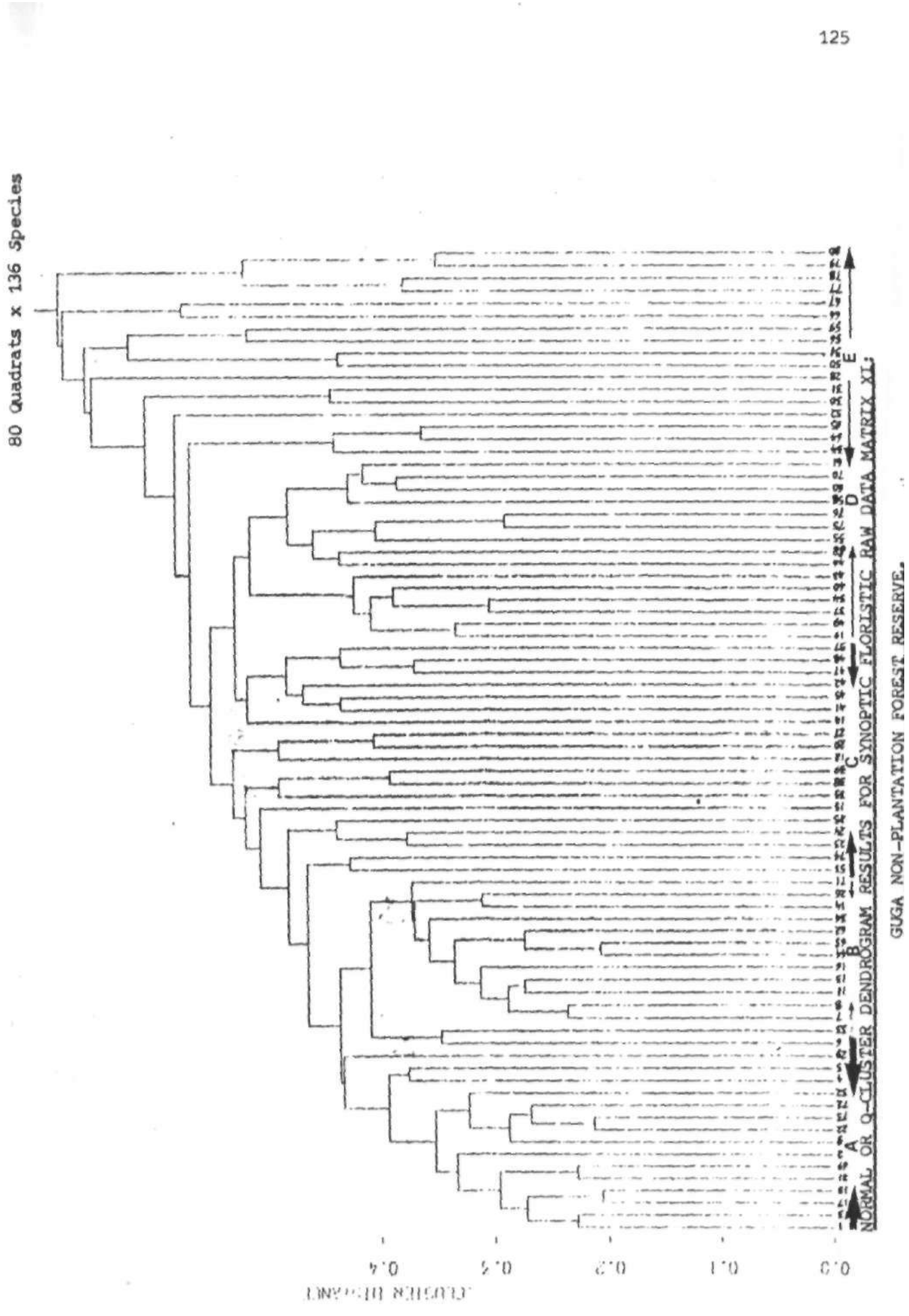
MAIRABO FOREST PLANTATION RESERVE

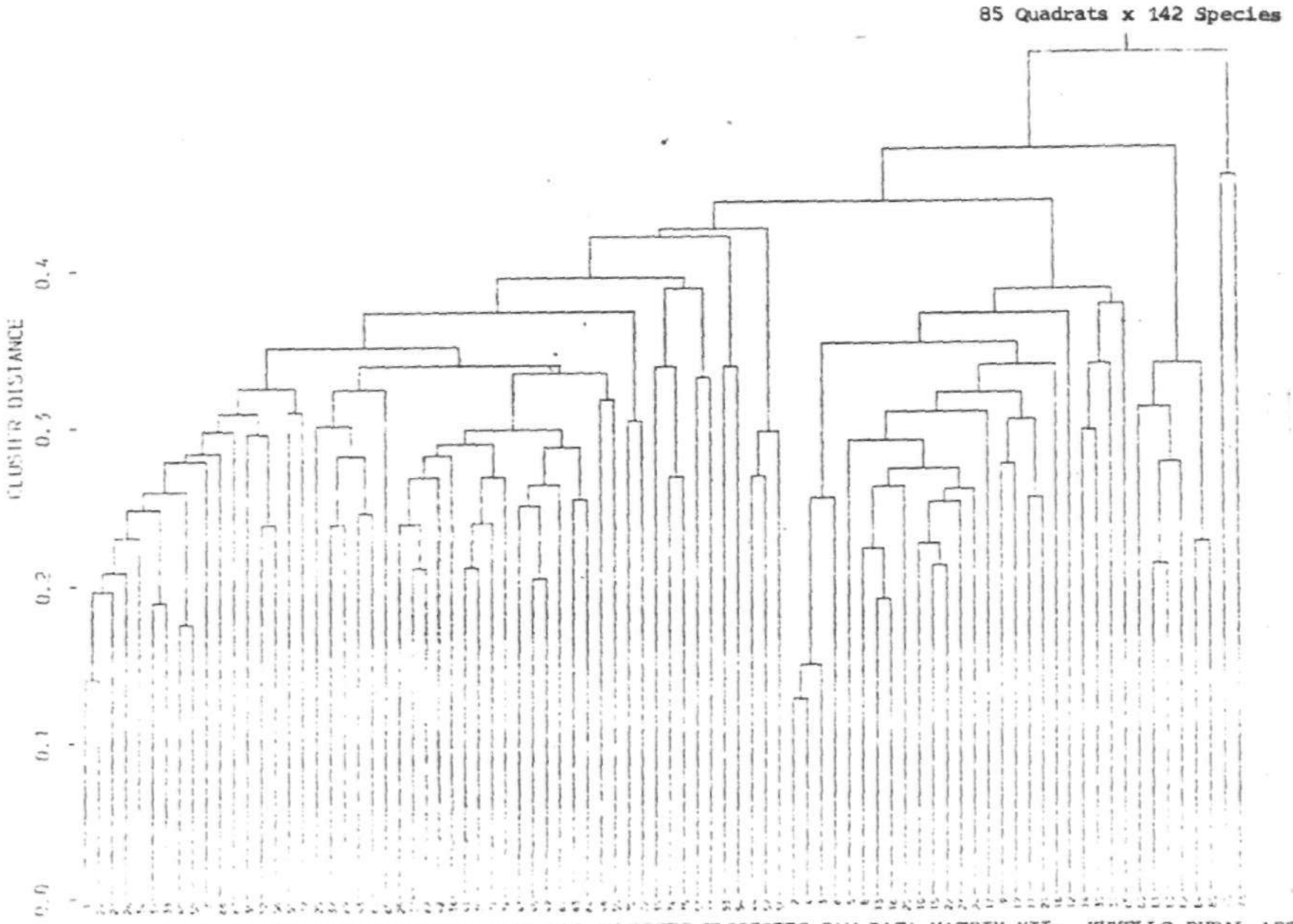


NORMAL OR Q-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX IX: KABAMA FOREST PLANTATION RESERVE.



NORMAL OR Q-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX X: GUGA PLANTATION FOREST RESERVE AND ENCLAVES.


80 Quadrats x 136 Species
0.0
0.1
0.2
0.3
0.4
A
B
C
D
E
NORMAL OR Q-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX XL;
GUGA NON-PLANTATION FOREST RESERVE.



NORMAL OR Q-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX XII; KUYELLO RURAL AREA.

FLORISTIC CODE NUMBERS AND THEIR

CORRESPONDING BOTANICAL NOMENCLATURES

PER STRATUM FROM I TO XII

No.	Species	No.	Species
01	Paspalum orbiculare	56	Setaria anceps
02	Borreria verticillata	57	Cyperus digitatus
03	Nelsonia canescens	58	Sida ovata
04	Vetiveria nigritana	59	Indigofera secundiflora
05	Vernonia perrottetii	60	Chloris pilosa
06	Sporobolus pyramidalis	61	Fimbristylis hispidula
07	Ageratum conyzoides	62	Melochia corchorifolia
08	Borreria radiata	63	Chrozophora senegalensis
09	Ipomoea eriocarpa	64	Acanthospermum hispidum
10	Pennisetum pedicellatum	65	Blumea aurita
11	Indigofera pulchra	66	Sida rhombifolia
12	Mimosa pigra	67	Crotalaria glauca
13	Centella asiatica	68	Hyptis specigera
14	Andropogon pseudapricus	69	Guiera senegalensis
15	Waltheria indica	70	Eriosema griseum
16	Oldenlandia herbacea	71	Urelytrum muricatum
17	Cassia rotundifolia	72	Hyparrhenia cyanescens
18	Eragrostis tremula	73	Eclipta prostrata
19	Ethulia conyzoides	74	Sesbania sesban
20	Hyparrhenia rufa	75	Heliotropium supinum
21	Jussiaea suffruticosa	76	Annona senegalensis
22	Scleria foliosa	77	Triumfetta pentandra
23	Leucas martinicensis	78	Cyperus dilatatus
24	Stachytarpheta angustifolia	79	Englerastrum gracillimum
25	Mitracarpus scaber	80	Helichrysum odoratissimum
26	Scoparia dulcis	81	Sida urens
27	Eragrostis atrovirens	82	Senecio abyssinicus
28	Schweinckia americana	83	Evolvulus alsinoides
29	Monechma ciliatum	84	Tephrosia linearis
30	Cassia tora	85	Pandiaka heudelotii
31	Hygrophila auriculata	86	Lactuca taraxacifolia
32	Guizotia scabra	87	Securinega virosa
33	Thelepogon elegans	88	Piliostigma thonningii
34	Glinus lotoides	89	Fadogia agrestis
35	Alysicarpus glumaceus	90	Lepidagathis collina
36	Sphaeranthus senegalensis	91	Schizachyrium sanguineum
37	Urena lobata	92	Ctenium newtonii
38	Aspilia africana	93	Carissa edulis
39	Imperata cylindrica	94	Asparagus africanus
40	Brachiaria stigmatisata	95	Penicum maximum
41	Cynodon dactylon	96	Biophytum petersianum
42	Hypoestes verticillaris	97	Andropogon gayanus
43	Vernonia ambigus	98	Eleusine indica
44	Vernonia pauciflora	99	Solanum torvum
45	Crotalaria senegalensis	100	Alternanthera nodiflora
46	Crotalaria macrocalyx	101	Dactyloctenium aegyptium
47	Panicum subalbidum	102	Commelina forskalaei
48	Cassia mimosoides	103	Rhytachne triaristata
49	Crotalaria lachnosema	104	Leersia hexandra
50	Elionurus pubeguinii	105	Uvaria chamae
51	Gardenia erubescens	106	Tephrosia pedicellata
52	Polygala petitiana	107	Pansum pansum
53	Euphorbia hirta	108	Indigofera arrecta
54	Sida linifolia	109	Ficus exasperata
55	Digitaria longiflora	110	Buchnera hispida

No.	Species
01	Paspalum orbiculare
02	Borreria verticillata
03	Jussiaea suffruticosa
04	Centella asiatica
05	Aspilia africana
06	Oryza sativa
07	Scoparia dulcis
08	Oldenlandia herbacea
09	Ipomoea aquatica
10	Ageratum conyzoides
11	Eclipta prostrata
12	Setaria anceps
13	Hyparrhenia rufa
14	Ethulia conyzoides
15	Physalis angulata
16	Leersia hexandra
17	Nelsonia canescens
18	Indigofera pulchra
19	Melochia corchorifolia
20	Panicum subalbidum
21	Digitaria ciliaris
22	Cyperus amabilis
23	Sporobolus pyramidalis
24	Commelina benghalensis
25	Portulaca cleracea
26	Stachytarpheta angustifolia
27	Ipomoea eriocarpa
28	Alternanthera nodiflora
29	Crotalaria naragutensis
30	Euphorbia hirta
31	Euphorbia heterophylla
32	Penisetum pedicellatum
33	Sesbania sesban
34	Imperata cylindrica
35	Sida linifolia
36	Urena lobata
37	Cyperus esculentus
38	Polyganum limbatum
39	Crotalaria retusa
40	Oryza longistaminata
41	Cassia tora
42	Vetiveria nigritana
43	Vernonia perrottetii
44	Brachiaria stigmatisata
45	Schweinckia americana
46	Eragrostis atrovirens
47	Gutenbergia nigritana
48	Sida rhomifolia
49	Mimosa pigra
50	Triumfetta pentandra
51	Indigofera hirsuta
52	Coldenia procumbens
53	Blumea perrottetiana
54	Cyperus rotundus
55	Sida urens

No.	Species
56	Kyllinga squamulata
57	Bidens pilosa
58	Waltheria indica
59	Crotalaria lachnosema
60	Tephrosia linearis
61	Indigofera arrecta
62	Eragrostis tremula
63	Eleusine indica
64	Cienfuegosia digitata
65	Mitracarpus scaber
66	Jacquemontia tamnifolia
67	Chrozophora senegalensis
68	Stylochiton lancifolius
69	Stylosanthes mucronata
70	Guiera senegalensis
71	Dissotis rotundifolia
72	Andropogon gayanus
73	Helichrysum odoratissimum
74	Guizotia scabra
75	Hypoestes verticularis
76	Acanthospermum hispidum
77	Cyperus dilatatus
78	Phragmites mauritianus
79	Hyparrhenia involurata
80	Heliotropium pterocarpum
81	Indigofera dendroides
82	Vernonia pauciflora
83	Fimbristylis hispidula
84	Dactyloctenium aegyptium
85	Corchorus tridens
86	Polygonum lanigerum
87	Eragrostis ciliaris
88	Kohautia grandiflora
89	Hygrophila auriculata
90	Hypoxis angustifolia
91	Leucas martinicensis
92	Heliotropium strigosum
93	Desmodium barbatum
94	Securinega virosa
95	Schizachyrium platyphyllum
96	Monechma ciliatum
97	Eriosema psoraleioides
98	Piliostigma thonningii
99	Dichrostachys glomerata
100	Annona senegalensis
101	Feretia apodanthera
102	Ochna afzelii
103	Asparagus africanus
104	Cochlospermum tinctorium
105	Eriosema griseum
106	Fadogia agrestis
107	Sida ovata
108	Blepharis linarifolia
109	Lepidagathis collina
110	Elionurus pobeguinii

111	Schizachyrium sanguineum	116	Vigna ambacensis
112	Cymbopogon giganteus	117	Tridax procumbens
113	Monocymbium ceresiiforme	118	Rottboellia exaltata
114	Vicoa leptoclada	119	Gynura amplixicaulis
115	Gloriosa superba		

GALMA BASIN:- ZARIA - DAMBO 'KURMI' FLORISTIC CODE
Species list correspond with the high to low order of recurrence as in the floristic raw data matrix table. Numbers of species correspond to the codings used in both the ordination with Rao's Canonical Factoring and the agglomerative Cluster Analyses computational techniques employed.

No.	Species
01	Panicum subalbidum
02	Digitaria ciliaris
03	Paspalum orbiculare
04	Melochia corchorifolia
05	Setaria pallide-fusca
06	Eleusine indica
07	Eriochloa nubica
08	Cyperus rotundus
09	Cyperus pustulatus
10	Brachiaria stigmatisata
11	Commelina forskalaei
12	Ageratum conyzoides
13	Alternanthera nodiflora
14	Eclipta prostrata
15	Ethulia conyzoides
16	Fimbristylis pilosa
17	Digitaria acuminatissima
18	Eragrostis pilosa
19	Physalis angulata
20	Oryza longistaminata
21	Cassia mimosoides
22	Vernonia pauciflora
23	Commelina benghalensis
24	Fimbristylis hispidula
25	Oldenlandia herbacea
26	Sacciolepis africana
27	Kyllinga squamulata
28	Leucas martinicensis
29	Scleria foliosa
30	Echinochloa colona
31	Mariscus squarrosus
32	Euphorbia heterophylla
33	Jussiaea suffruticosa
34	Indigofera nummulariifolia
35	Dyschoriste pedicellata
36	Eragrostis tremula
37	Indigofera hirsuta
38	Lipocarpha sphacelata
39	Sida ovata
40	Buchnera hispida
41	Pennisetum pedicellatum
42	Setaria anceps
43	Sesbania sesban
44	Chloris pilosa
45	Imperata cylindrica
46	Sida rhombifolia

GALMA BASIN:- GALMA IRRIGATION SCHEME SITE FLORISTIC CODES

Species list correspond with the high to low order of recurrence as in the floristic raw data table matrix. Numbers of species correspond to the codings used in both the ordination and cluster analytic methods, using Rao's Canonical Factor Analysis and Agglomerative Cluster Analysis.

No.	Species	No.	Species
01	Paspalum orbiculare	38	Sida rhombifolia
02	Digitaria ciliaris	39	Oldenlandia herbacea
03	Borreria verticillata	40	Crotalaria confusa
04	Dactyloctenium aegyptium	41	Hyparrhenia cyanescens
05	Mitracarpus scaber	42	Oryza sativa
06	Imperata cylindrica	43	Oryza longistaminata
07	Cassia mimosoides	44	Sesbania sesban
08	Centella asiatica	45	Cyperus amabilis
09	Eragrostis atrovirens	46	Hyparrhenia rufa
10	Eragrostis tremula	47	Crotalaria glauca
11	Indigofera arrecta	48	Cassia tora
12	Schwenckia americana	49	Vernonia ambigua
13	Cynodon dactylon	50	Eragrostis ciliaris
14	Heliotropium strigosum	51	Leucas martinicensis
15	Brachiaria stigmatisata	52	Chrozophora senegalensis
16	Jacquemontia tamnifolia	53	Ageratum conyzoides
17	Stachytarpheta angustifolia	54	Evolvulus alsinoides
18	Thelepogon elegans	55	Cleome aculiata
19	Tridax procumbens	56	Chrysanthellum americanum
20	Crotalaria senegalensis	57	Indigofera secundiflora
21	Nelsonia canescens	58	Hyperrthelia dissoluta
22	Sphaeranthus senegalensis	59	Indigofera hirsuta
23	Waltheria indica	60	Portulaca oleracea
24	Pennisetum pedicellatum	61	Corchorus tridens
25	Vetiveria nigritana	62	Cyperus esculentus
26	Mimosa pigra	63	Fimbristylis exilis
27	Vernonia perrottetii	64	Cassia nigricans
28	Acanthospermum hispidum	65	Urena lobata
29	Euphorbia hirta	66	Lepidagathis collina
30	Borreria radiata	67	Stylosanthes mucronata
31	Indigofera nummulariifolia	68	Panicum repens
32	Ipomoea aquatica	69	Hyptis specigera
33	Scoparia dulcis	70	Jussiaea suffruticosa
34	Indigofera pulchra	71	Tephrosia pedicellata
35	Ethulia conyzoides	72	Tamarindus indica
36	Tephrosia linearis	73	Diospyros mespiliformis
37	Sida linifolia	74	Pennisetum typhoides
		75	Sorghum vulgare

GALMA BASIN : KAKO VILLAGE - GALMA RIVER 'UPLAND' - 'FADAMA' SERAL AND WEEDY FLORISTIC CODES. Species list correspond with the high to low order of recurrence as in the floristic raw data table matrix. Numbers of species correspond to the codings used in ordination by RCFA and in the Cluster Analysis computations employed.

No.	Species	No.	Species
01	Pennisetum pedicellatum	56	Diospyros mespiliformis
02	Piliostigma thonningii	57	Gardenia erubescens
03	Indigofera pulchra	58	Dyschoriste perrottetii
04	Ageratum conyzoides	59	Lannea schimperi
05	Andropogon pseudapricus	60	Cassia singueana
06	Paspalum orbiculare	61	Brachiaria stigmatisata
07	Vernonia perrottetii	62	Sida ovata
08	Borreria radiata	63	Lepidagathis collina
09	Oldenlandia herbacea	64	Indigofera secundiflora
10	Terminalia avicennioides	65	Schizachyrium exile
11	Leucas martinicensis	66	Blumea aurita
12	Nelsonia canescens	67	Eragrostis pilosa
13	Annona senegalensis	68	Sacciolepis africana
14	Vernonia ambigua	69	Urena lobata
15	Guiera senegalensis	70	Parkia clappertoniana
16	Cochlospermum tinctorium	71	Entada africana
17	Hyptis spicigera	72	Tridax procumbens
18	Eragrostis tremula	73	Monechma cilialum
19	Sporobolus pyramidalis	74	Naucles latifolia
20	Andropogon gayanus	75	Melochia corchorifolia
21	Englerastrum gracillimum	76	Hygrophila auriculata
22	Anogeissus leiocarpus	77	Schizachyrium sanguinium
23	Setaria pallide-fusca	78	Combretum sericeum
24	Ctenium newtonii	79	Euphorbia hirta
25	Vernonia pauciflora	80	Acanthospermum hispidum
26	Butyrospermum paradoxum	81	Dichrostachys glomerata
27	Hyparrhenia rufa	82	Urelytrum muricatum
28	Loudetia simplex	83	Crotalaria confusa
29	Pandiaka heudelotii	84	Hyptis suaveolens
30	Jussiaea suffruticosa	85	Cassia rotundifolia
31	Stylosanthes mucronata	86	Combretum molle
32	Elionurus pobeguinii	87	Ximenia americana
33	Bridelia ferruginea	88	Kyllinga squamulata
34	Waltheria indica	89	Byroscarpus coccineus
35	Digitaria ciliaris	90	Sida urens
36	Ipomoea eriocarpa	91	Khaya senegalensis
37	Borreria verticillata	92	Vicoa leptoclada
38	Mitracarpus scaber	93	Indigofera hirsuta
39	Sphaeranthus senegalensis	94	Sesbania sesban
40	Ethulia conyzoides	95	Stereospermum kunthianum
41	Stachytarpheta angustifolia	96	Adenodolichos paniculatus
42	Cassia mimosoides	97	Carrisa edulis
43	Aspilia africana	98	Crotalaria senegalensis
44	Crotalaria lachnosema	99	Pseudocedrela kotschyi
45	Andropogon ascinodis	100	Indigofera capitata
46	Alysicarpus glumaceus	101	Indigofera macrocalyx
47	Eleusine indica	102	Schwenckia americana
48	Vitex doniana	103	Cissampelos mucronata
49	Combretum ghasalense	104	Dactyloctenium aegyptium
50	Cynodon dactylon	105	Brachiaria jubata
51	Centella asiatica	106	Strychnos innocua
52	Biophytum petersianum	107	Schizachyrium brevifolium
53	Tamarindus indica	108	Eragrostis ciliaris
54	Fimbristylis hispidula	109	Ipomoea aquatica
55	Monocymbium ceresiiforme	110	Scleria foliosa

111 Paulinia pinnata
112 Setaria anceps
113 Sida linifolia
114 Fimbristylis hispidula
115 Scoparia dulcis
116 Buchnera hispida
117 Imperata cylindrica
118 Isoberlina doka
119 Parinari curatellifolia
120 Eriosema griseum
121 Tephrosia linearis
122 Beckeropis uniseta
123 Ziziphus mucronata
124 Wissadula amplissima
125 Holarrhenia floribunda
126 Hypoestes verticillaris
127 Desmodium hirtum
128 Oryza sativa
129 Eragrostis atrovirens
130 Phragmites communis
131 Syzygium guineense
132 Heliotropium indicum
133 Cyperus pustulatus
134 Helichrysum odoratissimum
135 Cynura miniata
136 Cyperus amabilis
137 Hyparrhenia involucrata
138 Leersia hexandra
139 Monotes kerstingii
140 Aristida kerstingii
141 Adina microcephala
142 Desmodium barbatum
143 Feretia canthiodes
144 Eragrostis turgida
145 Microchloa indica
146 Thelepogon elegans
147 Securidace longepedunculata
148 Polygala petitiana
149 Corchorus tridens
150 Cassia tora
151 Vernonia oocephala
152 Striga senegalensis
153 Rottboella exaltata
154 Acacia ataxacantha
155 Triumfetta pentandra
156 Elionurus hirtifolius
157 Sorghastrum bipennatum
158 Indigofera arecta
159 Oryza longistiminata
160 Fuirena umbellata
161 Cissus crotalarioides
162 Hyparrhenia cyanescens
163 Vitex simplicifolia
164 Fadogia agrestis
165 Vernonia glaberrima
166 Tephrosia purpuea
167 Lactuca tarazacifolia
168 Cassia nigricans
169 Trichilia emetica
170 Vernonia nigritiana
171 Terminalia laxiflora
172 Pseudarthria hookeri
173 Clematis hirsuta
174 Crotalaria calycina
175 Zornia glochidiata
176 Evolvulus alsinoides
177 Hibiscus asper
178 Acacia seiberiana
179 Andropogon fastigiatus
180 Sida rhombifolia
181 Trema guineensis
182 Uvaria chamae
183 Panicum repens
184 Dioscorea bulbifera
185 Vigna racemosa
186 Lipocarpha sphacelata
187 Tephrosia linearis
188 Ipomoea agentaurata
189 Melothria maderaspatana
190 Justicia insularis
191 Panicum pansum
192 Mariscus squarossus
193 Sporobolus festivus
194 Panicum maximum
195 Kohautia grandiflora
196 Syzygium guineense
197 Ficus ingens
198 Alchornea cordiifolia
199 Culcasia sexatilis
200 Phaulopsis sp.
201 Dissotis rotundifolia
202 Sclerocarya birrea
203 Pavetta glaucescens
204 Trachypogon spicatus
205 Protea alliottii
206 Prosopis africana
207 Heeria pulcherrima
208 Echinops longifolius
209 Boswellia dalzielii
210 Crossopteryx febrifuga
211 Rauvolfia caffra
212 Phaulopsis barteri

GALMA BASIN : DUMBI PLAINS - ZARIA TO ZANGON AYA VEGETATION SURVEY (FEBRUARY)
List of recorded species ordered from high to low recurrence, as in the floristic raw data matrix. Numbers of species correspond to the codings used in ordination by RCFA and in the agglomerative Cluster Analysis employed.

No.	Species	No.	Species
01	Paspalum orbiculare	56	Tridax procumbens
02	Stylochiton lancifolius	57	Heliotropium strigosum
03	Annona senegalensis	58	Tephrosia pedicellata
04	Borreria radiata	59	Vernonia perrottetii
05	Cochlospermum tinctorium	60	Strychnos spinosa
06	Digitaria ciliaris	61	Nelsonia canescens
07	Piliostigma thonningii	62	Scoparia dulcis
08	Brachiaria stigmatisata	63	Fimbristylis ovata
09	Borreria verticillata	64	Sporobolus festivus
10	Guiera senegalensis	65	Tephrosia bracteolata
11	Dactyloctenium aegyptium	66	Andropogon pseudapricus
12	Jacquemontia tamnifolia	67	Nauclea latifolia
13	Pennisetum pedicellatum	68	Anogeissus leiocarpus
14	Sida rhombifolia	69	Cassia singueana
15	Andropogon gayanus	70	Stereospermum kunthianum
16	Terminalia avicennioides	71	Euphorbia hirta
17	Mitracarpus scaber	72	Adenodolichos paniculatus
18	Waltheria indica	73	Monocymbium ceresiiforme
19	Indigofera pulchra	74	Acalypha brachystachya
20	Aspilia africana	75	Heeria pulcherrima
21	Fadogia agrestis	76	Tephrosia linearis
22	Schweinckia americana	77	Urelytrum muricatum
23	Fimbristylis exile	78	Ximenia americana
24	Bridelia ferruginea	79	Evolvulus alsinoides
25	Butyrospermum paradoxum	80	Ethulia conyzoides
26	Urginea altissima	81	Imperata cylindrica
27	Chrysanthellum americanum	82	Sida linifolia
28	Dichrostachys glomerata	83	Tephrosia purpurea
29	Sporobolus pyramidalis	84	Diospyros mespiliformis
30	Eragrostis tremula	85	Gardenia erubeacens
31	Ctenium newtonii	86	Daniellia oliveri
32	Elionurus pobeguinii	87	Sida ovata
33	Cyperus obtusiflorus	88	Vitex simplicifolia
34	Stachytarpheta angustifolia	89	Chrozophora senegalensis
35	Eriosema griseum	90	Vernonia ambigua
36	Vitex doniana	91	Crotalaria confusa
37	Leucas martinicensis	92	Stylosanthes mucronata
38	Combretum sericeum	93	Indigofera arrecta
39	Gutenbergia nigritana	94	Ipomoea argentaurata
40	Indigofera capitata	95	Lippia chevalieri
41	Entada africana	96	Terminalia laciflora
42	Cassia mimosoides	97	Cassia tora
43	Brachiaria jubata	98	Combretum ghasalense
44	Physalis angulata	99	Parinari curatellifolia
45	Cissus rufescens	100	Alysicarpus glumaceus
46	Lannea schimperi	101	Indigofera dendroides
47	Oldenlandia herbecea	102	Monechma ciliatum
48	Indigofera nummulariifolia	103	Commelina benghalensis
49	Eleusine indica	104	Thelepogon elegans
50	Fimbristylis pilosa	105	Elionurus hirtifolius
51	Setaria anceps	106	Scleria foliosa
52	Parkia clappertoniana	107	Desmodium velutinum
53	Lasiosiphon kraussianus	108	Acanthospermum hispidum
54	Lepidagathis collina	109	Sida urens
55	Hyperthelia dissoluta	110	Crotalaria senegalensis

111	Cymbopogon giganteus
112	Psorospermum corymbiferum
113	Prosopis africana
114	Cynodon dactylon
115	Murdannia simplex
116	Melothria maderaspatana
117	Loudetia simplex
118	Feretia apodanthera
119	Hoslundia opposita
120	Swartzia madagascariensis
121	Ageratum conyzoides
122	Englerastrum gracillimum
123	Hyptis specigera
124	Fimbristylis dichotoma
125	Pseudocedrela kotachyi
126	Lannea acida
127	Eragrostis pilosa
128	Corchorus tridens
129	Vernonia pauciflora
130	Detarium macrocarpum
131	Lactuca taraxacifolia
132	Borreria octodon
133	Pandiaka heudelotii
134	Jussiaea suffruticosa
135	Zornia glochidiata
136	Lantana rhodesiensis
137	Cussonia barteri
138	Vernonia nigritana
139	Isoberlinia doka
140	Sclerocarya birrea
141	Heliotropium pterocarpum
142	Eragrostis turgida
143	Gardenia tarnifolia
144	Ficus ingens
145	Heeria pulcherrima
146	Echinops longifolius
147	Ficus platyphyla
148	Commiphora africana
149	Uvaria chamae
150	Paulinia pinnata
151	Ceiba pentandra
152	Grewia mollis
153	Schizachyrium sanguinum
154	Dyschoriste perrottetii
155	Asparagus africanus
156	Boswellia dalzielii
157	Schizachyrium brevifolium
158	Ziziphus mucronata
159	Euphorbia convolvuloides
160	Hyparrhenia rufa
161	Aneilema lanceolatum
162	Holarrhenia floribunda
163	Commelina forskalaei
164	Ipomoea aquatica
165	Blepharis linariifolia
166	Costus spectabilis
167	Alternanthera nodiflora
168	Bombax costatum
169	Milletia thonningii
170	Securinega virosa
171	Byrsocarpus coccineus
172	Dioscorea bulbifera
173	Cissampelos mucronata
174	Desmodium hirtum
175	Croton macrostachyos
176	Cyanotis lanata
177	Pulicaria crispa
178	Chrozophora plicata
179	Adansonia digitata
180	Fimbristylis hispidula
181	Ochna afzelii
182	Abrus precatorius
183	Merremia tridentata
184	Securidaca longepedunculata
185	Opilia celtidifolia
186	Panicum baumannii
187	Crotalaria naragutensis
188	Heliotropium indicum
189	Eclipta prostrata
190	Hygrophila auriculata
191	Kyllinga squamulata
192	Hyperthelia dissoluta
193	Tacca involucrata
194	Ziziphus mauritiana
195	Cassia rotundifolia
196	Staganotaenia araliacea
197	Bidens pilosa
198	Saba florida
199	Mariscus alternifolius
200	Achyranthes aspera
201	Indigofera hirsuta
202	Eriosema psoroleoides
203	Cyperus esculentus
204	Crotalaria glauca
205	Vicoa leptoclada
206	Pterocarpus erinaceus
207	Hymenocardia acida
208	Dyschoriste pedicellata
209	Tamarindus indica
210	Striga hermontheca
211	Cissus crotalarioides
212	Senecio abyssinicus
213	Platostoma africanum
214	Maytenus senegalensis
215	Cissus cornifolia
216	Buchnera hispida
217	Trichilia emetica
218	Brachiaria xantholeuca
219	Carissa edulis
220	Chloris pilosa
221	Crotalaria senegalensis

DUMBI - KAKO PLAINS TRANSECT SURVEY FLORISTIC CODES

List of species recorded in order of constancy from high to low. Code
...tations with RCFA and Cluster Analysis. They

No.	Species
01	Borreria radiata
02	Dioscorea bulbifera
03	Cissus rufescens
04	Clerodendron capitatum
05	Byrsocarpus coccineus
06	Milletia thonningii
07	Bombax costatum
08	Andropogon gayanus
09	Ipomoea involucrata
10	Cyanotis lanata
11	Cissus aralioides
12	Indigofera dendroides
13	Achyranthes aspera
14	Tephrosia bracteolata
15	Pondiaka heudelotii
16	Pennisetum pedicellatum
17	Acacia ataxacantha
18	Dissotis sp.
19	Tacca involucrata
20	Stereospermum kunthianum
21	Brachiaria lata
22	Anogeissus leiocarpus
23	Triumfetta pentandra
24	Rottboellia exaltata
25	Commiphora africana
26	Diospyros mespiliformis
27	Dioscorea preusii
28	Wissadula amplissima
29	Asparagus africanus
30	Eulophia quartiniana
31	Vigna racemosa
32	Scleria foliosa
33	Sporobolus pyramidalis
34	Bidens pilosa
35	Hackelochloa granularis
36	Entada africana
37	**Allophylus spicatus**
38	Cassia singueana
39	Parkia clappertoniana
40	Aneilema lanceolatum
41	Annona senegalensis
42	Cassia mimosoides
43	Sperobolus festivus
44	Melothria madaraspatana
45	Ficus umbellata
46	Brachiaria stigmatisata
47	Indigofera bracteolata
48	Indigofera hirsuta
49	Crotalaria naragutensis
50	Afrotrilepis pilosa
51	Gloriosa superba
52	Khaya senegalensis
53	Cassia tora
54	Stylochiton lancifolius
55	Grewia mollis

No.	Species
56	Holarrhenia floribunda
57	Ziziphus mucronata
58	Cissus quadrangularis
59	Setaria pallide-fusca
60	Clematis hirsuta
61	Jasminum dichotomum
62	Lannea kerstingii
63	Sesbania sesban
64	Gutenbergia nigritana
65	Canthium horizontale
66	Landolphia sp.
67	Lannea barteri
68	Solenostemon mannii
69	Celtis integrifolia
70	Cochlospermum tinctorium
71	Cussonia barteri
72	Bridelia ferruginea
73	Sida urens
74	Bambusa vulgaris
75	Pterocarpus erinaceus
76	Cyperus digitatus
77	Lantana rhodesiensis
78	Kyllinga squamulata
79	Schizachyrium exile
80	Monechma ciliatum
81	Tephrosia pedicellata
82	Heteropogon contortus
83	Lannea schimperi
84	Hyperthelia dissoluta
85	Albizia zygia
86	Solanum torvum
87	Cissampelos mucronata
88	Fadogia agrestis
89	Isoberlinia doka
90	Adenodolichos paniculatus
91	Euphorbia lateriflora
92	Digitaria homblei
93	Uvaria chamae
94	Urginea altissima
95	Mariscus alternifolius
96	Securinega virosa
97	Dichrostachys glomerata
98	Strychnos spinosa
99	Crotalaria senegalensis
100	Tamarindus indica
101	Sclerocarys birrea
102	Jacquemontia tamnifolia
103	Ekebergia senegalenisis
104	Euphorbia convolvuloides
105	Euphorbia hirta
106	Croton macrostachyus
107	Allophylus africanus
108	Kaempferia aethiopica
109	Combretum molle
110	Desmodium velutinum

111 Chrysophyllum albidum
112 Diospyros abyssinica
113 Pycreus macrostachyos
114 Jussiaea suffruticosa
115 Setaria anceps
116 Corchorus tridens
117 Trema guineensis
118 Ficus exasperata
119 Eleusine indica
120 Saba florida
121 Boerhavia diffusa
122 Urena lobata
123 Drosera indica
124 Synedrella nodiflora
125 Acalypha brachystachya
126 Ensete gilletii
127 Carissa edulis
128 Butyrospermum paradoxum
129 Strychnos innocua
130 Feretia apodanthera
131 Tephrosia purpurea
132 Loudetia togoensis
133 Microchloa indica
134 Crotalaria confusa
135 Waltheria indica
136 Fimbristylis hispidula
137 Cyperus esculentus
138 Trichilia emetica
139 Ximenia americana
140 Ipomoea argentaurata
141 Zornia glochidiata
142 Commelina forskalaei
143 Cymbopogon giganteus
144 Ficus polita
145 Nauclea latifolia
146 Vitex doniana
147 Aloe barteri
148 Ficus ingens
149 Paullinia pinnata
150 Cyperus pustulatus
151 Melochia corchorifolia
152 Acacia sieberiana
153 Dactyloctenium aegyptium
154 Echinochloa colona
155 Indigofera secundifolia
156 Cyperus rotundus
157 Alysicarpus glumaceus
158 Pandiaka involucrata
159 Blepharis linariifolia
160 Ageratum conyzoides
161 Eratrostis turgida
162 Sida rhombifolia
163 Commelina benghalensis
164 Strophanthus hispidus
165 Kleinia cliffordiana
166 Peristrophe bicalyculata
167 Cassia absus
168 Cissus caesia
169 Bulbostylis abortiva
170 Indigofera nummulariifolia
171 Dopatrium longidens
172 Commiphora kerstingii
173 Cissus populnea
174 Opilia celtidifolia
175 Acanthospermum hispidum
176 Biophytum petersianum
177 Paspalum orbiculare
178 Sida orata

DUMBI INSELBERG AND ROCKY HILLS (JUNE-JULY)
Species list from vegetation survey in order of high to low constancy.

No.	Species	No.	Species
01	Brachiaria stigmatisata	56	Gutenbergia nigritana
02	Sporobolus pyramidalis	57	Hoslundia opposita
03	Dyschoriste pedicellata	58	Leucas martinicensis
04	Cassia rotundifolia	59	Nelsonia canescens
05	Fimbristylis pilosa	60	Jacquenontia tamnifolia
06	Eucalyptus teriticornis	61	Cassia tora
07	Sida rhombifolia	62	Dactyloctenium aegyptium
08	Phyllanthus nigericus	63	Sida ovata
09	Waltheria indica	64	Balanites aegyptiaca
10	Aspilia africana	65	Diospyros mespiliformis
11	Triumfetta pentandra	66	Parkia clappertoniana
12	Sida urens	67	Eragrostis tremula
13	Stylochiton lancifolius	68	Brachiaria jubata
14	Eucalyptus camaldulensis	69	Zornia glochidiata
15	Cassia mimosoides	70	Acacia ataxacantha
16	Sida linifolia	71	Jasminum dichotomum
17	Borreria verticillata	72	Indigofera arrecta
18	Borreria radiata	73	Asparagus africanus
19	Desmodium barbatum	74	Tridax procumbens
20	Imperata cylindrica	75	Piliostigma thonningii
21	Andropogon gayanus	76	Cissampelos mucronata
22	Tephrosia pedicellata	77	Stachytapheta angustifolia
23	Evolvulus alsinoides	78	Fadogia agrestis
24	Indigofera pulchra	79	Chrysanthellum americanum
25	Blepharis linariifolia	80	Brachiaria xantholeuca
26	Stylosanthes mucronata	81	Feretia apodanthera
27	Schwenckia americana	82	Byroscarpus coccineus
28	Crotalaria retusa	83	Eleusine indica
29	Cassia siamae	84	Isoberlina doka
30	Annona senegalensis	85	Fimbristylis ovata
31	Dichrostachys glomerata	86	Terminalis avicennoides
32	Ageratum conyzoides	87	Saba florida
33	Carissa edulis	88	Bridelia ferruginea
34	Setaria anceps	89	Crotalaria senegalensis
35	Indigofera nummulariifolia	90	Securinega virosa
36	Eucalyptus citriodora	91	Dioscorea bulbifera
37	Tephrosia purpurea	92	Hyparthelia dissoluta
38	Clerodendrum capitatum	93	Vernonia nigritana
39	Paspalum orbiculare	94	Ipomoea asarifolia
40	Cyperus rotundus	95	Centella asiatica
41	Cissus rufescens	96	Crotalaria lachnophora
42	Euphorbia hirta	97	Commelina benghalensis
43	Bidens pilosa	98	Conyza aegyptiaca
44	Indigofera charlieriana	99	Desmodium velutinum
45	Kyllinga aquamulata	100	Setaria pallide-fusca
46	Khaya senegalensis	101	Vernonia perrottetii
47	Guiera senegalensis	102	Eragrostis gangetica
48	Eragrostis turgida	103	Lassiosiphon kraussianus
49	Digitaria ciliaris	104	Oldenlandia herbacea
50	Scopa-ria dulcis	105	Euphorbia convolvuloides
51	Acanthospermum hispidum	106	Lautuca taraxacifolia
52	Pennisetum pedicellatum	107	Tacca involucrata
53	Mitracarpus scaber	108	Pterocarpus erinaceus
54	Pandiaka heudelotii	109	Spigelia anthelmai
55	Cynodon dactylon	110	Urena lobata

MAIRABO PLANTATION RESERVE VEGETATION SURVEY (JULY 1978)
Species list from high to low constancy.

No.	Species	No.	Species
01	Cassia rotundifolia	56	Khaya senegalensis
02	Brachiaria stigmatisata	57	Eragrostis gigantica
03	Stylochiton lancifolius	58	Hoslundia opposita
04	Fimbristylis ovata	59	Nauclea latifolia
05	Gutenbergia nigritana	60	Crotalaria senegaleni
06	Fimbristylis pilosa	61	Sporobolus festivus
07	Sporobolus pyramidalis	62	Combretum ghasalensis
08	Stylosanthes mucronata	63	Cassia singueana
09	Indigofera pulchra	64	Eragrostis turgida
10	Blepharis linariifolia	65	Gardenia erubescens
11	Dyschoriste perrottetii	66	Clerodendron capitatum
12	Waltheria indica	67	Dactyloctenium aegyptium
13	Sida rhombifolia	68	Vitex doniana
14	Aspilia africana	69	Uvaria chamae
15	Eucalyptus camaldulensis	70	Eucalyptus citriodora
16	Borreria verticillata	71	Pterocarpus erinaceus
17	Paspalum orbiculare	72	Hypoxis angustifolia
18	Isoberlinia doka	73	Stereospermum kunthianum
19	Borreria radiata	74	Combretum sericeum
20	Setaria anceps	75	Urginea altissima
21	Sida urens	76	Bidens pilosa
22	Evolvulus alsinoides	77	Lactuca taraxacifolia
23	Andropogon gayanus	78	Curculigo pilosa
24	Hyperthelia dissoluta	79	Gladiolus gregarius
25	Terminalia avicennioides	80	Securidaca longepedunculata
26	Brachiaria jubata	81	Kyllinga squamulata
27	Tacca involucrata	82	Eragrostis tremula
28	Triumfetta dubia	83	Euphorbia hirta
29	Zornia glochidiata	84	Mitracarpus scaber
30	Cassia mimosoides	85	Parkia clappertoniana
31	Fadogia agrestis	86	Kaempferia aethopica
32	Indigofera nummulariifolia	87	Jasminum dichotomum
33	Dichrostachys glomerata	88	Cyperus dilatatus
34	Cissus rufescens	89	Eucalyptus robusta
35	Annona senegalensis	90	Acanthospermum hispidum
36	Tephrosia pedicellata	91	Psorospermum corymbiferum
37	Desmodium barbatum	92	Cassia tora
38	Pandiaka heudclotii	93	Lannea schimperi
39	Sida linifolia	94	Cochlospermum tinctorium
40	Asparagus africanus	95	Lannea acida
41	Pennisetum pedicellatum	96	Combretum glutinosum
42	Triumfetta pentandra	97	Ficus ingens
43	Scoparia dulcis	98	Stachytarpheta angustifolia
44	Daniellia oliveri	99	Euphorbia heterophylla
45	Guiera senegalensis	100	Nelsonia canescens
46	Schwenckia americana	101	Digitaria ciliaris
47	Gloriosa superba	102	Eriosema psoraleoides
48	Piliostigma thonningii	103	Anogeissus leiocarpus
49	Bridelia ferruginea	104	Piliostigma reticulatum
50	Carissa edulis	105	Erythrina senegalensis
51	Eucalyptus teriticornis	106	Indigofera arrecta
52	Ochna afzelii	107	Vitex simplicifolia
53	Diospyros mespiliformis	108	Crotalaria naragutensis
54	Chrysanthellum americanum	109	Acacia ataxacantha
55	Entada africana	110	Pseudocedrela kotschyi

111 Indigofera charlieriana
112 Feretia apodanthera
113 Sida ovata
114 Lasiosiphon kraussianus
115 Ageratum conyzoides
116 Monechma ciliatum
117 Cyperus obtusiflorus
118 Clematis hirsuta
119 Opilia celtidifolia
120 Tridax procumbens
121 Dioscorea bulbifera
122 Indigofera capitata
123 Urena lobata
124 Jacquemontia tamnifolia
125 Cassia siamae
126 Eleusine indica
127 Abrus precatorius
128 Swartzia madagascariensis
129 Indigofera dendroides
130 Cryptolepis sanguinolenta
131 Steganotaenia araliacea
132 Tephrosia purporea
133 Afromosia laxiflora
134 Eriosema griseum
135 Crossopteryx febrifuga
136 Combretum molle
137 Crotalaria lachnosema
138 Borassus aethiopum
139 Grewia mollis
140 Securinega virosa
141 Tephrosia bracteolata
142 Spigelia anthelmia
143 Schizachyrium platyphyllum
144 Mariscus alternifolius
145 Murdania simplex
146 Ipomoea argentaurata
147 Chrozophora senegalensis
148 Ipomoea eriocarpa
149 Ctenium newtonii
150 Hyptis specigera
151 Lippia chevalieri
152 Hymenocardia acida
153 Ipomoea vagans
154 Trema guineensis
155 Paulinia pinnata
156 Parinari curatelifolia
157 Englerastrum gracillimum
158 Maytenus senegalensis
159 Syzygium guineense
160 Borreria octodon
161 Eragrostis atrovirens
162 Detarium macrocarpum
163 Cyperus rotundus
164 Butyrospermum paradoxum
165 Crotalaria retusa
166 Maerus angolensis
167 Euphorbia convolvuloides
168 Feretia apodanthera
169 Byrsocarpus coccineus
170 Terminalia laxiflora
171 Vernonia ambigus
172 Imperata cylindrica
173 Cassia sieberiana
174 Phyllanthus negericus
175 Canthium venosum
176 Ekebergia senegalensis
177 Cussonia barteri
178 Balanites aegyptiaca
179 Chloris pilosa
180 Boerhavia diffusa
181 Wissadula amplissima
182 Brachiaria xantholeuca
183 Ceiba pentandra
184 Sida acuta
185 Eucalyptus grandis

KABAMA EUCALYPTUS PLANTATION RESERVE
Species list from vegetation survey records (May - June)
Order of species list is from high to low constancy.

No.	Species	No.	Species
01	Pennisetum pedicellatum	56	Khaya senegalensis
02	Dichrostachys glomerata	57	Bridelia ferruginea
03	Isoberlinia doka	58	Cassia singueana
04	Terminalia avicennioides	59	Ochna afzelii
05	Andropogon pseudapricus	60	Microchloa indica
06	Borreria radiata	61	Imperata cylindrica
07	Andropogon gayanus	62	Vernonia ambigua
08	Piliostigma thonningii	63	Securidaca longepeduncuta
09	Annona senegalensis	64	Diospyros mespiliformis
10	Aspilia africana	65	Daniellia oliveri
11	Elionurus pobeguinii	66	Adenodolichos paniculatus
12	Indigofera pulchra	67	Lannea acida
13	Isoberlinia tomentosa	68	Evolvulus alsinoides
14	Butyrospermum paradoxum	69	Indigofera capitata
15	Ctenium newtonii	70	Cassia mimosoides
16	Cochlospermum tinctorium	71	Vitex doniana
17	Lannea schimperi	72	Trichilia emetica
18	Ximenia americana	73	Blepharis linariifolia
19	Sporobolus pyramidalis	74	Prosopis africana
20	Monotes kerstingii	75	Schwenckia americana
21	Combretum ghasalense	76	Vernonia glaberrima
22	Waltheria indica	77	Opilia celtidifolia
23	Stylosanthes mucronata	78	Combretum molle
24	Panicum maximum	79	Grewia mollis
25	Detarium macrocarpum	80	Stereospermum kunthianum
26	Strychnos spinosa	81	Schizachyrium sanguineum
27	Lepidagathis collina	82	Fadogia agrestis
28	Eucalyptus camaldulensis	83	Gardenia ternifolia
29	Afrormosia laxiflora	84	Hymenocardia acida
30	Sida ovata	85	Alysicarpus glumaceus
31	Nauclea latifolia	86	Crotalaria retusa
32	Brachiaria jubata	87	Desmodium barbatum
33	Dyschoriste perrottetii	88	Terminalia laxiflora
34	Eucalyptus citriodora	89	Vitex simplicifolia
35	Hyparrhenia rufa	90	Strychnos innocua
36	Monechma ciliatum	91	Schizachyrium exile
37	Swartzia madagascariensis	92	Trachypogon spicatus
38	Pandiaka heudelotii	93	Heeria pulcherrima
39	Gardenia erubescens	94	Eriosema psoraleoides
40	Borreria verticillata	95	Tridax procumbens
41	Englerastrum gracillimum	96	Tephrosia linearis
42	Gardenia aqualla	97	Zornia glochidiata
43	Aristida funiculata	98	Sida linifolia
44	Eragrostis tremula	99	Panicum baumanii
45	Dyschoriste pedicellata	100	Beckeropsis uniseta
46	Lippia chevalieri	101	Buchnera hispida
47	Nelsonia canescens	102	Loudetia simplex
48	Entada africana	103	Cissus rufescens
49	Parkia clappertoniana	104	Burkea africana
50	Urelytrum muricatum	105	Maerua angolensis
51	Monocymbium ceresiiforme	106	Setaria anceps
52	Asparagus africanus	107	Centalla asiatica
53	Parinari curatellifolia	108	Acacia seiberiana
54	Paspalum orbiculare	109	Sphaeranthus senegalensis
55	Anogeissus leiocarpus	110	Eragrostis turgida

No.	Species	No.	Species
111	Leucas martinicensis	146	Costus spectabilis
112	Clerodendron capitatum	147	Carissa edulis
113	Polygala petitiana	148	Uvaria chamae
114	Uapaca togoensis	149	Eragrostis pilosa
115	Pavetta glaucescens	150	Urena lobata
116	Aristida adscensionis	151	Cassia seiberiana
117	Pterocarpus erinaceus	152	Gutenbergia nigritana
118	Crossopteryx febrifuga	153	Fimbristylis hispidula
119	Aloe barteri	154	Brachiaria brizantha
120	Maytenus senegalensis	155	Securinega virosa
121	Cassia nigricans	156	Saba florida
122	Hyperthelia dissoluta	157	Mitragyna inermis
123	Hygrophila auriculata	158	Ficus ingens
124	Ipomoea argentaurata	159	Chlofis pilosa
125	Oldenlandia herbacea	160	Kohautia grandiflora
126	Terminalia glaucescens	161	Stachytarpheta angustifolia
127	Crotalaria senegalensis	162	Heeria insignis
128	Dactyloctenium aegyptium	163	Aristida kerstingii
129	Tephorosia pedicellata	164	Thelepogon elegans
130	Ipomoea aquatica	165	Hyptis specigera
131	Euphorbia hirta	166	Indigofera arrecta
132	Oryza longistaminata	167	Antidesma venosum
133	Feretia apodanthera	168	Cyperus dilatatus
134	Vernonia perrottetii	169	Jussiaea suffruticosa
135	Indigogera secundiflora	170	Alternanthera nodiflora
136	Setaria pallide-fusca	171	Hemizygia welwitschii
137	Commiphora africana	172	Ziziphus mucronata
138	Sida rhombifolia	173	Balanites aegyptiaca
139	Hibiscus asper	174	Panicum subalbidum
140	Hyparrhenia involucrata	175	Brachiaria stigmatisata
141	Cussonia barteri	176	Cassia tora
142	Sphenostylis schweinfurthii	177	Mitracarpus staber
143	Biophytum petersionum	178	Psorospermum corymbiferum
144	Sida urens	179	Tamarindus indica
145	Indigofera macrocalyx		

GUGA FOREST RESERVE:- GUGA PLANTATION AND ENCLAVE
Floristic codes. Species list correspond to their high to low order of recurrence in the floristic raw data matrix table. Numbers of species correspond to codings for analytic procedures by RCFA ordination and Cluster Analysis.

No.	Species
01	Borreria radiata
02	Andropogon gayanus
03	Eragrostis turgida
04	Dyschoriste perrottetii
05	Kaempferia aethiopica
06	Stylosanthes mucronata
07	Digitaria lecardii
08	Dichrostachys glomerata
09	Zornia glochidiata
10	Cassia mimosoides
11	Cochlospermum tinctorium
12	Terminalia avicennioides
13	Stylochiton lancifolius
14	Microchloa indica
15	Digitaria gayana
16	Blepharis linariifolia
17	Monotes kerstingii
18	Isoberlinia tomentosa
19	Elionurus pobeguinii
20	Isoberlinia doka
21	Pennisetum pedicellatum
22	Brachiaria stigmatisata
23	Aspilia africana
24	Andropogon schirensis
25	Gutenbergia nigritana
26	Brachiaria jubata
27	Fimbristylis pilosa
28	Ctenium newtonii
29	Tephrosia pedicellata
30	Detarium microcarpum
31	Asparagus africanus
32	Lippia chevalieri
33	Panicum maximum
34	Sporobolus pyramidalis
35	Urginea altissima
36	Schizachyrium sanguineum
37	Waltheria indica
38	Pandiaka heudelotii
39	Vernonia perrottetii
40	Gladiolus gregarius
41	Monocymbium ceresiiforme
42	Hyperthelia dissoluta
43	Indigofera pulchra
44	Sida rhombifolia
45	Indigofera nummulariifolia
46	Sporobolus festivus
47	Costus spectabilis
48	Commiphora africana
49	Strychnos spinosa
50	Swartzia madagascariensis
51	Annona senegalensis
52	Piliostigma thonningii
53	Gardenia erubescens
54	Ximenia americana
55	Evolvulus alsinoides
56	Curculigo pilosa
57	Combretum molle
58	Lepidagathis collina
59	Cassia nigricans
60	Lannea barteri
61	Gardenia aqualla
62	Loudetia simplex
63	Ochna afzelii
64	Butyrospermum paradoxum
65	Cryptolepis sanguinolenta
66	Paspalum orbiculare
67	Anogeissus leiocarpus
68	Fadogia agrestis
69	Fimbristylis ovata
70	Pavetaa glaucescens
71	Combretum ghasalense
72	Monechma ciliatum
73	Fimbristylis hispidula
74	Sida linifolia
75	Urelytrum muricatum
76	Vernonia glaberrima
77	Diospyros mespiliformis
78	Stereospermum kunthianum
79	Dactyloctenium aegyptium
80	Bidens pilosa
81	Schizachyrium exile
82	Setaria anceps
83	Cissus rufescens
84	Lannea schimperi
85	Chloris lamproparia
86	Sida ovata
87	Feretia apadanthera
88	Terminalia laxiflora
89	Bridelia ferruginea
90	Vitex simplicifolia
91	Parinari curatellifolia
92	Aloe barteri
93	Setaria pallide-fusca
94	Jacquemontia tamnifolia
95	Tephrosia bracteolata
96	Crotalaria senegalensis
97	Hackelochlos granularis
98	Lannea acida
99	Chrysanthellum americanum
100	Hypoxis angustifolia
101	Entada africana
102	Polygala petitiana
103	Hymenocardia acida
104	Adenodolichos paniculatus
105	Tacca involucrata
106	Biophytum petersianum
107	Striga asiatica
108	Burkea africana
109	Khaya senegalensis
110	Grewia mollis

No.	Species	No.	Species
111	Pterocarpus erinaceus	143	Uvaria chamae
112	Cassia sieberiana	144	Macrosphyra longistyla
113	Aristida adscensionis	145	Lasiosiphon kraussianus
114	Afrormosia laxiflora	146	Heeria pulcherrima
115	Crotalaria glauca	147	Ipomoea eriocarpa
116	Tephrosia purpurea	148	Ipomoea argentaurata
117	Tephrosia linearis	149	Prosopis africana
118	Parkia clappertoniana	150	Lantana rhodesiensis
119	Maerua angolensis	151	Bombax costatum
120	Tamarindus indica	152	Scoparia dulcis
121	Cassia singueana	153	Jasminum dichotomum
122	Pseudocedrela kotschyi	154	Beckeropsis uniseta
123	Gardenia ternifolia	155	Leersia hexardra
124	Albizia chevalieri	156	Eragrostis atrovirens
125	Securidaca longipedunculata	157	Kyllinga squamulata
126	Dioscorea bulbifera	158	Triumfetta pentandra
127	Cissus aralioides	159	Nelsonia canesoens
128	Terminalia glaucescens	160	Hygrophila auriculata
129	Ficus gnaphalocarpa	161	Paulinia pinnata
130	Cassia tora	162	Mariscus alternifolius
131	Trichilia emetica	163	Strychnos innocua
132	Cyperus postulalus	164	Vernonia nigritiana
133	Crossopteryx febrifuga	165	Indigofera dendroides
134	Dicoma tomentosa	166	Echinops longifolius
135	Psorospermum corymbiferum	167	Vernonia ambigua
136	Opilia celtidifolia	168	Sida urens
137	Balanites aegyptiaca	169	Indigofera capitata
138	Cissus crotalarioides	170	Commiphora pedunculata
139	Eragrostis gangetica	171	Danniella oliveri
140	Hyparrhenia rufa	172	Brachiaria brizantha
141	Dioscorea dumetorum	173	Euphorbia convolvuloides
142	Hoslundia opposita	174	Desmodium barbatum

GUGA FOREST RESERVE: "UNIMPROVED" NON-PLANTATION RESERVE FLORISTIC CODES
Species list follow their high to low order of recurrence in the raw floristic data table matrix. Species numbers represent their codings for ordination by RCFA and the Cluster analytic procedures employed.

No.	Species
01	Isoberlinia doka
02	Pennisetum pedicellatum
03	Andropogon gayanus
04	Borreria radiata
05	Alysicarpus glumaceus
06	Annona senegalensis
07	Butyrospermum paradoxum
08	Andropogon pseudapricus
09	Monotes kerstingii
10	Panicum maximum
11	Lepidagathis collina
12	Adenodolichos paniculatus
13	Monocymbium ceresiiforme
14	Daniellia oliveri
15	Piliostigma thonningii
16	Terminalia laxiflora
17	Cassia mimosoides
18	Vernonia ambigua
19	Parinari curatellifolia
20	Ctenium newtonii
21	Cymbopogon giganteus
22	Uapaca togoensis
23	Afromorsia laxiflora
24	Elionurus pobeguinii
25	Ximenia americana
26	Aspilia africana
27	Strychnos spinosa
28	Isoberlinia tomentosa
29	Pterocarpus erinaceus
30	Loudetia simplex
31	Parkia clappertoniana
32	Hyptis specigera
33	Lactuca glandulifera
34	Ageratum conyzoides
35	Hyparrhenia rufa
36	Prosopis africana
37	Pavetta gloucescens
38	Leucas martinicensis
39	Detarium microcarpum
40	Imperata cylindrica
41	Beckeropsis uniseta
42	Vernonia pauciflora
43	Bridelia ferruginea
44	Entada africana
45	Ochna rhizomatosa
46	Scoparia dulcis
47	Paspalum orbiculare
48	Jacquemontia tamnifolia
49	Schwenckia americana
50	Mitracarpus scaber
51	Eriosema griseum
52	Crossopteryx febrifuga
53	Vernonia glaberrima
54	Dichrostachys glomerata
55	Psorospermum corymbiferum
56	Polygala petitiana
57	Swartzia madagascariensis
58	Terminalia avicennioides
59	Gardenia aqualla
60	Vitex doniana
61	Gardenia erubescens
62	Tridax procumbens
63	Vernonia perrottetii
64	Ficus capensis
65	Combretum ghasalense
66	Pandiaka heudelotii
67	Cussonia barteri
68	Nauclea latifolia
69	Lophira lanceolata
70	Eragrostis ciliaris
71	Trichilia emetica
72	Monechma ciliatum
73	Vernonia oocephala
74	Lannea schimperi
75	Hyparrhenia cyanescens
76	Nelsonia canescens
77	Echinops langifolius
78	Grewia mollis
79	Hyparrhenia involucrata
80	Oldenlandia herbacea
81	Stereospermum kunthianum
82	Syzygium guineensis
83	Ochna afzelii
84	Indigofera capitata
85	Schizachyrium sanguineum
86	Combretum molle
87	Terminalia gloucescens
88	Crotalaria senegalensis
89	Striga senegalensis
90	Loudetia togoensis
91	Aeschynomene indica
92	Mitragyna inermis
93	Guizotia scabra
94	Jussiaea suffruticosa
95	Hymenocardia acida
96	Ficus congensis
97	Securinega virosa
98	Afzelia africana
99	Diospyros mespiliformis
100	Asparagus africanus
101	Ficus platyphylla
102	Cryptolepis sanguinolenta
103	Vernonia nigritana
104	Byrsocarpus coccineus
105	Panicum baumannii
106	Pseudocedrela kotschyi
107	Gardenia ternifolia
108	Strychnos innocua
109	Rottboellia exaltata
110	Hannoa undulata

No.	Species	No.	Species
111	Eriosema psoraleoides	166	Sporobolus pyramidalis
112	Beckeropsis uniseta	167	Vitex simplicifolia
113	Urelytrum muricatum	168	Physalis angulata
114	Tephrosia bracteolata	169	Heeria pulcherrima
115	Khaya senegalensis	170	Sida rhombifolia
116	Ficus sp.	171	Tephrosia linearis
117	Sesbania sesban	172	Setaria pallide-fusca
118	Tamarindus indica	173	Indigofera microcarpa
119	Bacopa floribunda	174	Thelepogon elegans
120	Indigofera charlieriana	175	Sterculia setigera
121	Euphorbia hirta	176	Acacia polycantha
122	Chloris pilosa	177	Chrysanthellum americanum
123	Mangifera indica	178	Indigofera arrecta
124	Lannea kerstingii	179	Gynura miniata
125	Cassis tora	180	Ochna rhizomatosa
126	Sphaeranthus senegalensis	181	Dactyloctenium aegyptium
127	Securidaca longepedunculata	182	Digitaria ciliaris
128	Microchloa indica	183	Biophytum petersianum
129	Protea alliottii	184	Hibiscus asper
130	Acacia sieberiana	185	Gutenbergia nigritana
131	Fadogia agrestis	186	Trema guineensis
132	Oxytenathera abyssinica	187	Opilia celtidifolia
133	Andropogon tectorum	188	Borreria octodon
134	Pseudarthria hookeri	189	Ficus ingens
135	Mimosa pigra	190	Sporobolus festivus
136	Antidesma venosum	191	Anogeissus leiocarpus
137	Strophanthus preussii	192	Ipomoea agentaurata
138	Paulinia pinnata	193	Crotalaria calycina
139	Morelia senegalensis	194	Margaretta rosea
140	Polygonum limbatum	195	Haumaniastrum lilacinum
141	Schizachyrium brevifolium	196	Dicoma sessiliflora
142	Pulicaria crispa	197	Rhnchosia floribunda
143	Tephrosia bracteolata	198	Croton zambesicus
144	Eragrostis atrovirens	199	Canthium venosum
145	Combretum glutinosum	200	Maytenus senegalensis
146	Bombax costatum	201	Phyllanthus muellerianus
147	Crotalaria confusa	202	Borassus aethiopum
148	Buchnera hispida	203	Heteropogon contortus
149	Desmodium barbatum	204	Crotalaria lachnosema
150	Cochlospermum tinctorium	205	Adina microcephala
151	Sphenostylis schweinfurthii	206	Faurea speciosa
152	Andropogon ascinodis	207	Schizachyrium exile
153	Vicoa leptoclada	208	Indigofera nummulariifolia
154	Andropogon schirensis	209	Waltheria indica
155	Cassia sieberiana	210	Ostryoderris stuhmannii
156	Albizia chevalieri	211	Balanites aegyptiaca
157	Carissa edulis	212	Trachypogon spicatus
158	Clerodendrum capitatum	213	Costus spectabilis
159	Justicia insularis	214	Lannea barteri
160	Merremia hederacea	215	Phoenix reclinata
161	Chloris rubusta	216	Erythrina senegalensis
162	Ficus natalensis	217	Linociera nilotica
163	Desmodium salicifolium	218	Cyperus sp.
164	Clematis hirsuta	219	Santaloides afzelii
165	Eragrostis pilosa	220	Ipomoea ochraces

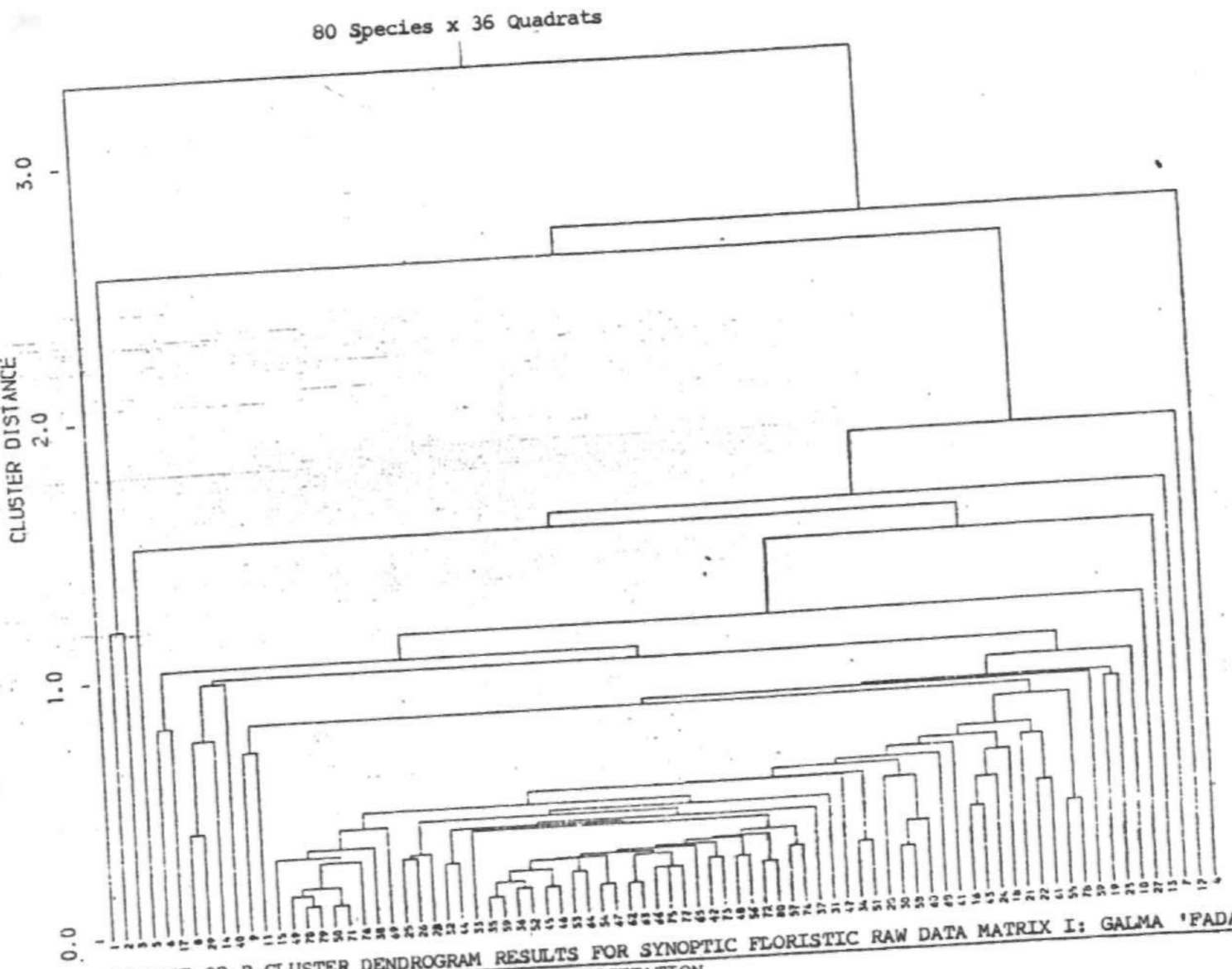
No.	Species	No.	Species
221	Polysphaeria orbuscula	226	Alternanthera nodiflora
222	Psychotria psychotrioides	227	Culcasia sexatilis
223	Alchornea cordifolia	228	Dyschoriste perrottetii
224	Echinochloa pyramidalis	229	Abrus precatorius
225	Cyperus digitatus	230	Panicum pansum

FLORISTIC CODES FROM VEGETATION SURVEY OF KUYELLO AND ITS ENVIRONS. List of species are from high to low order of recurrence as in the floristic raw data matrix table. Numbers correspond to species codings used in ordination with RCFA and agglomerative Cluster Analysis computational techniques employed.

R-CLUSTER DENDROGRAMS RESULTS

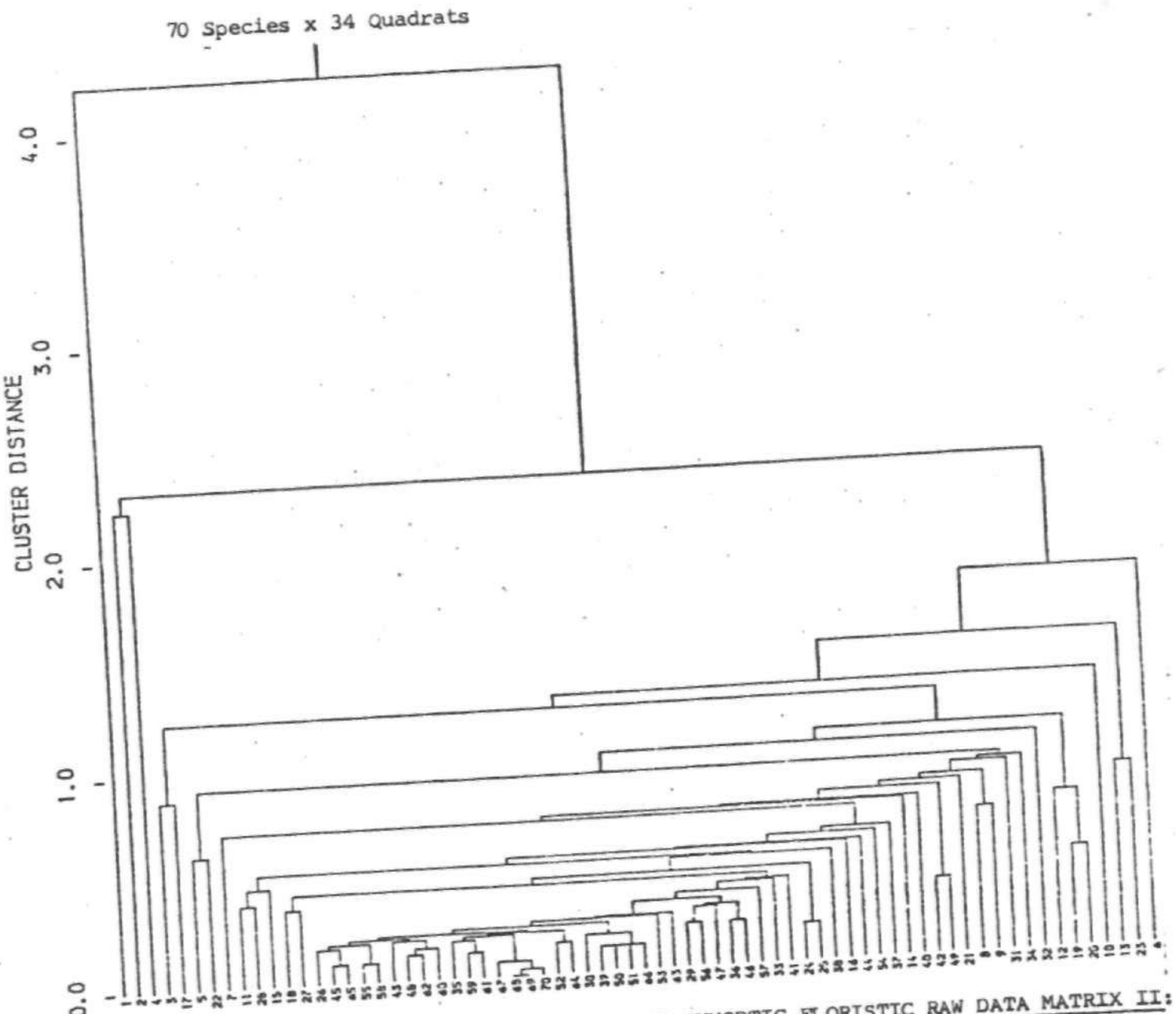
FOR SYNOPTIC FLORISTIC RAW DATA

MATRICES I TO XII



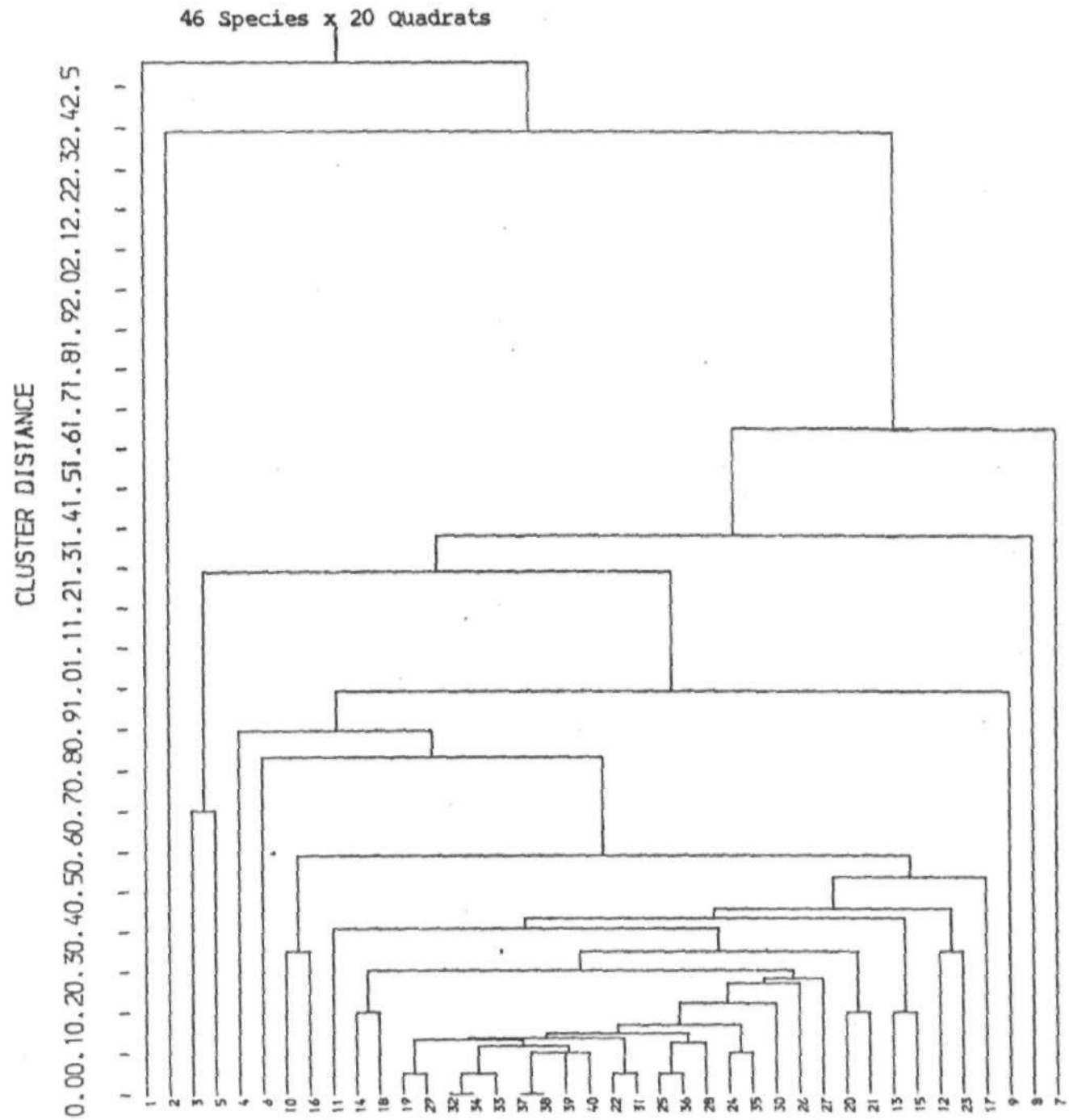
INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX I: GALMA 'FADAMA' VEGETATION

• See attached Floristic Codes for species associated with each number.



INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX II:
ZARIA-DAMBO 'KURMI'

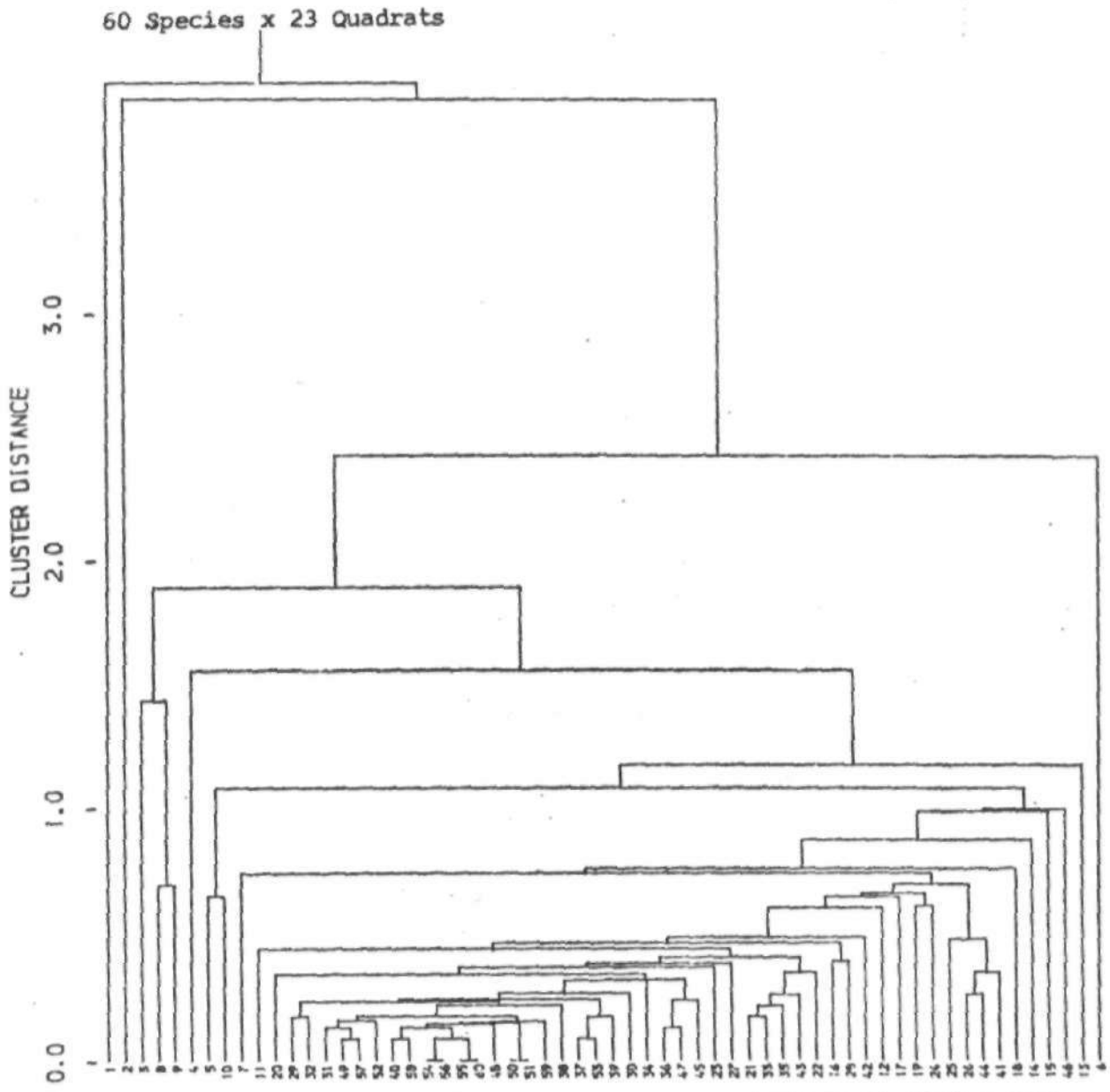
* See attached Floristic Codes for species associated with each number.



INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC DATA

MATRIX III: GALMA IRRIGATION SCHEME SITE

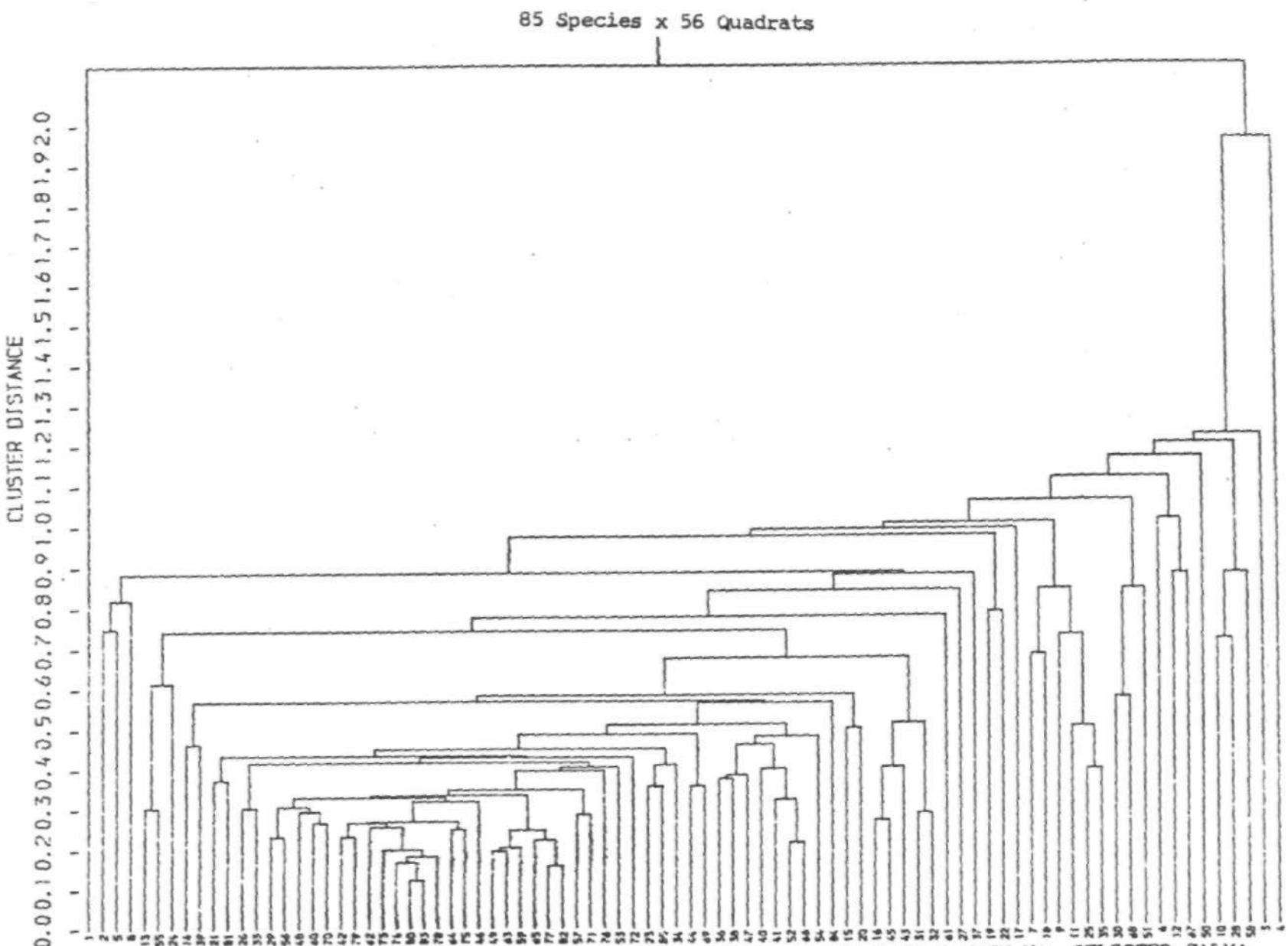
*See attached Floristic Codes for species associated with each number.



INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC DATA

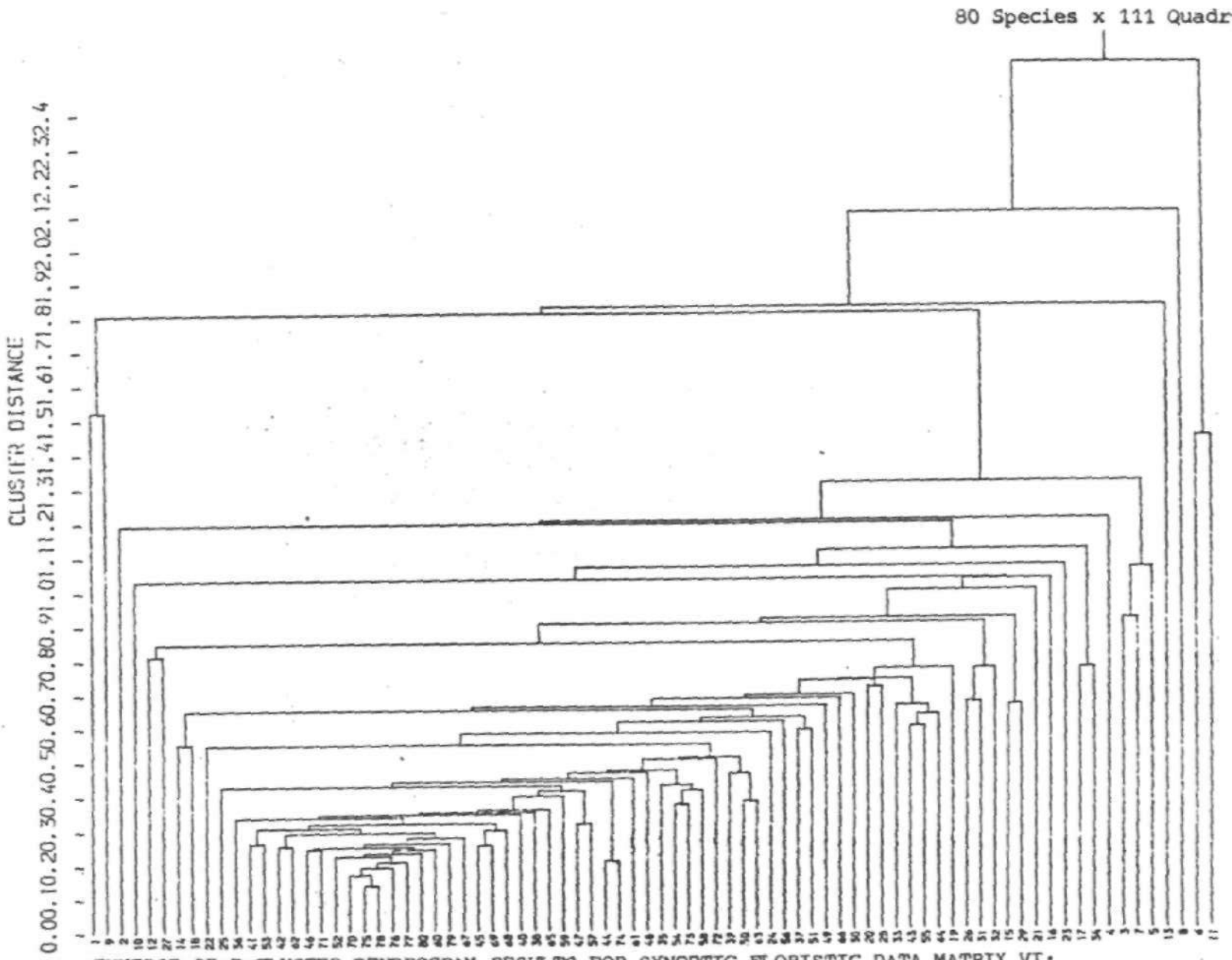
MATRIX IV: UPLAND KAKO VILLAGE TO GAIMA 'FADAMA'

• See attached Floristic Codes for species associated with each number.



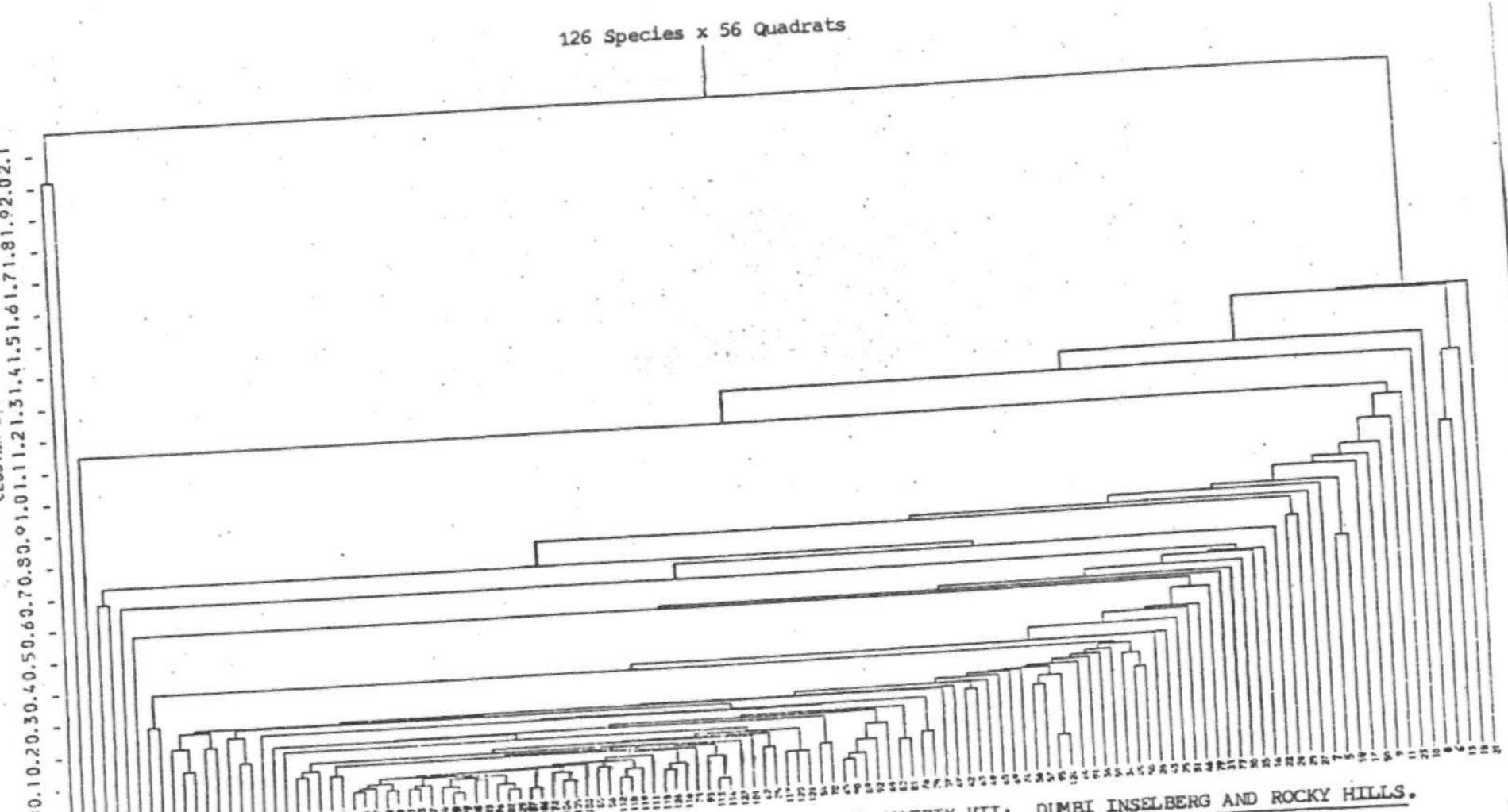
INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC DATA MATRIX V: SELECTED GALMA UPLAND SITES.

* See attached Floristic Codes for species associated with each number.



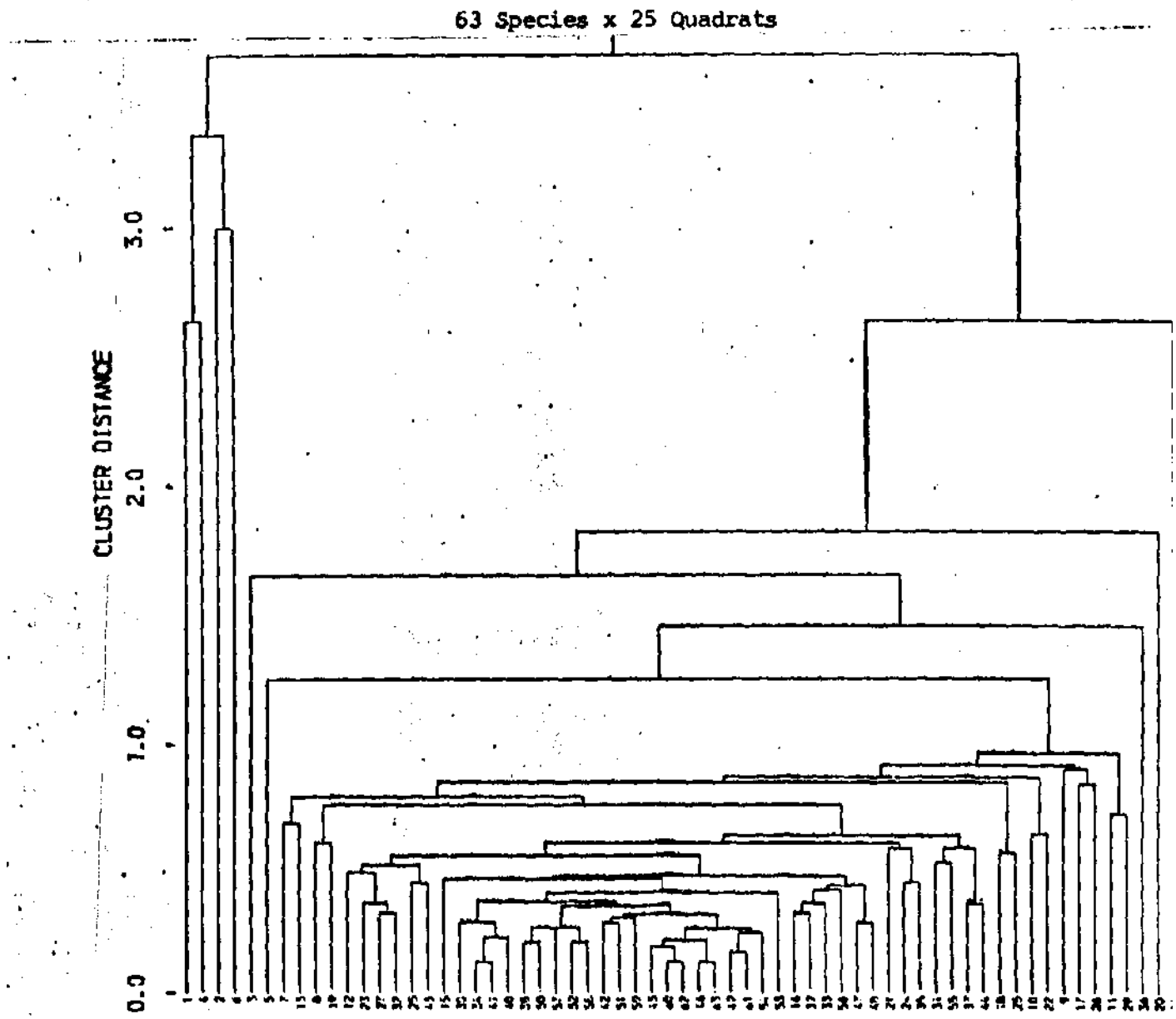
INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC DATA MATRIX VI:
DUMBI TO KAKO UPLAND PLAINS TRANSECT

* See attached Floristic Codes for species associated with each number.



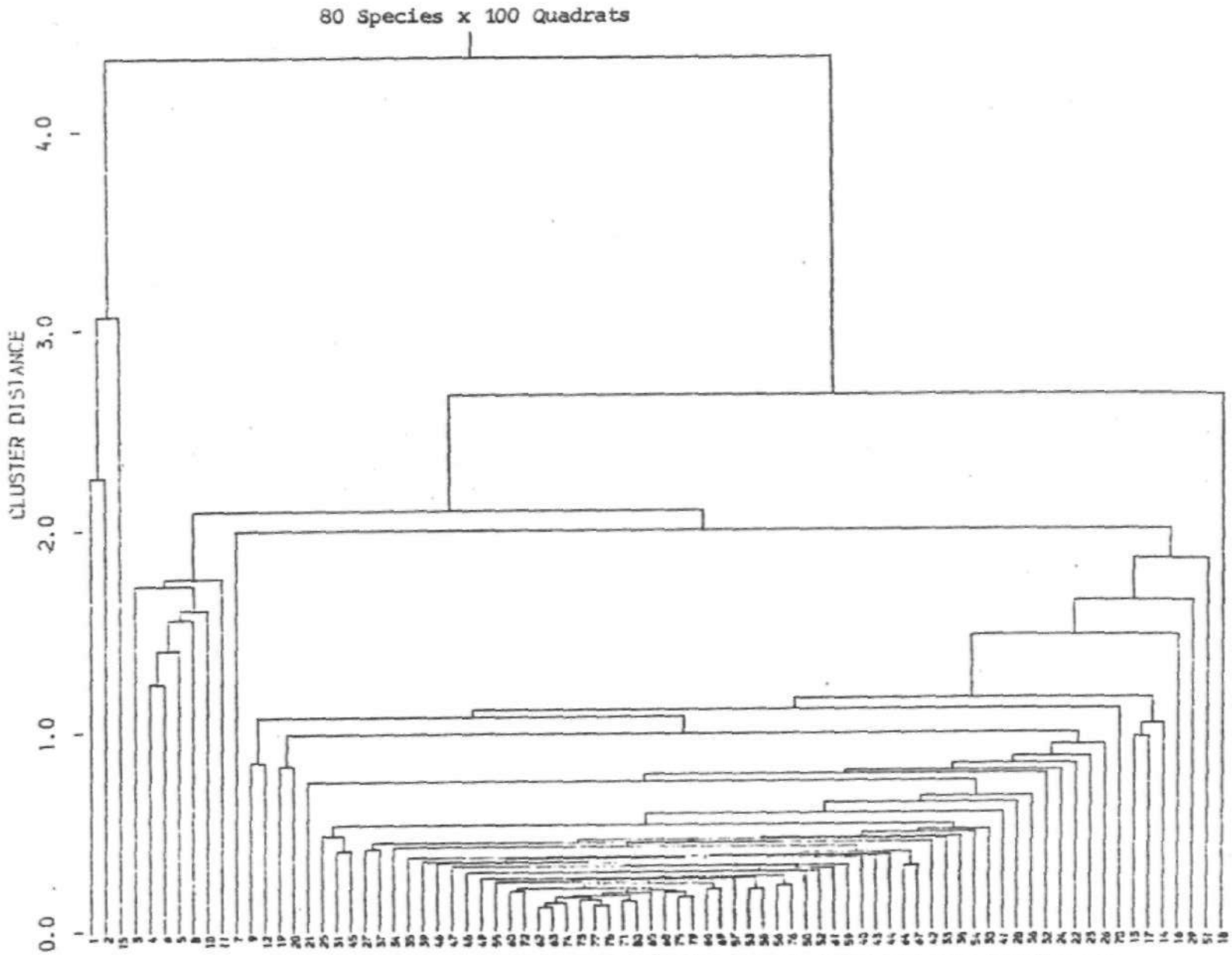
INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC DATA MATRIX VII: DUMBI INSELBERG AND ROCKY HILLS.

• See attached Floristic Codes for species associated with each number.



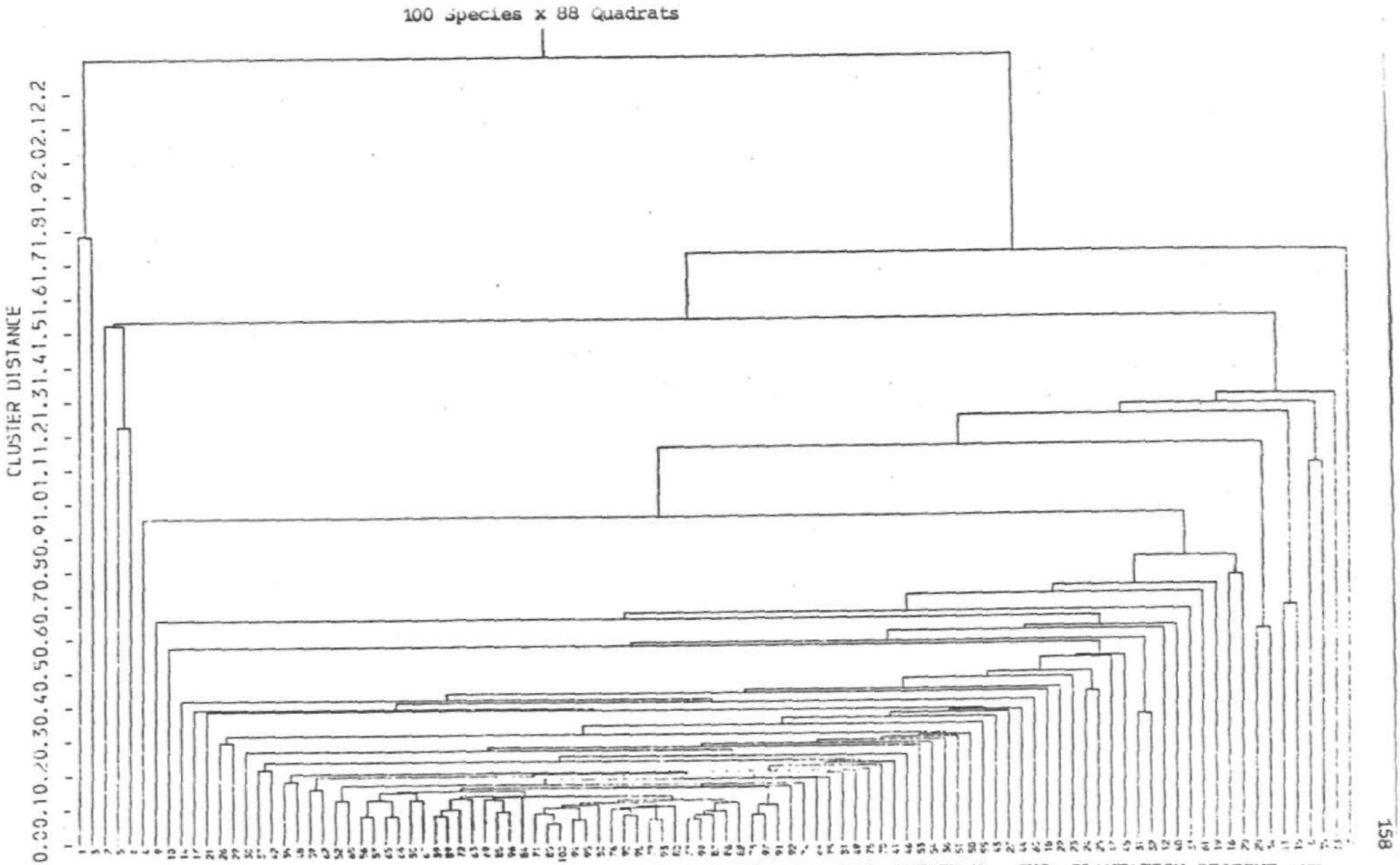
INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX VIII: MAIRABO FOREST PLANTATION RESERVE.

* See attached Floristic Codes for species associated with each number.



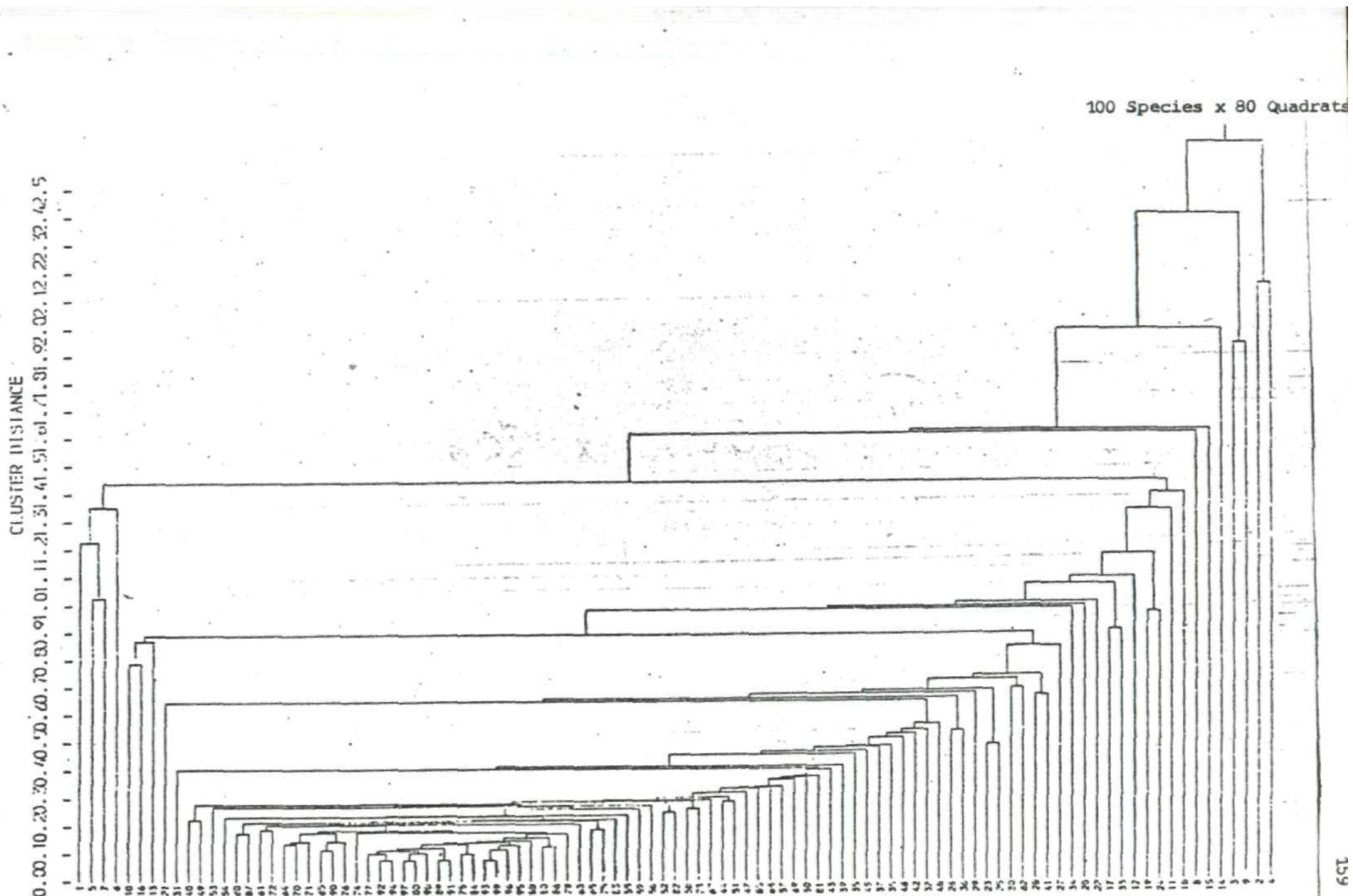
INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX IX: KABAMA FOREST PLANTATION RESERVE.

* See attached Floristic Codes for species associated with each number.



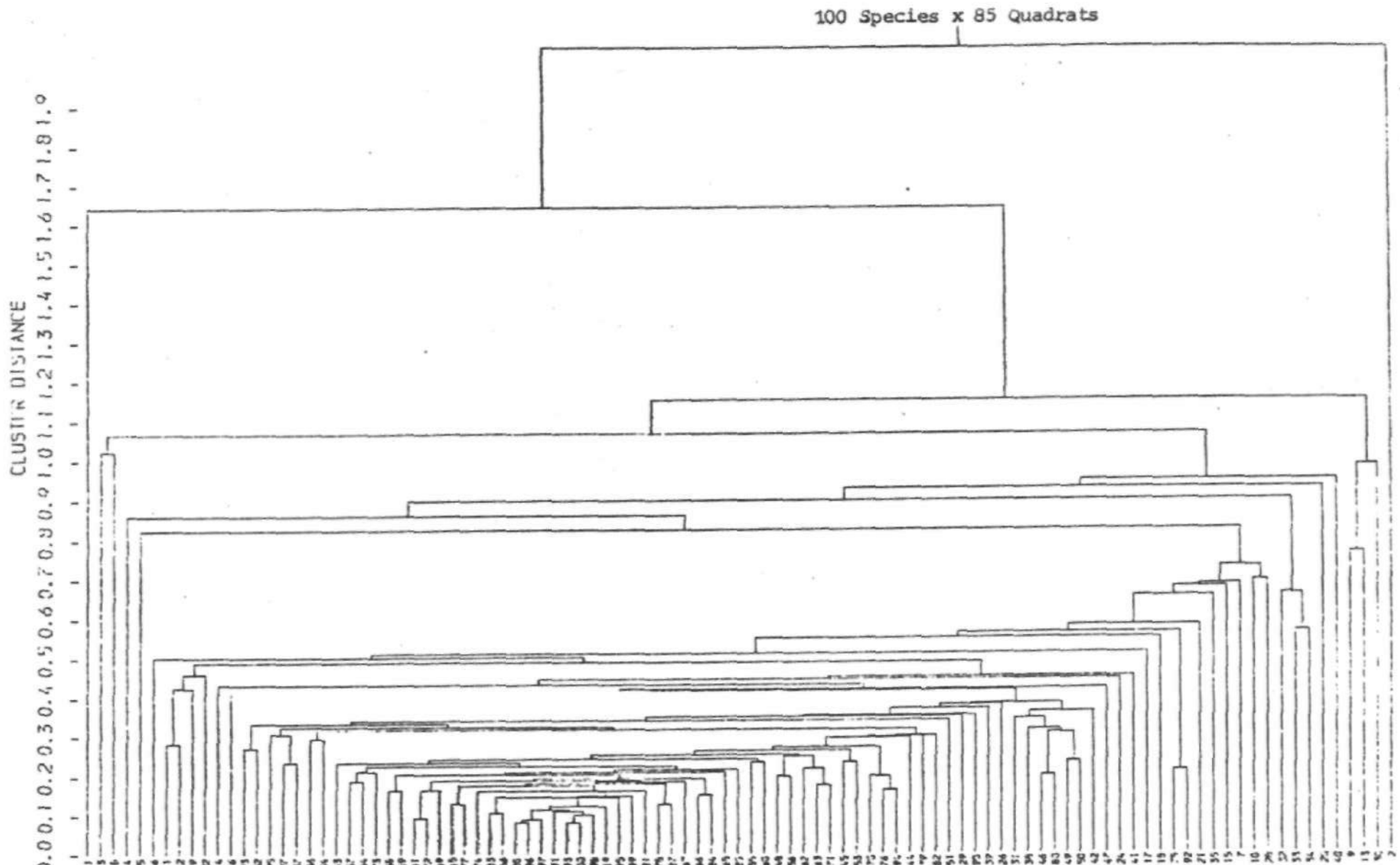
INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX X: GUGA PLANTATION RESERVE AND ENCLAVES.

* See attached Floristic Codes for species associated with each number.



INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR SYNOPTIC FLORISTIC RAW DATA MATRIX XI: GUGA NON-PLANTATION FOREST RESERVE.

* See attached Floristic Codes for species associated with each number.



INVERSE OR R-CLUSTER *DENDROGRAM RESULTS* FOR *SYNOPTIC* FLORISTIC RAW DATA MATRIX XII: KUYELLO RURAL AREA.

* See attached Floristic Codes for species associated with each number.

CHAPTER 7 ORDINATION

7.1 INTRODUCTION

The maxim for the analytic approaches to the detection and delimitation of natural groupings of species in an environment into plant community units was stated by Daubenmire (1968), viz: "Wherever areas of equivalent environment are encountered, whether continuous or detached, essentially the same plant assemblages reappear."

Anderson (1965) pointed out that "any procedure of vegetation classification involves an arrangement of communities into classes; the members of which have in common a constellation of attributes which serve to set them apart from members of another class". Also Greig-Smith (1964) stated that "the process of ordination involves an attempt to place each stand of vegetation in relation to one or more axes in such a way that a statement of its position relative to such axes conveys the maximum amount of information about its composition".

The objective of vegetation analysis by ordination and by numerical classification is thus to produce sorting criteria for the reorganisation of a floristic or environmental distributional raw data matrix such that the latent co-variations and organisations or the trends and clusters of species distribution become recognisable and become linkable to environmental causes.

A classificatory reorganisation of a raw floristic or environmental data matrix into communities thus seeks to group sample plots containing the species which have similar distributional patterns on the landscape together, as a criterion for similarities and differences among points in the environment.

"Ordinations are concerned with the identification of trends and patterns of variation in terms of correlations with external variables" as Whittaker (1967) pointed out. Implicitly, therefore, a fundamental function of ordination is the discovery of 'causes' for trends of observable continuum flora changes or sequences of species combinations.

Causality is, however, often as confusing as the 'equivalent environment'. Floral communities are the results of plurality of causes. Plurality of causal factors of which there may be many alternative combinations presupposes a plurality of floral combinations and recombinations into numerous possible communities. The same causes hardly ever produce the same plant communities of identical floral cover-abundance values. The recurrence of the same species is, however, highly probably to recur in 'equivalent environments" under a logical assumption of 'same same causes, the same species assemblages'. However, there is no question of repetitive same causes producing the same constant species within a plant community.

Rather, in a floristic ordination, it is the connected distribution of species or the observation of species related to each other that is the basis of an empirical generalization of relatively isolated number of quadrats from a larger number of field observations of quadrats. A plant community is therefore an empirical generalization of an isolated portion of quadrats from a larger number of observable quadrats, having a relatively uniformity of species composition, within an assignable level of error, under an operative, probable, estimable environmental cause.

The isolation of a plant community is relative; for one community is only isolated from another with regard to one or a few differential diagnostic species by which the members of the community are assignable to their approximate uniform area in the environment. Ordination of vegetation samples provides a possibility of discovering the quadrats containing the diagnostic species with positive definite relationships to the cause of variation.

Communities are, however, neither always true under all circumstances nor are they permanent. Rather they are temporal contiguities of floristic assemblages which will not necessarily endure for an infinite time; for in the breakdown of a web of floristic data into subsets of communities, it is the connected distribution of species at the time of the field survey which

is related to each other for the ecologist to seek the significance for which the trends or clusters stand in the environment.

However, in spite of the difficulties that there are no strictly invariable floristic uniformities between two separate points in the environment, and that there are no strictly repetitive 'equivalent environments', it is nevertheless commonly pre-supposed by ordinationists and classifiers in quantitative plant ecology that many fairly dependable regularities of aggregations and sequences occur in the flora distribution over an environment. And it is the regularities that have suggested a search for plant communities using classification where ordination has failed and ordination where classification has not provided the full answer.

Ordination procedures generate sorting criteria for sequencing and re-ordering quadrats according to values of factor score coefficients. By the same values, subsets of the raw floristic data are arbitrarily reducible into categories having relatively homogeneous species distributional characteristics.

A raw data table of plant distribution studied by a consideration for the species composition, takes the form of a two-dimensional tabular matrix consisting of species lists and of measured or estimated sample quadrats derived from a series of measured or estimated sample quadrats derived from a field survey. The plant distribution raw data matrix table thus represents a matrix with latent variations and organisations and may be reducible into relatively homogeneous subsets having closely related floristic distributions, either by ordination along some trends of co-variations or by a classificatory reorganisation into plant communities, each with the highest within-group collective floristic similarity, differentiated from the rest by a number of constant characteristic or diagnostic species combinations.

7.2 LITERATURE REVIEW OF THE DEFINITIONS OF ORDINATION

In terms of the nature of the mathematics from which ordinations are derived, Noy-Meir (1973) viewed ordination as "a collective term for multivariate techniques by which samples or other entities are arranged and metric information extracted". In terms of the displays of variables by factor leading coefficients on bivariate, trivariate or multidimensional scatter diagrams as a result of an ordination, Rolf (1971) described ordination as "the multidimensional scaling analysis by which most of the information about the co-variation among observations found in original characters are constructed on a few axes".

As an aid to an interpretation of plant distribution as non-discrete continuous variables, ordination was seen as a means of identifying and interpreting "community gradients" or "coenoclines" defined as "the sequences or directions of community compositional variation that can be directly related to gradients of environmental factors" (Whittaker, 1967). As a complement to numerical classification, Noy-Meir and Whittaker (1978) saw ordination as an aid to the "identification and typification of groups of related samples and species without necessarily drawing discrete boundaries between them".

McIntosh (1973) pointed out that "the matrix rearranged by inspection to produce orders or clusters is always subject to subjective interpretation of the arranger and large matrices become very unwieldly". So, "ordination is a method of evaluating similarity matrices in objective repeatable fashion". Goodall (1954) introduced ordination into plant distribution analysis for "an arrangement of units in uni- or multi-dimensional order", whether applied to quadrats or species. Orloci (1966) interpreted it as the "summarisation of information content of a matrix whose elements define

the spatial relationships between ecological entities, (where) the entities may represent either species or stands as well as factors from an environment or habitats". According to Orloci (1966) "the geometric model so obtained is interpreted in terms of the major ecological gradients and the clusters of individuals".

For a working explorative tool, Gittins (1969) defined ordination as "a means for analysing the causal factors determining the distribution of plants and vegetation". Ordination, however, does not analyse causal factors directly, as Gittins' definition suggests. Rather, it is a means of analysing the probable sequences of a distributional data that are assumed to be the consequences of causes. The resulting data sequences are thence investigated in terms of their possibilities to discover the probable underlying deterministic causes. The distribution data are thus subsequently interpreted in terms of those probable causal sequences under which the quadrats occurred in the environment.

Ordination of plant communities is made on the assumption that a latent restructurable organisation of some sort exists within the distributional data matrix. So, Kershaw (1968) pointed out that "ordination produces no defined units but merely relates all plots in a series of axes which reflects their interrelationships (so that) a more objective assessment of controlling factors can be made".

The process of an ordination proceeds from a set of objectively derived numerical indices of positive and negative correlations between all the possible pairs of quadrats within a raw data matrix. A differential quadrat is located at the end of an axis. The quadrats having the highest significant similarity measures with it are then located next to it. The remaining quadrats in the matrix are similarly successively arranged according to the sequences of the degrees of their significant positive and negative correlation values so that the quadrats

with the minimum similarities with the differential quadrat are arranged last.

The technique therefore provides a means to the identification of correlated quadrats, or quadrat-clusters and indicates the possible rearrangements of the data matrix, suggest the possible trends of the plant distributional co-variations and represents their patterns in relationships with the probable differential causal factors of the environment.

Ordination is therefore an objective sorting technique for re-shuffling quadrats to indicate their affinities with one another and to a common environment, starting from a complex mixture of floristic or environmental raw data samples.

Since related quadrats having greater affinity for similar environmental properties should occupy similar areas on the ground, and should be close together in the abstract vegetation space of an ordination diagram, ordination is also an aid to the synthesis of relatively homogeneous subsets from a plant distributional raw data matrix. It is thus a method for demonstrating, representing and identifying the possible groupings of correlated quadrats in relation to their common environmental factors and a supportive method of locating the clusters of correlated quadrats that represent different plant communities from a raw data matrix table.

7.3 LITERATURE REVIEW OF ORDINATION TECHNIQUES

By the distinction of ordination methods into either 'direct' or 'indirect' (Whittaker, 1967), the prevalent techniques are 'indirect' such as the principal component analysis (PCA), whereby axes of ordination are mathematically constructed from a matrix of similarity coefficients. The ordinated quadrats in an indirect ordination are characterised by their

quantitative floristic scores and the axes should represent some major directions of floristic assemblages or trends in relation to the environment. The constellations and alignments of the quadrats produced on the graphical scatter diagrams are thence evaluated in terms of one or more environmental properties by which floristic clusters and trends could be determined in the field source from which the samples were procured.

The main methods of indirect ordination derive from the large variety of multivariate numerical techniques organised around factor analysis used also in non-ecological disciplines to summarise matrices of correlation coefficient values into small numbers of 'factors'. Thus a 'factor' by indirect ordination is an ecological concept as well as a mathematical one. The application of factor analytic techniques to plant distribution arranges a given set of intercorrelations among field sample matrix of quantitative flora data into factor loading coefficients to which ecological meanings are attached from the relevant environmental characteristics of the related quadrats. The main function of a factor in plant distribution analysis is to organise the quadrats differentiated out by a common cause such that the floristic content of the quadrats which comprise the factor can be listed and related to their environments. Thus the floristic content of a factor is employed as an indicator of the properties of an environment. The species content of the quadrats loading high on a factor may therefore reflect a land use peculiarity, a restricted soil feature or a specific geomorphorlogical landmark typified or monitored by the species assembled by the factor. Thus an indirect ordination is made on the assumption that each axis of an ordination may indicate a basic direction of co-variation within the coded vegetation data which may be related to gradients or types of underlying factors. The interpretation of an ordination axis as to

whether it is a continuum gradient or a plant community cluster depends partly upon the theory of plant distribution held by the investigator and partly on the display of the factor solutions obtained.

The factor solutions obtained may also depend upon the nature and number of observations in the analysis. If the subset area surveyed is relatively homogeneous over the whole range of the environment, then the analysis will probably yield few factors and give prominence to one general factor or factor gradient. Conversely, analysis of samples from a floristically and environmentally heterogeneous area is probably going to require a large number of axes with which a mosaic of plant communities are related and minimise the likelihood of there being one general factor with loadings on all sample units.

A common problem of factor analytic techniques as a method of ordination is to know when to stop factor analysing, on which the number of communities are dependent. Quantitative ecologists normally stop the analysis when the known main 'causes' or factors have been considered extracted. For example, Austin and Greig-Smith (1968) reported that "only two axes are considered as, with limited amount of environmental information available, the examination of further axes is unlikely to profitable". Communities of plants are of unequal size and a complex matrix of correlations may require for its complete analysis a number of factors which have small loadings on any of the axes.

One of the criteria for a good ordination technique should perhaps be that the technique should enable an objective analysis of inter-correlations from the raw data matrix punched on cards without a subjective manual data manipulation. Thus, "direct gradient analysis" (Whittaker, 1967) and "polar ordination" (Bray and Curtis, 1957) have been criticised for linearity of vegetational gradients based on quadrat scores derived

from estimates of species in response to "subjectively estimated environmental variables or in response to those variables which are simple to measure" (Austin, 1971).

The preliminary choice of option required to be made concerns whether the calculation of correlation coefficients should be made for the columns or for the rows of an array of a raw data matrix. This is less important, however, with a technique such as the reciprocal averaging (Hill, 1973) which can be applied to perform a concurrent dual Q-matrix and R-matrix of similarity coefficients without a need for transposing the raw data matrix between analyses. The choice determines whether analysis is made for ordering quadrats, the basic units of a plant community, or species, the components and indicators of plant communities.

The Q-type calculations represent the analysis of the individual sample areas of vegetation (quadrats), as employed by Cattell (1952) and by Greig-Smith (1964), or the 'Normal Analysis' of Williams and Lambert (1960). While the R-type ordination may be usefully employed to explore "ecological species groups with similar distributional similarities" (Whittaker, 1967), it is considered that a plant community investigation should be based on the co-variation among the basic sample units of plant communities achieved with a Q-ordination.

The unifying first step in ordination is the assessment of the strength of association among the entities of floristic data coded as a series of columns and rows, representing quadrats and their species content values.

The strength of association is a reflection of the degree of the tendency for species to vary together in quadrats and hence for quadrats to resemble one another in species composition. For a ranked ratio-level interval-scaled species cover measurement scheme in quantitative floristic scores per quadrat such as species scores by the Domin scale,

bivariate correlation coefficient provides an appropriate linear relationship between two variables and forms the basic statistic for the strength of the association describing a continuum vegetation order. A correlation coefficient matrix may also be found for presence or absence data (Greig-Smith, 1971). The Pearson product-moment correlation coefficient $\underline{r}$ is calculated for all possible pairs of quadrats or environmental data by Pearson correlation coefficient:

$$r = \frac{\sum_{i=1}^{N} (x - \bar{x})(y - \bar{y})}{\sqrt{\{[\sum_{i=1}^{N} (x_i - \bar{x})^2][\sum_{i=1}^{N} (y - \bar{y})^2]\}}} \quad \longleftarrow \text{-----1}$$

where X and Y symbolize a pair of quadrats

Xi = ith observation of quadrat X

Yi = ith observation of quadrat Y

N = number of observed quadrats

$\bar{X}$ = = mean quantity of species scores in X

$\bar{Y}$ = = mean quantity of species scores in Y

Different ordination procedures explore the reduction possibilities of the similarity coefficients in different ways. The properties of the techniques employed were reviewed by several authors in Tuxen (1973) and in Whittaker (1978), with the outlines of the types of multivariate statistical techniques which have found use in ordination. Supports for, and criticisms of, each technique have been discussed.

Noy-Meir (1978) identified three periods in the evolution of multivariate techniques in plant distribution analysis, viz:

a) the early period of direct gradient analysis and informal techniques,

b) a middle period of testing multivariate techniques from other fields,

c) the present period of selection among available techniques and designs of new ones for ecological data.

Noy-Meir and Whittaker (1978) suggested that supports and criticisms of each technique have probably been overstated, as all the methods provide

numerical results which though not identical in general, lead to similar ecological interpretations: "No one method has emerged as the most suitable for describing and explaining patterns of variation in plant communities, but most techniques have been indicated to be useful in the analysis of data although they potentially lead to different ordination results." However, Robertson (1978) has appropriately suggested that "most often, the gradient or continuum of floral distribution have been more vehemently and exclusively supported by analysts of data taken from gradients such as elevation, topographic moisture, and successional factors. In those instances ordination techniques have been generally successful in elucidating floral relationships between environmental variables and linear gradient structures". Austin (1971) suggested that "non-linear" or "restrictive-linear" combinations between sets of vegetation and environmental variables are more realistic ecological models and that "most ecologists would not expect species to interact or respond to an environmental gradient in a linear manner".

The application of a variety of eigenvector multi-factor analytic techniques, such as the classical factor analysis (Spearman, 1904), principal component analysis (Hotelling, 1933) and reciprocal averaging (Hill, 1973) yields an "indirect ordination" or "phytosociological ordination" (Goldsmith and Harrison, 1976) by which factors are objectively abstracted by purely mathematical transformations and reductions of the coefficient of similarity matrix for the vegetation sample quadrats, into a few hypothetical underlying axes. The resulting orthogonal (uncorrelated) axes are interpreted along the major directions of community variations with the environment.

7.4 MY APPLICATION OF RAO'S CANONICAL FACTORING ANALYSIS AS AN ORDINATION TECHNIQUE

Rao's canonical factoring analysis (RCFA) is one available technique which I use in my ordinations here. I believe RCFA potentially makes substantial contributions to the organisation of community trends in plant distribution along with the other multivariate techniques introduced from other fields, though it has not been employed in plant ecological ordinations before.

Principal components analysis "the assumed method of factor extraction" (Morrison, 1967) was described by Gittins (1969) as "probably representing the most successful ordination technique currently employed in studies of vegetation" and Orloci (1969) believed that PCA "provides the most efficient means for a parsimonious summarisation of linear vegetational or environmental variation in a given sample". Conversely, the utility of PCA was questioned by Gauch and Whittaker (1973). They made an "over-all ranking of techniques" to form "an ordination of ordination methods", and concluded that PCA was the "worst".

Canonical correlation analysis (CCA) was introduced into phyto-sociological ordination by Austin (1968) and had been re-used by Casie and Michael (1968), Casie (1969), Barkham and Norris (1970), Gauch and Wentworth (1976) with varied reports about successes achieved from it. Barkham and Norris (1970) described a case of data analysis by both PCA and CCA, and they believed that both "techniques of data analysis described provide a workable strategy to investigate a complex vegetation-soil system". However, CCA was judged to have "little value for ordination" by Whittaker and Gauch (1978).

A major drawback to many of the popular indirect ordination multivariate eigen vector techniques is that the data must be "consistent with

the multi-variate normal distribution" (Rolf, 1971) on the assumption that they were derived by statistical random experiments. "The concept of principal component analysis applies to a random variable" (Hotelling, 1933). However, vegetation surveys are hardly randomly executed in the field. Greig-Smith (1964) stated that "truly random dispersal is hardly, if ever, found in nature" but that "plant individuals tend to be clumped or be contingously distributed around central points". Whittaker (1973) also pointed out that "formal randomisation of sample locations has been abandoned by most who have tried it". RCFA makes no assumption of a random sample and my data collection was not totally random.

The departure from random vegetation survey thus requires a departure from an ordination technique such as PCA whose predictive efficiency as a multi-dimensional scaling technique presupposes a random sampling. RCFA makes multiple correlations and readjusts the correlation matrix following the assumption that the observed N variables are only a sample from a universe of variables. "It implies that any observed point can be corrected for errors of measurement and can be expressed as linear combination of a number of basic vectors" (Rao 1964). It assumes that a given correlation matrix is based upon a sample of cases (species) and determines what the most likely population segments would be when determined by the linear combination of the common and unique (items) species of the observed variables (quadrats), assuming some sampling errors, without presupposing a random survey or a multi-variate normal distribution.

I consider Rao's canonical factoring analysis as a bridge between, and a combination of the features of the two multi-variate techniques of factor analysis by PCA and the canonical correlation analysis which Austin (1968) and others employed. Thus, like CCA, it extracts sets of

linear combinations of variables in order to account for maximal variance within the data matrix. Also, like PCA, it is a procedure for locating and defining multi-dimensional space among a large group of variables; locates a small number of dimensions, clusters, axes, or factors, specified by the user, in a large set of variables; it determines the degrees to which a set of variables are a part of a common underlying 'cause' or unique 'causes'; RCFA thus enables a simplification of the coefficients of correlations between a large number of independent variables (quadrats) and a large number of dependent variables (species).

In this way Rao's canonical factoring fits into the objectives of ordination and axes may be constructed for vegetational quadrats from situations where floristic variation is continuous or as an alternative to the classification of relatively discrete floral assemblages. The R-ordination of species' abundance in quadrats can also be executed by RCFA, but only after transposing the raw data matrix, unlike reciprocal averaging (Hill, 1973) in which a dual quadrat-species can be concurrently ordinated with the same data matrix. Similarly, an environmental ordination, where multi-dimensional scaling is executed from environmental data can be achieved with either a Q-ordination or an R-ordination.

RCFA may be employed for any one of the stated purposes of ordination either as a basis for "group identification" (Dagnelie, 1960); "cluster recognition" (Greig-Smith et al 1967); "graphical discrimination analysis" (Orloci 1968, Rolf 1971); "the identification of trends and patterns of floristic variations in terms of correlations with external factors" (Whittaker 1967, Austin and Greig-Smith 1968, Gittins 1969), or as an aid to plant community identification for which it is being investigated.

The statistics and the geometric principles involved in the canonical factor analysis by Rao have been detailed in Rao (1955) and reviewed with the criterion for judging the significance of factor loading estimates derived for explaining correlations between measurements particularly in psychology in Rao (1964). The computational procedures were described for sociological data in the computer manual of Statistical Packages for the Social Sciences by Nie et al (1970, 1975). However, I know of no ecological literature suggesting that the canonical factoring analysis has been adopted for the purpose of phytosociological ordination or related ecological analyses.

McDonald (1970) compared the theoretical mathematical foundations of factoring procedures by principal factoring analysis (PFA), canonical factoring analysis by Rao (1955) (CFA), alpha factoring analysis (AFA) and PCA. He reported that of them, Rao's "CFA seems the most natural choice" and that "constructed factor scores given by the method have (relative) maximum correlations with true factors". McDonald affirmed that "it seems possible to say unequivocally that CFA is the best procedure for almost all applications".

By the Q-type approach, bivariate correlation coefficients (r) between paired quadrats are calculated and arranged in a co-variance matrix to provide the idea of the concomitant variation as well as the degree to which variations in the quantitative floristic values in one quadrat is related to variations in the species values in other quadrats by the formula

$$r = \frac{\left(\sum_{i=1}^{N} x_i y_i - \left(\sum_{i=1}^{N} x_i\right)\left(\sum_{i=1}^{N} y_i\right)/N\right)}{\left[\sum_{i=1}^{N} x_i^2 - \left(\sum_{i=1}^{N} x_i\right)^2/N\right]\left[\sum_{i=1}^{N} y_i^2 - \left(\sum_{i=1}^{N} y_i\right)^2/N\right]^{1/2}} \quad \text{----2}$$

That is, the correlation coefficient formula 1 is restated by a division of the numerator and denominator by N-1 to show that r can also be defined as the covariance in X and Y divided by the product of their

standard deviations. Covariance in X and Y is given by

$$\frac{\sum_{i=1}^{N} (xi - \bar{x})(x_i - \bar{y})}{N-1} \quad \text{----------3}$$

and standard deviation is given by

$$\frac{\sum_{i=1}^{N} x_i y_i - N\bar{x}\bar{y}}{N-1} \quad \text{----------4}$$

The covariate species are assumed by 3 to be linearly related to the continuous variables (quadrats) in order to provide a convenient way for examining the combined effects and interactions of species combinations within quadrats in a continuum trend. 3 measures the dispersion about the mean of an interval level species score and how closely the individual scores of species cluster around the mean.

The computations of the factor loading coefficients only requires the set of bivariate correlation coefficients for a data to work out the assumed underlying structures in terms of hypothetical variables depending on what are called "common and specific or individual factors" (Rao 1955).

RCFA assumes that the calculated table of intercorrelations is influenced by various determinants. Some determinants are shared by others, others are not shared by the rest. Thus there are general factors common to a relatively higher proportion of the population group, and some peculiar factors uniquely or specifically shared by a few variables. Since the determinants of community correlation in a Q-ordination are the species, jointly shared or discriminantly distributed in the quadrats, it is possible to align the species with high constancy in a raw floristic data table with the 'common factor' goal of RCFA, while the subsequent successive axes will synthesize a correspondence to the 'fidelity' data of the Zurich-Montpellier School of Braun-Blanquent (1932). Braun-Blanquent used the concept of fidelity to determine the "characteristic" species of an association or plant community, and scaled the relative exclusiveness to which species are

confined to one or a few communities as "exclusive", "selective", "preferential" and "indifferent" (the order being from species most specific to unique communities to species which have the least pronounced affinity for any community and are common to a general factor).

The aims of RCFA are to explain a table of intercorrelations in terms of simpler covariations by decomposing the correlation coefficients such that variables determined by the same common and unique factors are mutually highly correlated positively ("non-negative positive-definite or positive semi-definite canonically reduced matrices", *Rao* 1955, 1964).

It is assumed that raw variable matrix is influenced by various determinants, some of which are shared by other variables in the set while others are not shared by any other variable, i.e. that some causes are 'common' and others are 'unique'. Thus the correlation coefficient matrix for the variable set is assumed to be the result of the correlated variables sharing some of the common factors, which is modelled as:

$$Zj = ajiF1 + ajzFz + aj3F3 + \ldots + ajmFm + djUj$$

where j = 1, 2, 3...n

Zj = variable j in standardized form

F = hypothetical factors (eco-mathematical factor)

Uj = unique factor for variable j

aji = standardized multiple-regression coefficient of variable j on factor i (factor loading)

dj = standardized regression coefficient of variable j on unique factor j

m = no. of factors common to all variables.

Since the computations can be tackled only on a computer there is no particular need to repeat the mathematics of Rao's canonical factoring

analysis which have been fully developed in Rao (1955, 1960, 1961 and 1964).

The unique factor Uj is assumed to be orthogonal to the common factors associated with other variables, i.e. factors are not related. The initial factoring results in the extraction of an unrotated factor matrix in which

1. all factors are imposed to be orthogonal;
2. factors are arranged in the order of their importance; the first factor being the most important component. The second factor is the second most important, and so on. That is, the axes are successive and progressively diminish in accounting for the maximum covariance or heterogeneities within a sample, like PCA (Hotelling, 1933, defined principal components as "the axes which successively account for maximal variability in a sample").
3. the first factor is a general factor; subsequent factors are bipolar, with mixed positive factor loadings and negative loadings.

A complete canonical factor solution provides a means of estimating factor loading coefficients from the observed variables, involving regression weight constants for factors to describe a variable

$$Zj = ajiFi + ajzF2 + aj3F3+.... + ajmFm + djUj$$

where aji and dj stand for regression weights

Zj for a variable

Fi for common factors

Uj for a unique factor

7.4.1 FACTOR SCORE COEFFICIENT MATRIX

The theoretical associations with the successive factors are represented by a composite of indices, the factor scores, calculated for each variable.

Rotation simplifies the factor scores and enhances a meaningful interpretation of each axis. The initial solutions extract orthogonal factors in the order of their importance, the first being a general factor with significant loadings on most variables. The second and subsequent factors tend to be approximately half and half positive and negative loadings by all the variables combined. From an unrotated original axis, the patterns of variables on a two-dimensional factor loading space tend not to be obvious, The goal of rotation is to obtain readily recognizable trends or clusters from the ordination.

Rotation may be achieved by one of several methods, the geometry of which are incorporated into the RCFA computing procedures in the S.P.S.S. (Nie et al 1975). Orthogonal rotation by varimax centres on simplifying the columns of the axes into maximum trends by a computational formula

$$n \sum_{p=1}^{m} \sum_{j=1}^{n} \left(\frac{a_{jp}}{h_j} \right)^4 - \sum_{p=1}^{m} \left(\sum_{j=1}^{n} \frac{a_{jp}^2}{h_{j2}} \right)^2 \longrightarrow \text{maximum}$$

where n = no. of eigen-values (= no. of variables)

m = no. of factors

hj2 = communality of variable j

a = factor loadings

$\sum_{j}^{n}$ = the sum of factor loadings for variable j

p = common factors (less than the number of variables)

7.4.2 EIGENVALUES AND PROPORTION OF COMMON VARIANCE

The number of successive factors are determined by discriminant quadrats derived in order of their importance and can be stopped whenever the relative proportion of the covariation of sets of significantly correlated variables have been adequately extracted. In the absence of any fixed rule for deciding what is too small, more parsimonious axes

RESULTS OF Q-ORDINATION MATRICES I TO XII

1. Quadrats are sequenced by the "Mean Trait Distance" and the "Average Linkage" results from the corresponding Cluster Analytic Dendrograms shown on pages 115-126.

2. Gaps among quadrats and factor coefficients on the six factors represent the relative boundaries between plant communities as predicted by the preliminary clustering of quadrats on each corresponding dendrogram (pages 115-126).

3. Accuracy to the fifth digit calculated by the computer was rounded up to three.

4. Factor solutions were rotated by the varimax method.

5. Graphical plotting of factor loadings for visual display of paired axes (i.e. ordination scatter diagrams) are concurrently produced for each set of matrix, but these are only illustrated by a few examples (pages 202-206).

6.i PCT of VAR = percentage of variation accounted for by a factor.

6.ii CUM PCT = Cumulative percentage of variation accounted for by successive additions of PCT of VAR.

7. Page 188 exemplifies the application of the RCFA as an R-ordination technique based on the first most constant forty species in the inverted synthetized synoptic floristic raw data matrix. Redundancy or trivilality of one or more species in a synoptic data matrix is a barrier to this method of approaching ordination by RCFA. Conversely, Cluster Analysis is insensitive to either the redundancy or the triviality of a species.

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
Q1	-0.069	0.005	-0.003	-0.036	0.047	-0.062
Q30	-0.094	0.029	-0.068	-0.021	0.186	0.078
Q2	0.046	0.478	0.207	-0.081	-0.227	-0.130
Q3	0.004	0.413	0.415	0.063	-0.137	-0.162
Q4	0.040	0.480	0.384	0.135	0.202	-0.033
Q9	0.884	-0.117	0.096	-0.305	0.121	-0.031
Q24	0.888	-0.141	0.112	-0.324	0.107	-0.001
Q19	0.940	-0.088	-0.035	-0.121	0.069	-0.028
Q21	0.944	-0.075	-0.007	-0.129	0.078	-0.013
Q10	0.835	0.126	0.077	-0.005	0.026	-0.140
Q18	0.771	-0.068	0.274	-0.306	0.150	-0.085
Q12	0.817	0.033	-0.268	0.435	-0.108	0.029
Q22	0.894	-0.035	-0.212	0.339	-0.077	0.031
Q23	0.439	-0.065	-0.304	0.346	-0.155	0.080
Q20	0.869	0.002	-0.079	0.018	0.136	0.055
Q11	0.477	-0.139	0.238	-0.384	-0.022	0.069
Q32	0.504	0.598	0.300	-0.194	-0.416	0.105
Q33	0.214	0.615	0.197	-0.139	-0.571	0.182
Q34	-0.036	0.172	0.032	-0.174	-0.390	0.103
Q6	0.173	0.212	0.339	0.084	-0.018	-0.017
Q5	-0.012	0.523	0.220	0.129	0.531	0.521
Q7	0.163	0.465	0.138	0.084	0.210	0.325
Q35	0.057	0.466	0.124	0.096	0.378	0.143
Q36	0.044	0.486	0.102	-0.021	0.019	0.197
Q13	0.327	0.362	-0.068	0.248	0.291	0.141
Q31	-0.070	0.281	0.002	0.028	0.397	0.304
Q8	0.126	0.462	0.182	0.167	0.444	-0.025
Q14	0.275	0.479	0.253	0.178	0.190	-0.170
Q25	0.097	0.504	0.216	0.150	0.369	0.010
Q26	0.138	0.212	0.406	0.310	0.123	-0.427
Q27	0.132	0.575	0.459	0.241	0.148	-0.324
Q28	0.143	0.615	0.441	0.239	0.214	-0.380
Q29	0.100	0.463	0.410	0.208	0.099	-0.474
Q15	0.010	-0.448	0.558	0.165	-0.076	0.032
Q16	0.068	-0.549	0.728	0.221	-0.112	0.093
Q17	0.095	-0.471	0.771	0.242	-0.064	0.104

ORDINATION MATRIX I: GALMA 'FADAMA' VEGETATION
FACTOR COEFFICIENT MATRIX FROM Q-ORDINATION USING RAO'S CANONICAL FACTOR ANALYSIS (RCFA) ON THE SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX I

Sequence of quadrats are in the order of the agglomerative Cluster Analysis first employed in the community classification.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	103.49318	53.5	53.5	3816.60596	594
2	28.49162	14.7	68.2	3204.88550	559
3	25.49689	13.2	81.4	2458.52661	525
4	15.74265	8.1	89.5	1908.94019	492
5	12.51413	6.5	96.0	1357.45630	460
6	7.73094	4.0	100.0	987.45166	429

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY SIX FACTOR-AXES ON ORDINATION

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
Q1	-0.062	0.207	-0.167	0.055	0.202	0.292
Q2	0.020	0.165	-0.148	-0.073	-0.061	0.120
Q32	-0.035	0.042	0.006	0.048	-0.008	0.025
Q10	0.366	0.185	0.451	0.609	0.008	0.015
Q12	0.088	0.071	0.186	0.229	-0.013	0.013
Q13	-0.024	0.149	0.117	0.441	-0.121	0.029
Q3	-0.052	0.067	0.194	-0.187	-0.041	0.092
Q5	0.46	0.207	0.709	-0.405	0.043	0.032
Q6	0.224	0.131	0.716	-0.452	-0.007	0.178
Q7	0.600	0.220	0.111	0.016	0.198	-0.282
Q15	0.485	0.289	-0.099	0.024	0.508	0.146
Q16	0.728	0.377	-0.175	0.020	0.284	0.224
Q18	0.750	0.314	0.007	0.023	0.207	-0.387
Q19	0.856	0.332	-0.103	-0.013	-0.225	-0.178
Q20	0.831	0.367	-0.250	-0.012	-0.213	0.100
Q17	0.496	0.151	0.080	0.022	0.158	-0.348
Q8	0.341	0.175	0.505	0.612	0.067	0.063
Q9	0.259	0.154	0.444	0.660	0.057	0.057
Q11	0.150	0.182	0.364	0.695	0.047	0.132
Q14	0.383	0.153	0.302	0.301	0.168	0.041
Q33	0.267	0.163	-0.342	0.048	-0.124	0.596
Q21	0.872	-0.271	0.041	-0.006	-0.168	0.151
Q22	0.646	-0.715	-0.017	0.019	-0.036	0.101
Q27	0.642	-0.650	0.095	0.045	0.103	-0.066
Q28	0.695	-0.491	-0.065	-0.019	0.286	-0.207
Q23	0.534	-0.314	-0.164	-0.033	0.121	0.092
Q26	0.525	-0.562	-0.054	-0.043	-0.050	0.006
Q29	-0.001	-0.433	-0.075	-0.046	-0.008	-0.096
Q4	0.374	0.301	-0.277	-0.127	0.319	0.019
Q30	0.537	0.231	-0.231	-0.062	0.381	-0.288
Q31	0.240	0.276	-0.276	-0.105	0.570	0.399
Q34	0.222	0.226	-0.243	-0.034	0.471	0.251
Q24	0.336	0.148	-0.436	-0.151	0.257	0.125
Q25	0.523	0.288	-0.362	-0.102	0.253	0.029

ORDINATION MATRIX II: ZARIA-DAMBO 'KURMI'
FACTOR COEFFICIENT MATRIX FROM Q-ORDINATION USING RCFA ON THE SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX II

Sequence of quadrats are partly due to test recombinations following the agglomerative Cluster Analysis first employed for the community classification.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	68.64105	48.4	48.4	2602.18579	527
2	27.09036	19.1	67.6	2119.35767	494
3	18.28801	12.9	80.5	1719.10547	462
4	12.40084	8.8	89.2	1403.03467	431
5	8.40263	5.9	95.1	1170.35254	401
6	6.88057	4.9	100.0	949.58887	372

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY SIX FACTOR-AXES ON ORDINATION MATRIX II IN THEIR DESCENDING ORDER OF IMPORTANCE

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
Q1	0.323	-0.120	0.328	-0.007	-0.046	-0.154
Q2	0.075	-0.404	0.605	-0.000	-0.255	0.051
Q3	0.281	-0.544	0.741	0.032	-0.134	0.058
Q4	0.567	-0.482	0.568	0.025	0.162	0.047
Q5	0.568	-0.416	0.538	-0.038	0.103	-0.019
Q6	0.558	-0.006	0.019	-0.093	0.646	-0.114
Q12	0.792	-0.222	-0.407	0.144	-0.285	0.018
Q13	0.933	-0.143	-0.192	-0.012	-0.014	-0.082
Q20	0.933	0.049	-0.228	-0.030	0.114	0.101
Q14	0.845	-0.256	-0.235	0.074	0.080	-0.096
Q15	0.512	0.490	0.206	-0.455	0.120	-0.237
Q16	0.511	0.531	0.265	-0.467	-0.213	-0.162
Q11	0.604	-0.008	-0.090	0.137	-0.057	0.078
Q7	0.200	0.798	0.261	-0.066	-0.152	0.222
Q8	0.272	0.773	0.292	-0.062	-0.021	-0.114
Q9	0.403	0.700	0.308	0.384	-0.060	-0.042
Q19	0.225	0.795	0.296	0.239	0.005	-0.129
Q18	0.106	0.642	0.225	0.553	0.072	-0.089
Q10	0.477	0.593	0.149	0.285	0.160	0.299
Q17	0.254	0.527	-0.003	-0.400	0.010	0.556

ORDINATION MATRIX III: GALMA IRRIGATION SCHEME SITE
FACTOR COEFFICIENT MATRIX FROM Q-ORDINATION USING RCFA ON THE SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX III

Sequence of quadrats are in the order of the agglomerative Cluster Analysis first employed in the community classification.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	75.89616	44.4	44.4	940.97900	170
2	43.05170	25.2	69.6	683.48071	151
3	28.42638	16.6	86.2	414.58374	133
4	11.28933	6.6	92.8	296.13379	116
5	6.74416	3.9	96.7	224.24957	100
6	5.56811	3.3	100.0	151.29027	85

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY SIX FACTOR-AXES ON ORDINATION MATRIX III IN THEIR DESCENDING ORDER OF IMPORTANCE

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
Q1	0.672	-0.288	0.328	-0.083	-0.109	-0.065
Q3	0.766	-0.295	0.402	0.019	-0.207	-0.151
Q5	0.833	-0.322	0.292	-0.171	-0.015	-0.031
Q11	0.900	-0.138	0.068	-0.117	-0.112	-0.230
Q10	0.882	-0.064	-0.185	-0.259	0.211	0.033
Q9	0.849	-0.002	-0.074	-0.058	-0.120	-0.039
Q12	0.800	0.013	-0.189	-0.250	0.327	0.101
Q2	0.567	0.021	0.294	0.204	0.161	0.263
Q6	0.579	0.151	0.344	0.152	0.323	0.504
Q4	0.738	-0.078	0.487	0.306	-0.146	0.169
Q7	0.608	-0.031	0.284	0.098	0.073	0.090
Q8	0.655	0.276	-0.456	0.419	-0.177	-0.074
Q13	0.645	0.309	-0.653	0.039	0.067	-0.010
Q14	0.572	0.330	-0.300	0.360	0.094	0.072
Q15	0.513	0.371	-0.077	0.215	0.129	-0.086
Q16	0.125	0.736	-0.103	-0.327	-0.468	0.195
Q17	0.011	0.502	0.180	-0.304	-0.312	0.266
Q18	0.062	0.782	0.412	-0.049	-0.012	0.010
Q19	0.066	0.828	0.400	-0.059	0.137	-0.119
Q23	0.102	0.791	0.329	0.120	0.149	-0.120
Q20	0.046	0.726	0.386	0.084	0.245	-0.236
Q22	0.020	0.753	0.417	-0.028	0.133	-0.169
Q21	-0.014	0.462	0.201	0.060	0.312	-0.287

ORDINATION MATRIX IV: UPLAND KAKO VILLAGE TO GALMA 'FADAMA'
FACTOR COEFFICIENT MATRIX FROM Q-ORDINATION USING RCFA ON THE SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX IV

Sequence of quadrats are in the order of the agglomerative Cluster Analysis first employed in the community classification.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	84.48830	47.6	47.6	1642.56909	230
2	37.98502	21.4	69.0	1239.16333	208
3	28.23535	15.9	85.0	781.12305	187
4	10.29647	5.8	90.8	619.73210	167
5	9.79105	5.5	96.3	405.09033	148
6	6.58132	3.7	100.0	239.11826	130

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY SIX FACTOR-AXES ON ORDINATIO MATRIX IV IN THEIR DESCENDING ORDER OF IMPORTANCE

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
Q1	.001	.372	.317	.088	.133	.057
Q2	-.034	.360	.373	.003	.083	.019
Q6	.064	.222	.350	-.002	.204	.138
Q9	.380	.096	.308	.270	.279	.375
Q10	.388	.178	.253	.097	.271	.513
Q11	.501	.160	.212	.097	.339	.507
Q12	.335	.082	.361	.379	.171	.059
Q20	.204	-.010	.366	.518	.081	-.086
Q19	.081	.047	.297	.541	-.193	-.218
Q21	.075	.051	.360	.649	-.165	-.244
Q24	.029	-.096	.193	.663	-.139	-.197
Q22	.065	-.074	.294	.540	.033	-.251
Q23	-.044	-.023	.145	.366	.011	-.152
Q41	-.107	-.027	-.061	-.027	.071	-.081
Q55	.010	-.031	.079	.130	.096	-.121
Q56	-.101	-.034	-.031	-.022	.076	-.088
Q42	.655	.345	-.120	-.080	-.118	-.154
Q44	.633	.277	-.195	-.097	-.155	-.274
Q48	.705	.358	-.168	-.029	-.125	-.202
Q45	.624	.342	-.092	-.092	-.108	-.137
Q50	.675	.318	-.098	.029	-.133	-.231
Q46	.776	.343	-.113	-.057	.061	.084
Q53	.772	.405	-.107	-.017	-.029	.003
Q49	.660	.216	-.105	-.109	.070	.045
Q43	.516	.226	-.187	-.124	-.122	-.134
Q51	.456	.252	-.151	.069	-.165	-.221
Q47	.561	.162	-.014	-.013	.175	.191
Q52	.621	.233	.040	.119	.185	.156
Q54	.371	.127	-.072	-.029	.082	.144
Q7	-.195	.509	.374	-.149	-.101	-.044
Q8	-.235	.547	.407	-.165	-.036	-.117
Q13	-.337	.525	.061	-.051	-.061	-.016
Q14	-.337	.496	.116	-.051	.104	-.189
Q16	-.275	.451	.079	.008	.050	-.090
Q15	-.340	.509	.088	-.123	.353	-.259
Q17	-.343	.411	-.003	-.112	.404	-.297
Q18	-.336	.398	-.107	-.032	.370	-.237
Q33	-.352	.491	-.110	.007	.052	.032
Q34	-.256	.397	.204	-.209	-.108	.039
Q35	-.239	.407	.302	-.254	-.200	.063
Q36	-.193	.249	.179	-.174	-.503	.232
Q37	-.168	.221	.089	-.011	-.559	.302
Q39	-.098	.252	.230	.056	-.381	.279
Q40	-.138	.368	.146	.061	-.566	.272
Q38	-.253	.326	-.028	.083	.006	.063
Q25	-.311	.241	-.488	.315	-.046	.203
Q26	-.261	.191	-.548	.269	.016	.121
Q27	-.310	.432	-.524	.261	.177	.017
Q31	-.449	.357	-.446	.244	.056	.168
Q32	-.298	.328	-.309	.131	.046	.070
Q29	-.243	.490	-.109	.180	-.165	.108
Q30	-.304	.557	-.368	.290	-.166	.108
Q28	-.347	.433	-.463	.256	.108	.098
Q3	-.310	.653	.344	-.138	.029	-.033
Q4	-.265	.513	.316	-.117	.101	-.041
Q5	-.233	.475	.363	-.130	.120	-.048

ORDINATION MATRIX V: SELECTED UPLAND SITES
FACTOR COEFFICIENT MATRIX FROM Q-ORDINATION USING RCFA ON THE SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX V

Sequence of quadrats are in the order of the agglomerative Cluster Analysis first employed in the community classification.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	19.51459	31.8	31.8	6253.61699	1484
2	14.65192	23.8	55.6	5240.80385	1429
3	8.96907	14.6	70.2	4633.53940	1375
4	7.12060	11.6	81.8	4136.47419	1322
5	5.82759	9.5	91.3	3722.72779	1270
6	5.16067	8.7	100.0	3309.49215	1219

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
Q1	.175	-.073	.042	-.266	-.050	.212
Q19	.322	-.109	.217	-.212	.034	.097
Q93	.179	-.122	-.170	.073	-.110	-.199
Q2	.127	.513	.478	.243	-.034	-.088
Q4	.281	.606	.483	.184	-.070	-.055
Q5	.377	.452	.391	.179	-.064	.005
Q9	.469	.393	.431	.066	.034	-.088
Q7	.278	.420	.027	.125	.123	-.102
Q10	.368	.606	.337	.215	.113	-.155
Q11	.230	.560	.461	.219	-.005	.046
Q12	.186	.417	.493	.154	.058	.122
Q16	.279	.524	.312	.191	.078	-.148
Q17	.232	.533	.109	.272	.271	-.174
Q6	.436	.488	.344	-.048	-.177	.171
Q8	.524	.330	.286	-.101	-.130	.310
Q14	.530	.391	.188	-.046	-.256	.197
Q15	.460	.547	.052	.027	-.033	.105
Q29	.382	.358	-.396	-.278	.022	-.018
Q32	.490	.339	-.143	-.242	-.033	.014
Q63	.506	.447	-.377	-.112	-.003	-.245
Q69	.546	.322	-.382	.024	.022	-.003
Q75	.396	.360	-.533	.084	-.131	.131
Q71	.476	.486	-.460	.132	.152	.088
Q72	.423	.600	-.436	.093	.105	-.006
Q96	.434	.267	-.323	.113	.326	.085
Q70	.391	.486	-.434	-.056	.043	-.010
Q35	.414	.237	-.338	-.324	-.171	-.060
Q94	.277	.464	-.219	.032	.034	-.027
Q109	.426	.460	-.444	.060	.042	-.024
Q102	.262	.457	-.095	.094	.323	-.025
Q87	.404	.054	-.403	.198	.037	-.180
Q47	.489	.048	.356	-.028	-.325	.094
Q62	.568	.074	.042	-.064	.058	-.130
Q13	.562	.005	.240	-.409	-.261	.025
Q38	.514	-.060	.257	-.431	-.241	-.105
Q36	.607	-.075	-.023	-.436	-.305	.095
Q40	.625	-.024	-.012	-.383	-.132	-.049
Q37	.484	.055	-.184	-.308	.073	.337
Q46	.468	.059	-.153	-.418	-.040	.033
Q18	.316	-.196	.094	-.228	.077	.213
Q20	.498	-.387	.166	-.138	.406	.071
Q21	.489	-.382	.082	-.049	.194	.220
Q22	.529	-.284	.116	-.053	.407	.256
Q23	.481	-.314	.131	-.085	.406	.228
Q25	.567	-.275	.187	-.116	.370	-.055
Q49	.572	-.465	.112	.033	.207	-.111
Q45	.511	-.351	.208	-.262	.004	-.270
Q44	.603	-.250	.065	-.254	.084	-.300
Q39	.603	-.295	.124	-.205	.017	-.057
Q33	.284	-.084	.063	-.107	-.065	-.078
Q34	.362	-.166	.171	-.328	.127	.032
Q65	.696	-.396	-.100	.032	-.017	-.325
Q66	.573	-.433	.103	.073	-.062	-.360
Q68	.483	-.443	-.054	.349	.002	-.265
Q91	.464	-.304	.068	.117	-.117	-.238
Q88	.433	-.414	-.081	.403	-.175	.031
Q92	.421	-.377	.129	.094	.325	.076
Q98	.513	-.383	.025	.400	-.086	.042
Q99	.514	-.443	-.085	.336	-.118	.155
Q100	.432	-.420	-.085	.452	-.076	.262
Q101	.568	-.404	-.030	.325	-.071	.245
Q107	.530	-.368	-.068	.342	-.325	-.009
Q108	.426	-.195	-.260	.372	-.397	.025
Q73	.495	-.295	-.059	.055	.007	.094
Q74	.544	-.367	-.018	.136	.172	.138
Q76	.325	-.137	-.135	.065	-.311	.191

ORDINATION MATRIX VI (WITHOUT THE CLUSTER 'A'): DUGBI TO KAKO UPLAND PLAINS FACTOR COEFFICIENT MATRIX FROM THE Q-ORDINATION USING RCFA ON THE SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX VI MINUS THE AGGLOMERATED CLUSTER COMMUNITY 'A' MARKED IN PLAIN 6 DENDROGRAM

Sequence of the 66 quadrats are in the order of the agglomerative Cluster Analysis first employed in the community classification of the 111 quadrats.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	32.29687	37.7	37.7	9656.52208	2079
2	22.28587	26.0	63.7	7904.04178	2014
3	11.61380	13.5	77.2	6980.42018	1950
4	8.70740	10.2	87.4	6261.84670	1887
5	5.99154	7.0	94.4	5798.34927	1825
6	4.83559	5.6	100.0	5435.01738	1764

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
Q3	0.13	0.23	0.56	-0.14	0.18	-0.32
Q52	0.70	0.08	-0.08	-0.13	-0.04	0.28
Q79	0.87	0.03	0.03	-0.26	-0.01	0.01
Q104	0.83	0.04	-0.16	0.19	0.17	-0.05
Q105	0.80	0.22	-0.14	0.24	0.23	0.24
Q28	0.70	0.14	-0.09	-0.24	0.12	0.27
Q56	0.91	-0.17	-0.01	-0.14	-0.13	0.10
Q58	0.93	-0.15	-0.15	-0.19	-0.10	0.04
Q57	0.85	-0.39	-0.03	-0.01	0.08	-0.08
Q81	0.83	-0.39	-0.01	0.05	-0.15	-0.01
Q59	0.67	-0.59	0.13	0.29	0.01	-0.03
Q82	0.83	-0.43	-0.03	0.06	-0.10	-0.12
Q77	0.73	-0.39	-0.07	0.05	0.07	-0.05
Q55	0.74	-0.01	0.01	-0.13	0.10	0.04
Q78	0.86	-0.07	-0.03	-0.19	-0.10	0.10
Q111	0.80	0.01	-0.09	-0.22	-0.04	0.14
Q89	0.73	0.28	-0.22	0.02	-0.03	-0.16
Q90	0.86	0.01	-0.24	0.03	-0.10	-0.19
Q42	0.73	0.26	0.02	-0.33	0.11	-0.06
Q95	0.68	-0.18	-0.12	0.14	0.38	0.14
Q97	0.63	0.03	-0.03	-0.03	0.32	0.23
Q61	0.61	0.50	-0.07	0.09	-0.41	-0.16
Q67	0.72	0.49	-0.23	0.08	-0.23	0.01
Q103	0.55	0.41	-0.28	0.45	-0.03	-0.04
Q64	0.75	0.32	-0.17	0.17	-0.07	0.15
Q54	0.56	0.12	0.62	0.32	-0.17	0.18
Q80	0.43	0.23	0.26	0.50	-0.30	0.16
Q60	0.73	0.05	0.57	-0.08	0.02	-0.05
Q84	0.56	-0.01	0.57	0.08	-0.21	0.01
Q27	0.43	0.32	-0.01	0.07	-0.01	0.14
Q85	0.66	-0.22	0.04	0.27	0.44	-0.04
Q106	0.54	0.18	0.03	0.14	0.43	0.07
Q51	0.54	0.29	-0.11	0.19	-0.10	0.10
Q41	0.73	0.18	0.07	-0.34	0.19	-0.08
Q43	0.64	0.17	0.14	-0.34	0.25	-0.18
Q24	0.68	0.30	0.28	-0.27	0.09	-0.04
Q26	0.59	0.42	0.33	-0.06	0.04	-0.04
Q53	0.65	0.34	0.32	-0.22	0.17	-0.14
Q48	0.72	0.37	0.04	0.04	0.16	0.07
Q30	0.74	0.39	0.01	-0.23	0.02	-0.01
Q31	0.48	0.26	0.06	-0.05	0.11	0.17
Q83	0.64	0.23	0.09	-0.18	0.04	0.01
Q50	0.68	0.22	-0.04	0.12	0.34	0.17
Q86	0.70	0.23	-0.03	0.25	0.17	-0.45
Q110	0.47	0.36	-0.13	0.46	0.08	-0.14

ORDINATION MATRIX VIA: DUMBI TO KAKO UPLAND PLAINS, CLUSTER'A' FROM PLAINS 6 CLUSTER DENDROGRAM OF QUADRATS (SEE DENDROGRAM)
FACTOR COEFFICIENT MATRIX ON THE FLORISTIC RAW DATA CONTENT OF THE AGGLOMERATED COMMUNITY USING RCFA

Sequence of the 45 quadrats are in the order of the agglomerative Cluster Analysis first employed in the community classification of 111 quadrats. Sub-ordination was made necessary because of the large number of quadrats involved. (The University of Manchester Regional Computer Centre limits maximum variables (quadrats) to 100, while it is limited to 46 at the Oxford University Computing Laboratory, hence the need for sub-ordination when analysing the 111 quadrats.)

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	133.33760	69.1	69.1	7129.25781	945
2	21.68909	11.2	80.3	5953.16016	901
3	12.63299	6.5	86.9	5237.28516	858
4	11.21362	5.8	92.7	4485.42187	816
5	8.27232	4.3	97.0	3890.19434	775
6	5.83692	3.0	100.0	3475.89600	735

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY SIX FACTOR-AXES ON ORDINATION MATRIX VIA IN THEIR DESCENDING ORDER OF IMPORTANCE

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
Q1	.757	-.046	-.120	.049	.127	.154
Q2	.632	-.261	-.203	.154	.114	.093
Q8	.670	-.125	-.211	.151	.044	.133
Q14	.704	-.216	-.189	.116	.131	-.043
Q11	.648	.108	-.247	.345	-.065	.138
Q5	.380	.146	-.157	.226	-.023	-.215
Q3	.554	-.179	-.098	-.008	.212	-.088
Q18	.571	-.288	-.170	.093	.198	-.260
Q19	.715	-.315	.023	-.075	-.007	-.207
Q13	.601	-.066	-.018	.006	.131	-.446
Q4	.444	-.210	-.084	-.035	.116	-.125
Q7	.696	-.301	-.108	-.019	.052	.129
Q17	.625	-.314	-.095	.028	.035	.020
Q12	.733	-.082	-.103	.243	-.217	-.049
Q15	.672	-.205	.107	-.159	-.079	-.089
Q16	.714	-.308	.007	-.055	-.046	-.061
Q20	.274	-.209	.021	-.024	.128	.243
Q25	.375	-.273	-.125	.055	.091	.037
Q22	.379	-.276	-.091	.014	-.014	.201
Q21	.380	-.240	-.129	.064	.122	-.107
Q27	.511	-.257	-.203	.093	.114	.095
Q26	.449	-.319	-.100	-.005	.117	-.215
Q23	.080	-.122	-.144	.043	.009	.105
Q48	-.045	-.071	.675	.507	.291	.149
Q53	-.054	-.085	.697	.471	.224	.058
Q50	-.072	-.071	.536	.462	.302	.136
Q24	.184	-.040	.080	-.215	-.007	.250
Q8	.492	-.248	-.053	-.012	-.047	.402
Q10	.602	-.106	-.169	.201	-.192	.324
Q6	.573	-.295	-.068	-.045	.078	-.032
Q41	.504	-.139	.200	-.108	-.251	.146
Q49	.302	-.124	.796	.035	-.059	-.003
Q54	.278	-.116	.777	-.098	-.216	-.066
Q51	.344	-.180	.425	-.175	-.355	-.420
Q52	.212	-.170	.580	.022	-.254	-.350
Q28	.245	.741	.021	.087	-.110	.074
Q33	.221	.749	-.026	.096	-.035	-.005
Q29	.220	.738	-.087	.189	.096	-.157
Q43	.244	.645	-.032	.032	.236	-.167
Q47	.188	.667	-.019	-.042	.252	-.161
Q39	.267	.823	.027	-.026	.157	-.018
Q42	.267	.744	.102	-.150	.248	-.079
Q38	.220	.662	-.075	.259	-.221	-.020
Q30	.253	.460	.181	-.352	.029	.150
Q44	.342	.334	.124	-.239	.130	-.023
Q45	.311	.251	.167	-.277	.124	-.200
Q46	.246	.535	.009	-.170	.328	-.043
Q35	.056	.473	-.056	.265	-.351	.004
Q36	.188	.565	-.120	.376	-.342	-.054
Q37	.257	.620	.010	.185	-.320	.093
Q55	.046	.313	-.107	.330	-.412	.019
Q31	.440	.213	.319	-.453	-.074	.362
Q32	.363	.483	.159	-.307	.216	.201
Q40	.513	.294	.382	-.425	-.152	.192
Q34	.022	.003	-.063	.129	-.268	.058
Q56	.140	.173	-.058	.169	-.172	-.086

ORDINATION MATRIX VII: DUNBI INSELBERG AND ROCKY HILLS
FACTOR COEFFICIENT MATRIX FROM R-ORDINATION USING NCPA ON THE SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX VII

Sequence of quadrats are in the order of the agglomerative Cluster Analysis results employed in the community classification.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	25.41901	33.8	33.8	5792.52675	1484
2	20.18635	26.8	60.6	4670.99449	1429
3	11.97709	15.9	76.6	3958.97623	1375
4	7.22728	9.6	86.2	3552.06775	1322
5	5.50753	7.3	93.5	3249.49868	1270

QUADRAT SAMPLE NO.	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
S2	0.518	0.563	-0.294	0.212	0.258	0.025
S3	0.425	0.394	0.634	0.243	-0.282	-0.037
S4	0.586	0.522	0.033	0.290	-0.011	0.212
S5	0.689	0.285	0.369	-0.004	0.218	-0.024
S6	0.369	0.512	0.132	-0.003	0.109	0.044
S7	0.521	-0.026	0.289	-0.145	0.632	0.037
S8	0.427	0.322	-0.020	-0.273	0.128	-0.185
S9	0.368	0.570	-0.193	0.124	0.225	0.263
S10	0.566	0.084	-0.368	0.107	0.263	0.155
S11	0.492	0.185	-0.527	0.443	0.013	-0.343
S12	0.449	0.134	0.272	0.018	-0.244	-0.318
S13	0.341	0.365	-0.167	0.417	-0.042	0.029
S14	0.498	-0.632	0.333	0.012	0.214	0.218
S15	0.491	0.538	-0.250	-0.115	-0.081	0.377
S16	0.190	0.224	-0.019	0.028	-0.042	0.256
S17	0.114	0.244	0.238	0.225	-0.061	0.127
S18	0.754	-0.429	-0.339	-0.087	-0.277	0.022
S19	0.556	-0.600	0.037	0.153	0.200	-0.107
S20	0.441	0.109	0.361	-0.421	0.174	-0.354
S21	0.297	0.545	0.029	0.084	0.197	0.037
S22	0.615	-0.569	0.356	-0.036	0.080	0.077
S23	0.502	0.426	-0.006	-0.676	-0.023	-0.151
S24	0.431	-0.466	-0.233	0.133	-0.204	-0.304
S25	0.306	0.048	-0.139	0.088	0.294	-0.048
S26	0.375	0.325	-0.035	0.135	-0.109	0.408
S27	0.299	0.196	0.566	0.355	-0.454	-0.130
S28	0.404	-0.518	0.445	0.117	-0.013	0.112
S29	0.460	-0.329	0.020	0.256	0.271	-0.207
S30	0.145	0.300	0.294	0.226	-0.148	-0.127
S31	0.305	0.255	0.168	0.333	0.298	0.107
S32	0.212	-0.218	0.050	0.118	-0.166	0.090
S33	0.280	0.407	-0.016	0.006	-0.004	-0.175
S34	0.253	0.399	0.316	-0.157	0.059	-0.410
S35	0.323	-0.108	-0.320	0.354	0.456	-0.296
S36	0.376	0.231	-0.332	-0.387	-0.287	0.293
S37	0.269	0.429	-0.292	0.282	0.209	0.268
S38	0.408	0.391	0.001	-0.025	-0.183	0.444
S39	0.094	0.193	0.142	-0.169	0.084	-0.269
S40	0.288	0.459	0.053	0.116	-0.059	-0.054

R-ORDINATION MATRIX VII: DUMBI INSELBERG AND ROCKY HILLS

FACTOR COEFFICIENT MATRIX FROM R-ORDINATION OF SPECIES USING RCFA ON THE INVERTED SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX VII

Due to the large number of species, analysis was based on the first forty most constant species occurring in the 56 quadrats. Exclusion of S1 was necessary because initial correlation coefficient matrix with it was not calculable.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	39.53810	34.4	34.4	6043.55859	702
2	27.14311	23.6	58.1	5649.21484	664
3	17.83145	15.5	73.6	5342.96094	627
4	13.09093	11.4	85.0	5079.22266	591
5	10.00035	8.7	93.7	4845.01172	556
6	7.20341	6.3	100.0	4660.87109	522

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY SIX FACTOR-AXES ON THE INVERTEI
MATRIX VII IN THEIR DESCENDING ORDER OF IMPORTANCE

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
Q1	0.308	0.867	0.157	-0.147	0.018	-0.012
Q2	0.355	0.834	0.113	-0.271	-0.012	-0.075
Q16	0.269	0.635	0.323	0.524	-0.013	-0.015
Q17	0.454	0.424	0.485	0.218	-0.053	0.162
Q6	0.361	0.682	-0.197	0.225	-0.034	0.307
Q9	0.385	0.687	0.162	0.176	-0.004	0.029
Q15	0.544	0.227	0.276	-0.067	0.103	0.112
Q7	0.253	0.232	0.148	0.675	-0.023	-0.135
Q8	0.256	0.087	0.144	0.558	0.003	-0.395
Q3	0.702	0.395	-0.448	-0.092	0.147	-0.036
Q5	0.581	0.265	-0.596	-0.146	-0.012	-0.171
Q4	0.245	0.356	-0.432	-0.136	-0.240	0.219
Q10	0.733	-0.215	0.509	-0.152	-0.231	0.007
Q18	0.682	-0.178	0.519	-0.046	-0.027	0.003
Q20	0.753	-0.293	0.316	-0.139	0.010	-0.144
Q19	0.836	-0.202	0.302	-0.059	0.202	-0.154
Q11	0.819	-0.136	-0.227	-0.011	-0.313	0.168
Q12	0.840	-0.145	-0.262	0.130	-0.286	-0.091
Q21	0.851	-0.222	0.077	0.026	0.206	0.024
Q22	0.849	-0.202	-0.136	-0.032	0.153	0.048
Q23	0.901	-0.175	-0.150	0.024	0.070	0.143
Q24	0.780	-0.225	0.026	0.071	0.324	0.255
Q13	0.758	-0.146	-0.370	0.122	-0.080	-0.204
Q14	0.688	-0.197	-0.298	0.190	0.221	-0.182
Q25	0.527	-0.219	0.147	0.047	0.053	0.278

ORDINATION MATRIX VIII: MAIRABO FOREST PLANTATION RESERVE
FACTOR COEFFICIENT MATRIX FROM Q-ORDINATION USING RCFA ON THE SYNTHETIZED SYNOPTIC FLORIST RAW DATA MATRIX VIII

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	78.29672	53.5	53.5	1665.81665	275
2	31.76375	21.7	75.3	1124.07764	251
3	17.74722	12.1	87.4	727.00464	228
4	8.05522	5.5	92.9	555.28760	206
5	5.96480	4.1	97.0	420.60278	185
6	4.42691	3.0	100.0	320.80078	165

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY SIX FACTOR-AXES ON ORDINATIO MATRIX VIII IN THEIR DESCENDING ORDER OF IMPORTANCE

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
Q1	.340	.590	.281	.474	.172	-.069
Q2	.341	.539	.395	.401	.112	.083
Q53	.559	.158	.319	-.077	-.015	-.004
Q61	.486	.488	.428	.298	.020	.038
Q13	.387	.574	.123	.502	-.111	-.019
Q14	.390	.565	.091	.386	-.078	-.116
Q28	.546	.547	.316	.306	-.083	-.089
Q37	.626	.511	.262	.264	-.111	-.050
Q36	.776	.446	.119	.054	.006	-.211
Q38	.735	.504	-.029	.166	-.027	-.145
Q60	.572	.488	.255	.294	.353	.029
Q62	.741	.411	.098	.089	-.192	-.071
Q63	.661	.203	-.026	-.162	.157	-.061
Q65	.752	.251	-.272	-.183	-.088	-.164
Q64	.726	.236	-.133	-.173	.009	-.179
Q3	.672	.482	-.143	.105	.054	-.032
Q12	.756	-.293	-.027	.139	.164	.070
Q87	.774	-.260	.240	.107	-.025	.074
Q89	.812	-.184	.024	.099	.037	-.059
Q90	.850	-.158	.048	-.024	-.104	-.065
Q72	.692	-.423	.058	.122	-.055	.087
Q78	.720	-.251	.229	-.024	-.128	.105
Q77	.642	-.297	.423	.048	-.016	.124
Q98	.657	-.380	.378	.067	-.223	.202
Q88	.779	-.393	.008	.183	-.117	-.011
Q99	.647	-.456	.333	.187	.079	.203
Q97	.627	-.416	.404	.177	.162	-.014
Q79	.712	-.299	.220	-.003	-.305	-.047
Q100	.770	-.265	.026	.031	-.280	-.230
Q71	.876	.012	.022	-.121	.034	-.236
Q95	.906	-.079	-.030	-.077	-.026	-.136
Q96	.825	-.193	.002	.035	.057	-.244
Q74	.794	-.232	-.077	.053	.187	-.208
Q82	.774	-.307	-.095	.050	.196	-.289
Q93	.800	-.273	.036	-.005	-.013	-.290
Q94	.878	-.232	-.059	.014	-.030	-.242
Q80	.823	-.177	-.023	-.052	-.358	-.138
Q83	.871	-.219	.069	-.005	-.058	-.218
Q76	.790	-.025	.184	-.213	-.155	.162
Q85	.833	-.087	.173	-.099	-.155	-.162
Q86	.800	-.064	.144	-.069	-.246	-.093
Q67	.700	-.177	-.065	.041	.276	-.080
Q69	.698	-.183	.028	.077	.187	.051
Q70	.603	-.448	.275	.235	.165	.015
Q84	.763	-.199	.165	.041	.256	-.117
Q24	.810	-.050	.235	.002	-.198	.198
Q25	.793	-.071	.116	-.014	-.242	.176
Q43	.758	-.113	.130	.012	-.173	.170
Q27	.892	-.009	-.063	-.087	-.109	.147
Q54	.932	-.041	-.032	-.057	-.082	-.002
Q34	.886	-.039	.074	-.092	.028	.000
Q35	.858	-.019	.148	-.073	-.173	-.008
Q44	.867	-.182	.092	.042	-.027	.078
Q45	.877	-.135	.067	-.032	.138	.076
Q46	.843	-.169	.087	-.007	.081	.131
Q33	.850	-.159	.106	-.022	-.035	.032
Q42	.753	-.272	.273	.056	-.042	.168

Q8	.636	.330	.123	-.482	-.068	.113
Q9	.622	.308	.294	-.541	-.036	-.078
Q18	.677	.236	.248	-.515	-.037	-.056
Q17	.718	.297	.151	-.468	-.044	-.169
Q19	.711	.215	.104	-.497	-.017	.063
Q16	.737	.291	.098	-.428	.187	.276
Q20	.632	.263	.172	-.470	.307	.166
Q10	.521	.284	-.070	-.469	.356	.207
Q21	.603	.277	-.004	-.444	.175	.006
Q22	.681	.285	-.243	-.455		
Q52	.452	.128	.268	-.110	.074	.207
Q59	.486	.023	.192	.567	.197	.105
Q73	.535	-.375	.258	.088	.286	-.119
Q81	.671	-.166	-.196	.035	.477	-.183
Q91	.480	-.243	-.344	.088	.400	.127
Q92	.678	-.165	-.250	-.058	.194	-.218
Q5	.784	-.063	-.368	.079	-.055	.245
Q6	.764	-.032	-.331	.049	-.047	.258
Q7	.788	-.058	-.369	.077	-.169	.119
Q29	.828	.167	-.114	.062	-.260	.072
Q30	.830	.005	-.365	-.006	-.065	.058
Q39	.787	-.007	-.442	-.002	-.060	.038
Q55	.771	-.118	-.422	.087	-.098	.034
Q40	.769	.074	-.488	.007	-.072	.108
Q66	.652	.159	-.488	-.122	.005	-.085
Q31	.739	.132	-.325	-.098	-.009	.016
Q47	.816	.190	-.298	.307	-.057	.050
Q56	.798	.221	-.181	.312	-.029	-.038
Q49	.747	.273	-.345	.257	-.024	.138
Q57	.751	.287	-.313	.276	-.080	.150
Q58	.696	.252	-.327	.315	-.021	.045
Q11	.825	-.077	-.053	-.074	.120	.054
Q26	.797	-.113	-.077	-.023	-.114	.235
Q15	.646	-.151	-.352	.102	.102	.115
Q41	.586	.007	-.325	-.003	.131	.119
Q23	.739	-.208	-.254	.078	.134	-.133
Q32	.607	-.209	-.148	.073	.236	.129
Q4	.627	.383	.200	.097	.163	.143
Q50	.545	-.132	-.201	.078	.366	.362

ORDINATION MATRIX IX: KABAMA PLANTATION FOREST RESERVE
FACTOR COEFFICIENT MATRIX FROM Q-ORDINATION USING RCFA ON THE SYNTHETIZED FLORISTIC RAW DATA MATRIX

Sequence of quadrats are in the order of the agglomerative Cluster Analysis first employed in the community classification.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	228.70757	69.2	69.2	28869.89932	4752
2	33.32108	10.1	79.3	26187.01905	4654
3	23.91972	7.2	86.6	23992.21102	4557
4	22.36516	6.8	93.3	21531.73261	4461
5	12.48159	3.8	97.1	20126.16422	4366
6	9.58256	2.9	100.0	19001.35073	4272

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY SIX FACTOR-AXES ON ORDINATION MATRIX IX IN THEIR DESCENDING ORDER OF IMPORTANCE

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
Q1	.753	-.306	-.198	.097	-.047	.014
Q3	.830	-.130	-.121	.163	.072	-.152
Q4	.788	-.277	-.187	.003	-.252	.153
Q17	.725	-.403	-.290	-.130	-.105	-.055
Q19	.772	-.384	-.263	-.124	-.179	.044
Q12	.676	-.388	-.320	-.442	.092	-.004
Q13	.616	-.298	-.282	-.553	.001	.191
Q20	.641	-.437	-.261	-.303	-.049	-.073
Q14	.800	-.318	-.280	-.224	.053	-.040
Q15	.826	-.368	-.232	-.130	.101	-.073
Q16	.753	-.465	-.206	-.237	.063	-.074
Q23	.853	-.236	-.225	.063	.005	-.193
Q24	.863	-.186	-.188	-.064	.049	-.020
Q18	.595	-.357	-.203	-.032	-.219	-.129
Q5	.649	-.160	-.191	-.214	.202	.093
Q25	.754	.008	-.018	-.243	.304	.071
Q6	.588	-.246	-.026	-.385	.224	-.017
Q8	.579	.127	.121	-.045	-.098	.054
Q9	.515	.225	.037	.121	.006	.143
Q40	.573	.106	.040	-.026	-.359	.122
Q22	.753	.111	.051	.292	.143	.004
Q30	.348	.139	.001	.257	.149	.025
Q87	.129	.120	.180	.117	.251	.007
Q64	.287	-.118	.236	.336	-.058	.535
Q68	.523	-.059	-.014	.500	-.396	.192
Q82	.522	.022	.031	.459	-.120	.186
Q83	.493	-.011	.022	.489	-.175	.396
Q70	.455	-.164	.046	.404	-.335	.235
Q84	.262	-.073	.062	.300	-.286	.326
Q57	.530	.280	.129	.233	-.046	.092
Q58	.701	.080	.045	.490	.018	-.031
Q63	.675	.092	.154	.476	.013	-.083
Q88	.646	.193	.106	.464	.023	-.053
Q85	.678	.074	.057	.518	.018	-.176
Q86	.668	.041	.027	.376	.053	.085
Q59	.338	-.083	.058	.306	-.248	-.195
Q60	.418	-.040	.147	.276	-.105	-.374
Q76	.322	.116	.255	.226	.644	.123
Q79	.259	.042	.134	.256	.433	.149
Q34	.305	.255	.074	.068	.199	.256
Q38	.555	.190	-.004	.170	.090	.006
Q67	.424	.144	.062	.247	.307	.361
Q66	.513	.149	.056	.349	.059	-.076
Q69	.377	.023	.125	.336	-.107	.363
Q47	.291	-.369	.503	-.220	.080	.189
Q48	.439	-.241	.558	-.133	-.096	-.048
Q49	.250	-.425	.694	-.108	.091	.118
Q50	.111	-.397	.834	-.122	.066	-.005
Q51	.051	-.390	.842	-.116	-.036	-.050
Q52	.097	-.401	.790	-.065	-.149	-.001
Q55	.103	-.362	.844	-.069	.032	-.103
Q53	.057	-.331	.845	-.113	-.039	-.088
Q54	.068	-.356	.832	-.106	-.055	-.096
Q56	-.007	-.291	.486	-.005	-.189	-.038
Q71	-.027	-.250	.474	-.061	-.111	-.105
Q73	.177	-.045	.349	.124	.354	.083

Q2	.417	.193	.022	-.047	-.086	-.257
Q21	.365	.422	.110	-.072	-.039	-.087
Q61	.565	.240	.234	.178	-.178	-.223
Q10	.367	.631	.149	-.228	-.206	-.194
Q43	.345	.631	.163	-.420	.009	.115
Q35	.302	.603	.140	-.252	-.132	.189
Q36	.420	.625	.172	-.180	.079	.102
Q37	.217	.643	.188	-.343	-.092	.006
Q42	.381	.599	.156	-.333	.160	.235
Q28	.497	.599	.171	.048	-.043	-.190
Q29	.700	.416	.139	.109	-.008	-.162
Q62	.460	.572	.179	.015	-.022	-.333
Q65	.666	.418	.193	.176	.071	-.249
Q44	.369	.365	.145	.060	.064	-.076
Q45	.361	.554	.161	-.034	.163	-.131
Q78	.401	.522	.250	-.050	.189	.007
Q32	.283	.647	.170	-.469	-.263	.172
Q39	.362	.537	.118	-.329	-.371	.159
Q33	.240	.539	.176	-.410	-.228	.104
Q41	.409	.447	.115	-.245	.294	.212
Q46	.609	.375	.112	-.058	.132	-.005
Q11	.520	.557	.117	-.080	-.040	-.009
Q26	.403	.503	.101	.046	-.058	- 108
Q27	.300	.413	.240	-.113	-.041	-.283
Q31	.308	.513	.179	-.255	-.156	-.120
Q77	.113	.028	.135	.105	.300	.126
Q80	.249	.314	.139	-.010	.444	-.047
Q81	.238	.417	.125	-.039	.203	.025
Q7	.365	.138	.125	-.089	-.075	.331

ORDINATION MATRIX X: GUGA PLANTATION FOREST RESERVE AND ENCLAVES FACTOR COEFFICIENT MATRIX FROM Q-ORDINATION USING RCFA ON THE SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX V

Sequence of quadrats are in the order of the agglomerative Cluster Analysis first employed in the community classification.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	70.62795	41.8	41.8	18000.28371	3740
2	33.78003	20.0	61.8	16005.12312	3653
3	30.05004	17.8	79.5	13769.76808	3567
4	18.19851	10.8	90.3	12227.21535	3482
5	8.72974	5.2	95.5	11537.13938	3398
6	7.66094	4.5	100.0	10892.21195	3315

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY SIX FACTOR-AXES ON ORDINATION MATRIX X IN THEIR DESCENDING ORDER OF IMPORTANCE

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
Q1	.629	-.447	.129	-.195	-.052	-.091
Q3	.486	-.450	.218	-.101	.119	-.190
Q17	.450	-.366	.293	.103	.122	-.167
Q18	.521	-.467	.363	-.176	.014	.040
Q21	.448	-.456	.314	-.013	.095	-.121
Q69	.562	-.350	.230	-.273	.233	-.035
Q2	.444	-.422	.100	-.079	.118	-.040
Q9	.617	-.345	.232	-.087	.071	-.049
Q22	.593	-.343	.431	.112	.028	.071
Q73	.479	-.497	.409	.064	-.013	-.060
Q72	.596	-.548	.299	-.022	.021	-.101
Q32	.597	-.296	.335	.117	.115	-.069
Q4	.723	-.252	.014	.135	-.075	-.295
Q5	.717	-.128	.151	.201	-.143	-.112
Q29	.736	-.340	-.001	.084	.103	.055
Q6	.697	-.059	-.429	.108	-.253	.059
Q33	.720	-.112	-.250	.184	.005	.213
Q7	.586	-.199	-.291	-.046	-.070	.212
Q8	.620	-.043	-.264	-.117	-.009	.124
Q11	.764	-.136	-.090	-.406	-.022	.019
Q13	.834	-.030	-.346	-.087	-.036	.002
Q16	.478	-.241	-.287	-.214	-.317	-.137
Q44	.640	.294	-.198	.044	-.030	-.327
Q63	.636	.302	-.296	-.120	.068	-.250
Q62	.724	.299	-.281	-.046	-.100	-.252
Q36	.685	-.140	-.091	-.120	-.253	-.102
Q14	.619	.238	-.395	-.140	.101	-.058
Q26	.772	-.029	-.339	-.170	-.218	-.084
Q71	.664	.162	-.198	.005	.147	.077
Q53	.504	-.334	.234	.060	.298	.092
Q74	.758	-.029	.120	.022	.123	.304
Q23	.666	-.170	.032	-.330	.059	-.049
Q24	.657	-.290	.227	-.150	.016	.018
Q25	.751	-.132	-.117	-.063	.088	.010
Q15	.604	-.040	-.220	.058	.184	-.022
Q35	.438	.349	-.023	-.055	-.075	-.378
Q38	.634	.270	-.262	-.033	-.154	-.363
Q39	.688	.265	-.201	.239	-.341	-.011
Q12	.672	-.115	-.267	.025	-.359	-.040
Q20	.696	-.200	-.367	.026	-.291	.129
Q27	.793	-.105	-.247	.099	-.078	.213
Q10	.502	.124	.035	.413	-.048	.302
Q41	.699	.300	.152	.234	.006	-.110
Q45	.631	.158	.251	.403	.299	-.060
Q42	.507	.226	.157	.051	-.086	.015
Q47	.648	.201	.134	.188	.199	-.193
Q48	.589	.079	.163	.193	.168	-.119
Q57	.493	.013	.426	-.049	.131	-.030

Q19	.429	-.199	.527	.135	-.238	-.045
Q49	.448	.045	.605	.240	-.098	-.226
Q37	.084	.316	.578	.255	-.343	.010
Q54	.102	.327	.601	.143	-.310	.093
Q40	.290	.520	.369	.187	-.336	.069
Q43	.354	.478	.396	.168	-.283	-.054
Q46	.564	.438	-.201	.153	-.046	.222
Q68	.405	.407	.199	.007	.078	.139
Q55	.299	.388	.325	-.011	-.259	.124
Q75	.519	-.188	.395	-.407	-.167	.356
Q76	.440	.138	.288	-.487	-.066	.326
Q58	.599	.337	-.006	-.048	.262	-.152
Q60	.506	.352	.069	.052	-.047	.168
Q70	.373	.406	.210	-.108	-.061	.214
Q61	.426	.360	.270	.039	-.002	.063
Q77	.121	.412	.285	-.410	-.149	.203
Q78	.228	.465	.376	-.503	-.069	.180
Q79	.358	.571	.106	-.473	.185	-.145
Q80	.359	.584	.229	-.437	.059	-.014
Q34	.474	.128	-.344	.120	.305	.197
Q64	.547	.460	-.223	-.086	.376	-.079
Q65	.606	.352	-.289	.197	.351	.137
Q52	.056	.021	.052	.234	.182	.199
Q30	.533	-.027	-.286	.252	.018	.344
Q31	.558	.027	-.371	.240	-.037	.316
Q28	.606	-.306	-.012	.177	.208	.196
Q50	.405	.299	.374	.049	.130	-.099
Q51	.263	.179	.475	.410	.055	-.001
Q56	.124	.277	.508	.022	-.025	.136
Q59	.308	.465	.492	.080	.086	-.037
Q66	.246	.126	.080	.133	.552	.179
Q67	.359	.301	.062	-.116	.522	-.006

ORDINATION MATRIX XI: GUGA NON-PLANTATION FOREST RESERVE
FACTOR COEFFICIENT MATRIX FROM Q-ORDINATION USING RCFA ON THE SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX XI

Sequence of quadrats are in the order of the agglomerative Cluster Analysis first employed in the community classification.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	68.96618	51.3	51.3	12979.74997	3080
2	20.60036	15.3	66.6	11749.02002	3001
3	19.30311	14.4	81.0	10366.08042	2923
4	10.13127	7.5	88.5	9665.45387	2846
5	8.65275	6.4	94.9	9026.63363	2770
6	6.81619	5.1	100.0	8518.17219	2695

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY SIX FACTOR-AXES ON ORDINATION MATRIX XI IN THEIR DESCENDING ORDER OF IMPORTANCE

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
Q1	.338	.320	-.305	-.061	.004	-.006
Q2	.150	.542	.693	.074	.243	-.062
Q3	.137	.527	.628	.089	.280	-.015
Q4	.185	.576	.642	.068	.220	-.026
Q5	.467	.475	.103	.166	-.111	.158
Q6	.016	.329	.543	.066	.246	-.095
Q7	.692	.266	-.421	-.040	.131	-.125
Q8	.388	.495	-.144	-.073	-.260	.134
Q9	.248	.492	.228	-.017	-.002	.007
Q10	.137	.413	.363	.051	.009	-.069
Q11	.424	.694	.202	-.080	-.022	.018
Q12	.463	.625	.078	-.057	-.000	-.059
Q13	.525	.633	.009	-.009	-.155	.132
Q14	.433	.535	-.140	-.098	-.203	.136
Q15	.479	.539	-.105	-.096	-.200	.067
Q16	.447	.482	.019	.081	-.180	.132
Q17	.485	.480	.116	.146	-.165	.100
Q18	.249	.493	.213	.038	.042	.069
Q19	.108	.507	.478	.019	.083	-.084
Q20	.112	.430	.232	.016	.003	.062
Q21	.500	.619	.167	-.057	.005	-.012
Q22	.352	.394	-.087	-.102	-.145	.049
Q23	.485	.481	.319	.034	.022	-.029
Q24	.337	.550	.018	-.144	-.112	-.018
Q25	.541	-.301	.127	.344	.240	-.116
Q26	.459	-.112	-.138	.295	.264	-.043
Q27	.582	.175	-.368	.141	.361	-.203
Q28	.574	-.240	.109	.388	.016	.061
Q29	.409	.456	.093	-.042	.176	-.150
Q30	.448	.473	-.172	.010	-.082	.122
Q31	.474	.527	-.135	-.088	-.251	.111
Q32	.602	.508	-.356	-.190	-.127	.009
Q33	.637	.428	-.352	-.183	-.040	-.056
Q34	.693	.058	-.175	-.035	-.084	.014
Q35	.727	-.043	-.047	.058	-.328	.095
Q36	.413	-.379	.150	.011	-.188	.031
Q37	.458	-.503	.193	-.329	.096	.012
Q38	.328	-.148	-.234	.281	.330	-.217
Q39	.596	-.372	-.029	.386	.045	-.019
Q40	.576	.020	-.200	-.506	.116	-.023
Q41	.550	-.463	.198	-.133	-.027	.045
Q42	.614	-.449	.122	-.127	-.025	-.018
Q43	.472	-.302	-.038	.530	.044	.010
Q44	.377	.407	-.121	-.010	.131	-.004
Q45	.516	-.352	.115	.442	-.248	.115
Q46	.518	-.208	-.129	-.137	.198	-.119
Q47	.481	-.525	.262	-.394	-.030	.060
Q48	.562	-.456	.041	-.099	.333	-.056
Q49	.604	-.353	.040	-.119	.149	.121
Q50	.605	.101	-.267	-.456	.150	-.057
Q51	.156	-.091	-.117	.221	.045	-.102
Q52	.201	-.217	-.087	-.196	.466	.111
Q53	.365	-.148	-.119	.423	.023	-.042
Q54	.200	-.115	-.043	.428	.071	.262
Q55	.360	-.409	.200	-.306	-.002	.046
Q56	.370	-.174	-.212	-.055	.508	-.194

Q57	.458	-.357	.143	.062	-.217	.023
Q58	.386	.095	-.316	.276	.281	.054
Q59	.345	.211	-.208	.195	.274	.015
Q60	.547	-.132	-.127	.536	-.041	.093
Q61	.396	-.407	.041	-.287	.251	-.072
Q62	.638	-.428	.034	.071	.093	-.012
Q63	.592	-.542	.230	-.094	-.034	.036
Q64	.597	-.506	.229	-.264	-.110	.063
Q65	.508	.362	-.197	.032	-.085	.065
Q66	.428	.286	-.348	.025	.115	-.057
Q67	.547	.042	-.370	.256	.248	-.102
Q68	.288	-.228	-.044	.263	.134	.009
Q69	.345	-.255	-.089	.380	.183	.009
Q70	.582	-.374	.126	.239	-.233	.101
Q71	.436	-.465	.154	-.398	.142	.002
Q72	.539	-.346	.157	.073	-.330	.126
Q73	.475	-.527	.250	.076	-.263	.076
Q74	.465	-.472	.204	.101	-.213	.060
Q75	.339	-.443	.247	-.119	-.176	.014
Q76	.464	-.449	.095	-.258	.185	-.001
Q77	.401	-.406	.176	-.020	-.115	.017
Q78	.405	-.459	.182	-.112	-.039	-.046
Q79	.065	-.011	-.055	.007	.050	.314
Q80	-.048	.025	.014	-.161	.334	.585
Q81	-.168	.012	-.043	-.022	.218	.507
Q82	-.172	.030	-.059	-.014	.251	.711
Q83	-.147	.014	-.066	-.033	.213	.683
Q84	-.072	.044	-.072	.067	.203	.517
Q85	-.126	.014	-.092	-.012	.251	.724

ORDINATION MATRIX XII: KUYELLO RURAL AREA
FACTOR COEFFICIENT MATRIX FROM Q-ORDINATION USING RCFA ON THE SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX XII

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	41.17859	36.7	36.7	13243.87406	3485
2	32.50426	29.0	65.6	10904.23784	3401
3	13.19194	11.8	77.4	9965.39401	3318
4	10.02142	8.9	86.3	9227.55732	3236
5	8.06987	7.2	93.5	8616.87949	3155
6	7.28328	6.5	100.0	8027.85156	3075

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY SIX FACTOR-AXES ON ORDINATION MATRIX XII IN THEIR DESCENDING ORDER OF IMPORTANCE

(usually the first two or three) are often extracted or supported in related factor analytic techniques, e.g. reciprocal averaging (Hill, 1973) and PCA (Austin and Greig-Smith 1968). However, Cattell (1965) pointed out that "our real aim is not in fact to minimize the number of factors. Though it is certainly the real goal, it is not necessarily the right one". And Cattell (1965) believed that a parsimony of factor axes may lead to "degenerative factor fission" and suggested that "the best possible is the true number of factors actually at work in a given area, as far as can be possibly gauged from the evidence".

RCFA provides two measures for judging the relative importance of a factor as a result of canonical reduction of matrices; by eigenvalues and by the percentages of the eigenvalues associated with each of the rotated factors.

7.4.3 GRAPHICAL REPRESENTATION OF RCFA ORDINATION AXES

The data matrix transformation processes by Rao's canonical factoring analysis results in sets of factor loading scores arranged in columns corresponding to the successive hypothetical eco-mathematical factor axes. The scores per column take on the values of +1.0 to -1.0 equal to the number of variables analysed.

Each value corresponds to the significance of each variable on the rotated factor axes. For the purpose of identifying subsets of variables that are relatively homogeneous, to which some common underlying causes may be attributed, Rao (1955, 1964) suggested that the factor loadings for an axis be divided into non-negative "positive-definite" and positive semi-definite" values. A general strategy of interpreting plant communities from a Q-ordination factor axis thus consists of locating strongly associated series of non-negative positive-definite quadrats characterised by high loadings from successive column-axis.

Plotting the relative positions of the variables by their orthogonal varimax rotated factor loading coefficients on all possible factor axes-pairs provide two-dimensional space graphical representation of the factor loading matrix scatterplots for visual representations of the possible trends and clusters for the quadrats as well as the interconnections between factors.

On the general linear hypothesis approach to vegetation analysis (continuum), the graphical representation provides a test for trends across categories or communities. Significantly correlated quadrats will tend to cluster on successive factor axes hierarchically (in proportion to their eigenvalues. Like in PCA, the axes are "successive" and progressively account for "maximal variability in a sample" (Hotelling 1933, Gittins 1969) so that sets of covariates of likely group memberships can be partitioned into series of regions. Highly correlated quadrats are brought together so that groups representing homogeneous populations are separated in clusters or in trends as much as possible. Variables clustering near the mean suggest that variance or heterogeneity is small while variables spreading out suggest a heterogeneous population, the end result of which is that groups are as distinct as possible on different axes.

However, Cattell (1965) had pointed out that "the simplification of observed numerous variables by factor analytic methods may consist of producing a set of classificatory categories where the important causal influences lie in a bewildering array of possibilities". Rao's canonical factor analysis is essentially a linear hypothesis modelling technique and its power as a classification technique may be greatly reduced by complications due to correlations between factors which may result in factorial complexities whereby some variables load significantly on more

than one axis because the 'cause' of the variable is more than what can be explained in one direction.

7.5 PLANT COMMUNITY INTERPRETATION FROM RCFA

The ordination technique by Rao's canonical factoring analysis does not produce definite classes of plant communities *per se*. The factor trends and clusters identified are the expressions of the rank-ordered coefficients of correlation among quadrats, as the result of the interactions of the multi-variate floristic measurements, on a linear hypothesis modelling theory. Each axis is a floristic description of possible underlying environmental properties or 'causal factors' by which relatively similar floral combinations are jointly stimulated in the environment.

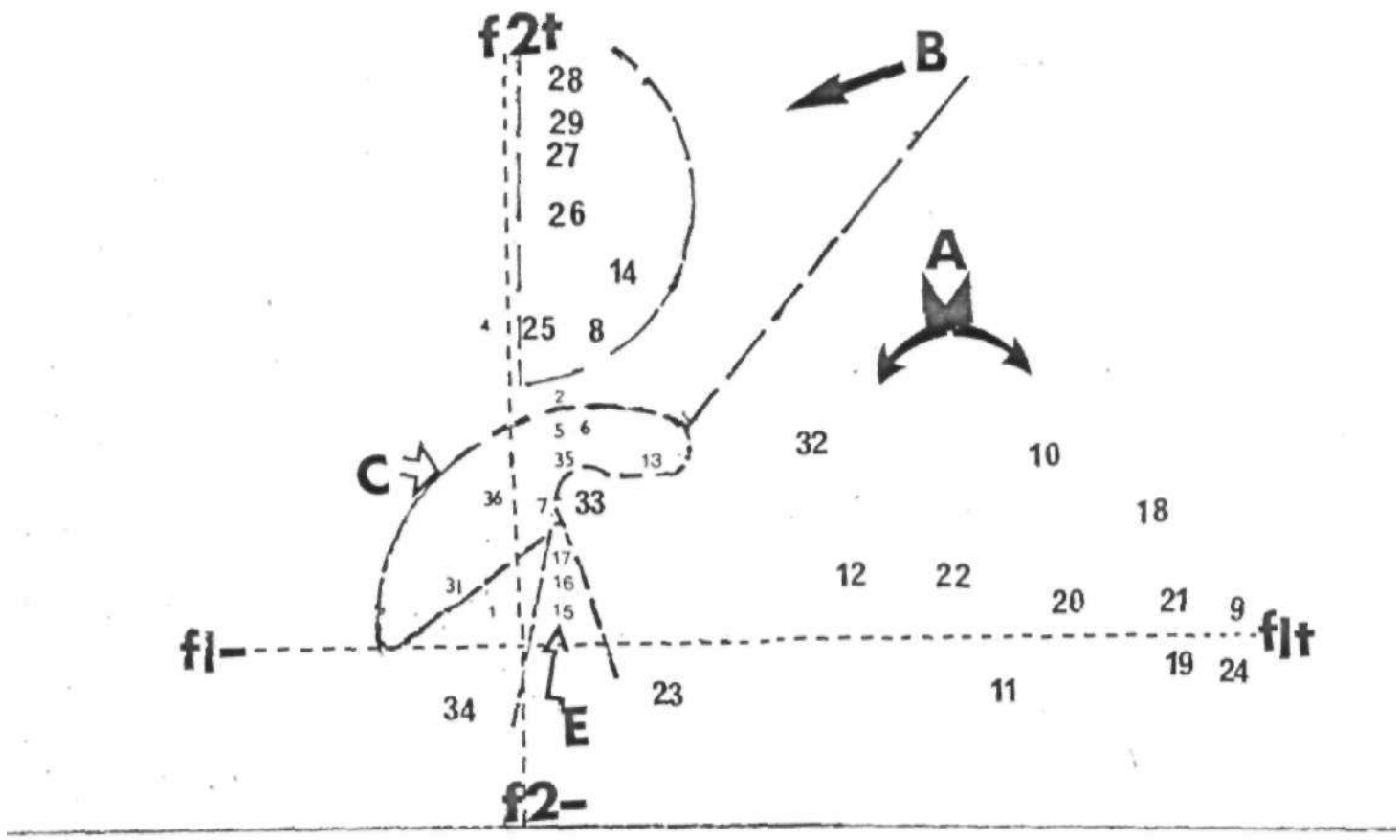
However, while an ordination axis may be regarded as quadrats lying along a continuum to which causal factors may be attached, it is conceivable that classification may be applied to the same axis-trend to delineate types of highly correlated homogeneous plant communities identified by positive-definite factor loadings on an axis; by similar floristic score measurements; and possibly by a similar underlying cause.

Rao's canonical factoring analysis assumes that it is possible to characterise 'canonical variates' or independent quadrats in a vegetation data matrix; where a 'canonical variate' "measures the extent to which relationships in one set of characters can be predicted by a set of features" (Rolf 1971). The canonical variates or the 'typical' variables are the best discriminators or predictors of successive trends "postulated by a factorial structure" (Rao 1964). The technique, according to Rao (1964) postulates that "any observed variables can be expressed as linear combinations of some basic vectors".

Therefore, a typical variable in a linear model approach may be interpreted as the criterion variable whose predictive value is used to decompose a factor-trend or clusters of variables that belong together on an axis of a multi-dimensional ordination. RCFA may thus be considered as the identification of key quadrats of theoretical importance to the decomposition of successive linear factor-trends. The factor axes are orthogonal (uncorrelated) and are therefore distinct and independent from each other. They are multi-level (or hierarchical) and successive; derived by step-wise resolutions of non-key quadrats (or residuals) around 'typical' factor-determinant quadrats. The successive resolutions of non-key quadrats around the instrumental quadrats thus has the capacity to produce multiple classifications consisting of fairly distinct, relatively homogeneous, subsets of the linear trends on each axis. Contour lines drawn around adjacent quadrats therefore groups relatively homogeneous groups of quadrats into plant community clusters.

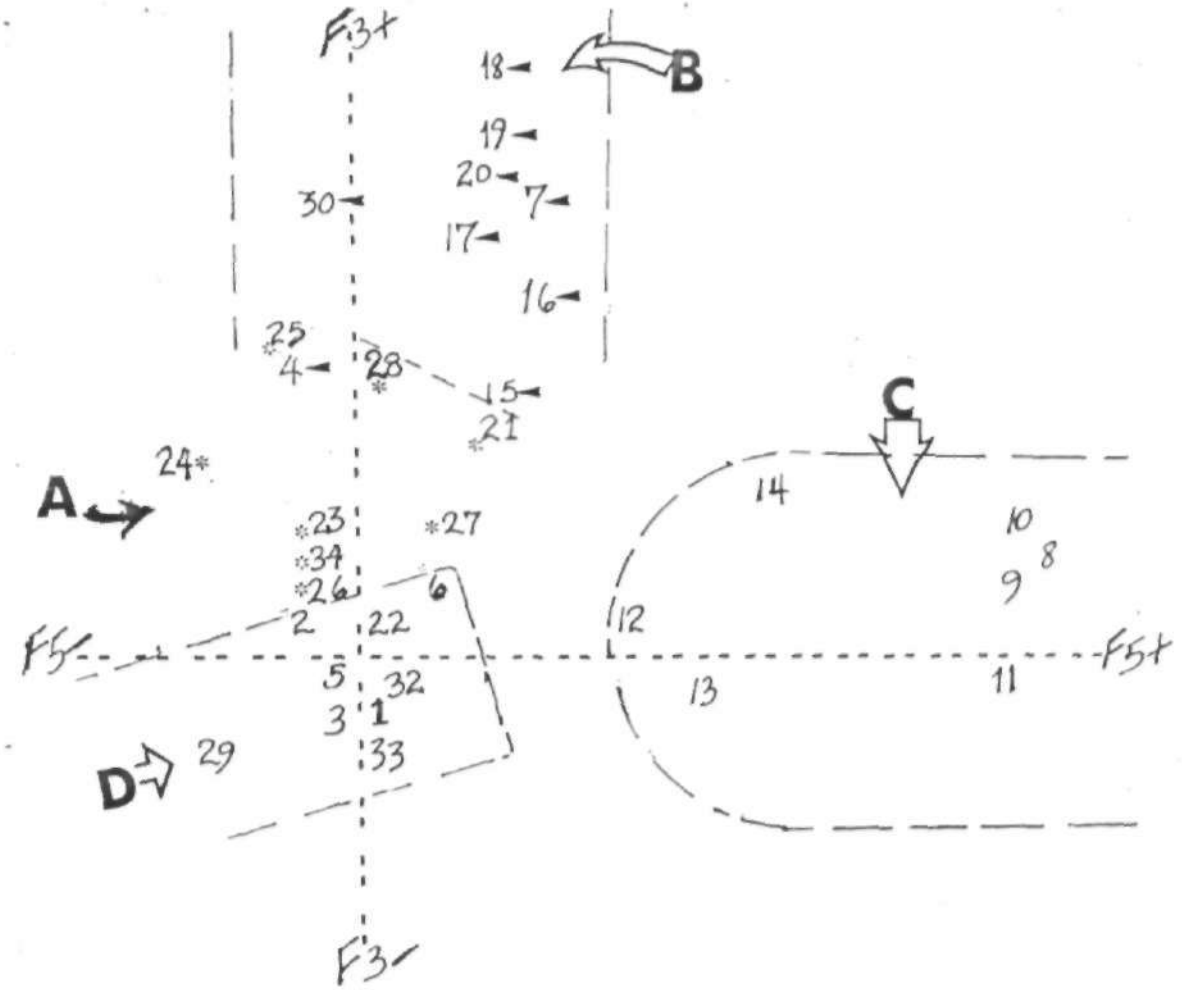
RCFA is thus my technique of arranging observation units in order to establish continuum connections as well as serving as a method for decomposition of heterogeneous communities into homogeneous subsets. The general strategy for the partition of the ordination axes consists of locating strongly associated significantly correlated clusters of variables on successive factor axes by which the floristic data matrix are organised into series of "non-negative positive-definite and positive semi-definite submatrices", Rao (1964).

The following only exemplify a fraction of the ordination scatter diagrams. They appear to suggest that Andrew's (1975) Cluster Analysis and my introduced Rao's Canonical Factoring Analysis are basically two complementary methods of multivariate numerical transformations of data matrices into clusters of relatively homogeneous groups. The differences in results are minor. Ordination graphs are minimized since the constructed dendrograms

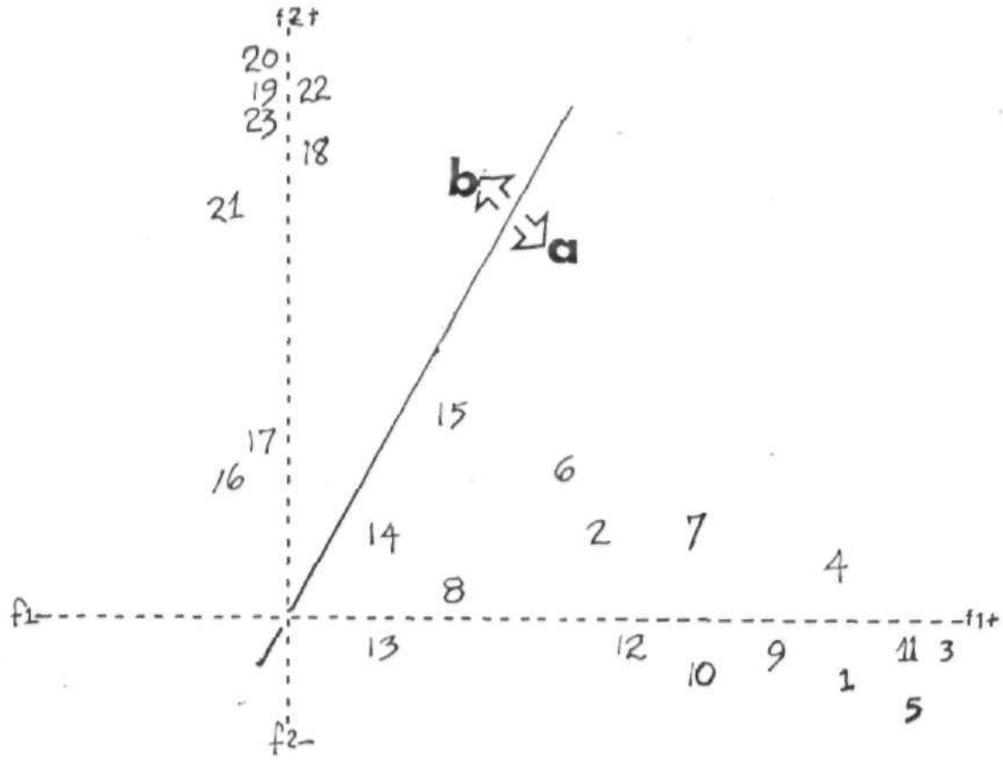


I:1, 2 An example graphical representation of the factor loadings in Ordination Matrix I - Axes 1 and 2:

'A' represents the quadrats which are positive-definite on the first axis. 'B' represents those quadrats which are positive-definite on factor 2. 'C' and 'E' are the quadrats clustered together by the preceding agglomerative Cluster Analytic technique C, D, E, become positive-definite or positive-semi-definite on successive axes. Five relatively distinct communities of unequal size were therefore suggested by both the Cluster Analysis and the Rao's Canonical Factor Analysis ordination, trends and factorial complexities notwithstanding. Each of the five cluster-factor floristic communities from the 'Fadama' was tabulated as a community. The arrangements of the communities in the stratum follow the trends suggested by the successive loadings on the successive factor axes, for the ordination relates to the trends of the communities with environments as indicated on the associated Floristic plant community tables based on the analyses of the synthetized synoptic floristic data and subsequently related with the environmental data matrix.

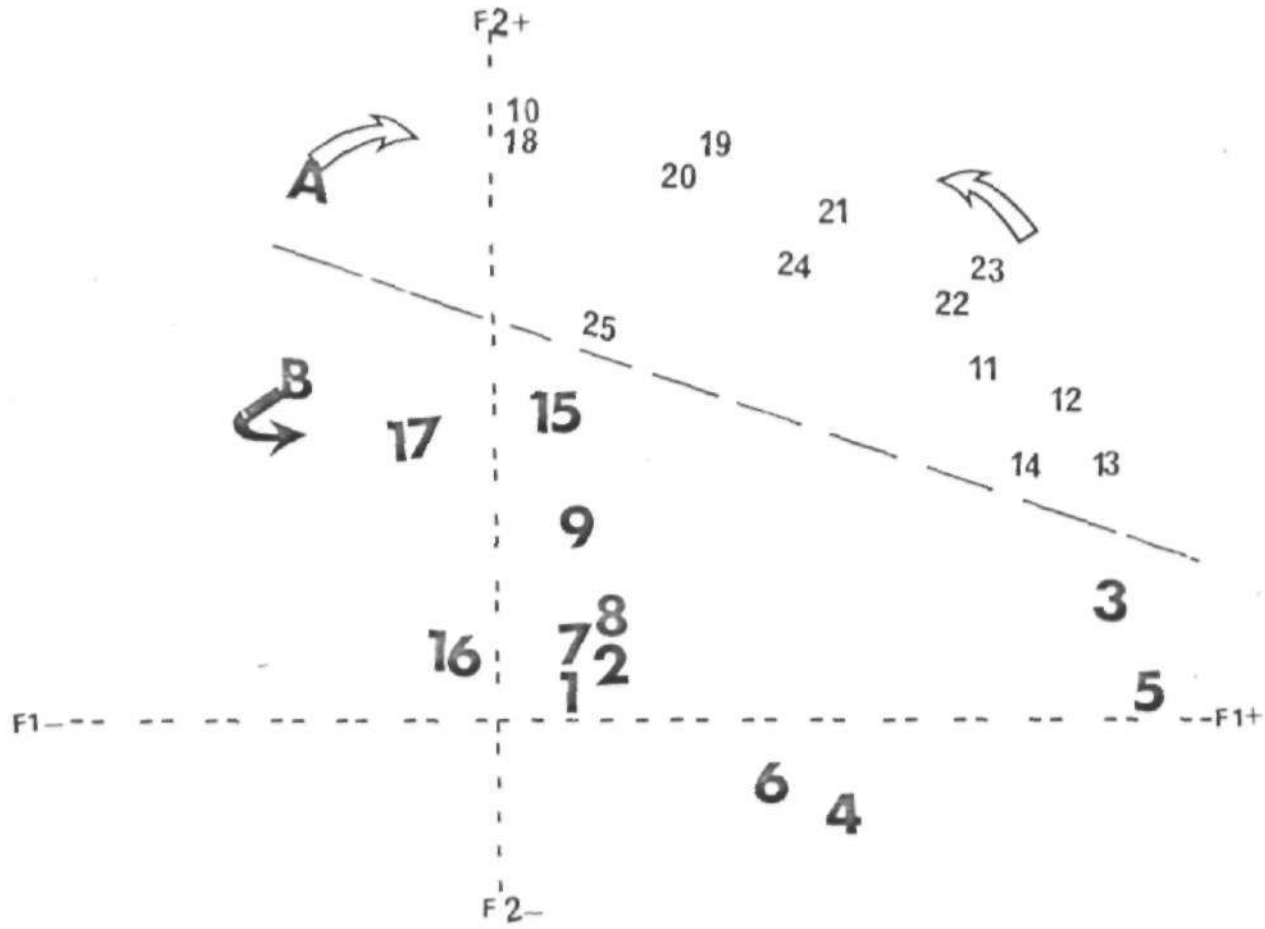


II:3, 5 An example graphical representation of the factor loadings on Ordination Matrix II: Axes 3 and 5:
Cluster-factor quadrats change positions with successive axes, but each set of quadrats derived from the preceding Cluster Analysis tend to be clustered together on the ordination scatter-plot.

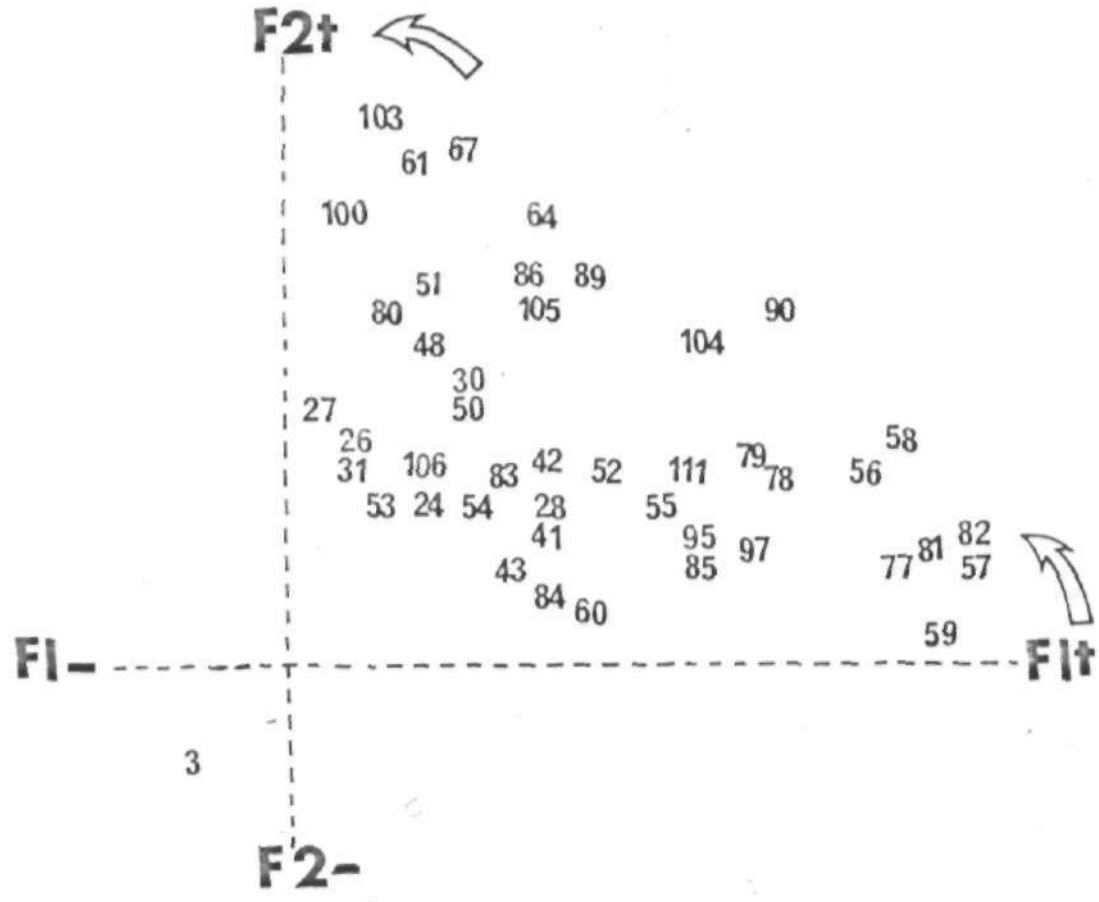


IV: 1, 2. An example graphical representation of the factor loadings on Ordination Matrix IV - Axes 1 and 2:

The floristic data was sampled using 10m. x 10m. quadrats placed at 50m. regular intervals along a 1.15km. 23 samples were thus collected. The transect was located near Kako, an old agricultural village on the edge of the River Galma, Fig. 18. The vegetation was visibly in the seral or weedy stage. The geomorphologic distinction from the 'upland' to the 'fadama' was visible but it was not an abrupt change. The floristic composition, or the weed flora in 'a' represent the gradual gradation of species from the deep, freely drained, unmottled, reddish brown to yellowish brown 'upland' loamy soils to the edges of the 'fadama'. The 'a' continuum thus reflects the topography and the hydrology in the form of the lateral flow of water from the upland to lower-lying fadama. The 'b' continuum reflects largely the intensity of water-logging within the 'fadama' alluvial complex. The dividing line corresponds to the geomorphological division between the 'upland' and the 'fadama' complexes.



XII: 1, 2. An example graphical representation of the factor loadings in Ordination Matrix XII - Axes 1 and 2:
The demarcation line drawn represents the two major clusters derived from the Cluster Analysis. The 'A' factor-cluster consist of all quadrats sampled in Eucalyptus camaldulensis stands. The 'B' cluster-factor represents the quadrats sampled in Eucalyptus teriticornis stands along two transects. (See Discussions and Conclusions, point 9, for the possible explanations.)



VIA: 1, 2: An example graphical representation of the factor loadings in Ordination Matrix VI - Axes 1 and 2:

An ordination within ordination following Cluster Analysis. The data collected in my sixth stratum was too large (111 quadrats x 221 species), even when transferred from the Oxford Computing Laboratory to the University of Manchester Regional Computer Centre where the maximum workspace for S.P.S.S. computation was available. A sub-ordination was made on the Community of weeds in current arable lands identified and clustered by the Cluster Analysis. For the Cluster Analysis the 111 quadrats and the most recurrent 167 species from the synoptic floristic raw data matrix VI was used. Cluster 'A' from the dendrogram (p. 120) was separated, and ordinated for this computer workspace limitation reason. It will be noticed that 69.1% of the variation is explained the first (succession) factor on current arable lands, p. 186. (See also Plates 9, 10 and 11.) Successive factors in their descending order of importance (11.2%, 6.5%, 5.8%, 4.3% and 3%) are considered too trivial for further synecological investigations. The Andrew's Cluster Analysis and my introduced RCFA ordination are therefore, in my view, harmonious, though not identical, in their uses for exploring plant communities and their trends.

CHAPTER 8 FIELD DESCRIPTIONS OF SOIL SAMPLES

Soil profile descriptions within the quadrats in the field were made from samples taken at fixed depths of 0-3", 3-6", 12-18", 18-24", 24-30" and 30-36". The excavation equipment included the core auger or the screw auger, depending on the looseness, compactness, stoniness or hardness of the soil at the time and site of the field survey. In general, the core auger was used in the rainy season over all sites. In the dry season, the soil was often hard and required to be bored, using the screw auger. Manual labour was employed. My other field tools included the Munsell Soil Colour Code Book, field note recording form for each soil sample described, plastic or cellophane soil sample bags, and wash-bottle containing distilled water. Plate 52 illustrates my instruments for soil descriptions on the field and the successive descriptions of the horizons at the fixed depth intervals made in all the first eleven domains.

The twelfth domain around Kuyello was however different. Since it was a multi-disciplinary team work, in which I was acting purely as the plant ecologist, soil pit excavations and descriptions were looked after by my colleague, the pedologist. Several large grave-like pits were dug with diggers, shovels, spades and lots of manual labour. Plates 53 and 54 illustrate the large pits dug around Kuyello in contrast to my 'core' and 'screw' method used in domains I to XI, Plate 52.

8.1 PHYSICO-CHEMICAL LABORATORY ANALYSES OF SOIL SAMPLES

The soil samples from the field were transferred in numbered cellophane bags to the Soil Survey Section of the Institute for Agricultural Research, Samaru. They were analysed in accordance with the procedures in operation at the Laboratory.

Each augured sample was separately air-dried in trays and cleaned up from non-soil materials (leaves, twigs, or any biotic debris). Soil aggregates were crumbled. Sub-samples of 500-600 gms. of each 'horizon sample' were extracted and ground with mortar and pestle. The particles were shaken and sieved through a 10 mesh (= 2mm.) sieve. Suspended particles in the sieve were weighed as 'stones'.

Sub-samples of 2mm. fraction were apportioned for fractionalisation into the three primary textural groups, 'sand', 'silt', and 'clay', before chemical analyses. The soil particle size fractional definitions are in accordance with the U.S.D.A. (1951) diameter ranges, viz:

stone	$>$2mm.
sand	2mm - 0.05mm.
silt	0.05mm - 0.002mm.
clay	$<$0.002mm.

The determination of sand, silt and clay particles were executed with Bouyouco's sedimentation and sieving methods and dispersion with Calgon solution. The soil particle sizes are reported as weights percentages per sub-sample, Appendix B.

Chemical analyses were performed on each sub-sample extract to determine the pH, percentage Organic Carbon, milli-equivalent (meq) per 100gm. of exchangeable cations: Sodium (Na^{+}) Potassium (K^{+}), Calcium and Magnessium (Ca^{++} + Mg^{++}) and the Cation Exchange Capacity (C.E.C.).

pH values were read from 1:5 soil-distilled water solutions, using standardised EEL model 23A pH meter. Organic carbon percent determination were achieved by the Walkley-Black procedure (1965) of oxidation with standard dichromate in sulphuric acid followed by back titration using ferous ammonium sulphate and diphenylamine as indicator. Sodium and

Potassium determination were effected by use of an EEL flame photometer. Calcium with magnessium were determined by titration against 0.01M E.D.T.A. Cation Exchange Capacity values were measured as the sum of exchangeable Na^{+}, K^{+}, Ca^{++} + Mg^{++} which can be displaced by N ammonium acetate, following personal communication (Abolarin 1978). Each C.E.C. value was obtained by leaching measured soil samples by the N NH_4OAc, followed by alcohol washing and distillation.

Drzymalski (1974) pointed out that "the analytic procedures used in the Soil Survey Section of the Institute for Agricultural Research, Samaru, are the same as those routinely used by other soil investigators in the Nigerian Savanna zone" (e.g. the Land Resources Division, Ministry of Overseas Development); and that "they have shown to produce reproducible reliable results when carefully performed".

8.2 OTHER EVALUATED ENVIRONMENTAL PROPERTIES MADE IN THE QUADRATS SAMPLED

As pointed out by Valette (1977) a quantitative approach to soil and environmental analyses are yet non-existent in the Nigerian 'savanna' My approach here is essentially an exploratory extension of my floristic analytic strategies into the analyses of environmental data. Qualitative enthusiasts and critics of quantitative approaches may therefore consider my approach, in some cases, pseudo-quantitative. It is probably not completely objective where visual estimations were involved, and therefore still partially pseudo-quantitative in that sense. However, the results will perhaps be more objective, more concise, and more consistent than the totally subjective verbal descriptions of the environment in use in the regional zone up till now.

For an example, Pullan and de Leeuw (1969) described the soils and vegetation in the Kirawa Area of the former North East State, Nigeria, as

"series" named after thirteen towns, villages and hamlets, viz: 1) Mamourgi Series, 2) Zale Series, 3) Arawa Series, 4) Dougouma Series, 5) Jebra Series, 6) Tireji Series, 7) Peteke Series, 8) Ashigashiya Series, 9) Pulke Series, 10) Kirawa Series, 11) Doutarou Series, 12) Ngoshie Series, and, 13) Guva Series. de Leeuw, the ecologist, then subjectively described the plant assemblages concurrently examined with the soils as thirteen "associations" (or plant communities) based on trees, shrubs and their physiognomic appearance, each of which perfectly reflected one of the thirteen soil series described by the pedologist.

Apart from the seemingly perfect wedlock purported to exist between "soil series" and "plant associations", the nomenclature of soil series and plant communities after obscure localities, is, in my view, a tremendous barrier to an objective comparative correlation of floristic-environment interrelationships from one part of the Country to another, or even in one regional zone.

The non-floristic environmental factors which I observed, measured, estimated or named from the quadrats, fall into four broad classes, viz: vegetational, biological, geological and the edaphic.

"Edaphic" is employed ecologically in its broad sense, meaning the physical and chemical properties of the soil. It includes the site of the quadrat in relationship with the relief of the landscape; its slope or steepness at the micro-relief scale; its erosional position during the field survey, its drainage status or soil moisture regime, each of which were visually observed and rated on a five-point scale.

The other components of the edaphic factor were obtained by physico-chemical measurements. They include the colour, depth, textural particles, stone content, pH, cations, organic carbon, total exchangeable base, cation

exchange capacity, and base saturation. This last set of edaphic properties was obtained through analyses of soil samples, before they were each converted into a five-point interval ratio.

Similarly, the biological factors were rated on the five-point scale but they were derived from the field by visual assessments. The features were the earthworm casts on the ground surface, the termitaria or termite hills there, the last cultivation status of the site and the ridges and furrows with which cultivation is normally associated under land use by professional farmers. (Pastoralists are, for example, mainly ad hoc non-professional farmers.)

Three vegetational factors were evaluated and given the five-point level assignments on the field. These were: the proportion of the land which was bare; the canopy closure; and the physiognomy. My criticism of the physiognomic approach should, however, be borne in mind along with the statements quoted from quantitative ecologists who invariably place more emphasis on the floristic composition rather than on physiognomic distribution.

Stevens (1946) identified four levels of quantifying measurements as: nominal, ordinal, interval and ratio levels, for the purpose of statistical and numerical analyses. Combs (1953) pointed out that "there are situations where categories can be defined for some items, but not for others by the scientist". I applied the "nominal level" of Stevens to the geological properties of the quadrats and to the crops found there. These are given a dichotomous rating in the environmental data matrices, where a dichotomy is a property with only two possible values, such as the present and absence scores.

The raw data results for edaphic property measurements are shown in Appendix for the domains, except for Domains III (Galma Irrigation

Scheme Site on the River Galma 'Fadama') and VIII (Mairabo Forest Plantation Reserve).

A possible question that may be asked is: "Why convert the actual figures from laboratory measurements into five-point ratio levels by fixing stopping points between continuum or ordinal real laboratory figures before analyses?" And the answers are: for a practical ecological reason and for a practical computational reason.

The ecological reason for the modification of raw environmental data is that it facilitates a simplified use of the quantitative data results as a guide to the interpretation of the associated floral communities. The five-point interval level means that quantitative comparisons can be made about the associated plant communities, based on the simplified relative magnitudes of the environmental properties, measured, or estimated. Goodall (1952) pointed this out that "quantitative methods can never be more than an adjunct to description - they can never provide interpretations".

The computational reason is that the amount of computer core storage (i.e. space) required for each set of data analyses from the domains or strata depend both on the number of properties to be inter-associated or cross-correlated to each other and on the number of integers to be cross-calculated among the individuals. The reduction to five-point interval values results in computer core savings, which was particularly essential with my large data matrices.

The following table lists the five-point scales, and their meanings, for the environmental properties:

8.3 CATEGORIES OF ENVIRONMENTAL FACTORS EVALUATED THEIR CODINGS AND MEANINGS

8.3.I I PHYSICO-CHEMICAL EDAPHIC FACTORS

Code	Topographic Site by visual estimation
1	summit; crest
2	sub-summit
3	middle slope
4	lower middle slope
5	valley

Code	Slope or Steepness by measurement
1	level or nearly level (0 - 3)°
2	gently or moderately sloping (3-5)°
3	strongly or steeply sloping (5-15)°
4	steeply sloping (15-25)°
5	very steeply sloping to precipitous slopes 25°

Site modification for Dumbi Inselberg, Strata No. 7 (see Fig. 19)

1	summit	2500-2565'	≃ 760m -	775m	A.M.S.L.
2	sub-summit	2450-2500'	≃ 745m -	760m	A.M.S.L.
3	middle slope	2400-2450'	≃ 730m -	745m	A.M.S.L.
4	lower middle	2350-2400'	≃ 715m -	730m	A.M.S.L.
5	foot hill of inselberg	2300-2350'	≃ 700m -	715m	A.M.S.L.

(A.M.S.L. = Above Mean Sea Level.)

Code	Erosion by visual estimation
1	slight
2	moderate
3	severe
4	very severe
5	gullied; extreme

Code	Drainage by soil profile description
1	perfect throughout profile; dry; no mottles.
2	slightly imperfect at depths; fresh; few mottles.
3	imperfect at depths; damp; mottles common.
4	poor at depths; moist; mottles many.
5	poorly drained throughout profile; wet; mottles very many.

Code	Colour[1]
1	Red
2	Dark Brown
3	Brown
4	Yellow
5	Grey

Code	Soil (Augur) Depth[2]	
1	very shallow	25cm
2	shallow	25-50cm
3	moderately deep	51-75cm
4	deep	76-100cm
5	very deep	100cm

---

1 Based on Munsell Soil Colour Code, but rounded up to the prevalent colour in the top soil profiles.

2 Unreliable over the whole cerado because of the changes in the compactness of the soils with the dry and rainy seasons, but useful within each domain surveyed within one to four continuous weeks in either the dry or rainy season.

		Soil particle sizes		
Code	Texture	Clay %	Silt %	Sand %
1	very light	0-10	0-10	0-20
2	light	11-20	11-20	21-40
3	moderately heavy	21-30	21-30	41-60
4	heavy	31-40	31-40	61-80
5	very heavy	40	40	80

		Stone %	pH	
1	very slightly stony	0-10	5	acidic
2	slightly stony	11-20	5.1-6.0	slightly acidic
3	moderately stony	21-30	6.1-7.0	neutral
4	very stony	31-40	7.1-8.0	slightly alkaline
5	extremely stony	40	8.0	alkaline

		EXCHANGEABLE CATION		
		Na^{+} (meq/100g)	K^{+} (meq/100g)	$Ca^{++} + Mg^{++}$ (meq/100g)
1	very low	0.05	0.05	0-5
2	low	0.06-0.10	0.06-0.10	5.1-10.0
3	moderate	0.11-0.15	0.11-0.15	10.01-15.0
4	high	0.16-0.20	0.16-0.20	15.01-20.0
5	very high	0.20	0.20	20.0

		Organic carbon %	Total (meq)	C.E.C.(meq)	Base Saturation %
1	very low	0-0.5	1.0	10.0	20
2	low	0.51-1.0	1.01-2.0	11-20	20-40
3	moderate	1.10-1.5	2.01-3.0	21-30	41-60
4	high	1.60-2.0	3.01-4.0	31-40	61-80
5	very high	2.0	4.0	40	80

8.3.II II GEOLOGICAL FACTORS

	Rock material
(+/-)	Quartzite
(+/-)	Mica
(+/-)	Schist
(+/-)	Ironstone
(+/-)	Granite

8.3.III III BIOLOGICAL FACTORS

	Earthworm casts[3]	Termitaria[3]
1	rare	rare
2	occasional	occasional
3	frequent	frequent
4	common	common
5	abundant	abundant

3 The relative abundance of mobile fauna were not attempted. They are however profusely illustrated in my Photographs.

Code	Last Cultivation in Arable Lands	Ridges and Furrows
1	current cultivation	very faintly ridged
2	post harvest	faintly ridged
3	1-2 years fallow	distinct ridges
4	3-4 years fallow	prominent ridges
5	uncultivated for over 4 years	very prominent high ridges

8.3.IV

IV VEGETATION FACTORS

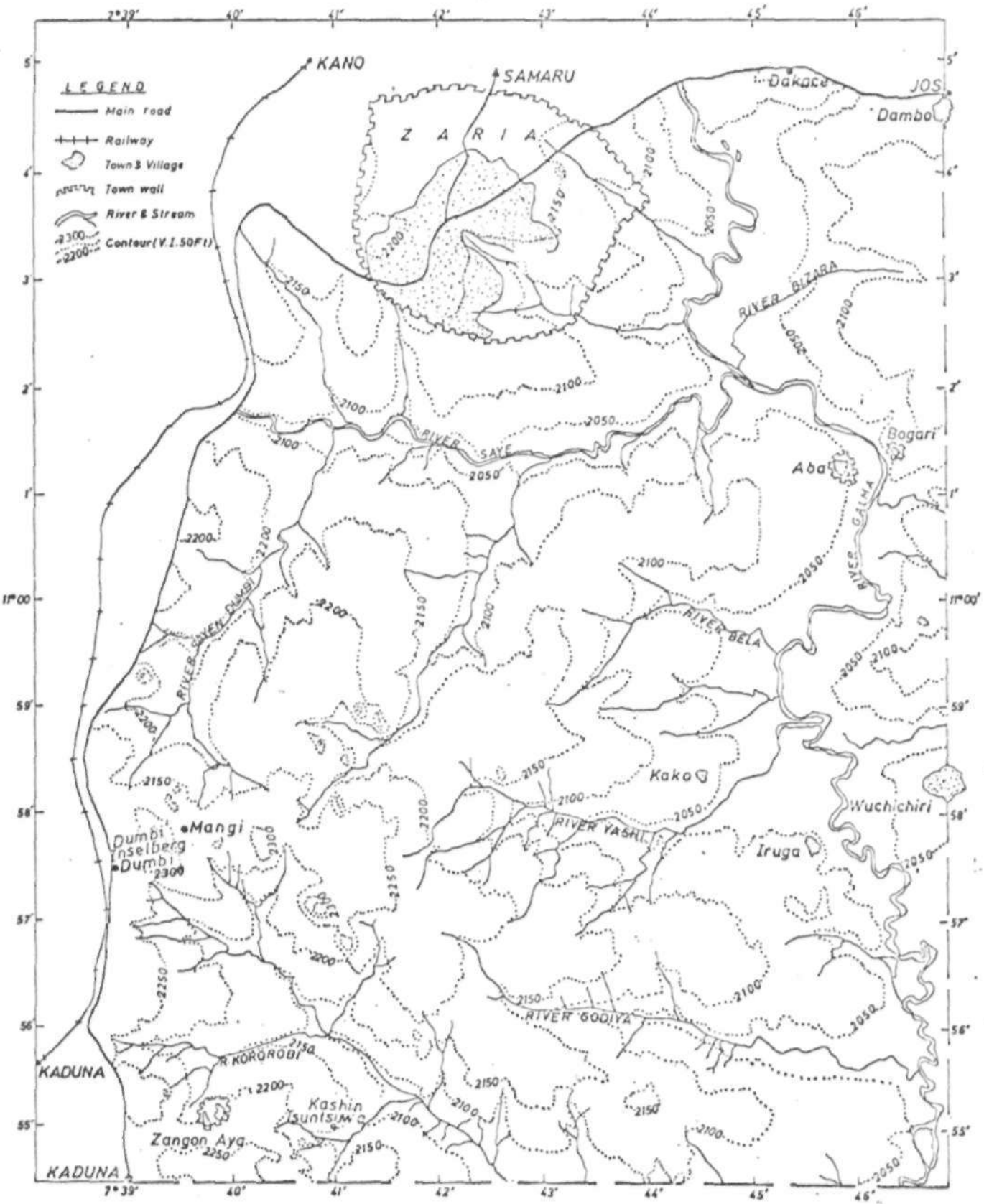
	Bare Area %	Canopy Closure %	Physiognomy
1	1-20	0-20 arboreal cover	Farmland; current
2	21-40	21-40 arboreal cover	Forb-grassland; often in fallow.
3	41-60	41-60 arboreal cover	Scrubland
4	61-80	61-80 arboreal cover	Shrubland
5	81-100	100 arboreal cover	Tree/Shrubland/Woodland[4].

CROPS

The number of crops observed in arable lands were recorded. The crops are given presence and absence (+/-) scores in the environmental data matrices, e.g.

Sorghum vulgare	+/-
Lycopersicum esculentum	+/-
Discorea sp.	+/-
Zea mays	+/-
Capsicum sp.	+/-
Pennesetum typhoides	+/-
Saccharum officinarium	+/-
Gossypium barbadense	+/-

4 Visual estimation beyond shrubland becomes progressively too subjective, inconsistent and useless for numerical analyses and interpretation.



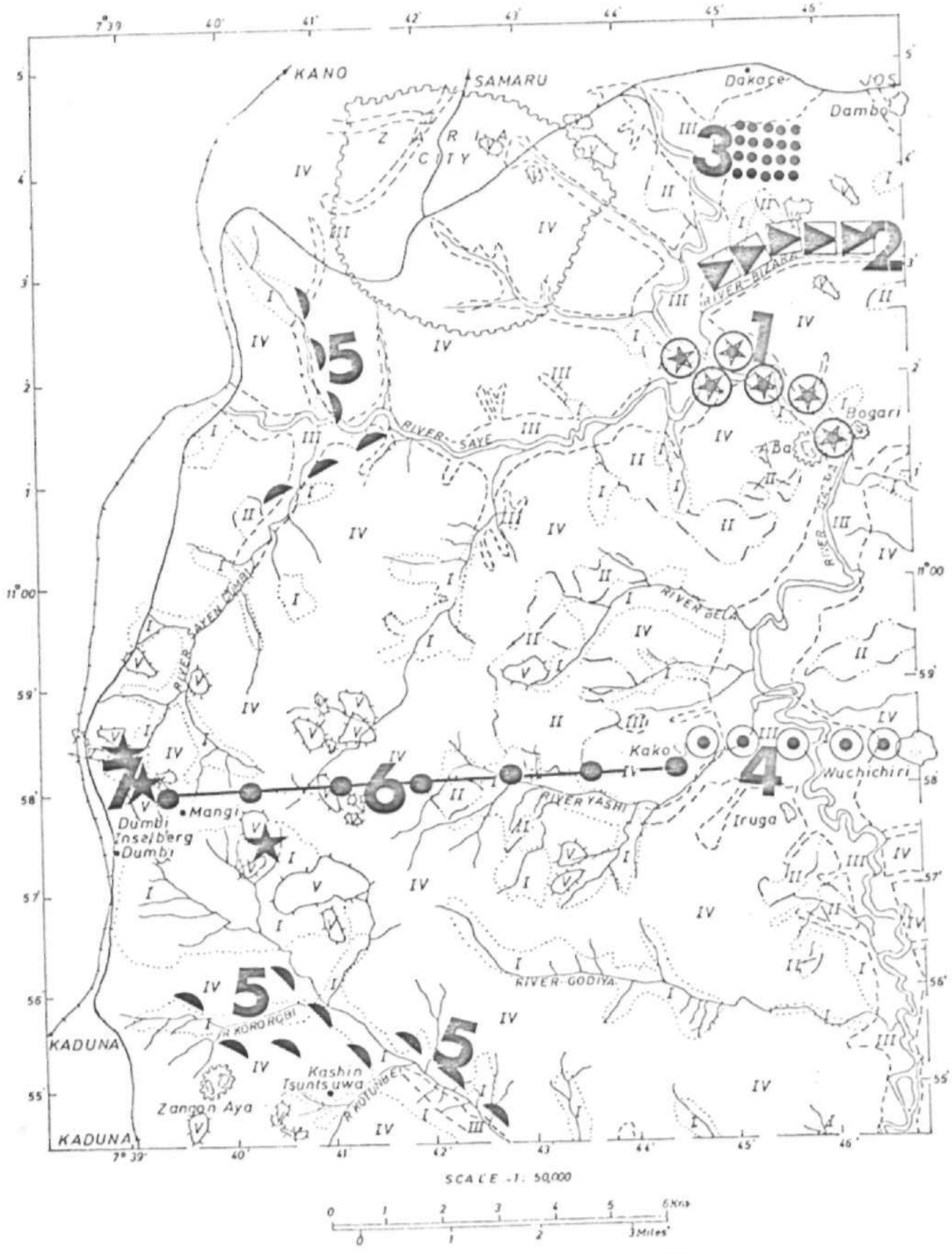
Based on Nigeria 1:50,000 Sheets 102 Zaria, S.W. and 124 Igabi, N.W. N.E. Second Edition published by Northern Nigeria Survey 1964.

GALMA BASIN: PHYSICAL MAP

SCALE:- 1:50,000

0 1 2 3 4 5 6 7 8 Km.
0 1 2 3 4 5 Miles

Fig. 16


KANO
SAMARU
ZARIA CITY
Dakace
JOS
Dambo
RIVER BIZARA
RIVER SAYE
Bogari
Ba
RIVER GELA
RIVER SAYEN GORO
Kako
Wuchichiri
Iruga
RIVER YASHI
Mangi
Dumbi Inselberg
Dumbi
RIVER GODIYA
KORORGBI
KADUNA
Kashin Tsuntsuwa
Zangan Aya
KOTURBE
KADUNA
SCALE - 1: 50,000
0 1 2 3 4 5 6Kms
0 1 2 3Miles
I = Gully Complex
II = Ironstone Mesas and Ironpans
III = Fadamas and Floodplains
IV = Gently undulating plains
V = Inselberg and Rocky Hills

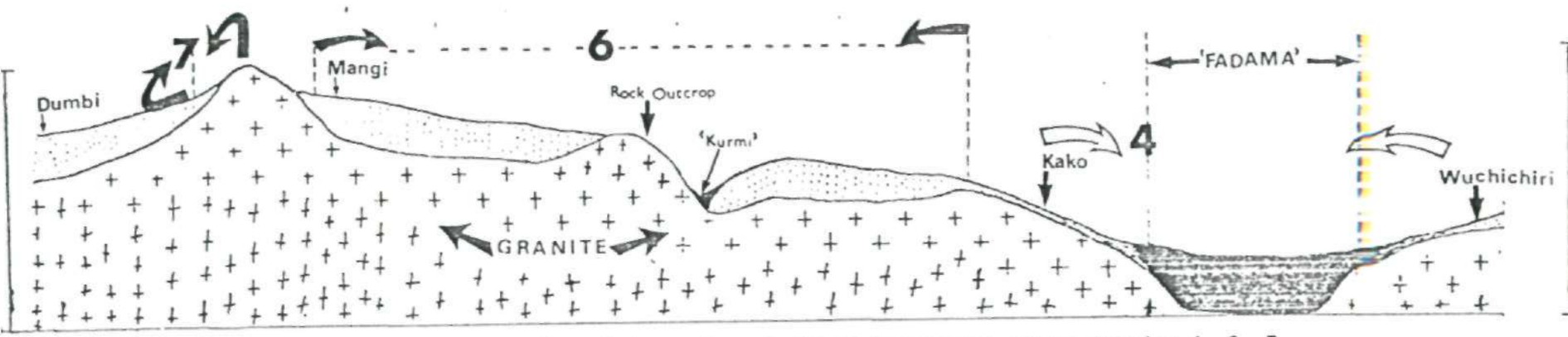
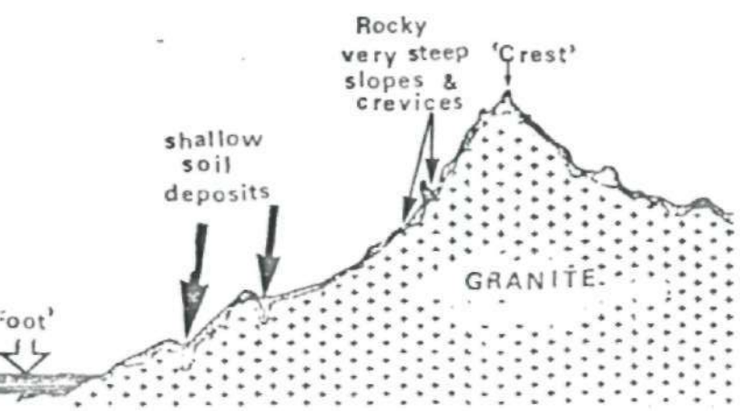


Fig. 18 A schematized sketch of the 11.1 km. distance from Dumbi to Wuchichiri across Domains 4, 6, 7 (Relative heights are in meters above mean sea level.)



19 A semi-schematic cross-section of Dumbi Inselberg Domain 7: Heights are in above mean sea level values.

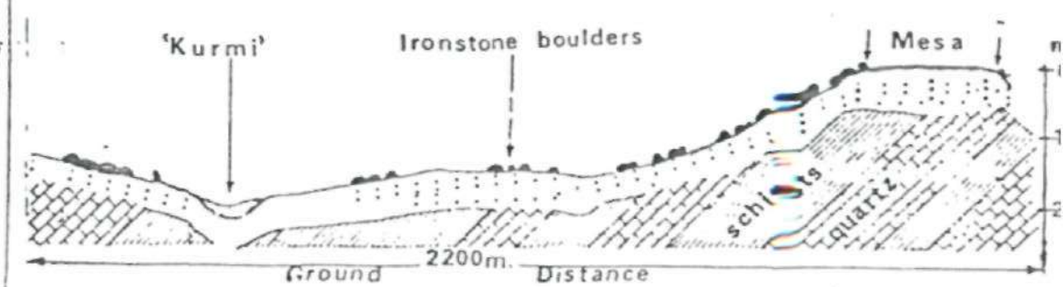
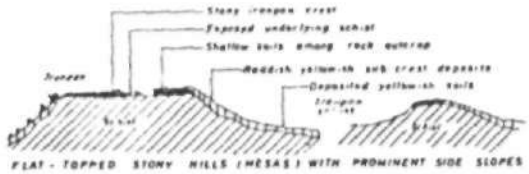


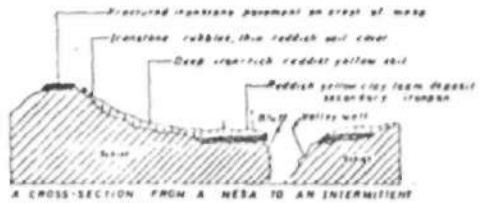
Fig. 20 A cross section of the soil 'catena' along one of the two transects examined in the Guga non-plantation reserve, Domain 11. Redrawn from Osanoto (1972).



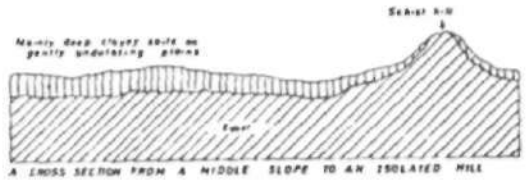
GENERALIZED SCHEMATIC CROSS-SECTION OF A PORTION OF KUYELLO AREA



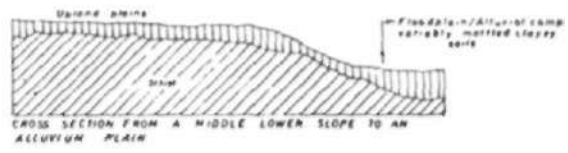
FLAT-TOPPED STONY HILLS (MESAS) WITH PROMINENT SIDE SLOPES



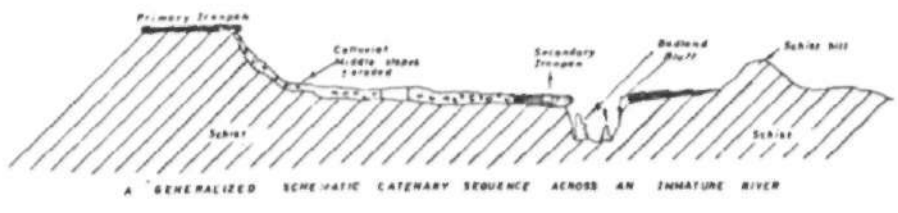
A CROSS-SECTION FROM A MESA TO AN INTERMITTENT DRAINAGE CHANNEL



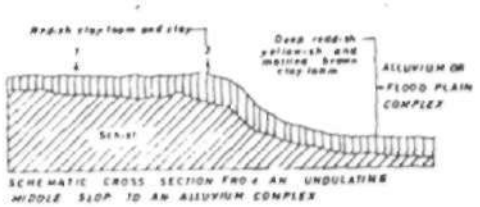
A CROSS SECTION FROM A MIDDLE SLOPE TO AN ISOLATED HILL



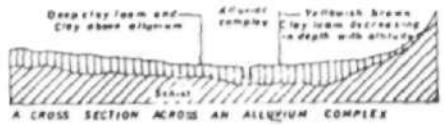
CROSS SECTION FROM A MIDDLE LOWER SLOPE TO AN ALLUVIUM PLAIN



A GENERALIZED SCHEMATIC CATENARY SEQUENCE ACROSS AN INMATURE RIVER



SCHEMATIC CROSS SECTION FROM AN UNDULATING MIDDLE SLOP TO AN ALLUVIUM COMPLEX



A CROSS SECTION ACROSS AN ALLUVIUM COMPLEX

SEMI-SCHEMATIC CROSS-SECTIONS OF PORTION OF KUYELLO AREA

Fig. 21 after Valette (1977)



Fig. 22. Site of my Domain III on the terrace of the Galma 'Fadama' Alluvial Complex. Redrawn and reduced from the contoured base map after Kaduna State Ministry of Agric. & Nat. Resources, Irrigation Section, Zaria. Scale 1:400

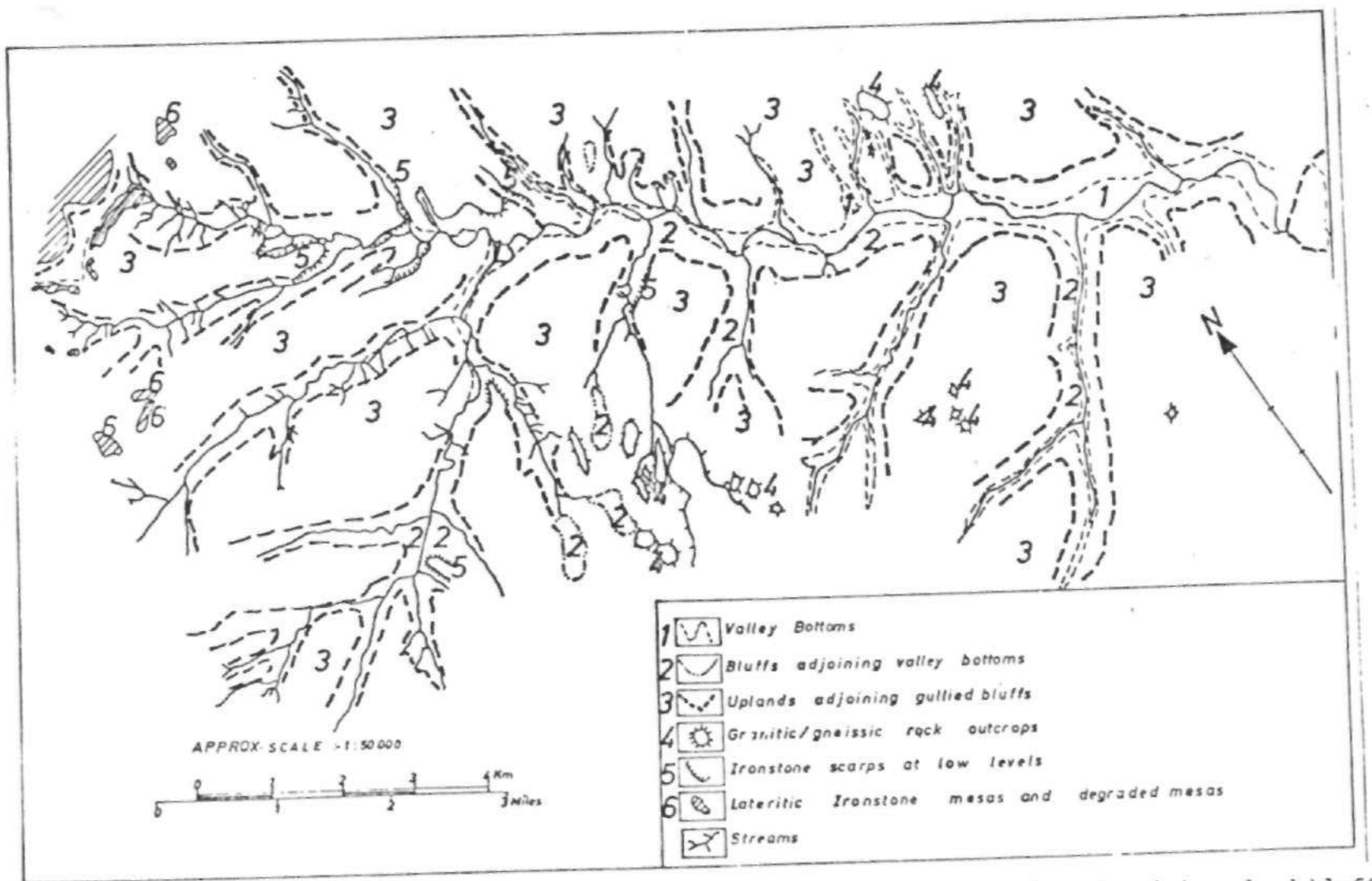


Fig. 23. A semi-generalized sketch of the intergitations of erosion complexes with 'Kurmis', upland bluffs, real 'uplands' and geological features along Marke Stream, Guga Forest Reserve, my Domain XI. (Partly drawn to scale from aerial photographs and from field impressions.)

REFINED ENVIRONMENTAL DATA MATRICES

FROM TEN OUT OF THE TWELVE DOMAINS

1. These sets of data have been refined from the raw field data for the purpose of computations.
2. The laboratory raw data from which some of the data were converted into the 5-point ratio-level are contained in Appendix B (pages 373-382).
3. The meanings of the codings are found on pages 213-215. Figs. 16-21 are attached to elucidate my attempts at an objective interpretation of the environmental properties where visual estimations are involved.
4. Where estimations cannot be relied upon for judging the intensity of an operative environmental property, I have relied upon the nominal level of scoring and have indicated these as dichotomous (+/-) data.

ENVIRONMENTAL DATA MATRIX I: GALMA 'FADAMA'

Quadrat Sample No.	1. Site	2. Slope	3. Erosion	4. Colour	5. Drainage	6. Depth	7. Clay	8. Silt	9. Sand	10. Stone	11. pH	12. Org. Carbon	13. Na^{+}	14. K^{+}	15. $Ca^{++} + Mg^{++}$	16. Total meq.	17. C.E.C.	18. Base Sat.	19. Granite	20. Gneiss	21. Schist	22. Ironstone	23. Worm Cast	24. Termitaria	25. Physiography	26. Last Cult.	27. Bare Area	28. Ridges	29. No. of Crops	30. Capsicum	31. Sorghum	32. Discorea	33. Oryza	34. Lycopersicum
QS1	4	1	0	3	4	2	3	4	2	0	2	3	3	5	2	5	1	5	1	1	1	+	0	0	2	2	3	0	0	1	1	1	1	1
QS2	4	1	0	3	4	3	3	5	2	0	2	3	2	4	1	4	1	3	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS3	4	1	0	3	4	2	3	5	2	0	2	3	2	4	1	3	1	4	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS4	4	1	0	3	4	1	2	5	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS5	4	1	3	3	3	2	1	5	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS6	4	1	3	3	3	1	1	5	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS7	4	1	0	3	3	2	1	5	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS8	4	1	0	3	4	2	3	4	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS9	5	1	0	3	4	2	3	4	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS10	5	1	0	3	4	2	3	4	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS11	4	1	0	3	5	2	1	3	4	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS12	4	1	0	3	3	2	1	3	4	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS13	4	1	0	3	4	2	3	4	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS14	4	1	0	3	4	2	3	4	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS15	4	2	0	3	4	2	3	4	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS16	4	2	0	3	4	2	3	4	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS17	4	2	3	4	4	1	2	5	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS18	5	0	0	3	5	1	2	5	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS19	5	0	0	3	5	1	2	5	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS20	5	0	0	3	5	1	2	5	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS21	5	0	0	4	5	1	2	5	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS22	5	0	0	4	5	1	2	5	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS23	5	0	0	3	5	1	2	5	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS24	5	0	0	3	5	1	2	5	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS25	5	1	0	3	4	2	3	4	2	0	2	3	2	4	1	4	1	5	1	1	1	+	0	0	2	2	3	1	0	1	1	1	1	1
QS26	5	2	0	3	2	4	1	4	3	0	2	2	1	2	1	2	1	2	-	2	-	-	2	0	3	3	1	0	0	-	-	-	-	-
QS27	5	1	0	3	4	1	1	4	3	0	2	2	1	2	1	3	0	3	1	1	+	+	3	2	1	0	0	1	0	-	-	-	-	-
QS28	5	1	0	3	4	1	1	4	3	0	2	2	1	2	1	3	1	4	1	1	-	+	4	0	1	3	1	0	0	-	-	-	-	-
QS29	5	1	0	3	5	1	1	4	3	0	2	2	1	2	1	3	1	3	1	1	-	-	0	0	3	3	1	0	0	1	-	-	-	-
QS30	1	1	0	3	1	1	1	4	3	0	2	2	1	4	1	3	1	3	1	1	-	-	0	0	3	5	2	0	0	1	+	-	-	-
QS31	1	1	0	3	1	1	1	4	3	0	2	2	1	4	1	3	1	3	1	1	-	-	0	0	3	5	2	0	0	-	-	-	-	-
QS32	5	1	0	3	5	1	1	4	3	0	2	2	1	4	1	3	1	2	1	1	+	+	0	0	3	5	2	0	0	-	-	-	-	-
QS33	5	1	0	3	5	1	1	5	3	0	2	2	1	4	1	3	1	3	1	1	-	+	3	0	0	2	5	0	0	-	-	-	-	-
QS34	5	1	0	2	5	4	1	5	3	0	2	2	1	3	1	2	1	2	-	1	-	-	0	0	2	5	0	0	0	-	-	-	-	-
QS35	4	1	0	3	4	4	1	4	3	0	2	3	2	4	1	3	1	2	-	1	-	+	0	0	1	2	3	1	2	+	-	+	-	+
QS36	4	1	0	3	4	4	1	4	4	0	3	2	1	5	1	2	1	2	-	1	-	-	3	0	3	2	1	0	1	-	-	+	-	-

Entries consist of five point ratio-level conversions from laboratory measurements and field estimates of quadrat site edaphic properties. Geological, biological and land use characteristics were scored either on the five point scale level or on dichotomous presence and absence nominal level as indicated.

Quadrat Sample No.	1. Site	2. Slope	3. Erosion	4. Colour	5. Drainage	6. Depth	7. Clay	8. Silt	9. Sand	10. Stone	11. pH	12. Org. Carbon	13. Na^{+}	14. K^{+}	15. $Ca^{++} + Mg^{++}$	16. Total aeq.	17. C.E.C.	18. Base Sat.	19. Granite	20. Gneiss	21. Schist	22. Ironstone	23. Worm Cast	24. Termitaria	25. *Physiognomy*	26. Last Cult.	27. Bare Area	28. Ridges	29. No. of Crops	30. Capsicum	31. Sorghum	32. Oryza	33. Zea	34. Hibiscus	35. Pennesetum	36. Saccharum	37. Lycopersicum	38. Brassica	39. Cucumis	40. Sesamum
QS1	3	0	0	3	3	4	1	3	4	0	2	1	2	4	1	2	1	5	-	-	-	-	0	0	1	1	2	4	2	-	-	-	-	+	-	-	+	-	-	-
QS2	3	0	0	4	1	4	1	3	3	0	2	2	1	2	1	2	1	5	-	-	-	-	3	0	1	1	1	4	0	-	-	-	-	-	-	-	-	-	-	-
QS3	3	0	0	3	1	4	1	5	3	0	2	2	1	2	1	1	1	5	-	-	-	-	3	0	1	2	2	3	0	-	-	-	-	-	-	-	-	-	-	-
QS4	3	0	0	3	3	4	2	5	2	0	1	2	1	3	1	2	1	5	-	-	-	-	3	0	1	1	2	4	4	+	-	-	-	-	+	-	-	-	+	+
QS5	3	0	0	3	1	4	1	4	3	0	2	5	1	2	1	2	1	5	-	-	-	-	3	0	1	1	2	4	4	+	-	-	-	-	+	-	-	-	+	+
QS6	3	0	0	4	3	2	3	4	2	0	1	3	1	3	1	3	1	5	-	-	-	-	3	0	2	3	1	2	0	-	-	-	-	-	-	-	-	-	-	-
QS7	3	0	0	3	3	4	3	4	1	0	1	2	1	5	1	2	1	3	-	-	-	-	3	0	1	1	1	5	2	+	-	-	-	-	-	-	-	-	+	-
QS8	3	0	0	3	3	4	3	4	2	0	1	2	1	3	1	2	1	3	-	-	-	-	3	0	1	2	2	3	1	-	-	+	-	-	-	-	-	-	-	-
QS9	3	0	0	3	4	4	1	4	3	0	1	4	1	3	1	1	1	2	-	-	-	-	3	0	2	3	1	2	1	-	-	+	-	-	-	-	-	-	-	-
QS10	3	0	0	5	3	4	3	5	3	0	1	4	1	5	1	3	1	3	-	-	-	-	3	1	2	3	1	2	1	-	-	+	-	-	-	-	-	-	-	-
QS11	3	0	0	5	3	4	2	4	3	0	2	3	1	3	1	2	1	5	-	-	-	-	3	3	2	3	1	2	1	-	-	+	-	-	-	-	-	-	-	-
QS12	3	0	0	5	3	4	2	4	3	0	2	1	2	3	1	2	1	5	-	-	-	-	3	0	1	1	1	4	1	-	+	-	-	-	-	-	-	-	-	-
QS13	3	0	0	5	3	4	1	3	4	0	2	1	2	4	1	2	1	5	-	-	-	-	3	3	1	1	1	4	1	-	+	-	-	-	-	-	-	-	-	-
QS14	3	0	0	4	1	4	1	3	3	0	2	2	1	2	1	2	1	5	-	-	-	-	3	0	1	1	1	4	0	-	-	-	-	-	-	-	-	-	-	-
QS15	3	0	0	3	1	4	1	5	3	0	2	2	1	2	1	1	1	5	-	-	-	-	3	0	1	2	2	3	0	-	-	-	-	-	-	-	-	-	-	-
QS16	3	0	0	3	3	4	2	5	2	0	1	2	1	3	1	2	1	5	-	-	-	-	3	0	1	1	2	4	4	+	-	-	-	-	+	-	-	-	+	+
QS17	3	0	0	3	1	4	1	4	3	0	2	5	1	2	1	2	1	5	-	-	-	-	3	0	1	1	2	4	4	+	-	-	-	-	+	-	-	-	+	+
QS18	3	0	0	4	3	2	3	4	2	0	1	3	1	3	1	3	1	5	-	-	-	-	3	0	2	3	1	2	0	-	-	-	-	-	-	-	-	-	-	-
QS19	3	0	0	3	3	4	3	4	1	0	1	2	1	5	1	2	1	3	-	-	-	-	3	0	1	1	1	5	2	+	-	-	-	-	-	-	-	-	+	-
QS20	3	0	0	3	3	4	3	4	2	0	1	2	1	3	1	2	1	3	-	-	-	-	3	0	1	2	2	3	1	-	-	+	-	-	-	-	-	-	-	-
QS21	3	0	0	3	4	4	1	4	3	0	1	4	1	3	1	1	1	2	-	-	-	-	3	0	2	3	1	2	1	-	-	+	-	-	-	-	-	-	-	-
QS22	3	0	0	5	3	4	3	5	3	0	1	4	1	5	1	3	1	3	-	-	-	-	3	1	2	3	1	2	1	-	-	+	-	-	-	-	-	-	-	-
QS23	3	0	0	5	3	4	2	4	3	0	2	3	1	3	1	2	1	5	-	-	-	-	3	3	2	3	1	2	1	-	-	+	-	-	-	-	-	-	-	-
QS24	3	0	0	5	3	4	2	4	3	0	2	1	2	3	1	2	1	5	-	-	-	-	3	0	1	1	1	4	1	-	+	-	-	-	-	-	-	-	-	-
QS25	3	0	0	5	3	4	2	4	3	1	2	1	2	2	1	2	1	5	-	-	-	-	3	3	1	1	1	4	1	-	+	-	-	-	-	-	-	-	-	-
QS26	3	0	0	5	3	4	3	4	4	0	2	3	2	4	1	2	1	2	-	-	-	-	3	1	2	3	1	3	1	-	-	+	-	-	-	-	-	-	-	-
QS27	3	0	0	5	3	4	2	2	3	1	2	4	1	1	1	2	1	5	-	-	-	-	1	1	2	3	1	1	0	-	-	-	-	-	-	-	-	-	-	-
QS28	4	1	0	5	3	4	2	4	3	0	2	4	1	3	1	1	1	3	-	-	-	-	1	1	2	3	1	1	0	-	-	-	-	-	-	-	-	-	-	-
QS29	3	0	0	4	2	4	1	4	4	0	2	2	1	3	1	2	1	5	-	-	-	-	3	3	4	5	1	0	0	-	-	-	-	-	-	-	-	-	-	-
QS30	2	2	0	5	3	4	1	2	3	0	2	1	1	3	1	1	1	5	-	-	-	-	3	1	1	2	1	0	0	-	-	-	-	-	-	-	-	-	-	-
QS31	3	1	0	3	3	4	1	5	3	0	2	2	2	3	1	2	1	5	-	-	-	-	3	0	1	1	1	4	2	-	-	+	-	-	-	+	-	-	-	-
QS32	3	1	0	5	3	4	1	5	3	0	3	2	1	5	1	5	1	5	-	-	-	-	3	0	1	1	2	3	1	-	-	-	-	-	-	+	-	-	-	-
QS33	3	1	0	5	3	4	1	4	3	0	2	2	1	3	1	1	1	5	-	-	-	-	1	0	1	2	1	3	1	-	-	+	-	-	-	-	-	-	-	-
QS34	3	1	0	5	3	4	1	4	4	2	2	2	1	3	1	3	1	5	-	-	-	-	3	0	1	2	1	4	1	-	+	-	-	-	-	-	-	-	-	-

ENVIRONMENTAL DATA MATRIX II: ZARIA-DAMBO 'KURMI'

Entries consist of five point ratio-level conversions from laboratory measurements and field estimates of quadrat site edaphic properties. Geological, biological and land use characteristics were scored either on the five point scale level or on dichotomous presence and absence nominal level as indicated.

ENVIRONMENTAL DATA MATRIX IV: UPLAND KANO VILLAGE TC GALA 'FADAMA'

Quadrat Sample No.	1. Site	2. Slope	3. Erosion	4. Colour	5. Drainage	6. Depth	7. Clay	8. Silt	9. Sand	10. Stone	11. pH	12. Org. Carbon	13. Na^+	14. K^+	15. $Ca^{++} + Mg^{++}$	16. Total meq.	17. C.E.C.	18. Base Sat.	19. Granite	20. Gneiss	21. Schist	22. Ironstone	23. Worm Cast	24. Termitaria	25. Physiography	26. Last Cult.	27. Bare Area	28. Ridges	29. No. of Crops	30. Sorghum	31. Oryza	32. Pennesetum	33. Aracnis
QS1	3	1	0	3	1	2	1	3	4	1	2	1	1	3	1	2	1	5	-	-	-	-	0	0	1	1	3	4	1	-	-	+	-
QS2	3	1	0	4	1	2	2	3	3	1	2	1	1	2	1	4	1	5	-	-	-	-	0	0	1	2	3	3	0	-	-	-	-
QS3	3	1	0	3	1	2	1	3	4	0	2	1	1	1	1	3	1	5	-	-	-	-	0	0	1	1	3	4	1	-	+	-	-
QS4	3	1	0	4	1	2	1	4	4	0	3	1	1	2	1	3	1	5	-	-	-	-	0	0	1	2	3	3	1	+	-	-	-
QS5	3	1	0	4	1	2	1	4	3	0	2	1	1	2	1	3	1	5	-	-	-	-	0	0	1	2	3	3	1	+	-	-	-
QS6	3	1	0	4	1	4	1	3	3	1	2	1	1	2	1	3	1	5	-	-	-	-	0	0	1	2	2	3	1	+	-	-	-
QS7	3	1	0	4	1	4	1	3	4	0	2	1	1	2	1	3	1	5	-	-	-	-	0	0	1	1	2	4	1	+	-	-	-
QS8	3	1	0	4	1	2	1	4	4	0	2	1	1	2	1	3	1	5	-	-	-	-	0	0	1	1	3	4	1	+	-	-	-
QS9	3	1	0	4	1	4	1	3	4	0	2	1	1	2	1	3	1	5	-	-	-	-	0	0	1	1	3	4	2	+	-	-	-
QS10	3	2	0	4	1	2	1	3	4	1	3	1	1	3	1	5	1	5	-	-	-	-	0	0	1	1	3	4	2	+	-	-	-
QS11	3	2	0	4	1	3	1	2	4	0	3	1	1	3	1	5	1	5	-	-	-	-	0	0	1	1	2	4	1	+	-	-	-
QS12	4	1	0	4	1	4	1	3	4	1	3	1	1	3	1	5	1	5	-	-	-	-	0	0	1	2	2	3	1	+	-	-	-
QS13	4	1	0	4	1	2	1	4	4	0	2	1	1	3	1	5	1	5	-	-	-	-	0	0	1	2	1	3	1	+	-	-	-
QS14	4	1	0	4	1	2	1	4	4	1	3	1	1	3	1	5	1	5	-	-	-	-	0	0	1	2	2	3	1	+	-	-	-
QS15	4	1	0	4	1	4	1	3	4	1	2	1	1	2	1	3	1	3	-	-	-	-	0	0	2	1	3	2	1	-	-	-	-
QS16	3	1	0	4	1	4	2	5	3	0	2	2	2	3	1	3	1	5	-	-	-	-	0	0	2	2	3	1	3	-	-	-	-
QS17	3	1	0	3	3	2	4	4	2	0	2	3	1	4	1	3	1	4	-	-	-	-	0	0	2	2	3	2	3	-	-	-	-
QS18	3	1	0	4	1	2	3	5	2	0	2	2	1	2	1	3	1	3	-	-	-	-	0	0	2	3	3	1	3	-	-	-	-
QS19	3	1	0	4	1	4	2	4	3	0	2	1	1	2	1	5	1	5	-	-	-	-	0	0	2	3	3	1	3	-	-	-	-
QS20	3	1	0	4	1	3	2	5	2	0	3	1	1	5	1	2	1	5	-	-	-	-	0	0	2	3	1	1	0	-	-	-	-
QS21	3	1	0	4	3	2	4	3	2	0	1	3	1	4	1	4	1	5	-	-	-	-	0	0	2	3	1	3	1	-	-	+	-
QS22	3	1	0	3	3	4	1	4	4	0	1	1	1	2	1	1	1	5	-	-	-	-	0	0	2	3	1	3	1	-	-	-	-
QS23	3	1	0	4	3	2	2	3	3	0	1	2	1	2	1	3	1	5	-	-	-	-	0	0	2	3	1	3	1	-	-	-	-

Entries consist of ratio-level conversions from laboratory measurements and field estimates of quadrat site properties. Geological, biological and land use characteristics were scored either on the five point scale level or on dichotomous presence and absence nominal level as indicated.

Quadrat Sample No.	1. Site	2. Slope	3. Erosion	4. Colour	5. Drainage	6. Depth	7. Clay	8. Silt	9. Sand	10. Stone	11. pH	12. Org. Carbon	13. Na^{+}	14. K^{+}	15. $Ca^{++} + Mg^{++}$	16. Total meq.	17. C.E.C.	18. Base Sat.	19. Granite	20. Gneiss	21. Schist	22. Ironstone	23. Worm Cast	24. Termitaria	25. Physiography	26. Last Cult.	27. Bare Area	28. Ridges	29. No. of Crops	30. Capsicum	31. Sorghum	32. Discorea	33. Oryza	34. Zea	35. Pennesetum	36. Arachis	37. Ipomoea	38. Saccharum
QS1	3	2	0	4	3	1	2	3	3	0	2	2	1	3	1	2	1	3	1	1	1	1	0	2	3	4	2	1	0	1	1	1	1	1	1	1	1	1
QS2	3	2	0	4	4	2	1	3	4	0	2	3	1	4	1	2	1	3	1	1	1	1	0	2	3	4	2	1	0	1	1	1	1	1	1	1	1	1
QS3	3	1	0	4	3	1	2	4	4	0	2	2	1	4	1	2	1	3	1	1	1	1	0	2	3	4	2	1	0	1	1	1	1	1	1	1	1	1
QS4	3	2	0	4	3	2	1	4	4	0	2	2	1	4	1	2	1	3	1	1	1	1	0	2	3	4	2	1	0	1	1	1	1	1	1	1	1	1
QS5	3	1	0	4	3	2	1	4	4	0	2	2	1	4	1	3	1	2	-	-	-	-	0	0	1	2	2	3	1	-	+	-	-	-	-	-	-	-
QS6	3	2	0	4	3	2	1	4	4	0	2	2	1	4	1	3	1	2	-	-	-	-	0	0	1	2	2	3	1	-	+	-	-	-	-	-	-	-
QS7	3	2	0	3	3	2	1	4	4	1	2	2	1	3	1	2	1	1	-	-	-	-	0	0	1	2	2	3	1	-	+	-	-	-	-	-	-	-
QS8	3	2	0	3	3	2	1	3	4	1	2	2	1	4	1	3	1	2	-	-	-	-	0	0	1	2	2	3	1	-	+	-	-	-	-	-	-	-
QS9	3	2	0	3	3	2	1	4	4	1	2	2	1	4	1	3	1	2	-	-	-	-	0	0	1	2	2	3	1	-	+	-	-	-	-	-	-	-
QS10	3	2	0	3	1	2	1	4	4	1	2	3	1	4	1	3	1	2	-	-	-	-	0	0	2	4	2	3	1	-	+	-	-	-	-	-	-	-
QS11	3	2	0	4	3	2	1	3	4	0	2	3	1	5	1	3	1	2	-	-	-	-	0	0	2	4	2	3	1	-	+	-	-	-	-	-	-	-
QS12	3	2	0	4	3	2	1	4	4	0	2	2	1	4	1	3	1	2	-	-	-	-	0	0	2	4	2	3	1	-	+	-	-	-	-	-	-	-
QS13	3	1	0	4	3	2	1	4	4	0	2	2	1	4	1	3	1	2	-	-	-	-	0	0	1	2	2	3	1	-	+	-	-	-	-	-	-	-
QS14	3	1	0	4	3	2	1	4	4	0	2	2	1	4	1	3	1	2	-	-	-	-	0	0	1	2	2	3	1	-	+	-	-	-	-	-	-	-
QS15	3	1	0	4	3	2	1	4	4	0	2	2	1	4	1	3	1	2	-	-	-	-	0	0	1	2	2	3	1	-	+	-	-	-	-	-	-	-
QS16	3	1	0	4	3	2	1	4	4	0	2	2	1	4	1	3	1	2	-	-	-	-	0	0	1	2	2	3	1	-	+	-	-	-	-	-	-	-
QS17	3	1	0	3	3	2	1	4	4	1	2	2	1	3	1	2	1	1	-	-	-	-	0	0	1	2	2	3	1	-	+	-	-	-	-	-	-	-
QS18	3	1	0	3	3	2	1	3	4	1	2	2	1	4	1	4	1	3	-	-	-	-	0	0	1	2	2	3	1	-	+	-	-	-	-	-	-	-
QS19	3	1	0	1	1	1	1	5	4	2	2	3	1	3	1	5	1	3	+	-	-	-	0	0	5	5	1	1	0	-	-	-	-	-	-	-	-	-
QS20	3	1	0	3	1	1	1	3	4	3	2	3	1	3	1	4	1	2	+	-	-	-	0	0	5	5	2	1	0	-	-	-	-	-	-	-	-	-
QS21	3	2	0	3	1	1	1	3	4	2	2	3	1	3	1	3	1	2	+	-	-	-	0	2	4	5	1	1	0	-	-	-	-	-	-	-	-	-
QS22	3	1	0	3	1	1	1	4	3	1	3	4	2	5	3	5	1	5	+	-	-	-	0	0	4	5	1	1	0	-	-	-	-	-	-	-	-	-
QS23	3	1	0	3	3	2	3	3	3	0	2	3	2	3	2	3	2	3	+	-	-	-	0	0	4	5	1	1	0	-	-	-	-	-	-	-	-	-
QS24	3	1	0	3	1	1	1	3	4	1	2	3	1	5	1	4	1	2	+	-	-	-	0	0	5	5	2	1	0	-	-	-	-	-	-	-	-	-
QS25	3	1	0	5	3	1	2	4	3	0	1	3	2	3	1	3	2	2	-	-	-	-	0	0	1	2	0	1	1	-	-	-	-	-	-	-	-	+
QS26	5	1	0	5	5	4	2	4	3	0	2	3	3	4	1	4	1	2	-	-	-	-	0	0	1	2	0	1	1	-	-	-	-	-	-	-	-	+
QS27	5	1	0	5	5	4	2	5	3	0	1	2	1	3	1	1	1	1	-	-	-	-	0	0	1	2	0	1	1	-	-	-	-	-	-	-	-	+
QS28	5	1	0	5	3	4	2	4	3	0	2	3	2	3	1	4	1	2	-	-	-	-	0	0	1	2	0	1	1	-	-	-	-	-	-	-	-	+
QS29	5	1	0	5	3	4	3	4	2	0	2	3	2	5	1	3	1	3	-	-	-	-	0	0	1	2	0	1	1	-	-	-	-	-	-	-	-	+
QS30	5	1	0	5	3	4	3	4	2	1	2	4	2	5	1	3	1	3	-	-	-	-	0	0	1	2	0	1	1	-	-	-	-	-	-	-	-	+
QS31	5	1	0	5	3	4	2	3	3	1	2	3	2	4	1	2	1	4	-	-	-	-	0	0	1	2	2	1	1	-	-	-	-	-	-	-	-	+
QS32	5	1	0	3	3	2	3	3	2	0	2	2	2	3	1	3	1	4	-	-	-	-	0	0	1	2	0	1	1	-	-	-	-	-	-	-	-	+
QS33	3	1	0	3	1	4	1	3	4	1	2	1	1	2	1	2	1	3	-	-	-	-	0	0	1	2	1	3	2	-	-	+	+	-	-	-	-	-
QS34	3	1	0	4	1	4	1	5	3	1	2	1	1	2	1	2	1	5	-	-	-	-	0	0	1	2	2	3	5	+	-	-	+	-	-	-	+	-
QS35	3	1	0	3	1	1	1	2	4	1	3	1	1	2	1	2	1	5	-	-	-	-	0	0	1	1	1	4	3	-	+	+	+	-	-	-	-	-
QS36	3	1	0	3	1	2	1	4	4	1	2	1	1	4	1	3	1	5	+	-	-	-	0	0	1	2	1	3	1	-	-	-	+	-	-	-	-	-
QS37	3	1	0	4	1	2	2	3	3	0	2	1	1	3	1	4	1	5	-	-	-	-	0	0	1	1	1	4	0	-	-	-	-	-	-	-	-	-
QS38	5	1	0	3	5	4	2	4	3	1	2	3	2	5	1	2	1	3	-	-	-	-	0	3	2	3	0	2	2	-	-	+	+	-	-	-	-	-
QS39	5	1	0	3	4	4	1	3	4	1	3	2	1	2	1	3	1	5	-	-	-	-	0	0	3	5	1	1	0	-	-	-	-	-	-	-	-	-
QS40	5	1	0	4	3	1	1	2	5	2	3	5	3	5	1	2	1	3	-	-	-	+	0	0	1	2	2	3	1	-	-	+	-	-	-	-	-	-
QS41	5	0	0	3	3	4	2	4	3	0	2	2	1	4	1	3	1	5	-	-	-	-	0	0	6	5	1	1	0	-	-	-	-	-	-	-	-	-
SF42	3	2	4	4	1	2	3	4	3	0	2	2	1	5	1	4	1	5	-	-	-	+	0	4	4	5	2	1	0	-	-	-	-	-	-	-	-	-
QS43	3	3	5	4	1	1	2	4	3	0	2	1	2	4	1	3	1	5	-	-	-	+	0	4	4	5	2	1	0	-	-	-	-	-	-	-	-	-
QS44	3	3	4	4	1	3	3	4	3	0	2	1	1	5	1	3	1	2	-	-	-	+	0	2	4	5	1	1	0	-	-	-	-	-	-	-	-	-
QS45	3	2	0	4	1	3	3	3	3	0	2	3	1	5	1	4	1	5	-	-	-	+	0	2	4	5	1	1	0	-	-	-	-	-	-	-	-	-
QS46	3	2	4	4	1	2	3	4	3	0	2	1	1	3	1	3	1	2	-	-	-	-	0	3	4	5	1	1	0	-	-	-	-	-	-	-	-	-
QS47	5	2	5	4	1	2	2	4	3	0	2	2	1	4	1	4	1	5	-	-	-	+	0	3	4	5	1	1	0	-	-	-	-	-	-	-	-	-
QS48	3	2	4	4	3	1	2	4	3	2	2	1	1	3	1	2	1	5	-	-	-	+	0	3	4	5	3	1	0	-	-	-	-	-	-	-	-	-
QS49	3	2	1	4	1	2	2	3	4	3	2	1	1	3	1	2	1	4	-	-	-	+	0	3	4	5	2	1	0	-	-	-	-	-	-	-	-	-
QS50	5	3	2	4	1	2	1	3	4	1	2	2	1	4	1	2	1	4	-	-	-	+	0	3	4	5	1	1	0	-	-	-	-	-	-	-	-	-
QS51	5	2	5	4	1	2	2	4	3	1	2	1	1	3	1	2	1	4	-	-	-	+	0	3	4	5	2	1	0	-	-	-	-	-	-	-	-	-
QS52	5	3	5	3	1	2	3	4	2	0	2	5	2	5	1	5	1	3	-	-	-	-	0	0	4	5	1	1	0	-	-	-	-	-	-	-	-	-
QS53	3	2	4	4	3	2	3	3	3	2	2	2	1	3	1	3	1	5	-	-	-	+	0	3	4	5	2	1	0	-	-	-	-	-	-	-	-	-
QS54	3	2	0	4	3	2	1	4	3	1	2	2	1	3	1	2	1	5	-	-	-	-	0	3	4	5	1	1	0	-	-	-	-	-	-	-	-	-
QS55	5	0	2	3	5	2	3	4	2	0	2	5	3	5	2	5	1	5	-	-	-	-	0	0	6	5	1	1	0	-	-	-	-	-	-	-	-	-
QS56	5	0	0	3	3	2	3	4	2	0	2	4	1	5	1	3	1	4	-	-	-	-	0	0	6	5	3	1	0	-	-	-	-	-	-	-	-	-

ENVIRONMENTAL DATA MATRIX V: SELECTED GALMA UPLAND SITES

Entries consist of five point ratio-level conversions from laboratory measurements and field estimates of quadrat site edaphic properties. Geological, biological and land use characteristics were scored either on the five point scale level or on dichotomous presence and absence nominal level as indicated.

Quadrat Sample No.	1. Site	2. Slope	3. Erosion	4. Colour	5. Drainage	6. Depth	7. Clay	8. Silt	9. Sand	10. Stone	11. pH	12. Org. Carbon	13. Na^{+}	14. K^{+}	15. $Ca^{++} + Mg^{++}$	16. Total meq.	17. C.E.C.	18. Base Sat.	19. Granite	20. Worm Cast	21. Physiognomy	22. Last Cult.	23. Bare Area	24. Canopy Closure
QS1	5	3	0	2	1	1	3	4	2	0	2	1	2	3	1	2	1	3	+	0	5	5	3	2
QS2	5	3	0	2	1	1	1	2	4	2	3	5	1	5	2	5	1	5	+	0	5	5	2	2
QS3	5	2	0	2	1	1	1	2	4	1	3	5	1	5	2	5	1	5	+	0	4	5	2	2
QS4	5	2	0	2	1	1	1	2	4	3	2	5	1	4	2	5	1	5	+	0	4	5	2	2
QS5	5	2	0	2	1	1	1	2	4	3	2	5	2	2	2	5	1	5	+	1	5	5	2	4
QS6	1	1	3	2	1	1	1	2	4	3	2	3	1	5	1	4	1	5	+	1	3	5	2	2
QS7	5	2	0	5	1	1	1	3	4	2	2	5	1	3	1	5	1	5	+	1	4	5	2	2
QS8	1	1	3	2	1	1	1	3	4	1	2	3	1	4	2	5	1	5	+	1	3	5	3	0
QS9	5	3	0	2	1	1	1	4	3	2	3	5	1	5	2	5	1	5	+	1	5	5	2	2
QS10	1	1	3	2	1	1	1	3	3	1	2	5	1	5	3	5	1	5	+	1	3	5	3	0
QS11	5	3	0	2	1	1	1	3	4	2	2	5	2	5	2	5	1	5	+	1	3	5	2	2
QS12	5	2	0	2	1	2	1	3	4	1	3	5	1	3	1	2	1	3	+	1	4	5	1	0
QS13	5	2	0	2	1	1	1	3	4	2	2	5	1	3	1	3	1	4	+	1	3	5	2	0
QS14	5	3	0	2	1	1	1	2	4	3	2	5	1	4	2	5	1	5	+	1	3	5	2	2
QS15	5	2	0	2	1	1	1	2	4	3	3	5	1	4	2	5	1	5	+	1	3	5	2	2
QS16	5	2	0	2	1	1	1	3	4	1	2	5	2	5	3	5	2	5	+	1	3	4	3	0
QS17	5	2	0	2	1	1	1	2	4	2	3	5	1	5	1	5	1	5	+	1	3	4	2	0
QS18	5	2	0	5	1	1	1	3	4	1	4	5	2	5	3	5	1	5	+	1	3	4	4	0
QS19	5	2	0	2	1	1	1	2	5	4	3	5	1	5	2	5	1	5	+	1	3	4	3	0
QS20	1	3	0	3	1	1	1	2	4	2	2	3	1	3	1	2	1	5	+	1	3	4	3	0
QS21	3	4	0	3	1	1	1	3	4	0	2	3	1	3	1	2	1	5	+	1	3	4	3	0
QS22	1	3	0	2	1	1	1	3	4	0	2	5	1	5	1	5	1	4	+	1	3	4	3	0
QS23	3	4	0	1	1	1	1	2	4	1	2	3	1	5	1	3	1	5	+	1	3	4	2	0
QS24	1	1	3	2	1	1	1	3	4	1	2	5	1	5	2	5	1	5	+	1	3	3	3	0
QS25	1	3	0	5	1	1	3	2	3	0	2	2	1	3	1	5	1	5	+	1	3	4	3	0
QS26	3	4	0	4	1	2	1	2	4	1	2	2	1	2	1	2	1	5	+	1	3	4	3	0
QS27	3	4	0	2	1	1	1	4	3	1	2	5	1	5	2	5	1	5	+	1	3	4	3	0
QS28	3	2	1	1	1	2	1	2	4	4	2	5	1	3	1	4	1	5	+	1	3	4	3	0
QS29	4	4	1	2	1	2	1	4	3	1	1	5	1	5	2	5	1	5	+	1	3	4	2	2
QS30	2	4	1	2	1	1	1	3	4	0	2	5	1	5	2	5	1	5	+	0	4	5	4	0
QS31	4	2	1	2	1	1	1	3	4	4	2	5	1	4	1	3	1	5	+	0	4	5	2	0
QS32	4	2	1	2	1	1	1	3	3	1	2	5	1	5	2	5	1	5	+	1	3	4	2	2
QS33	4	2	0	2	1	1	1	4	3	1	3	5	1	4	2	5	1	5	+	1	3	4	2	4
QS34	4	3	0	4	3	1	1	4	3	1	3	5	1	4	2	5	1	5	+	1	3	4	1	0
QS35	4	3	0	1	1	2	1	3	4	0	4	5	1	5	2	5	1	5	+	1	3	4	1	0
QS36	4	3	0	1	1	4	1	4	4	1	2	5	2	5	2	5	1	5	+	1	3	4	1	2
QS37	4	3	0	3	1	2	1	2	4	1	2	5	1	5	2	5	1	5	+	1	3	4	1	2
QS38	2	4	1	2	1	1	2	4	4	0	2	1	1	4	1	5	1	5	+	1	3	4	1	2
QS39	2	4	1	2	1	1	1	4	4	0	2	2	1	4	1	3	1	5	+	1	3	4	1	2
QS40	4	3	1	2	1	1	1	2	4	5	1	2	2	5	2	2	1	5	+	1	3	4	1	0
QS41	2	1	3	2	1	1	1	3	4	0	3	2	1	4	2	2	1	5	+	0	3	5	2	0
QS42	2	4	1	2	1	2	1	3	4	2	3	5	2	5	3	5	1	5	+	1	3	4	2	4
QS43	3	4	1	2	1	1	1	4	3	0	2	*	3	5	5	5	1	5	+	1	3	4	3	4
QS44	2	4	1	2	1	1	1	5	2	0	1	*	2	5	4	5	1	5	+	1	1	4	2	2
QS45	2	4	1	3	1	1	1	2	4	2	2	4	1	4	1	3	1	5	+	1	1	2	2	0
QS46	2	4	1	2	1	1	1	5	3	1	2	2	1	4	1	3	1	5	+	1	1	4	3	4
QS47	3	4	1	2	1	1	2	4	3	2	2	5	2	5	2	5	1	5	+	1	1	4	3	4
QS48	1	1	0	*	1	*	*	*	*	*	*	*	*	*	*	*	*	*	+	0	0	2	4	0
QS49	1	2	0	*	1	*	*	*	*	*	*	*	*	*	*	*	*	*	+	0	0	2	1	0
QS50	1	1	0	*	1	*	*	*	*	*	*	*	*	*	*	*	*	*	+	0	0	2	2	0
QS51	1	2	0	*	1	*	*	*	*	*	*	*	*	*	*	*	*	*	+	0	0	2	1	0
QS52	1	2	0	*	1	*	*	*	*	*	*	*	*	*	*	*	*	*	+	0	0	2	1	0
QS53	1	1	0	*	1	*	*	*	*	*	*	*	*	*	*	*	*	*	+	0	0	2	1	0
QS54	1	2	0	*	1	*	*	*	*	*	*	*	*	*	*	*	*	*	+	0	0	2	3	0
QS55	4	2	0	2	1	5	1	3	4	2	4	2	2	5	2	5	1	5	+	3	5	5	1	2
QS56	4	2	0	2	1	4	1	4	3	1	3	5	2	5	2	5	1	5	+	3	4	5	1	4

ENVIRONMENTAL DATA MATRIX VII: DUNDI INSELBERG AND ROCKY HILLS

Entries consist of five point ratio-level conversions from laboratory measurements and field estimates of quadrat site edaphic properties. Geological, biological and land use characteristics were scored either on the five point scale level or on dichotomous presence and absence nominal level as indicated.


Quadrat Sample No.
1. Site
2. Slope
3. Erosion
4. Colour
5. Drainage
6. Depth
7. Clay
8. Silt
9. Sand
10. Stone
11. pH
12. Org. Carbon
13. Na^{+}
14. K^{+}
15. $Ca^{++} + Mg^{++}$
16. Total meq.
17. C.E.C.
18. Base Sat.
19. Worm Cast
20. Termitarium
21. Physiognomy
22. Bare Area
23. Canopy Closure

Quadrat Sample No.
1. Site
2. Slope
3. Erosion
4. Colour
5. Drainage
6. Depth
7. Clay
8. Silt
9. Sand
10. Stone
11. pH
12. Org. Carbon
13. Na^{+}
14. K^{+}
15. $Ca^{++} + Mg^{++}$
16. Total meq.
17. C.E.C.
18. Base Sat.
19. Quartzite
20. Mica
21. Schist
22. Ironstone
23. Worm Cast
24. Termitaria
25. Physiognomy
26. Last Cult.
27. Ridges
28. Canopy Closure
29. Bare Area
30. No. of Crops
31. Sorghum
32. Gossypium
33. Lycopersicum

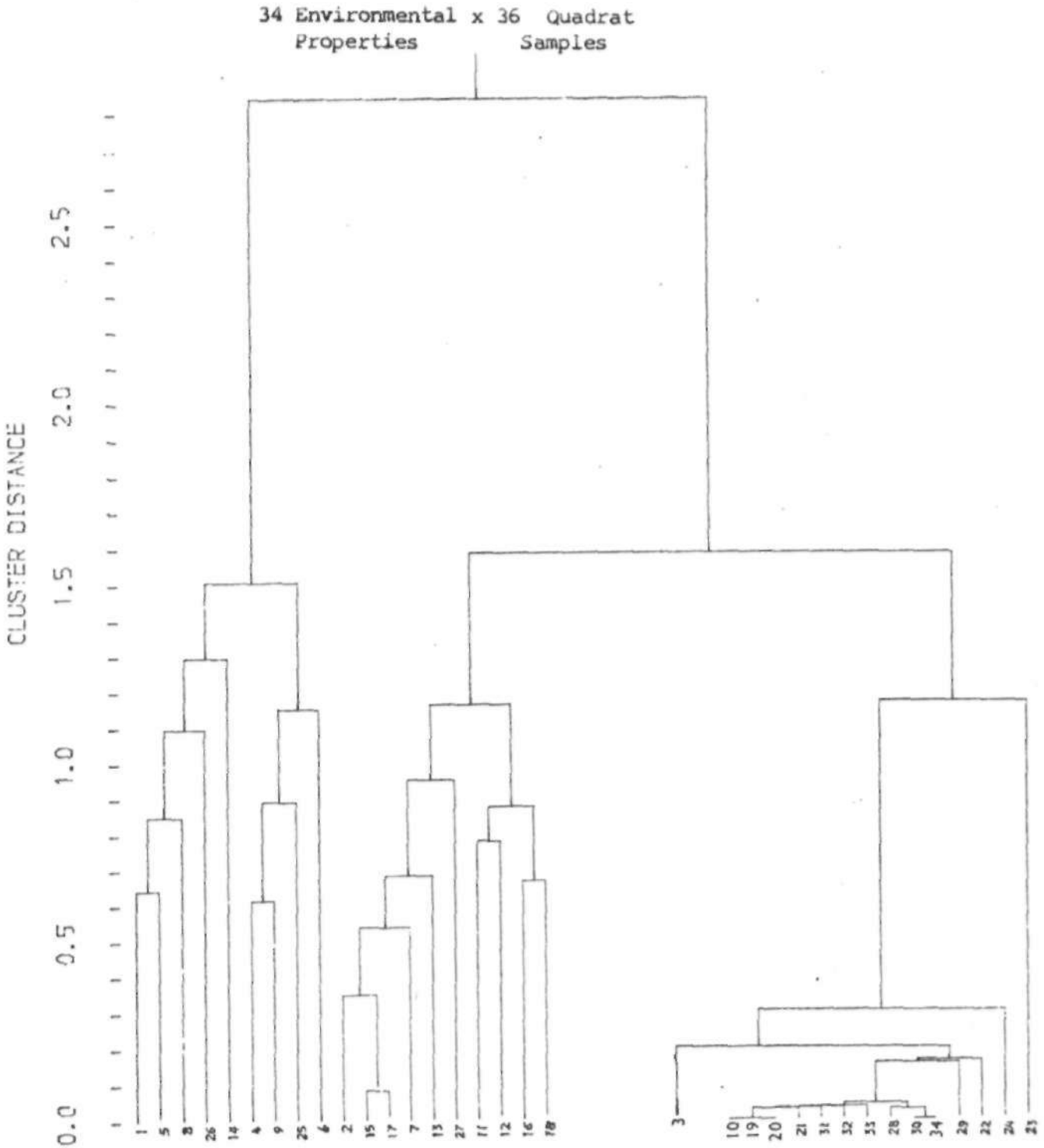
Quadrat Sample No.	1. Site	2. Slope	3. Erosion	4. Colour	5. Drainage	6. Depth	7. Clay	8. Silt	9. Sand	10. Stone	11. pH	12. Org. Carbon	13. Na^{+}	14. K^{+}	15. $Ca^{++} + Mg^{++}$	16. Total meq.	17. C.E.C.	18. Base Sat.	19. Gneiss	20. Schist	21. Quartzite	22. Ironstone	23. Worm Cast	24. Termitaria	25. Physiography	26. Bare Area
QS1	2	2	2	4	3	3	2	2	4	0	2	1	1	3	1	4	1	5	+	+	+	+	0	0	4	3
QS2	3	1	2	5	3	2	2	3	3	0	3	1	1	4	1	5	1	5	+	+	+	+	0	1	4	3
QS3	2	2	2	4	3	2	4	2	3	5	3	1	1	5	3	5	1	5	+	+	+	+	0	1	4	3
QS4	2	2	2	3	1	1	1	1	5	3	0	2	1	2	2	5	1	5	+	+	+	+	3	1	4	2
QS5	2	2	2	3	1	1	1	1	4	3	0	2	1	1	3	5	1	5	+	+	+	+	1	1	4	2
QS6	4	2	3	4	1	1	4	2	4	3	0	2	1	2	3	6	1	5	+	+	+	+	3	1	4	3
QS7	4	2	3	5	1	1	3	2	3	1	3	1	1	3	5	9	2	5	1	1	5	+	0	1	4	3
QS8	4	2	3	3	1	3	1	4	3	0	2	1	1	2	1	4	2	1	5	+	+	+	0	1	4	4
QS9	4	2	3	5	3	3	2	1	4	3	2	2	1	2	3	6	1	1	5	+	+	+	0	1	4	2
QS10	4	2	3	4	3	3	2	4	3	0	3	1	1	3	1	5	1	1	5	+	+	+	3	3	4	1
QS11	4	2	3	4	1	3	1	2	4	1	2	1	1	3	1	4	1	5	+	+	+	+	0	1	4	3
QS12	4	2	3	4	1	4	1	3	4	1	2	1	1	2	1	4	1	5	+	+	+	+	1	1	4	1
QS13	4	2	3	4	1	2	3	3	3	0	2	1	1	3	1	4	1	5	+	+	+	+	1	1	4	2
QS14	4	2	3	3	1	2	1	3	4	0	2	1	1	2	1	3	1	5	+	+	+	+	1	1	4	2
QS15	4	2	3	4	1	4	2	3	3	0	2	1	1	3	1	4	1	5	+	+	+	+	1	1	4	2
QS16	4	2	3	5	1	3	1	2	4	0	2	1	1	3	1	5	1	5	+	+	+	+	1	1	4	2
QS17	3	2	3	5	3	2	2	3	4	0	3	1	1	4	1	6	1	5	+	+	+	+	1	1	4	3
QS18	3	2	3	4	1	1	2	2	4	1	2	1	1	3	1	5	1	5	+	+	+	+	0	2	4	4
QS19	3	2	3	4	1	1	2	5	2	0	3	1	1	3	1	5	1	5	+	+	+	+	0	3	4	3
QS20	2	2	3	3	1	2	2	4	3	0	2	1	1	2	1	4	1	5	+	+	+	+	0	1	4	2
QS21	2	2	3	5	3	2	2	3	4	0	2	1	1	3	1	5	1	5	+	+	+	+	0	0	4	4
QS22	3	2	3	4	3	3	2	2	4	1	2	1	1	3	1	5	1	5	+	+	+	+	0	0	4	2
QS23	3	2	3	4	2	2	1	3	4	1	2	1	1	2	1	5	1	5	+	+	+	+	3	3	4	2
QS24	3	2	3	4	1	4	3	3	3	3	2	1	1	2	1	5	1	5	+	+	+	+	1	1	4	2
QS25	3	2	3	4	1	4	2	4	3	0	2	1	1	2	1	5	1	5	+	+	+	+	3	3	4	1
QS26	3	2	3	4	1	3	1	3	4	0	2	2	1	2	1	5	1	5	+	+	+	+	3	1	4	2
QS27	4	2	3	4	1	2	1	4	3	0	2	1	1	3	1	5	1	5	+	+	+	+	3	1	4	1
QS28	4	2	3	4	1	2	2	4	3	0	3	2	1	3	1	4	1	5	+	+	+	+	3	1	4	1
QS29	4	2	3	4	1	4	1	2	4	0	2	1	1	3	1	4	1	5	+	+	+	+	1	0	4	2
QS30	4	2	3	3	1	2	1	4	3	1	2	2	1	3	1	4	1	5	+	+	+	+	1	0	4	1
QS31	3	1	1	4	1	2	2	5	2	0	2	2	3	4	1	3	1	5	-	-	-	+	1	0	4	1
QS32	3	2	3	4	2	4	2	3	3	0	2	1	1	3	1	2	1	5	-	-	-	+	3	1	4	3
QS33	3	2	3	4	2	4	1	3	3	0	1	1	1	2	1	3	1	5	-	-	-	+	3	1	4	2
QS34	4	2	0	3	1	3	1	2	4	0	1	1	1	3	1	2	1	5	-	-	-	+	3	0	4	1
QS35	2	2	3	1	1	4	1	3	4	0	1	2	1	2	1	2	1	5	-	-	-	+	0	3	2	2
QS36	3	2	3	1	1	2	2	3	3	5	1	1	1	4	1	2	1	5	-	-	-	+	0	5	4	3
QS37	3	2	0	1	1	2	2	4	3	0	1	1	1	3	1	2	1	5	-	-	-	+	3	1	4	1
QS38	3	2	3	4	1	1	1	3	4	0	1	1	1	2	1	2	1	5	-	-	-	+	3	1	4	2
QS39	3	2	3	1	1	3	1	3	4	4	1	1	1	2	1	2	1	5	-	-	-	+	1	3	4	2
QS40	3	2	0	1	1	4	2	2	4	0	1	2	1	2	1	2	1	5	-	-	-	+	3	3	4	1
QS41	3	2	0	1	1	4	2	3	3	0	1	2	1	2	1	2	1	4	-	-	-	+	3	3	4	1
QS42	3	2	0	1	1	4	1	2	4	0	1	1	1	2	1	2	1	5	-	-	-	+	0	3	4	1
QS43	3	2	0	1	1	1	1	4	3	1	1	1	1	3	1	3	1	5	-	-	-	+	0	3	4	2
QS44	3	2	2	1	1	2	2	3	3	0	1	1	1	2	1	2	1	5	-	-	-	+	0	3	4	4
QS45	4	2	0	1	1	4	2	4	3	0	4	2	1	4	2	5	2	5	-	-	-	+	0	3	4	1
QS46	4	2	0	1	1	4	1	4	3	0	1	1	1	3	1	2	1	5	-	-	-	+	0	3	4	2
QS47	4	2	2	1	1	5	1	4	3	0	2	1	1	2	1	2	1	5	-	-	-	+	0	3	4	3
QS48	4	2	2	4	1	4	2	4	3	0	1	1	1	3	1	4	1	5	-	-	-	+	0	3	4	3
QS49	4	2	3	4	1	2	3	3	3	1	2	1	1	5	1	4	1	5	-	-	-	+	0	3	4	3
QS50	4	2	0	4	1	4	1	4	3	0	1	1	1	2	1	1	1	4	-	-	-	+	0	3	4	1
QS51	4	2	0	4	1	4	1	4	3	0	2	1	1	3	1	3	1	5	-	-	-	+	0	3	4	1
QS52	4	2	0	5	4	4	3	5	2	0	3	2	2	5	2	5	1	5	-	-	-	-	0	0	4	1
QS53	4	2	0	1	3	4	3	2	3	5	3	2	2	5	1	5	1	5	-	-	-	+	3	0	5	1
QS54	2	2	0	4	1	2	1	3	4	5	2	1	1	3	1	2	1	5	-	-	-	+	0	3	4	1
QS55	2	2	2	4	1	2	1	3	3	0	1	1	1	3	1	2	1	5	-	-	-	+	0	3	4	4
QS56	2	2	0	1	1	5	1	3	4	0	2	2	1	3	1	2	1	5	-	-	-	+	3	3	4	1
QS57	2	2	0	1	1	5	1	3	3	0	1	1	1	2	1	2	1	5	-	-	-	+	3	3	4	1
QS58	2	2	1	2	5	1	4	3	0	2	1	2	3	1	3	1	5	0	-	-	-	+	3	4	1	1
QS59	2	2	0	4	1	5	1	3	4	2	2	1	1	3	1	2	1	5	-	-	-	+	0	3	4	1
QS60	2	2	2	4	1	5	2	3	3	0	2	1	1	2	1	2	1	5	-	-	-	+	0	3	4	4
QS61	2	3	2	4	1	1	1	3	4	1	2	1	1	2	1	1	1	5	-	-	-	+	0	3	4	3
QS62	2	3	2	1	1	2	1	2	4	5	3	2	1	3	1	2	1	5	-	-	-	+	0	3	4	3
QS63	3	1	2	1	1	2	2	2	4	0	2	1	1	2	1	2	1	5	-	-	-	+	0	1	4	4
QS64	3	1	0	4	1	3	1	3	4	0	2	2	1	3	1	2	1	5	-	-	-	+	0	3	4	2
QS65	3	1	1	1	1	4	1	2	4	0	2	1	1	3	1	3	1	5	-	-	-	+	0	3	4	2
QS66	3	1	0	1	1	4	1	4	4	0	2	3	2	4	1	4	1	5	-	-	-	+	0	3	4	1
QS67	3	1	0	1	1	4	1	4	4	0	2	2	1	3	1	2	1	5	-	-	-	+	0	3	4	1
QS68	3	1	0	1	1	4	1	4	3	0	2	1	1	3	1	3	1	5	-	-	-	+	0	3	4	1
QS69	2	2	3	1	1	4	3	3	3	0	2	1	2	4	1	3	1	5	-	-	-	+	0	0	4	4
QS70	2	2	2	1	1	4	1	4	3	0	2	1	1	5	1	2	1	5	-	-	-	+	0	3	4	3
QS71	3	2	2	4	1	4	2	4	3	0	2	2	1	5	1	3	1	5	-	-	-	+	0	3	4	2
QS72	4	2	3	4	1	4	1	3	4	0	3	1	1	2	1	2	1	5	-	-	-	+	0	0	4	2
QS73	4	2	3	4	3	2	3	3	3	0	3	1	1	3	1	3	1	5	-	-	-	+	0	0	4	3
QS74	4	2	2	1	3	4	1	3	4	0	3	1	1	5	1	5	1	5	-	-	-	+	0	3	4	2
QS75	2	2	2	1	1	4	2	2	3	0	1	1	1	3	1	1	1	3	-	-	-	+	0	3	4	3
QS76	2	2	2	1	1	2	2	2	3	0	1	2	1	2	1	1	1	2	-	-	-	+	0	3	4	3
QS77	2	2	0	1	2	3	1	2	4	0	2	2	1	1	1	2	1	5	-	+	+	-	0	1	4	1
QS78	1	1	0	4	1	1	1	2	4	0	2	1	1	2	1	2	1	5	-	+	+	-	0	3	4	1
QS79	1	1	0	1	1	4	1	3	4	1	2	1	1	4	1	3	1	5	-	-	-	+	0	3	4	1
QS80	1	1	0	1	1	4	3	3	3	0	2	1	1	4	1	4	1	5	-	-	-	+	0	3	4	1

ENVIRONMENTAL DATA MATRIX XI: GUGA NON-PLANTATION FOREST RESERVE

Entries consist of five point ratio-level conversions from laboratory measurements and [illegible] site edaphic and biological properties. Geological

Quadrat Sample No.	1. Site	2. Slope	3. Erosion	4. Colour	5. Drainage	6. Depth	7. Clay	8. Silt	9. Sand	10. Stone	11. pH	12. Org. Carbon	13. Na^{+}	14. K^{+}	15. $Ca^{++} + Mg^{++}$	16. Total meq.	17. C.E.C.	18. Base Sat.	19. Quartzite	20. Schist	21. Ironstone	22. Worm Casts	23. Termitaria	24. Physiogmony	25. Land cult.	26. Canopy Closure	27. Ridges	28. Crops	29. Sorghum	30. Cassytpium	31. Hibiscus	32. Colocasia	33. Ipomaria	34. Cryza
QS1	4	2	0	3	2	5	2	4	3	1	3	2	1	5	1	3	1	2	-	-	-	-	+	1	2	0	3	1	-	-	-	-	-	-
QS2	4	2	0	3	5	5	5	3	5	2	0	3	3	1	5	1	4	1	3	-	-	-	-	1	2	0	0	0	1	-	-	-	-	-
QS3	4	1	0	3	5	5	5	3	5	2	0	2	3	1	3	1	2	1	2	-	-	-	-	1	2	0	0	0	1	-	-	-	-	-
QS4	4	2	0	3	5	5	2	5	2	5	2	3	1	2	1	2	1	2	1	-	-	-	-	1	2	0	3	1	+	+	-	-	-	-
QS5	3	2	0	3	2	5	3	3	3	5	3	1	1	2	1	3	1	2	1	-	-	-	-	1	2	0	3	1	+	+	-	-	-	-
QS6	4	2	0	3	5	4	1	5	3	2	3	2	1	2	1	2	1	2	1	-	-	-	-	1	2	1	3	1	+	+	-	-	-	-
QS7	3	1	0	1	1	5	2	5	2	0	2	2	1	2	1	1	1	1	2	-	-	-	-	2	5	1	0	0	-	-	-	-	-	-
QS8	3	1	0	1	2	5	2	5	2	0	3	3	1	4	1	3	1	2	1	-	-	-	-	1	2	0	3	1	+	+	-	-	-	-
QS9	3	1	0	1	2	5	2	5	3	4	2	3	1	3	1	2	1	2	1	-	-	-	-	1	2	0	3	1	+	+	-	-	-	-
QS10	4	1	0	3	2	5	2	5	3	1	3	3	1	3	1	2	1	2	1	-	-	-	-	1	2	0	3	1	+	+	-	-	-	-
QS11	3	1	0	3	2	5	2	5	2	0	2	2	1	5	1	3	1	2	1	-	-	-	-	1	3	0	2	1	+	+	-	-	-	-
QS12	3	1	0	1	2	5	2	5	2	0	2	2	1	2	1	3	1	2	1	-	-	-	-	2	3	0	1	2	+	+	-	-	-	-
QS13	3	1	0	1	2	5	4	4	2	1	2	1	2	4	1	1	2	1	1	-	-	-	-	2	3	0	1	1	+	+	-	-	-	-
QS14	3	1	0	1	2	5	4	5	1	3	2	2	1	2	1	2	1	2	1	-	-	-	-	1	2	0	2	1	+	+	-	-	-	-
QS15	4	1	0	1	2	5	2	5	2	0	3	3	1	3	1	4	1	2	1	-	-	-	-	1	2	0	2	1	+	+	-	-	-	-
QS16	3	1	0	3	2	5	3	3	3	0	2	5	1	5	1	5	1	2	1	-	-	-	-	1	2	0	3	1	+	+	-	-	-	-
QS17	3	1	0	1	2	5	3	3	3	0	2	5	1	5	1	5	1	2	1	-	-	-	-	1	2	0	3	1	+	+	-	-	-	-
QS18	3	1	0	3	2	5	4	3	3	0	3	5	4	4	1	5	1	2	1	-	-	-	-	1	1	0	4	1	-	+	-	-	-	-
QS19	5	1	0	3	2	5	2	4	3	1	4	2	3	5	1	5	1	2	1	-	-	-	-	1	2	2	3	1	+	+	-	-	-	-
QS20	3	1	0	1	3	5	3	5	2	1	3	5	2	4	1	4	2	2	2	-	-	-	-	1	2	0	1	2	+	+	-	-	-	-
QS21	3	1	0	3	2	5	3	3	3	5	1	5	2	4	1	5	2	2	2	-	-	-	-	1	4	0	3	1	+	+	-	-	-	-
QS22	3	1	0	1	2	5	2	5	2	3	3	3	2	3	1	4	1	3	1	-	-	-	-	1	2	0	3	1	+	+	-	-	-	-
QS23	4	1	0	3	2	5	2	4	3	0	3	2	1	4	1	3	1	2	1	-	-	-	-	-	1	0	4	1	-	+	-	-	-	-
QS24	4	1	0	3	2	5	3	4	2	0	3	3	2	5	1	4	1	2	1	-	-	-	-	-	4	5	0	0	0	-	-	-	-	-
QS25	3	1	0	3	1	5	3	5	2	0	3	3	2	5	1	4	1	2	1	-	-	-	+	-	4	5	0	0	0	-	-	-	-	-
QS26	3	3	0	3	1	5	2	4	3	1	3	5	2	5	1	3	1	2	1	-	-	-	-	-	4	5	0	0	0	-	-	-	-	-
QS27	3	2	0	1	1	5	1	5	2	1	3	2	2	5	1	3	1	2	1	-	-	-	-	-	2	3	0	0	0	-	-	-	-	-
QS28	3	2	0	4	1	5	3	3	3	0	3	5	5	2	2	5	1	1	1	-	-	-	-	-	2	4	0	0	0	-	-	-	-	-
QS29	3	1	0	1	2	5	3	3	3	0	3	3	5	2	2	5	1	1	1	-	-	-	-	-	1	1	0	4	4	+	+	-	-	-
QS30	3	1	0	1	2	5	2	5	2	0	3	3	5	1	1	3	1	2	1	-	-	-	-	-	2	3	0	1	0	-	-	-	-	-
QS31	2	2	0	3	2	5	3	4	2	1	3	2	5	1	1	3	1	2	1	-	-	-	-	-	2	3	0	1	0	-	-	-	-	-
QS32	3	1	0	1	2	5	2	3	3	5	3	3	5	1	1	5	2	3	2	-	-	-	-	-	2	3	0	1	1	+	+	-	-	-
QS33	3	1	0	1	1	5	3	3	3	4	3	3	5	2	2	5	2	3	2	-	-	-	-	-	2	3	0	1	1	+	+	-	-	-
QS34	3	1	0	1	1	5	2	2	2	5	3	3	1	3	1	3	1	2	1	-	-	-	-	-	4	5	0	0	0	-	-	-	-	-
QS35	5	1	0	1	2	5	4	2	3	5	3	5	1	5	1	5	2	2	2	+	-	-	-	-	4	5	0	0	0	-	-	-	-	-
QS36	3	1	0	3	2	5	3	3	3	0	2	5	2	5	1	4	1	3	1	2	-	-	+	-	4	5	0	0	0	-	-	-	-	-
QS37	2	3	0	1	1	5	2	4	3	0	2	3	1	4	1	3	1	2	1	+	-	-	-	-	4	5	0	0	0	-	-	-	-	-
QS38	3	1	0	3	1	5	3	4	2	0	2	3	1	2	1	3	2	2	2	+	-	-	-	-	4	5	0	0	0	-	-	-	-	-
QS39	3	1	0	1	1	5	2	2	2	5	3	2	5	1	3	1	2	2	2	+	-	-	-	-	4	5	0	0	0	-	-	-	-	-
QS40	3	3	0	3	1	5	4	3	2	1	2	3	1	4	1	3	1	2	1	+	-	-	-	-	4	5	0	0	0	-	-	-	-	-
QS41	3	1	0	1	1	5	2	4	2	0	2	4	1	5	1	3	2	2	2	+	-	-	-	-	4	5	0	0	0	-	-	-	-	-
QS42	3	1	0	1	1	2	3	4	2	1	3	4	1	5	1	3	1	2	1	+	-	-	-	-	2	4	0	0	0	-	-	-	-	-
QS43	3	2	0	3	1	5	3	5	1	0	2	3	2	3	1	4	1	2	1	+	-	-	-	-	2	3	0	1	0	-	-	-	-	-
QS44	3	1	0	3	2	5	2	4	3	5	3	3	2	2	1	5	1	2	2	1	+	-	-	-	5	5	4	0	0	-	-	-	-	-
QS45	4	1	0	3	1	5	2	3	3	3	2	2	1	3	2	5	2	2	2	+	-	-	-	-	5	5	3	0	0	-	-	-	-	-
QS46	1	2	0	1	1	5	4	4	2	4	3	3	1	4	1	2	1	2	1	+	-	-	-	-	5	5	2	0	0	-	-	-	-	-
QS47	2	4	0	1	1	5	2	4	3	0	3	2	1	4	1	2	2	1	2	+	-	-	-	-	5	5	3	0	0	-	-	-	-	-
QS48	4	2	0	1	2	5	4	5	1	0	2	3	1	4	1	3	2	2	2	+	-	-	1	-	5	5	3	0	0	-	-	-	-	-
QS49	5	2	5	3	2	5	2	5	2	1	4	5	2	2	2	5	2	3	2	+	-	-	-	-	5	5	4	0	0	-	-	-	-	-
QS50	1	2	5	3	1	5	2	5	2	3	2	4	2	4	1	3	2	2	2	+	-	-	-	-	5	5	0	0	0	-	-	-	-	-
QS51	2	2	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	3	0	0	-	-	-	-	-
QS52	4	2	0	3	2	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	0	0	0	-	-	-	-	-
QS53	3	1	0	3	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	4	5	1	0	0	-	-	-	-	-
QS54	3	2	0	1	4	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	4	0	0	-	-	-	-	-
QS55	1	3	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	0	0	0	-	-	-	-	-
QS56	3	2	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	0	0	0	-	-	-	-	-
QS57	1	1	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	2	0	0	-	-	-	-	-
QS58	3	1	0	3	2	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	2	0	0	-	-	-	-	-
QS59	3	1	0	3	2	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	0	0	0	-	-	-	-	-
QS60	3	2	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	0	0	0	-	-	-	-	-
QS61	5	3	5	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	3	0	0	-	-	-	-	-
QS62	3	1	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	3	0	0	-	-	-	-	-
QS63	3	1	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	2	0	0	-	-	-	-	-
QS64	3	2	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	2	0	0	-	-	-	-	-
QS65	3	2	0	1	2	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	2	0	0	-	-	-	-	-
QS66	3	1	0	3	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	0	0	0	-	-	-	-	-
QS67	3	1	0	3	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	2	0	0	-	-	-	-	-
QS68	3	2	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	2	0	0	-	-	-	-	-
QS69	4	2	0	3	2	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	6	5	5	0	0	-	-	-	-	-
QS70	3	2	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	4	0	0	-	-	-	-	-
QS71	3	1	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	6	5	5	0	0	-	-	-	-	-
QS72	3	2	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	5	5	6	0	0	-	-	-	-	-
QS73	3	1	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	6	5	5	0	0	-	-	-	-	-
QS74	1	1	0	3	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	6	5	0	0	0	-	-	-	-	-
QS75	1	3	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	6	5	6	0	0	-	-	-	-	-
QS76	1	3	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	6	5	6	0	0	-	-	-	-	-
QS77	2	1	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2	5	0	0	0	-	-	-	-	-
QS78	1	4	0	1	1	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	6	5	9	0	0	-	-	-	-	-
QS79	5	2	0	5	3	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2	2	4	3	2	+	-	-	-	-
QS80	5	1	0	5	5	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	6	5	9	0	0	-	-	-	-	-
QS81	5	1	0	5	5	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2	5	0	0	0	-	-	-	-	-
QS82	5	1	0	5	5	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2	2	2	0	1	+	-	-	-	-
QS93	5	1	0	5	5	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	2	5	0	0	0	-	-	-	-	-
QS84	4	1	0	5	5	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	3	3	0	0	1	-	-	-	-	-
QS85	4	1	0	5	5	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	6	5	5	0	0	-	-	-	-	-

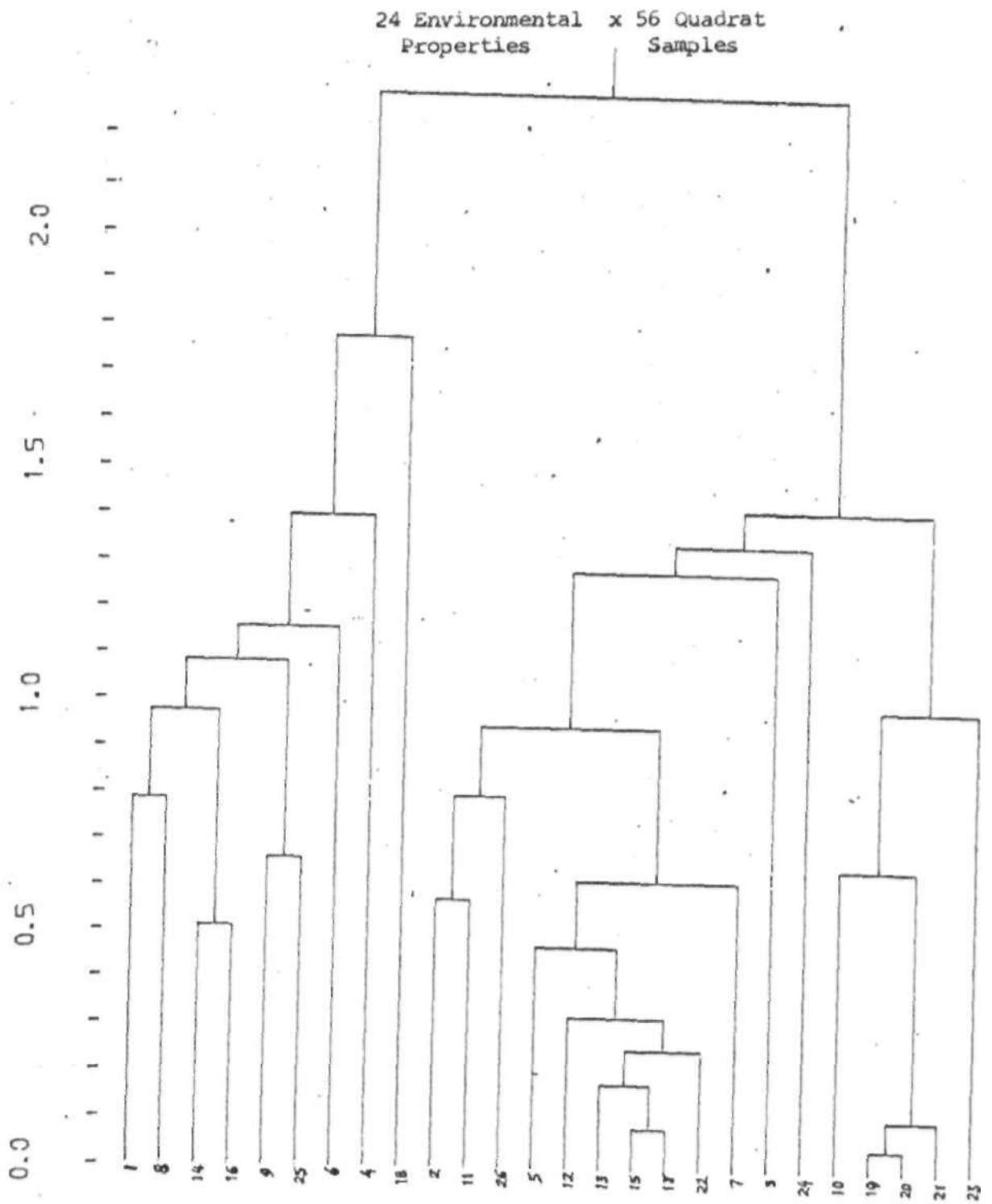
RESULTS OF THE
ENVIRONMENTAL DATA ANALYSES
IN THE FORM OF
INVERSE DENDROGRAMS DERIVED FROM
THE AGGLOMERATIVE CLUSTER ANALYSIS



INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR ENVIRONMENTAL DATA

MATRIX I: GALMA 'FADAMA'

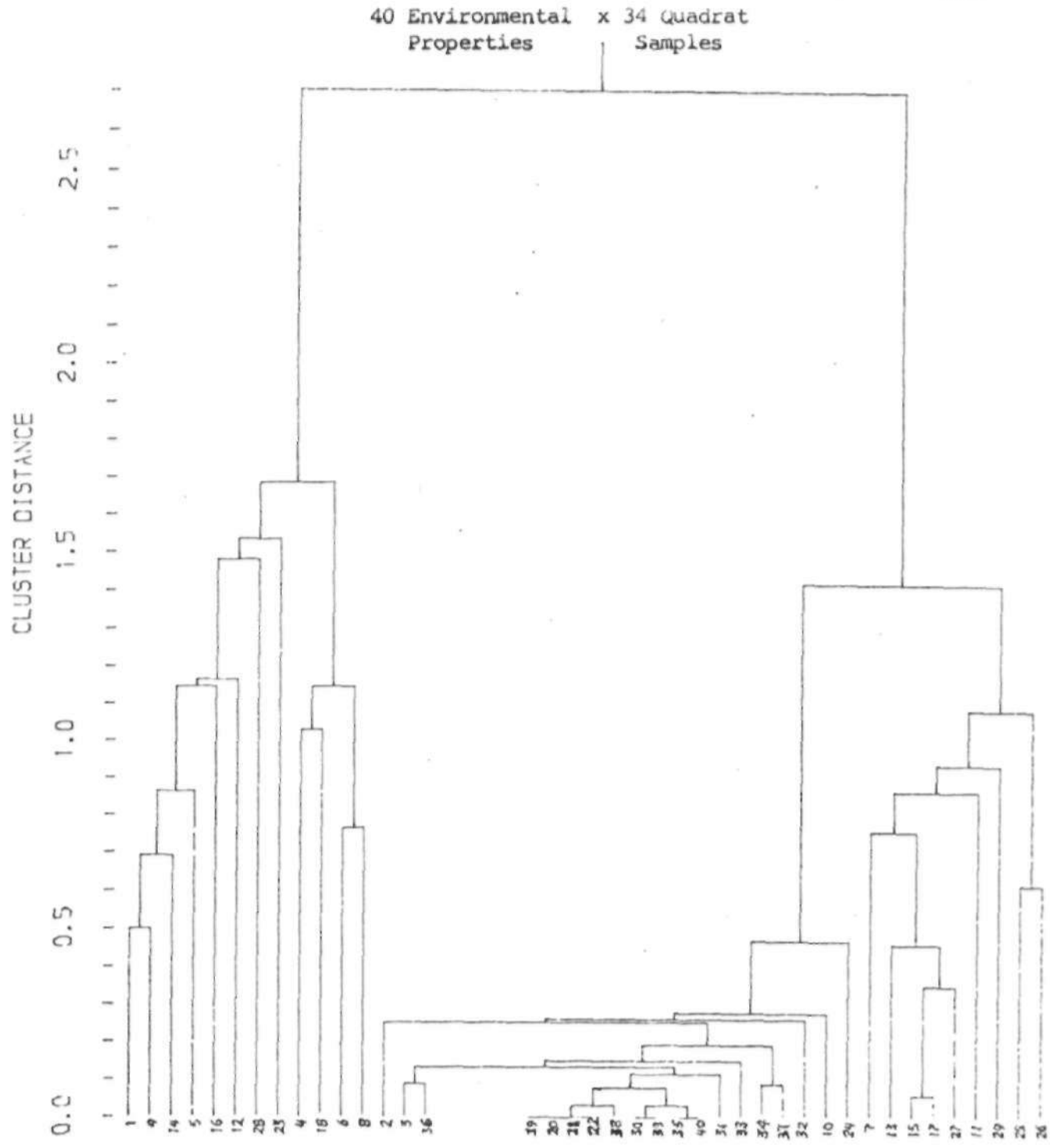
For the relatively clustered and the relatively distinct groups in the results, see Matrix I for the meaning associated with each number.



INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR ENVIRONMENTAL DATA

MATRIX VII: DUMBI INSELBERG AND ROCKY HILLS

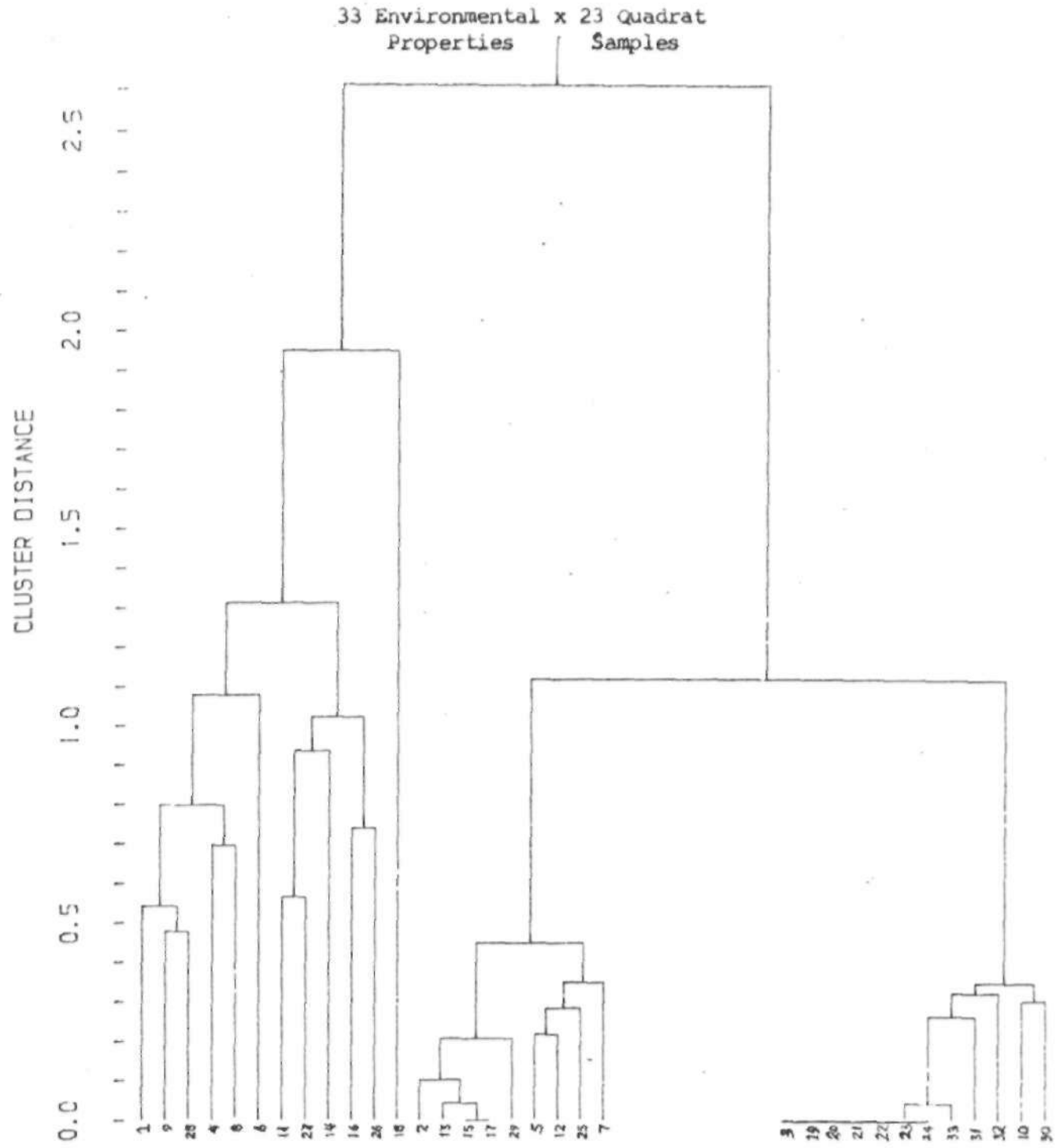
For the relatively clustered and the relatively distinct groups in the results, see Matrix VII for the meaning associated with each number.



INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR ENVIRONMENTAL DATA

MATRIX II: ZARIA-DAMBO 'KURMI'

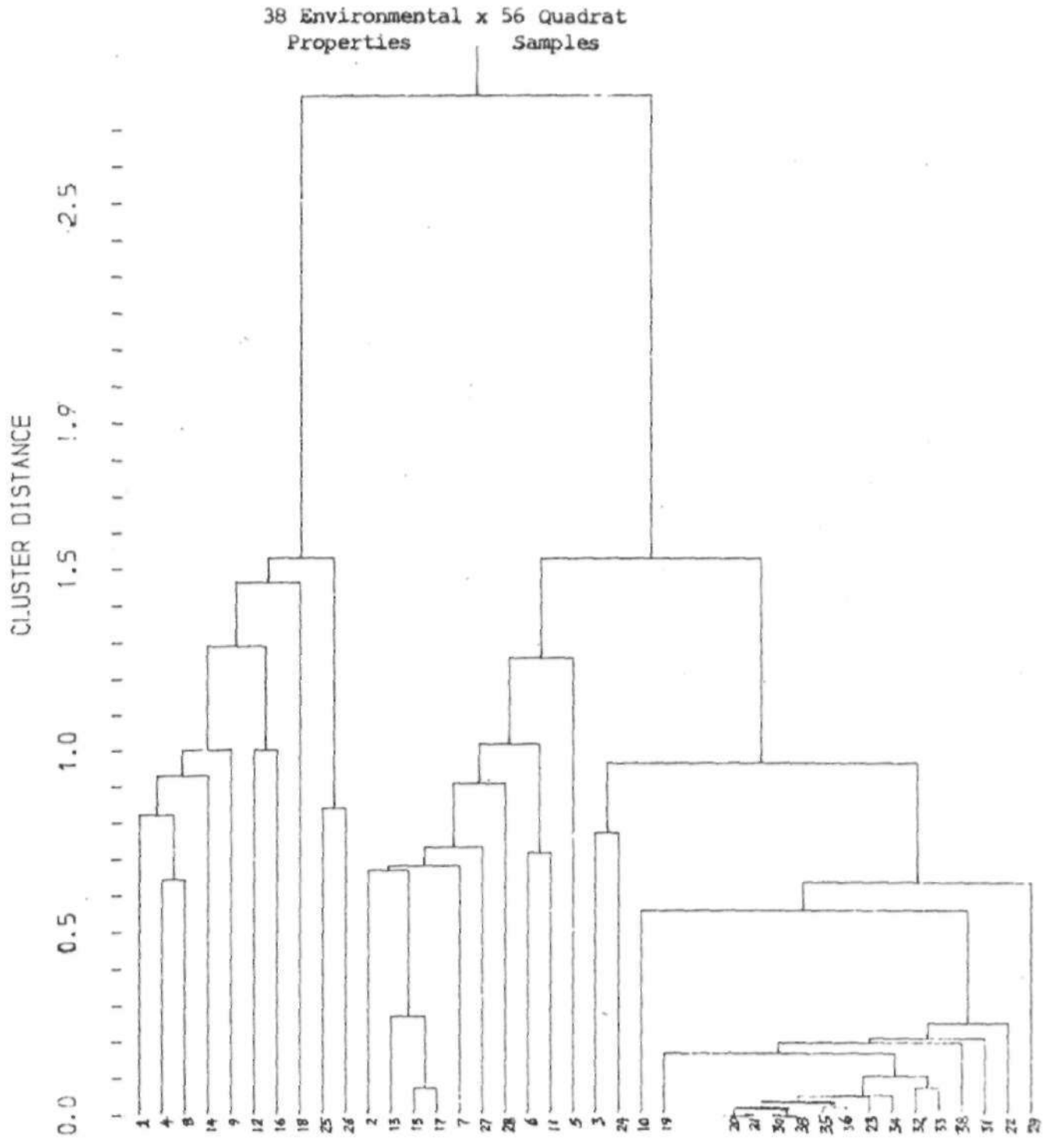
For the relatively clustered and the relatively distinct groups in the results, see Matrix II for the meaning associated with each number.



INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR ENVIRONMENTAL DATA

MATRIX IV: UPLAND KAKO VILLAGE TO GALMA 'FADAMA'

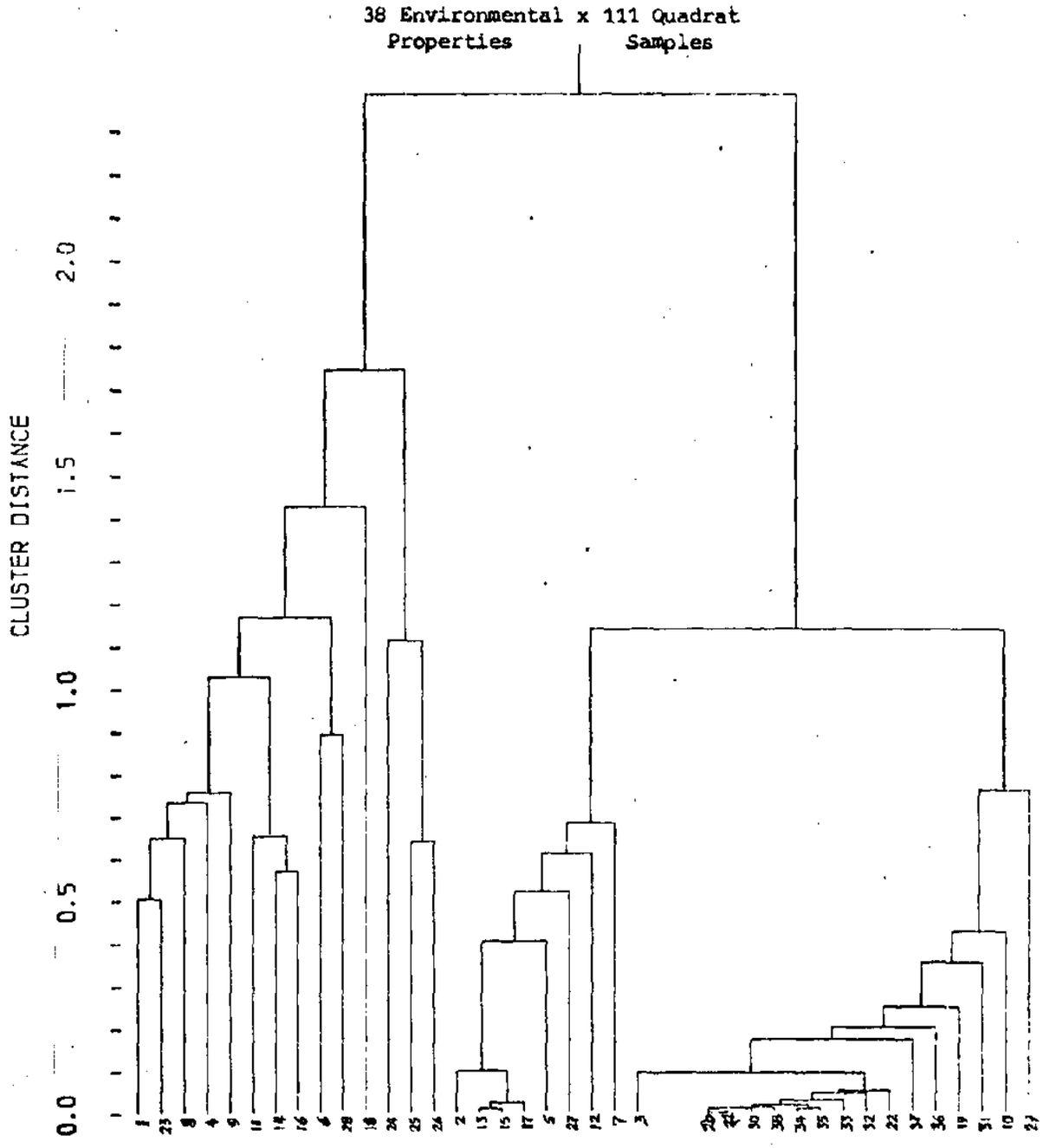
For the relatively clustered and the relatively distinct groups in the results, see Matrix IV for the meaning associated with each number.



INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR ENVIRONMENTAL DATA

MATRIX V: SELECTED GALMA UPLAND SITES

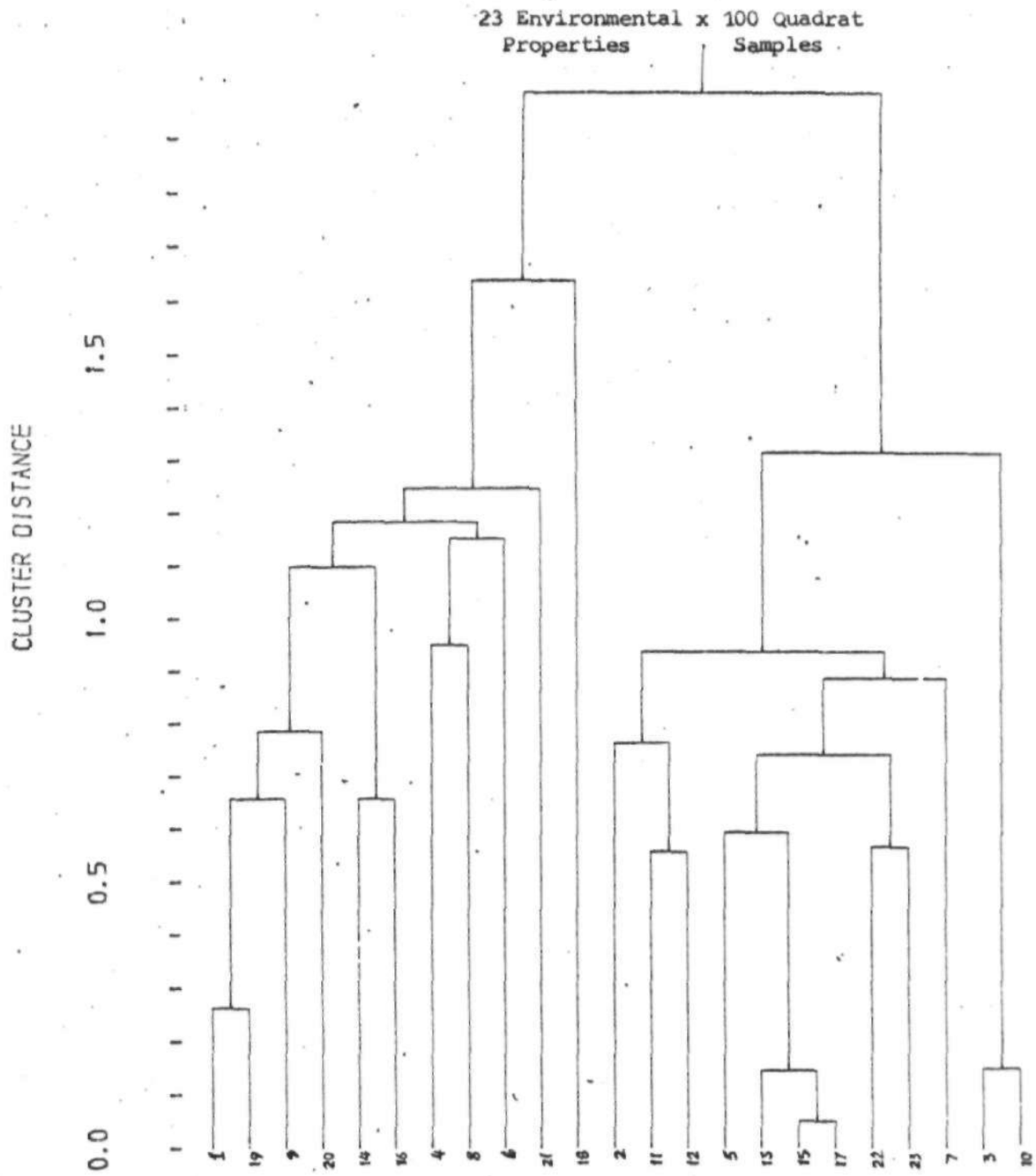
For the relatively clustered and the relatively distinct groups in the results, see Matrix V for the meaning associated with each number.



INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR ENVIRONMENTAL DATA

MATRIX VI: DUMBI TO KAKO UPLAND PLAINS

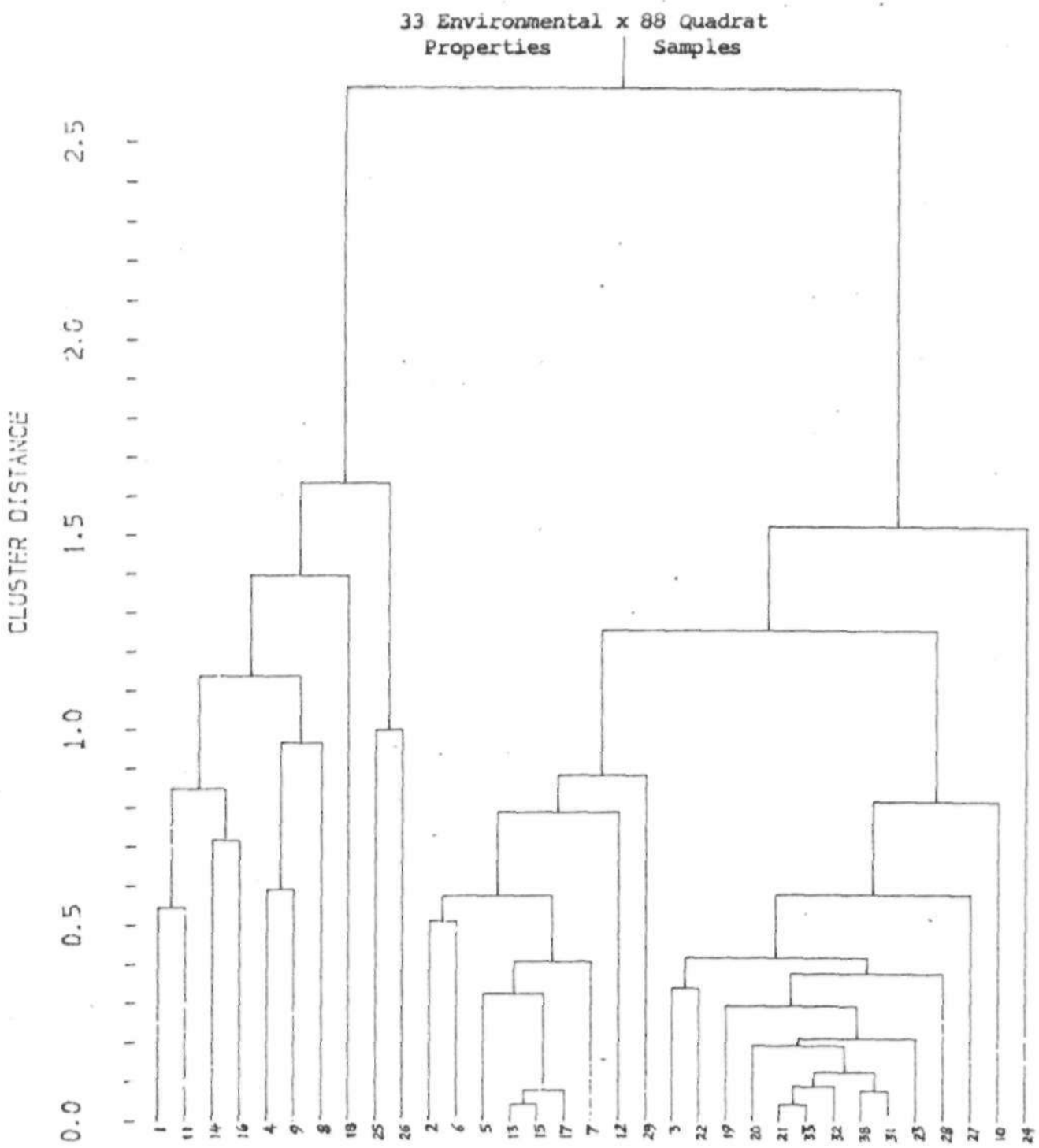
For the relatively clustered and the relatively distinct groups in the results, see Matrix VI for the meaning associated with each number.



INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR ENVIRONMENTAL DATA

MATRIX IX: KABAMA PLANTATION FOREST RESERVE

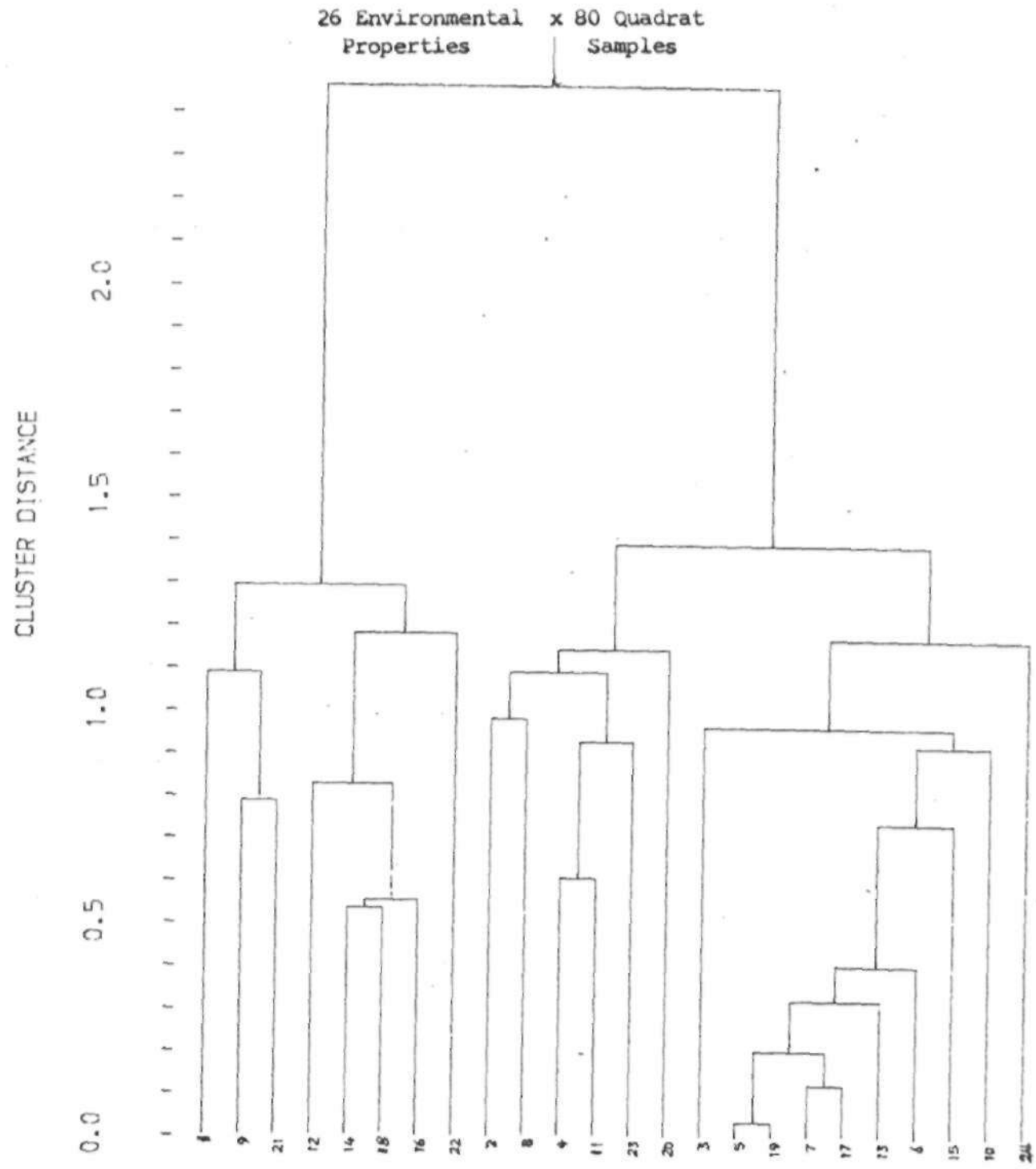
For the relatively clustered and the relatively distinct groups in the results, see Matrix IX for the meaning associated with each number.



INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR ENVIRONMENTAL DATA

MATRIX X: GUGA PLANTATION FOREST RESERVE AND ENCLAVES

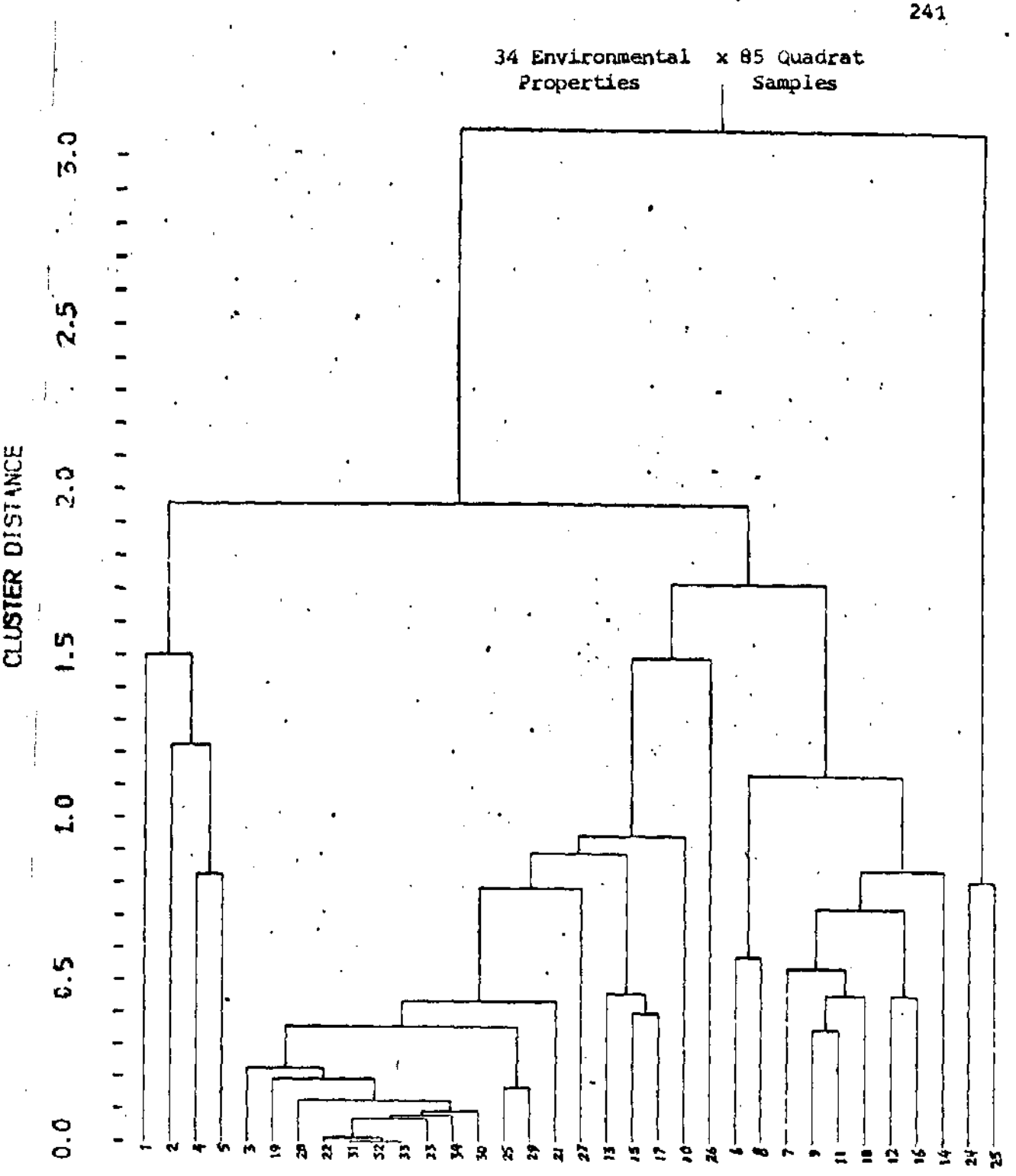
For the relatively clustered and the relatively distinct groups in the results, see Matrix X for the meaning associated with each number.



INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR ENVIRONMENTAL DATA

MATRIX XI: GUGA NON-PLANTATION FOREST RESERVE

For the relatively clustered and the relatively distinct groups in the results, see Matrix XI for the meaning associated with each number.



INVERSE OR R-CLUSTER DENDROGRAM RESULTS FOR ENVIRONMENTAL DATA

MATRIX XII: KUYELLO RURAL AREA

For the relatively clustered and the relatively distinct groups in the results, see Matrix XII for the meaning associated with each number.

RESULTS OF THE ENVIRONMENTAL DATA ANALYSES IN THE FORM OF R-ORDINATION FACTOR SCORES

1. QSn, etc., remain to mean Quadrat Sample Number, etc., as used in the matrices on pages 222-232.

2. The ecological environmental ordination have also been constructed into ordination graphs which are similar to the constructed dendrograms presented on pages 232-241. The figures are, however, preferred to the scatter diagrams.

3. The proportion of variation accounted for by six factors explored in the data matrices are sequenced in their descending order of importance for the sets of matrices.

4. The environmental properties which load significantly on each factor can be easily read in conjunction with the environmental data matrices on pages 222-232. The interpretation is discussed along with the general discussions and on conclusions on pages 304-323.

5. A trivial or redundant data on the RCFA could mean
   i) an unnecessary overloading with a set of data which the analyst ought to recognize, sort, and delete before re-submission for ordination, or
   ii) the property have the same value in all the cases being analyzed, and should also be deleted before re-submission to the computer. A redundant environmental property in the RCFA inverse ordination may, in fact, be the salient common factor within the stratum under examination, such as the granite rocks on the Dumbi Inselberg, Environmental Data Matrix VII, variable 19 on page 227, demonstrated on the R-ordination Matrix VII on page 247.

QUADRAT SAMPLE NO.	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
QS1	0.82	-0.35	0.35	-0.09	0.09	0.11
QS2	-0.71	0.03	0.58	0.18	0.09	-0.12
QS4	-0.18	-0.53	-0.10	0.09	0.15	0.51
QS5	0.97	0.12	0.01	-0.03	0.02	-0.05
QS6	0.18	-0.28	0.06	-0.13	0.22	-0.25
QS7	0.32	0.22	0.10	0.41	0.03	0.20
QS8	0.62	0.29	-0.10	-0.13	-0.34	-0.18
QS9	-0.48	-0.30	0.02	-0.23	0.23	0.00
QS11	-0.36	0.42	0.32	-0.27	0.24	-0.23
QS12	0.25	0.21	0.55	0.35	-0.05	-0.15
QS13	0.23	0.41	0.33	-0.03	-0.03	-0.07
QS14	0.11	0.56	0.30	0.12	0.01	-0.22
QS15	0.05	0.41	0.10	0.14	0.32	0.43
QS16	0.15	0.89	0.10	0.07	-0.10	0.23
QS17	0.28	-0.10	0.04	0.51	0.48	-0.35
QS18	0.07	0.82	-0.07	0.25	0.24	0.13
QS23	0.02	-0.05	0.19	-0.13	-0.26	-0.06
QS24	-0.47	-0.38	0.47	0.01	-0.24	0.34
QS25	0.36	-0.50	-0.28	0.62	-0.09	0.08
QS26	0.31	-0.34	-0.04	0.47	-0.01	-0.11
QS27	-0.26	-0.08	-0.26	-0.25	0.72	0.17

R-ORDINATION OF ENVIRONMENTAL DATA MATRIX I: GALMA 'FADAMA'
EXPLORATION OF THE FIRST SIX MOST SIGNIFICANT FACTORS USING RCFA

Trivial and redundant scores were deleted before computation. Accuracy beyond the second digit from the computer output were rounded up in the factor coefficient matrix results.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	50.60928	49.0	49.0	631.58545	189
2	22.75943	22.0	71.0	471.33081	169
3	10.93991	10.6	81.6	392.58960	150
4	7.54941	7.3	88.9	335.38452	132
5	6.32610	6.1	95.0	278.02295	115
6	5.16782	5.0	100.0	222.17560	99

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY THE SIX ENVIRONMENTAL FACTORS EXPLORED IN THE R-ORDINATION OF ENVIRONMENTAL DATA MATRIX I

Factor sequence are in their descending order of importance.

QUADRAT SAMPLE NO.	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
QS4	-0.09	-0.30	0.75	0.48	0.07	0.04
QS5	-0.12	-0.56	-0.14	0.31	0.62	-0.16
QS6	0.21	-0.06	0.24	0.17	0.22	-0.21
QS7	-0.32	-0.15	-0.45	0.73	-0.13	0.02
QS8	-0.03	-0.33	-0.40	-0.40	0.32	0.27
QS9	0.05	0.30	0.80	0.03	-0.19	0.04
QS10	0.37	0.56	0.19	0.17	0.05	-0.14
QS11	0.31	0.77	0.15	-0.12	0.38	0.10
QS12	-0.30	0.03	-0.01	0.18	-0.32	-0.09
QS13	0.10	-0.03	0.07	0.42	-0.06	0.35
QS14	0.04	0.16	-0.02	0.52	0.00	-0.01
QS15	0.46	0.81	-0.08	0.19	-0.03	-0.19
QS16	0.03	0.62	-0.17	0.37	0.04	0.52
QS18	0.20	0.21	0.19	-0.25	0.08	0.48
QS23	-0.05	-0.34	0.09	-0.16	-0.07	-0.33
QS24	-0.30	-0.01	0.36	0.09	0.17	-0.25
QS25	-0.85	0.31	-0.10	-0.01	0.18	0.07
QS26	-0.94	0.29	0.02	-0.02	-0.06	0.01
QS27	0.55	0.23	-0.10	0.01	-0.24	0.10
QS28	0.89	-0.24	-0.06	0.08	-0.06	0.17
QS29	0.67	-0.07	-0.34	0.04	0.01	0.02

R-ORDINATION OF ENVIRONMENTAL DATA MATRIX II: ZARIA-DAMBO 'KURMI'
EXPLORATION OF THE FIRST SIX MOST SIGNIFICANT FACTORS USING RCFA

Trivial and redundant scores were deleted before computation. Accuracy beyond the second digit from the computer output were rounded up in the factor coefficient matrix results.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	56.76282	41.8	41.8	754.15674	189
2	36.86005	27.1	68.9	554.05396	169
3	15.41203	11.3	80.3	462.95825	150
4	13.27226	9.8	90.0	353.50317	132
5	7.90068	5.8	95.9	281.36987	115
6	5.61372	4.1	100.0	223.48941	99

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY THE SIX ENVIRONMENTAL FACTORS EXPLORED IN THE R-ORDINATION OF ENVIRONMENTAL DATA MATRIX II

Factor sequence are in their descending order of importance.

QUADRAT SAMPLE NO.	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
QS1	-0.23	-0.02	-0.34	-0.15	-0.16	0.60
QS2	-0.41	0.20	0.41	0.69	-0.15	-0.04
QS4	-0.08	0.20	-0.32	0.31	0.25	0.13
QS5	0.66	-0.27	0.23	-0.02	-0.61	-0.11
QS6	-0.01	0.40	-0.10	-0.18	-0.07	0.01
QS7	0.81	-0.44	0.21	0.23	0.16	0.05
QS8	0.54	0.34	-0.16	-0.13	0.41	0.20
QS9	-0.80	0.20	-0.05	-0.24	-0.36	0.04
QS10	-0.42	-0.14	-0.20	0.04	0.01	0.16
QS11	-0.53	0.19	-0.03	0.39	0.36	0.49
QS12	0.74	-0.47	0.25	0.25	-0.06	-0.03
QS13	0.23	0.24	0.04	0.01	0.27	-0.14
QS14	-0.01	-0.15	0.39	0.32	0.09	0.29
QS16	0.34	-0.46	0.15	0.25	0.28	-0.20
QS25	0.94	0.20	0.27	0.02	0.01	-0.01
QS26	0.95	0.16	-0.23	0.06	-0.01	-0.02
QS27	-0.76	-0.12	-0.02	0.13	0.31	-0.49
QS28	-0.74	0.17	0.37	-0.16	0.03	0.07
QS29	-0.56	0.68	0.24	0.32	-0.11	-0.00
QS31	-0.47	0.14	-0.51	0.61	-0.22	-0.02
QS33	0.67	0.66	0.18	-0.15	0.12	-0.08
QS36	-0.70	-0.08	0.68	-0.10	0.02	0.04
QS37	-0.07	-0.01	-0.21	-0.15	-0.03	0.12

R-ORDINATION OF ENVIRONMENTAL DATA MATRIX IV: KAKO VILLAGE TO GALMA 'FADAMA'
EXPLORATION OF THE FIRST SIX MOST SIGNIFICANT FACTORS USING RCFA

Trivial and redundant scores were deleted before computation. Accuracy beyond the second digit from the computer output were rounded up in the factor coefficient matrix results.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	234.52084	61.6	61.6	3.17391	15
2	50.87805	13.4	75.0	1.08696	7
3	41.14328	10.8	85.8	3.82609	6
4	24.38994	6.4	92.2	1.34783	4
5	18.69702	4.9	97.2	2.78261	4
6	10.80860	2.8	100.0	1.56522	3

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY THE R-ORDINATION OF ENVIRONMENTAL DATA MATRIX IV

Factor sequence are in their descending order of importance.

QUADRAT SAMPLE NO.	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
QS1	-0.02	0.65	0.19	0.38	0.06	-0.33
QS2	0.41	-0.22	-0.61	0.16	0.33	0.32
QS3	0.49	0.10	-0.43	0.01	0.32	0.02
QS4	-0.22	0.36	-0.35	0.40	0.09	-0.02
QS5	-0.29	0.47	0.25	0.29	-0.20	-0.13
QS6	-0.24	0.44	-0.06	0.17	0.01	-0.42
QS7	0.24	0.70	-0.15	-0.13	0.19	0.02
QS8	0.03	0.42	-0.25	-0.12	-0.19	-0.06
QS9	-0.15	-0.84	0.15	0.36	-0.19	0.03
QS10	0.14	-0.41	0.15	0.24	-0.10	-0.17
QS11	0.06	-0.44	0.51	0.06	0.62	-0.15
QS12	0.19	0.39	0.62	0.10	0.01	0.35
QS13	-0.11	0.57	0.43	0.37	0.27	0.17
QS14	0.14	0.33	0.22	-0.04	0.10	0.47
QS15	0.21	0.15	0.52	-0.13	0.13	0.23
QS16	0.31	0.15	0.43	-0.24	0.11	0.39
QS17	-0.01	0.24	0.11	0.11	-0.28	0.38
QS18	0.16	-0.12	0.02	-0.41	0.41	-0.15
QS19	0.19	-0.22	0.38	-0.07	-0.31	0.31
QS24	0.60	-0.16	-0.53	0.18	0.27	-0.04
QS25	0.94	-0.04	0.14	-0.19	-0.08	-0.05
QS26	0.98	-0.09	0.01	0.03	-0.00	-0.01
QS27	0.24	-0.45	-0.03	-0.23	0.06	0.01
QS28	-0.77	-0.40	0.04	-0.36	0.10	0.02
QS29	-0.77	-0.02	-0.03	-0.20	0.11	-0.09

R-ORDINATION OF ENVIRONMENTAL DATA MATRIX V: SELECTED GALMA UPLAND SITES
EXPLORATION OF THE FIRST SIX MOST SIGNIFICANT FACTORS USING RCFA

Trivial and redundant scores were deleted before computation. Accuracy beyond the second digit from the computer output were rounded up in the factor coefficient matrix results.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	72.48396	55.7	55.7	1125.24561	275
2	23.14417	17.8	73.4	851.09473	251
3	13.37858	10.3	83.7	670.64453	228
4	8.51151	6.5	90.2	550.71899	206
5	7.84193	6.0	96.3	406.88550	185
6	4.87824	3.7	100.0	320.80127	165

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY THE R-ORDINATION OF ENVIRONMENTAL DATA MATRIX V

Factor sequence are in their descending order of importance.

QUADRAT SAMPLE NO.	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
QS1	0.04	0.22	-0.13	0.12	-0.08	-0.01
QS2	0.24	-0.05	-0.08	-0.05	-0.06	0.08
QS3	-0.22	0.12	0.01	0.06	0.11	0.16
QS4	-0.16	-0.01	-0.16	-0.01	-0.02	-0.18
QS5	0.18	-0.04	-0.24	0.14	-0.22	-0.05
QS6	0.57	0.06	0.09	-0.12	0.02	-0.18
QS7	0.09	0.22	0.46	-0.43	-0.18	-0.23
QS8	0.24	0.44	0.04	-0.11	-0.03	-0.41
QS9	0.16	0.63	-0.35	0.41	0.08	0.42
QS10	-0.15	0.14	-0.20	0.23	0.10	0.23
QS11	0.09	0.59	0.05	-0.02	0.20	0.04
QS12	-0.19	0.44	-0.01	-0.03	0.15	0.20
QS13	0.30	0.92	-0.05	0.08	-0.05	-0.10
QS14	0.33	0.37	0.22	-0.30	0.16	0.19
QS15	0.31	0.77	-0.06	0.10	-0.01	-0.28
QS16	0.22	0.43	0.55	-0.60	0.06	0.17
QS17	0.28	0.65	-0.07	0.05	-0.11	-0.04
QS18	0.31	0.35	0.02	-0.28	0.21	0.28
QS19	-0.37	-0.11	-0.01	0.01	0.09	0.31
QS22	-0.02	0.06	0.43	0.20	-0.01	0.10
QS23	-0.03	-0.03	0.12	-0.15	0.02	-0.07
QS24	-0.72	0.06	-0.06	0.05	-0.01	-0.03
QS25	-0.94	0.13	0.11	0.06	0.18	-0.02
QS26	-0.97	0.13	0.09	0.02	0.03	-0.04
QS27	0.49	-0.06	0.16	0.13	0.19	-0.07
QS28	0.94	-0.13	-0.06	-0.07	-0.04	0.00
QS29	0.82	-0.14	0.22	0.21	0.37	-0.09
QS30	0.09	-0.02	-0.09	0.05	-0.10	0.08
QS31	0.62	-0.11	-0.13	-0.06	0.23	0.02
QS32	0.23	-0.01	0.41	0.15	-0.18	-0.17
QS33	0.24	-0.03	0.54	0.25	0.01	0.09
QS34	0.22	-0.07	0.60	0.45	0.06	-0.08
QS35	0.17	-0.04	0.77	0.49	-0.21	0.07
QS36	0.51	-0.08	-0.05	0.05	0.58	-0.14
QS37	0.33	-0.06	-0.06	0.04	0.22	-0.01
QS38	0.06	-0.06	-0.10	0.08	-0.15	-0.15

R-ORDINATION OF ENVIRONMENTAL DATA MATRIX VI: DUMBI TO KAKO UPLAND PLAINS
EXPLORATION OF THE FIRST SIX MOST SIGNIFICANT FACTORS USING RCFA

Trivial and redundant scores were deleted before computation. Accuracy beyond the second digit from the computer output were rounded up in the factor coefficient matrix results.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	83.26125	52.3	52.3	3791.11084	594
2	34.18079	21.5	73.7	2747.58447	559
3	17.42308	10.9	84.7	2113.81396	525
4	12.91207	8.1	92.8	1536.65820	492
5	6.33218	4.0	96.7	1282.30176	460
6	5.18389	3.3	100.0	1060.69458	429

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY THE R-ORDINATION OF ENVIRONMENTAL DATA MATRIX VI

QUADRAT SAMPLE NO.	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
QS1	0.60	0.01	0.69	-0.08	0.19	-0.17
QS2	0.36	0.01	0.01	0.20	0.05	0.49
QS3	0.14	-0.01	-0.80	0.05	-0.04	-0.14
QS4	0.66	-0.01	-0.04	-0.15	0.14	0.17
QS5	0.05	0.01	0.05	0.01	0.09	-0.02
QS6	0.56	0.01	0.21	0.18	-0.71	-0.04
QS7	0.59	0.01	-0.03	0.07	0.08	0.46
QS8	0.75	0.01	-0.06	0.35	0.04	0.22
QS9	0.90	-0.01	-0.09	-0.33	-0.07	0.01
QS10	0.41	0.01	0.11	-0.38	0.00	-0.23
QS11	0.80	0.01	0.13	-0.10	-0.12	-0.11
QS12	0.72	-0.01	0.15	-0.31	0.06	-0.32
QS13	0.73	0.01	0.07	0.49	-0.01	0.07
QS14	0.90	-0.01	-0.17	0.10	0.01	-0.18
QS15	0.69	0.01	-0.14	0.51	0.19	-0.26
QS16	0.86	-0.01	-0.05	0.13	0.08	-0.18
QS17	0.93	-0.01	-0.07	-0.05	0.08	0.08
QS18	0.96	-0.01	-0.16	-0.05	0.02	0.06
QS20	0.57	0.01	0.07	-0.05	-0.22	0.08
QS21	0.81	0.01	0.40	0.09	0.09	0.23
QS22	0.01	0.96	-0.01	-0.01	0.01	-0.01
QS23	0.09	-0.01	-0.30	-0.04	0.33	0.15
QS24	0.36	0.01	0.17	0.49	0.01	0.06

R-ORDINATION OF ENVIRONMENTAL DATA MATRIX VII: DUMBI INSELBERG AND ROCKY HILLS EXPLORATION OF THE FIRST SIX MOST SIGNIFICANT FACTORS USING RCFA

Trivial and redundant scores were deleted before computation. Accuracy beyond the second digit from the computer output were rounded up in the factor coefficient matrix results.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	100.93999	67.3	67.3	877.40698	230
2	14.34681	9.6	76.8	746.56470	208
3	12.62545	8.4	85.3	599.58838	187
4	9.67736	6.5	91.7	465.45459	167
5	7.23331	4.8	96.5	350.01636	148
6	5.20890	3.5	100.0	260.73706	130

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY THE R-ORDINATION OF ENVIRONMENTAL DATA MATRIX VII

Factor sequence are in their descending order of importance.

QUADRAT SAMPLE NO.	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
QS1	-0.03	-0.23	-0.11	0.39	-0.02	0.20
QS2	0.15	-0.02	-0.10	-0.03	0.11	0.22
QS3	-0.08	-0.13	0.14	0.27	0.23	0.28
QS4	0.14	0.15	0.06	0.33	-0.36	0.04
QS5	-0.34	0.01	0.09	-0.42	0.05	0.02
QS6	-0.07	-0.01	0.04	-0.18	0.14	-0.08
QS7	0.57	0.01	0.58	0.24	0.23	-0.09
QS8	0.79	0.13	-0.32	-0.03	-0.07	-0.07
QS9	0.81	0.15	-0.39	0.19	0.01	-0.00
QS10	0.12	-0.18	-0.05	0.13	0.22	0.35
QS11	0.86	0.03	-0.17	0.07	-0.14	-0.15
QS12	0.64	0.23	-0.32	0.13	-0.09	0.21
QS13	0.49	-0.10	-0.20	-0.45	0.56	-0.08
QS14	0.82	0.11	0.18	-0.34	-0.18	0.16
QS15	0.92	0.12	-0.05	0.04	0.06	-0.04
QS16	0.82	0.02	0.43	-0.03	-0.08	-0.02
QS17	0.82	-0.02	0.09	0.31	0.24	0.13
QS18	0.83	0.08	-0.16	-0.17	-0.13	-0.07
QS19	0.01	-0.20	0.18	0.07	0.06	-0.53
QS20	0.28	-0.07	0.17	0.18	-0.23	-0.33
QS21	-0.20	0.93	0.05	-0.07	0.05	-0.02
QS22	-0.17	0.51	-0.03	0.06	0.10	0.42
QS23	-0.18	0.91	-0.01	0.10	0.01	-0.04

R-ORDINATION OF ENVIRONMENTAL DATA MATRIX IX: KABAMA FOREST PLANTATION
EXPLORATION OF THE FIRST SIX MOST SIGNIFICANT FACTORS USING RCFA

Trivial and redundant scores were deleted before computation. Accuracy beyond the second digit from the computer output were rounded up in the factor coefficient matrix results.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	52.98843	53.6	53.6	1321.84863	230
2	23.76463	24.0	77.6	702.38379	208
3	7.95060	8.0	85.7	524.29004	187
4	6.14759	6.2	91.9	377.37476	167
5	4.78048	4.8	96.7	259.50586	148
6	3.24201	3.3	100.0	195.81279	130

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY THE R-ORDINATION OF ENVIRONMENTAL DATA MATRIX IX

Factor sequence are in their descending order of importance.

QUADRAT SAMPLE NO.	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
QS1	0.26	-0.19	0.31	0.17	0.04	-0.15
QS2	-0.13	0.18	-0.31	0.19	0.02	-0.08
QS3	-0.21	-0.01	-0.24	0.49	0.04	0.42
QS4	0.12	-0.01	-0.07	-0.15	-0.03	-0.32
QS5	-0.09	-0.18	0.60	-0.23	-0.37	0.33
QS6	0.46	0.03	0.10	0.14	-0.18	-0.13
QS7	-0.20	-0.02	0.49	0.32	-0.25	0.38
QS8	0.08	0.01	0.37	0.10	0.13	-0.30
QS9	0.10	0.33	-0.36	0.03	0.48	-0.15
QS10	-0.18	0.15	-0.30	-0.24	0.43	0.47
QS11	0.01	0.13	0.36	0.06	0.47	-0.17
QS12	-0.17	0.12	0.67	-0.02	0.14	0.07
QS13	0.22	0.93	0.07	0.11	-0.04	0.02
QS14	0.06	-0.11	0.65	0.20	0.27	-0.03
QS15	-0.02	0.26	0.28	0.26	0.62	-0.14
QS16	-0.10	-0.09	0.65	0.34	0.20	-0.07
QS17	-0.07	0.12	0.72	0.08	-0.01	0.16
QS18	0.01	-0.17	0.17	0.47	0.12	-0.46
QS19	0.01	-0.03	-0.28	0.01	0.09	-0.05
QS20	-0.17	-0.11	0.13	-0.33	-0.16	0.10
QS21	0.07	0.53	-0.10	0.03	-0.14	0.12
QS22	-0.22	0.06	-0.20	-0.06	0.52	0.54
QS23	-0.13	0.04	0.03	0.04	0.28	-0.19
QS24	-0.12	0.29	-0.31	0.19	-0.14	0.16
QS25	-0.81	0.28	-0.20	-0.06	-0.07	-0.12
QS26	-0.95	-0.20	0.01	0.03	0.07	-0.02
QS27	0.98	-0.07	-0.02	-0.01	0.01	0.01
QS28	-0.10	0.18	-0.14	-0.18	-0.15	-0.36
QS29	0.12	-0.26	-0.29	0.80	-0.15	0.10
QS30	0.89	-0.25	0.02	-0.03	0.11	0.01
QS31	0.82	-0.23	-0.02	-0.03	0.10	0.06
QS32	0.64	-0.18	0.06	0.02	0.04	-0.06
QS33	0.31	-0.08	-0.01	-0.11	0.11	0.01

R-ORDINATION OF ENVIRONMENTAL DATA MATRIX X: GUGA FOREST PLANTATION AND ENCLAVES
EXPLORATION OF THE FIRST SIX MOST SIGNIFICANT FACTORS USING RCFA

Trivial and redundant scores were deleted before computation. Accuracy beyond the second digit from the computer output were rounded up in the factor coefficient matrix results.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI SQUARE	DEG FREEDOM
1	70.42841	59.7	59.7	2773.20312	495
2	17.50049	14.8	74.5	2337.74658	463
3	10.40662	8.8	83.3	2070.05200	432
4	7.97152	6.8	90.1	1847.79419	402
5	6.37348	5.4	95.5	1655.38403	373
6	5.37096	4.5	100.0	1475.65723	345

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY THE R-ORDINATION OF ENVIRONMENTAL DATA MATRIX X

Factor sequence are in their descending order of importance.

QUADRAT SAMPLE NO.	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
QS1	-0.15	0.09	0.43	0.17	-0.31	0.34
QS2	0.04	-0.03	-0.12	0.36	-0.12	0.11
QS3	-0.10	0.23	-0.16	0.81	-0.21	0.29
QS4	-0.08	0.32	-0.03	0.32	-0.16	0.39
QS5	0.43	0.29	0.13	0.07	0.25	0.24
QS6	-0.20	-0.34	0.32	-0.25	-0.04	-0.05
QS7	0.42	0.53	0.24	0.18	0.15	-0.09
QS8	0.10	0.23	0.09	-0.29	-0.78	-0.02
QS9	-0.72	-0.37	-0.16	0.04	0.42	0.19
QS10	0.09	0.14	0.05	0.04	0.33	0.01
QS11	-0.18	0.57	0.16	-0.02	0.10	0.31
QS12	0.20	-0.10	0.18	-0.35	0.08	0.09
QS13	0.43	0.49	0.20	-0.04	0.10	0.06
QS14	-0.22	0.66	0.57	-0.11	0.23	-0.08
QS15	0.63	0.39	0.10	-0.06	0.28	0.08
QS16	-0.18	0.73	0.38	-0.07	0.13	0.19
QS17	0.94	-0.10	0.04	0.07	0.13	0.10
QS18	-0.83	0.19	0.01	-0.09	-0.13	0.13
QS19	0.05	0.53	-0.49	-0.06	0.01	-0.07
QS20	0.06	0.47	-0.77	-0.31	0.03	0.02
QS21	0.30	0.46	-0.56	0.03	0.26	-0.04
QS22	0.50	-0.26	0.27	0.05	0.08	-0.18
QS23	0.19	-0.17	0.03	-0.08	-0.22	0.40
QS24	0.18	-0.34	-0.01	-0.19	0.09	-0.31
QS25	-0.77	0.18	0.05	-0.13	-0.07	-0.11
QS26	-0.13	0.23	-0.15	0.76	0.06	-0.43

R-ORDINATION OF ENVIRONMENTAL DATA MATRIX XI: GUGA NON-PLANTATION FOREST RESERVE
EXPLORATION OF THE FIRST SIX MOST SIGNIFICANT FACTORS USING RCFA

Trivial and redundant scores were deleted before computation. Accuracy beyond the second digit from the computer output were rounded up in the factor coefficient matrix results.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	32.85406	33.8	33.8	1601.52661	299
2	19.01967	19.6	53.3	1346.60547	274
3	16.32874	16.8	70.1	1064.92212	250
4	14.22662	14.6	84.8	730.72266	227
5	9.28200	9.5	94.3	472.00391	205
6	5.52703	5.7	100.0	318.13135	184

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY THE R-ORDINATION OF ENVIRONMENTAL DATA MATRIX XI

Factor sequence are in their descending order of importance.

QUADRAT SAMPLE NO.	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
QS1	0.09	-0.44	-0.06	0.39	0.04	0.27
QS2	-0.19	0.29	-0.17	-0.01	0.03	-0.15
QS3	0.04	0.21	-0.06	0.09	-0.13	-0.02
QS4	-0.02	-0.40	0.03	0.51	-0.14	0.15
QS5	0.01	-0.74	-0.03	0.60	-0.10	0.01
QS6	0.97	0.08	-0.09	0.05	0.10	-0.09
QS7	0.87	0.17	0.05	0.10	0.10	-0.08
QS8	0.90	-0.01	-0.27	0.06	0.14	-0.18
QS9	0.91	0.09	0.04	0.01	0.05	0.07
QS10	0.43	0.08	-0.14	0.07	-0.16	0.03
QS11	0.95	0.06	-0.16	-0.04	-0.07	-0.02
QS12	0.89	0.21	0.22	0.16	0.02	0.09
QS13	0.74	0.05	0.16	-0.13	-0.45	-0.13
QS14	0.84	0.13	-0.06	0.10	0.37	0.21
QS15	0.93	0.15	0.03	0.02	-0.10	-0.17
QS16	0.95	0.11	0.11	-0.02	-0.16	0.12
QS17	0.75	0.12	0.61	0.06	0.01	-0.02
QS18	0.87	0.02	-0.36	-0.07	-0.17	0.17
QS19	0.05	0.45	-0.02	0.18	0.10	-0.01
QS20	-0.24	0.10	0.15	-0.24	0.01	-0.16
QS21	-0.29	0.49	-0.05	-0.03	0.11	0.27
QS23	0.01	0.01	0.04	-0.09	0.16	0.10
QS24	-0.68	0.59	-0.02	0.06	-0.02	0.05
QS25	-0.62	0.73	-0.05	0.19	-0.01	0.01
QS26	-0.48	0.10	0.02	0.09	-0.05	-0.01
QS27	0.56	-0.58	0.11	-0.41	0.10	0.12
QS28	0.45	-0.63	0.29	-0.15	0.10	-0.08
QS29	0.43	-0.52	0.25	-0.23	0.19	-0.03
QS30	0.24	-0.19	-0.08	-0.19	0.16	0.13
QS34	0.02	-0.48	-0.11	0.39	-0.06	-0.06

R-ORDINATION OF ENVIRONMENTAL DATA MATRIX XII: KUYELLO RURAL AREA
EXPLORATION OF THE FIRST SIX MOST SIGNIFICANT FACTORS USING RCFA

Trivial and redundant scores were deleted before computation. Accuracy beyond the second digit from the computer output were rounded up in the factor coefficient matrix results.

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT	CHI-SQUARE	DEG FREEDOM
1	191.51326	73.0	73.0	2313.44385	405
2	32.57104	12.4	85.4	1635.24023	376
3	15.29059	5.8	91.3	1271.11304	348
4	10.93561	4.2	95.4	964.32593	321
5	7.03680	2.7	98.1	759.89819	295
6	4.92766	1.9	100.0	619.09570	270

ESTIMATED PROPORTION OF VARIATION ACCOUNTED FOR BY THE R-ORDINATION OF ENVIRONMENTAL DATA MATRIX XII

Factor sequence are in their descending order of importance.

THE FIFTY PLANT COMMUNITIES AND THE FOUR SUB-COMMUNITIES

WITH THEIR ENVIRONMENTS AS DETECTED BY

THE QUANTITATIVE EXAMINATION OF

714 QUADRATS x 419 SPECIES

CODE	SPECIES	DOMIN SCORES													EVALUATION		
		9	24	19	21	10	18	12	22	23	20	11	32	33	34	I	II	III
1	Paspalum orbiculare	5	4	7	8	6	5	9	6	.	6	2	4	5	.	12	67	4.8
4	Vetiveria nigritana	9	9	8	9	9	7	3	4	1	7	7	5	.	.	12	78	5.6
12	Mimosa pigra	2	2	5	4	8	.	9	7	7	4	.	2	.	.	10	50	3.6
2	Borreria verticillata	.	.	.	.	8	2	.	.	.	1	.	5	3	.	5	19	1.4
34	Glinus lotoides	.	.	.	1	.	.	6	3	1	8	.	.	.	.	5	19	1.4
41	Cynodon dactylon	.	.	1	4	.	3	.	.	.	2	4	.	.	.	5	14	1.0
51	Gardenia erubescens	.	.	.	1	.	.	.	2	1	3	.	.	.	.	4	7	0.5
57	Cyperus digitatus	.	.	.	.	.	.	2	1	1	.	.	2	.	.	4	6	0.4
22	Scleria foliosa	.	.	.	.	.	.	.	.	.	.	2	.	2	3	3	7	0.5
27	Eragrostis atrovirens	.	.	.	.	.	.	.	.	.	.	.	4	6	5	3	15	1.1
47	Elionurus pobeguinii	3	.	2	.	3	.	.	.	.	.	.	.	.	.	3	8	0.6
55	Digitaria longiflora	.	.	.	.	.	.	.	.	.	.	.	4	9	3	3	16	1.1
72	Hyparrhenia cyanescens	.	.	.	.	.	.	.	.	.	.	.	.	1	.	3	6	0.4
74	Sesbania sesban	.	.	2	.	.	3	.	.	.	.	.	1	.	.	3	6	0.4
78	Cyperus dilatatus	.	1	.	.	.	.	.	.	4	.	.	4	6	9	3	19	1.4
80	Helichrysum odoratissimum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	4	0.3
3	Nelsonia canescens	.	.	2	1	.	.	.	1	.	.	.	5	3	.	2	8	0.6
6	Sporobolus pyramidalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	7	0.5
8	Borreria radiata	.	.	.	.	.	3	.	.	.	.	4	.	.	.	2	2	0.1
13	Centella asiatica	.	.	.	.	.	1	.	1	.	.	.	.	.	.	2	13	0.9
16	Oldenlandia herbacea	.	.	.	.	.	.	.	.	.	.	.	6	7	.	2	3	0.2
17	Cassia rotundifolia	.	.	.	.	.	.	.	.	.	2	.	.	1	.	2	5	0.4
18	Eragrostis tremula	.	.	.	.	.	1	.	.	.	.	4	.	.	.	2	2	0.1
21	Jussiaea suffruticosa	.	.	.	.	.	.	.	.	.	1	.	.	.	.	2	5	0.1
48	Cassia mimosoides	.	.	.	.	.	1	.	.	.	1	.	.	.	3	2	3	0.2
62	Melochia corchorifolia	.	.	.	1	.	.	.	.	.	.	2	.	.	.	2	2	0.1
67	Crotalaria glauca	.	.	.	.	.	.	.	.	.	.	.	1	.	.	2	3	0.2
87	Securinega virosa	.	.	.	.	.	.	1	1	.	.	.	.	.	2	2	22	0.1
102	Commelina forskalaei	.	.	.	.	.	.	.	.	.	.	.	.	1	2	2	3	0.2

Key to the Evaluation column: I = Absolute Constancy Value (ACV), II = Total Domin Cover-Abundance Value (TDCV), and III = Mean Domin Cover-Abundance Value (MDCV).

DOMAIN: GALMA 'FADAMA' - FACTOR 1 FLORISTIC CLUSTER DETERMINANTS

I.1. Floristic Community Table 1
Vetiveria nigritana - Paspalum orbiculare - Mimosa pigra Community

of thickets on oxbow lake-like depressions within the 'fadama'. Its environmental features are: prolonged annual water-logging during and after the rainy season; mainly silty; brown, stoneless soil; organic carbon, $Ca^{++} + Mg^{++}$ contents are high on average. Cultivation within last four years nil, but heavily grazed in the dry season. In general, the soils appear to be similar to the "Hydromorphic Soils" of Klinkenberg and Higgins (1970).

CODE	SPECIES	DOMIN SCORES							EVALUATION		
		8	14	25	26	27	28	29	I	II	III
1	Paspalum orbiculare	5	8	4	5	4	4	3	7	33	4.7
2	Borreria verticillata	3	7	7	4	7	7	7	7	42	6.0
3	Nelsonia canescens	6	7	7	4	7	7	7	7	45	6.4
5	Vernonia perrottetii	7	5	9	2	1	3	1	7	28	4.0
11	Indigofera pulchra	2	3	1	2	1	3	3	7	15	2.1
10	Pennisetum pedicellatum	2	1	2	5	3	.	2	6	15	2.1
7	Ageratum conyzoides	7	1	1	.	3	1	.	5	13	1.9
8	Borreria radiata	.	.	1	8	3	2	1	5	15	2.1
9	Ipomoea eriocarpa	.	3	2	1	1	3	.	5	10	1.4
18	Eragrostis tremula	.	.	3	3	2	3	1	5	12	1.7
40	Brachiaria stigmatisata	9	.	.	6	7	5	2	5	29	4.1
14	Andropogon pseudapricus	.	.	.	4	3	4	7	4	18	2.6
35	Alysicarpus glumaceus	.	.	1	1	.	1	2	4	5	0.7
36	Sphaeranthus senegalensis	.	.	1	1	.	1	1	4	4	0.6
37	Urena lobata	3	.	.	.	2	1	3	4	9	1.3
52	Polygala petitiana	.	.	.	1	1	1	1	4	4	0.6
16	Oldenlandia herbacea	1	.	7	.	1	.	.	3	9	1.3
17	Cassia rotundifolia	.	2	1	.	.	1	.	3	4	0.6
25	Mitracarpus scaber	.	.	2	.	1	1	.	3	4	0.6
26	Scoparia dulcis	1	.	.	.	.	1	1	3	3	0.4
29	Monechma ciliatum	.	.	.	7	4	.	1	3	12	1.7
33	Thelepogon elegans	.	.	1	.	2	3	.	3	6	0.9
45	Crotolaria senegalensis	.	1	.	1	.	1	.	3	3	0.4
6	Sporobolus pyramidalis	1	1	.	.	.	.	.	2	2	0.3
13	Centella asiatica	.	.	.	.	5	3	.	2	8	1.1
15	Waltheria indica	1	.	.	.	.	1	.	2	2	0.3
20	Hyparrhenia rufa	.	.	.	1	1	.	.	2	2	0.3
21	Jussiaea suffruticosa	.	1	.	.	.	1	.	2	2	0.3
22	Scleria folioso	.	.	.	1	.	.	4	2	5	0.7
23	Leucas martinicensis	.	.	6	.	.	2	.	2	8	1.1
24	Stachytapheta angustifolia	.	.	3	.	1	.	.	2	4	0.6
30	Cassia tora	1	.	.	1	.	.	.	2	2	0.3
43	Vernonia ambigua	2	.	6	.	.	.	.	2	8	1.1
46	Crotalaria lachnosema	1	.	.	.	.	.	1	2	2	0.3
48	Cassia mimiosoides	.	.	.	1	.	.	2	2	3	0.4
53	Euphorbia hirta	.	.	.	.	1	.	1	2	2	0.3
56	Setaria anceps	.	.	1	1	.	.	.	2	2	0.3
59	Indigofera secundiflora	.	.	.	1	.	.	1	2	2	0.3
63	Chrozophora senegalensis	.	.	.	.	1	1	.	2	2	0.3
77	Triumpheta pentandra	.	.	.	1	.	1	.	2	2	0.3
103	Rhytachne triaristata	.	.	.	4	3	.	.	2	7	1.0

DOMAIN GALMA 'FADAMA' - FACTOR 2 FLORISTIC CLUSTER DETERMINANTS

I.1. Floristic Community Table 2
Nelsonia canescens - Borreria verticillata - Paspalum orbiculare Community

on flat 'fadama' terrace; soil colour brown; texture silty-sand (loam), stoneless, soil water mainly moist, poorly drained at depths; worm casts common; signs of current cultivation rare but occasional standing crops present; signs of cultivation within last four years frequent. Therefore it may be called 'fadama' weeds community of recent (1-4 years) Arable lands, largely in fallow.

CODE	SPECIES	DOMIN SCORES					EVALUATION		
		1	30	2	3	4	I	II	III
6	Sporobolus pyramidalis	5	2	1	1	4	5	13	2.6
2	Borreria verticillata	2	.	9	7	5	4	23	4.6
19	Ethulia conyzoides	2	.	1	1	1	4	5	1.0
20	Hyperrhenia rufa	5	.	2	2	2	4	11	2.2
31	Hygrophila auriculata	1	.	2	2	1	4	6	1.2
3	Nelsonia canescens	.	.	1	2	9	3	12	2.4
9	Ipomoea eriocarpa	4	1	2	.	.	3	7	1.4
10	Pennisetum pedicellatum	2	5	1	.	.	3	8	1.6
30	Cassia tora	9	2	1	.	.	3	12	2.4
42	Hypoestes verticillaris	3	1	.	.	1	3	5	1.0
1	Paspalum orbiculare	.	.	1	.	1	2	2	0.4
5	Vernonia perrottetii	.	.	.	2	1	2	3	0.6
7	Ageratum conyzoides	.	2	.	.	2	2	4	0.8
13	Centella asiatica	.	.	2	2	.	2	4	0.8
22	Scleria foliosa	.	.	4	5	.	2	9	1.8
27	Eragrostis atravirens	.	.	8	6	.	2	14	2.8
58	Sida ovata	8	.	.	.	1	2	9	1.8
60	Chloris pilosa	5	3	.	.	.	2	8	1.6
11	Indigofera pulchra	.	.	.	1	.	1	1	0.2
14	Andropogon pseudapricus	.	.	.	8	.	1	8	1.6
15	Waltheria indica	.	.	.	1	.	1	1	0.2
21	Jussiaea suffruticosa	.	.	3	.	.	1	3	0.6
23	Leucas martinicensis	.	2	.	.	.	1	2	0.4
24	Stachytapheta angustifolia	.	2	.	.	.	1	2	0.4
32	Guizotia scabra	.	1	.	.	.	1	1	0.2
35	Alysicarpus glumaceus	2	.	.	.	.	1	2	0.4
36	Sphaeranthus senegalensis	.	.	.	.	2	1	2	0.4
37	Urena lobata	.	.	.	.	1	1	1	0.2
38	Aspilia africana	.	.	.	.	3	1	3	0.6
44	Vernonia pauciflora	.	2	.	.	.	1	2	0.4
59	Indigofera secundiflora	2	.	.	.	.	1	2	0.4
61	Fimbristylis hispidula	.	.	5	.	.	1	5	1.0
66	Sida rhombifolia	.	1	.	.	.	1	1	0.2
75	Heliotropium supinum	.	2	.	.	.	1	2	0.4
77	Triumfetta pentandra	.	3	.	.	.	1	3	0.6
98	Elusine indica	.	1	.	.	.	1	1	0.2
101	Dactyloctenium aegyptium	.	4	.	.	.	1	4	0.8
105	Uvaria chamae	.	.	.	.	1	1	1	0.2
81	Sida urens	.	.	.	.	2	1	2	0.4
82	Senecio abyssinicus	.	.	.	.	1	1	1	0.2
83	Evolvulus alsinoides	.	.	.	.	1	1	1	0.2

DOMAIN: GALMA 'FADAMA' - FACTOR 3ii FLORISTIC CLUSTER DETERMINANTS

I.3.

Floristic Community Table 3
Borreria verticillata - Sporobolus pyramidalis - Nelsonia canescens Community

on damp, imperfectly drained flat lower middle slopes of the 'fadama'. Soils are stoneless, brown, mottled at depths (moist to damp); mainly silty-clay; with moderate Organic carbon content. The floristic composition is a mixture of forbs and grasses, suggesting vegetation in a 1-2 year fallow regrowth.

CODE	SPECIES	DOMIN SCORES							EVALUATION		
		6	5	7	21	35	36	13	I	II	III
2	Borreria verticillata	4	2	1	4	2	4	2	7	19	2.7
3	Nelsonia canescens	1	6	1	4	2	2	2	7	18	2.6
1	Paspalum orbiculare	4	1	4	2	2	7	.	6	20	2.8
7	Ageratum conyzoides	.	9	2	8	5	7	4	6	35	5.0
23	Leucas martinicensis	.	3	3	.	2	2	5	5	15	2.1
25	Mitracarpus scaber	.	1	1	3	2	2	.	5	9	1.3
26	Scoparia dulcis	1	1	.	3	1	1	.	5	7	1.0
28	Schweinkia americana	.	1	1	4	.	1	1	5	8	1.1
32	Guizotia scabra	.	2	4	.	1	1	1	5	9	1.3
5	Vernonia perrottetii	1	7	8	1	.	.	.	4	17	2.4
13	Centella asiatica	6	3	5	.	6	.	.	4	20	2.8
16	Oldenlandia herbacea	.	1	.	2	.	3	1	4	7	1.0
19	Ethulia conyzoides	1	5	.	.	.	3	7	4	16	2.3
24	Stachytapheta angustifolia	.	2	1	.	.	5	2	4	10	1.4
39	Imperata cylindrica	2	1	.	.	1	.	4	4	8	1.1
8	Borreria radiata	1	1	1	.	.	.	.	3	3	0.4
15	Waltheria indica	.	1	.	.	1	.	1	3	3	0.4
21	Jussiaea suffruticosa	.	.	.	2	2	4	.	3	8	1.1
6	Sporobolus pyramidalis	3	2	.	.	.	.	.	2	5	0.7
10	Pennisetum pedicellatum	.	.	.	1	4	.	.	2	5	0.7
18	Eragrostis tremula	.	.	.	.	.	4	1	2	5	0.7
20	Hyparrhenia rufa	2	.	.	.	2	.	.	2	4	0.6
33	Thelepogon elegans	.	.	1	1	.	.	.	2	2	0.3
43	Vernonia ambigua	.	2	.	.	.	.	1	2	3	0.4
44	Vernonia pauciflora	.	2	2	.	.	.	.	2	4	0.6
53	Euphorbia hirta	.	.	.	3	1	.	.	2	4	0.6
54	Sida linifolia	.	.	.	.	2	.	1	2	3	0.4
64	Acanthospermum hispidum	.	.	1	2	.	.	.	2	3	0.4
65	Blumea aurita	.	.	1	.	3	.	.	2	4	0.6
68	Hyptis specigera	.	.	.	.	.	8	4	2	10	1.4
104	Leersia hexandra	.	.	.	2	5	.	.	2	7	1.0

Incidental species having an absolute constancy value (ACV) of one are:

(4) Vetiveria nigritana, (11) Indigofera pulchra, (14) Andropogon pseudapricus, (12) Mimosa pigra, (17) Cassia rotundifolia, (22) Scleria foliosa, (27) Eragrostis afrovirens, (29) Monechma ciliatum, (30) Cassia tora, (31) Hygrophila auriculata, (34) Glinus lotoides, (42) Hypoestes verticillaris, (45) Crotolaria senegalensis, (62) Melochia corchorifolia, (63) Chrozophora senegalensis, (73) Eclipta prostrata, (75) Heliotropium supinum, (81) Sida urens, (82) Senecio abyssinicus, (84) Tephrosia linearis, (85) Pandiaka heudelotii, (86) Lactuca taraxacifolia, and (96) Biophytum petersianum.

DOMAIN: GALMA 'FADAMA' - FACTOR 3i FLORISTIC CLUSTER DETERMINANTS

I.4. Floristic Community Table 4
Ageratum conyzoides - Centella asiatica - Paspalum orbiculare Community

on the outer zones of the 'fadama'. It occupies the flat lower middle slopes which form the 'fadama - upland ecotone'. It is in places eroded, possibly by occasional water waves from Galma River lapping against the banks. The soil is damp, brown, and contains very heavy silt. Na^+ and K^+ contents tend to be high in the sites. Forb-grasslands in 3-4 years fallow.

CODE	SPECIES	DOMIN SCORES			EVALUATION		
		15	16	17	I	II	III
4	Vetiveria nigrinata	2	3	3	3	8	2.7
6	Sporobolus pyramidalis	5	4	3	3	12	4.0
8	Borreria radiata	2	5	4	3	11	3.7
14	Andropogon pseudapricus	2	4	4	3	10	3.3
15	Waltheria indica	2	2	2	3	6	2.0
17	Cassia rotundifolia	1	4	3	3	8	2.7
29	Monechma ciliatum	3	3	2	3	8	2.7
38	Aspilia africana	3	3	3	3	9	3.0
49	Crotalaria lachnosema	3	4	1	3	8	2.7
50	Elionurus pobeguinea	1	3	3	3	5	1.7
70	Erisema griseum	2	3	4	3	9	3.0
71	Urelytrum muricatum	1	2	2	3	5	1.7
69	Guiera senegalensis	5	6	7	3	18	6.0
79	Englerastrum gracillimum	3	2	3	2	8	2.7
11	Indigofera pulchra	3	.	2	2	5	1.7
46	Crotalaria lachnosema	1	1	.	2	2	0.7
76	Annona senegalensis	1	1	.	2	2	0.7
93	Carissa edilis	1	1	.	2	2	0.7
94	Asparagus africanus	1	1	.	2	2	0.7
95	Panicum maximum	1	2	.	2	3	1.0
9	Ipomoea eriocarpus	3	1	.	2	4	1.3
3	Nelsonia canescens	.	.	1	1	1	0.3
5	Vernonia perrottetii	.	.	1	1	1	0.3
84	Tephrosia linearis	.	2	.	1	2	0.7
85	Pandiaka heudelotii	.	2	.	1	2	0.7
88	Piliostigma thonningii	4	.	.	1	4	1.3
89	Fadogia agrestis	3	.	.	1	3	1.0
90	Lepidagathis collina	3	.	.	1	3	1.0
91	Schizachyrium sanguienum	2	.	.	1	2	0.7
92	Ctenium newtonii	1	.	.	1	1	0.3
96	Biophytum petersianum	.	1	.	1	1	0.3
97	Andropogon gayanus	.	1	.	1	1	0.3
98	Eleusine indica	.	.	1	1	1	0.3
99	Solanum torvum	.	.	1	1	1	0.3
100	Alternanthera nodiflora	.	.	1	1	1	0.3
105	Uvaria chamae	.	1	.	1	1	0.3

DOMAIN: GALMA 'FADAMA' FACTOR 4 FLORISTIC CLUSTER DETERMINANTS

I.5. *Floristic Community Table 5*

Guiera senegalensis - Sporobolus pyramidalis - Andropogon pseudapricus Community

of an indistinct 'fadama' - 'upland' zone of geomorphological intergradation. The community occurs on gently sloping lower middle slopes from the upland to the 'fadama' alluvial plain. It is eroded, stony with ironstone concretions, and sandy. Soil colour is yellow in contrast to the greyish to brownish 'fadama' soils. The flora combination, in my view, appears to be an antithesis of 'fadama' and 'upland' in a wedlock, possibly due to the factorial complexities.

CODE	SPECIES	DOMIN SCORES										EVALUATION		
		21	22	27	23	28	26	24	25	31	34	I	II	III
5	Vernonia perrottetii	1	3	2	5	2	2	3	3	2	2	10	25	2.5
1	Paspalum orbiculare	9	5	6	3	7	3	.	3	4	3	9	43	4.3
2	Borreria verticillata	2	1	2	2	6	3	4	6	.	2	9	28	2.8
13	Centella asiatica	7	8	8	7	8	9	.	.	.	1	7	48	4.8
4	Vetiveria nigritana	1	.	.	3	4	.	8	8	9	7	7	40	4.0
22	*Scleria foliosa*	2	4	.	.	4	2	4	3	2	.	7	21	2.1
23	Leucas martinicensis	7	8	8	7	8	9	.	.	.	1	6	48	4.8
6	Sporobolus pyramidalis	7	3	.	3	.	2	2	4	.	.	6	21	2.1
29	Monechma ciliatum	.	1	.	1	2	1	.	1	.	.	5	6	0.6
17	Cassia rotundifolia	.	.	.	.	.	.	7	7	4	4	4	22	2.2
3	Nelsonia canescens	.	.	.	.	.	.	6	3	5	4	4	18	1.8
7	Ageratum conyzoides	.	.	.	.	.	.	2	3	3	2	4	10	1.0
18	*Eragrostis tremula*	.	1	2	1	2	.	.	.	.	.	4	6	0.6
9	Ipomoea eriocarpa	.	.	.	.	.	6	4	1	.	.	3	11	1.1
35	Alysicarpus glumaceus	.	.	.	.	.	1	.	.	2	1	3	4	0.4
16	Oldenlandia herbacea	.	.	.	.	.	.	.	1	2	2	3	5	0.5
47	Panicum subalbidum	.	3	.	.	2	2	.	.	.	.	3	7	0.7
56	Setaria anceps	.	.	.	.	3	.	.	2	1	.	3	6	0.6
36	Sphaeranthus senegalensis	.	.	1	.	2	3	.	.	.	.	3	6	0.6
8	*Borreria radiata*	.	.	.	.	.	2	1	.	3	.	3	6	0.6
48	Cassia mimosoides	.	.	.	.	.	.	1	1	.	1	3	3	0.3
10	Pennisetum pedicellatum	.	.	.	.	.	.	.	.	8	6	2	14	1.4
32	Guizotia scabra	.	.	.	.	.	.	.	.	4	4	2	8	0.8
27	Eragrostis atrovirens	.	3	4	.	.	.	.	.	.	.	2	7	0.7
12	*Mimosa pigra*	.	.	.	.	.	2	.	2	.	.	2	4	0.4
53	Euphorbia hirta	.	.	.	.	.	.	3	1	.	.	2	4	0.4
46	Crotalaria macrocalyx	.	.	.	.	2	2	.	.	.	.	2	4	0.4
34	Glinus lotoides	.	.	.	6	.	.	.	1	.	.	2	7	0.7
14	Andropogon pseudapricus	.	.	.	.	.	.	2	2	.	.	2	4	0.4
74	Sesbania sesban	.	.	.	.	.	.	.	.	4	1	2	5	0.5
42	Hypoestes verticillaris	2	.	.	.	.	2	.	.	.	.	2	4	0.4
58	Sida ovata	2	.	.	.	.	.	.	.	.	1	2	3	0.3

Incidental species having ACV of one:
(26) Stachytarpheta angustifolia, (45) Schweinckia americana, (30) Euphorbia hirta, (65) Mitracarpus scaber, (55) Sida urens, (57) Bidens pilosa, (53) Blumea perrottetiana, (59) Crotalaria lachnosema, (41) Cassia tora, (61) Indigofera arrecta, (68) Stylochiton lancifolius, (69) Stylosanthes mucronata, (70) Guiera senegalensis, and (38) Polygonum limbatum.

DOMAIN: ZARIA - DAMBO 'KURMI' - FACTOR 1 FLORISTIC CLUSTER DETERMINANTS

II.1. Floristic Community Table 6
Centella asiatica - Leucas martinicensis - Paspalum orbiculare Community

flanking the local marsh at the head of a 'kurmi' which is the spring from which a narrow tributary seasonally flows to the 'fadama' of the main Galma River. It occupies a gentle middle slope; not eroded, grey and damp (during field survey). Soil texture is loam. Laboratory soil sample analyses indicate stonlessness but the area is surrounded by impermeable granitic rock outcrops on the field. Sites were cultivated and terraced, similar to Plates 10, 14 and 18. Crops were Sorghum, Oryza, and Saccharum. This is therefore a floristic community of weeds in Arable Crops.

CODE	SPECIES	DOMIN SCORES									EVALUATION		
		4	7	17	16	19	20	18	15	30	I	II	III
1	Paspalum orbiculare	3	9	7	7	8	8	9	6	5	9	62	6.8
2	Borreria verticillata	3	5	4	3	7	5	9	1	8	9	45	5.0
7	Scoparia dulcis	1	1	.	1	2	.	1	1	2	7	9	1.0
4	Centella asiatica	6	.	.	6	.	3	3	8	7	6	33	3.7
3	Jussiaea suffruticosa	2	.	.	2	3	4	1	1	.	6	13	1.4
8	Oldenlandia herbacea	.	2	.	2	1	2	1	5	.	6	13	1.4
9	Ipomoea aquatica	1	.	.	2	2	2	1	2	.	6	10	1.1
10	Ageratum conyzoides	.	1	.	5	.	1	1	2	.	5	10	1.1
6	Oryza sativa	3	.	.	4	6	9	.	2	2	5	26	2.9
43	Vernonia perrottetii	.	1	1	.	.	1	.	.	2	4	5	0.6
14	Ethulia conyzoides	.	.	.	.	1	3	2	.	.	3	6	0.7
44	Brachiaria stigmatisata	.	.	.	.	.	4	7	3	.	3	14	1.6
34	Imperata cylindrica	.	.	8	3	.	.	.	.	5	3	16	1.8
32	Pennisetum pedicellatum	8	7	.	.	.	.	.	.	5	3	20	2.2
17	Nelsonia canescens	4	.	.	.	.	2	1	.	.	3	7	0.8
26	Stachytarpheta angustifolia	.	.	1	.	1	.	1	.	.	3	3	0.3
60	Tephrosia linearis	1	3	.	.	.	.	.	.	.	2	6	0.7
33	Sesbania sesban	2	2	.	.	.	.	.	.	.	2	6	0.7
41	Cassia tora	3	.	.	.	.	.	3	.	.	2	6	0.7
55	Sida urens	.	.	.	.	.	1	1	.	.	2	2	0.2
51	Indigofera hirsuta	1	.	1	.	.	.	.	.	.	2	2	0.2
46	Eragrostis atrovirens	.	.	.	.	.	2	.	.	3	2	5	0.6
45	Schweinckia americana	.	.	2	.	.	.	.	.	1	2	3	0.3
39	Crotalaria retusa	1	.	.	.	.	.	1	.	.	2	2	0.2
18	Indigofera pulchra	1	.	.	.	.	.	.	.	2	2	3	0.3

Incidental species with ACV of one are:
(15) Physalis angulata, (65) Mitracarpus scaber, (58) Waltheria indica, (48) Sida rhombifolia, (62) Indigofera arrecta, (59) Crotalaria lachnosema, (67) Chrozophora senegalensis, (52) Coldenia procumbens, (64) Cienfuegosia digitata, (30) Euphorbia hirta, (50) Triumfetta pentandra, (29) Crotalaria naragutensis, (36) Urena lobata, (37) Cyperus esculentus, (40) Oryza longistaminata, (21) Digitaria ciliaris, (31) Euphorbia heterophylla, (12) Setaria anceps, (19) Melochia corchorifolia, and (72) Andropogon gayanus.

DOMAIN: ZARIA - DAMBO 'KURMI' FACTORS 1/2 FLORISTIC CLUSTER DETERMINANTS

II.2. Floristic Community Table 7
Paspalum orbiculare - Borreria verticillata - Centella asiatica Community

of weeds in arable crops (Zea, Capsicum, Pennesetum, Cucumis, Sesamum, Oryza) on fresh to damp, deep silty loam soils containing moderately high organic carbon, on average. Worm casts are common, termitaria are nil. The quadrats, though trailing a 'kurmi', are near to Dambo Village, situated on the main roadside. Intensive care is therefore suggested, and floral diversity is probably lower than expected for this reason.

CODE	SPECIES	DOMIN SCORES								EVALUATION		
		1	33	2	3	29	32	5	6	I	II	III
3	Jussiaea suffruticosa	3	1	5	2	.	.	1	.	5	12	1.5
15	Physalis angulata	1	1	1	.	.	.	2	.	4	5	0.6
1	Paspalum orbiculare	.	.	.	.	.	1	8	4	3	13	1.6
49	Mimosa pigra	.	.	.	4	.	.	9	9	3	22	2.7
16	Leersia hexandra	3	.	1	3	.	.	.	.	3	7	0.9
8	Oldenlandia herbacea	3	1	1	.	.	.	.	.	3	5	0.6
30	Euphorbia hirta	2	1	.	.	.	1	.	.	3	4	0.5
38	Polyganum limbatum	.	.	1	8	.	.	.	1	3	10	1.3
25	Portulaca oleracea	2	.	1	.	.	3	.	.	3	6	0.8
31	Euphorbia heterophylla	2	.	3	.	.	8	.	.	3	13	1.6
27	Ipomoea eriocarpa	.	.	1	1	1	.	.	.	3	3	0.4
10	Ageratum conyzoides	5	7	.	.	.	.	.	.	2	12	1.5
4	Centella asiatica	2	3	.	.	.	.	.	.	2	5	0.6
50	Triumfetta pentandra	2	.	2	.	.	.	.	.	2	4	0.5
42	Vetiveria nigritana	.	.	.	.	.	.	5	9	2	14	1.8
11	Eclipta prostrata	2	.	.	2	.	.	.	.	2	4	0.5
5	Aspilia africana	.	2	.	.	2	.	.	.	2	4	0.5
57	Bidens pilosa	.	2	.	.	.	4	.	.	2	6	0.8
24	Commelina benghalensis	2	.	.	.	.	6	.	.	2	8	1.0
35	Sida linifolia	.	1	.	.	1	.	.	.	2	2	0.3
9	Ipomoea aquatica	.	.	1	.	.	1	.	.	2	2	0.3

Incidental species with an absolute constancy value (ACV) of one are: (2) Borreria verticillata, (7) Scoparia dulcis, (28) Alternanthera nodiflora, (18) Indigofera pulchra, (26) Stachytarpheta angustifolia, (61) Indigofera arrecta, (67) Chrozophora senegalensis, (68) Stylochiton lancifolius, (69) Stylosanthes mucronata, (70) Guiera senegalensis, (52) Coldenia procumbens, (39) Crotalaria retusa, (51) Indigofera hirsuta, (66) Jacquemontia tamnifolia, (53) Blumea perrottetiana, (47) Guttenbergia nigritana, (33) Sesbania sesban, (41) Cassia tora, (37) Cyperus esculentus, and (40) Oryza longistaminata.

DOMAIN: ZARIA - DAMBO 'KURMI' - AN AMORPHOUS FLORISTIC CLUSTER DUE TO FACTORIAL COMPLEXITIES. MAINLY FACTOR 3.

II.3.

Floristic Community Table 8
Mimosa pigra - Paspalum orbiculare -
Euphorbia heterophylla Community

of weeds associated with Zea, Saccharum, Hibiscus, Lycopersicum crops (Plate 18 for example), on damp to moist 'kurmi' (floodplain) valleys. Soil colour is brownish to grey, organic carbon content is variable but tends to be high. Proximity to Dambo Village and differences in the individual farmer's conscientiousness to the manual weeding is probably a factor responsible for relative floral heterogeneity in the Community.

CODE	SPECIES	DOMIN SCORES							EVALUATION		
		8	9	11	10	12	13	14	II	II	III
11	Eclipta prostata	2	2	3	1	1	2	1	7	12	1.7
1	Paspalum orbiculare	8	6	4	5	2	.	7	6	32	4.5
20	Panicum subalbidum	4	8	8	3	.	6	1	6	30	4.2
19	Melochia corchorifolia	7	7	7	3	.	.	2	5	26	3.3
12	Setaria anceps	6	2	6	2	.	.	3	5	19	2.7
28	Alternanthera nodiflora	2	2	.	2	3	.	1	5	10	1.4
21	Digitaria ciliaris	3	1	.	2	5	.	.	4	11	1.6
24	Commelina benghalensis	2	1	1	1	.	.	.	4	5	0.7
54	Cyperus rotundus	.	.	.	4	7	3	.	3	14	2.0
14	Ethulia conyzoides	.	.	4	2	.	4	.	3	10	1.4
25	Portulaca oleracea	1	.	1	1	.	.	.	3	3	0.4
15	Physalis angulata	4	1	.	.	.	.	2	3	7	1.0
40	Oryza longistaminata	.	.	4	.	.	.	9	2	13	1.9
63	Eleusine indica	3	.	.	.	.	2	.	2	5	0.7

Incidental species with ACV equal to one: (4) Centella asiatica, (3) Jussiaea suffruticosa, (62) Eragrostis tremula, (52) Coldenia procumbens, (39) Crotalaria retusa, (66) Jacquemontia tamnifolia, (33) Sesbania sesban, (16) Leersia hexandra, (37) Cyperus esculentus, and (10) Ageratum conyzoides.

DOMAIN: ZARIA - DAMBO 'KURMI' FACTOR 4 FLORISTIC CLUSTER DETERMINANTS.

II.4. Floristic Community Table 9
Paspalum orbiculare - Panicum subalbidum -
Melochia corchorifolia Community

of weeds observed in association with Zea, Hibiscus, Lycopersicum, Brassica, as the standing crops along the 'kurmi'. The sites are depressed, stoneless, middle slopes, showing no signs of erosion. Drainage poor, with mottles close to the topsoil profile; moist. Organic carbon low, possibly drifted to the 'fadama' below the sites. Mainly current arable lands and arable lands in fallows.

CODE	SPECIES	DOMIN SCORES								EVALUATION		
		6	12	13	20	14	15	16	11	II	II	III
1	Panicum sulbalbidum	2	8	8	6	8	1	2	4	8	39	4.9
3	Paspalum orbiculare	4	.	2	2	2	2	1	1	7	14	1.8
5	Setaria pallide-fusca	4	.	3	2	3	2	.	1	6	15	1.9
2	Digitaria ciliaris	1	.	2	2	.	6	8	1	6	20	2.5
13	Alternanthera nodiflora	.	1	1	1	1	2	.	.	5	6	0.8
4	Melochia corchorifolia	.	1	.	.	1	1	1	1	5	5	0.6
15	Ethulia conyzoides	.	.	1	.	2	2	.	.	3	5	0.6
7	Eriochloa nubica	.	.	1	.	1	.	1	.	3	3	0.4
12	Ageratum conyzoides	1	.	.	.	.	.	1	1	3	3	0.4
26	Sacciolepis africana	.	2	2	.	.	.	.	.	2	4	0.5
27	Kyllinga squamulata	.	.	.	.	2	.	2	.	2	4	0.5
11	Commelina forskalaei	.	.	.	.	.	1	.	2	2	3	0.4
6	Eleusine indica	.	.	.	2	.	.	.	1	2	3	0.4
9	Cyperus pustulatus	.	.	2	.	.	.	.	4	2	6	0.8

Incidental species having ACV of one are: (10) Brachiaria stigmatisata, (22) Vernonia pauciflora, (38) Lipocarpha sphacelata, (16) Fimbristylis pilosa, (40) Buchnera hispida, (14) Eclipta prostrata, (18) Eragrostis pilosa, (41) Pennisetum pedicellatum, (37) Indigofera hirstuta, and (38) Lipocarpha sphacelata.

DOMAIN: GALMA IRRIGATION SCHEME SITE - FACTOR 1 FLORISTIC CLUSTER DETERMINANTS.

III.1. Floristic Community Table 10
Panicum sulbalbidum - Digitaria ciliaris -
Setaria pallide-fusca Community

of aquatic weeds controlled by flooding and standing water in the Galma Irrigation Scheme Centre. (N.B. Physico-chemical data on Strata III were not completed before leaving Nigeria. My interpretations are based on field experience and photographic illustrations. No mention of these unavailable data will be made on communities 10-12 for this reason.)

CODE	SPECIES	DOMIN SCORES							EVALUATION		
		7	8	9	19	18	10	17	I	II	III
2	Digitaria ciliaris	6	4	3	4	2	3	4	7	26	3.7
6	Eleusine indica	2	1	1	1	1	4	3	7	13	1.9
8	Cyperus rotundus	4	2	4	4	6	4	.	6	24	3.4
3	Paspalum orbiculare	.	1	.	1	1	2	1	5	6	0.9
10	Brachiaria stigmatisata	.	.	1	1	1	.	1	4	4	0.6
14	Eclipta prostrata	.	.	1	1	.	1	1	4	4	0.6
1	Panicum subalbidum	.	.	1	.	.	2	1	3	4	0.6
11	Commelina forskalaei	.	1	.	.	1	1	.	3	3	0.4
12	Ageratum conyzoides	2	.	.	.	.	1	2	3	5	0.7
24	Fimbristylis hispidula	.	2	1	.	.	.	.	2	3	0.4
16	Fimbristylis pilosa	.	.	.	2	1	.	.	2	3	0.4
18	Eragrostis pilosa	.	.	.	.	.	2	1	2	3	0.4
25	Oldenlandia herbacea	.	.	.	.	.	1	1	2	2	0.3
28	Leucas martinicensis	.	.	.	.	1	.	1	2	2	0.3
15	Ethulia conyzoides	.	.	.	.	1	.	1	2	2	0.3
4	Melochia corchorifolia	.	.	.	1	.	.	1	2	2	0.3
5	Setaria pallide-fusca	.	.	.	1	.	.	1	2	2	0.3
23	Commelina benghalensis	3	.	.	.	.	.	4	2	7	1.0

Incidental species with ACV of one are: (32) Euphorbia heterophylla, (33) Jussiaea suffruticosa, (34) Indigofera nummularifolia, (46) Sida rhombifolia, (44) Chloris pilosa, (45) Imperata cylindrica, (36) Eragrostis tremula, (19) Physalis angulata, (42) Setaria anceps, and (43) Sesbania sesban.

DOMAIN: GALMA IRRIGATION SCHEME SITE - FACTOR 2 FLORISTIC DETERMINANTS

III.2.

Floristic Community Table 11
Digitaria ciliaris - Cyperus rotundus - Eleusine indica Community

of weeds on poorly drained 'fadama' alluvial terrace possibly on soils sandier than either community 11 or 12. It may be named moist 'fadama' weeds of arable crops. The relative paucity of species in Domin III, represented by Communities 10-12 is partly due to (a) I changed my quadrat size to 1m. x 1m. instead of my normal 10m. x 10m. maintained in the rest of the surveys; (b) the water level was high on the terrace during the field work in July 1978, which probably covered some species. (c) Only a few species are probably adapted to grow in the extreme inundation.

CODE	SPECIES	DOMIN SCORES					EVALUATION		
		1	2	3	4	5	I	II	III
7	Eriochloa nubica	4	6	6	6	6	5	28	5.6
4	Melochia corchorifolia	1	2	3	3	1	5	10	2.0
9	Cyperus pustulatus	6	2	2	.	2	4	12	2.4
1	Panicum subalbidum	2	.	1	3	3	4	9	1.8
17	Digitaria acuminatissima	.	.	3	3	2	3	8	1.6
5	Setaria pallide-fusca	.	.	2	3	3	3	8	1.6
3	Paspalum orbiculare	2	.	.	3	2	3	7	1.4
20	Oryza longistaminata	.	.	5	1	.	2	6	1.2
21	Cassia minosoides	.	.	2	2	.	2	4	0.8
2	Digitaria ciliaris	2	.	.	.	1	2	3	0.6

Incidental species having ACV of one are: (10) Brachiaria stigmatisata, (16) Fimbristylis pilosa, (19) Physalis angulata, (29) Scleria foliosa. (22) Vernonia pauciflora, (11) Commelina forskalaei, and (30) Echinochloa colona.

DOMAIN: GALMA IRRIGATION SCHEME SITE - FACTOR 3 FLORISTIC CLUSTER DETERMINANTS.

III.3. Floristic Community Table 12
Eriochloa nubica - Panicum subalbidum - Cyperus pustulatus Community

of semi-aquatic weeds in the Galma Irrigation Scheme Centre (Plate 17). The agricultural land use at the Centre is controlled by the Kaduna State Government. Land treatment is uniform. Irrigation channels are constructed and maintenance is executed using tractors (Plate 48). Variations in flora are, in my view, controlled by the minor topographic variations on the alluvial 'fadama' terrace.

CODE	SPECIES	DOMIN SCORES															EVALUATION		
		1	3	5	11	10	9	12	2	6	4	7	8	13	14	15	I	II	III
2	Digitaria ciliaris	8	6	8	8	6	7	8	5	5	8	6	3	3	4	5	15	90	6.0
1	Paspalum orbiculare	.	.	.	1	1	.	2	4	4	2	4	3	2	6	9	11	38	2.5
4	Dactyloctenum	3	4	5	4	2	2	.	2	.	4	5	3	.	.	.	10	34	2.3
5	Mitracarpus scaber	1	2	1	.	.	.	.	4	4	6	2	3	.	4	.	9	27	1.8
12	Schwenckia americana	1	.	1	.	1	.	.	.	1	1	.	2	1	1	4	9	13	0.9
6	Imperata cylindrica	.	.	.	3	4	4	5	.	.	.	.	9	9	8	4	8	46	3.1
10	Eragrostis tremula	2	.	.	.	.	1	.	3	2	1	2	2	.	5	.	8	18	1.2
13	Cynodon dactylon	.	.	2	.	4	.	6	3	4	.	2	.	2	.	.	7	23	1.5
16	Jacquemontia tamnifolia	1	1	1	.	1	1	3	.	.	.	.	.	.	.	2	7	10	0.7
3	Borreria verticillata	1	1	.	.	.	2	.	1	3	3	1	.	.	.	.	7	12	0.8
11	Indigofera arrecta	1	1	.	.	.	.	1	1	1	.	2	.	.	.	1	7	8	0.5
19	Tridax procumbens	.	.	1	.	.	1	.	1	5	2	2	.	.	.	.	6	8	0.5
20	Crotalaria senegalensis	.	.	.	.	.	.	1	1	1	1	.	.	1	1	.	6	6	0.4
15	Brachiaria stigmatisata	.	.	.	.	.	2	.	.	.	.	2	4	2	.	3	5	13	0.9
14	Heliotropium strigosum	.	1	.	.	.	.	.	3	.	3	.	3	.	.	4	5	14	0.9
18	Thelepogon elegans	.	.	2	.	1	.	.	6	.	.	.	.	1	1	.	5	11	0.7
24	Pennisetum pedicillatum	.	.	.	.	1	2	.	.	1	1	7	.	.	.	.	5	12	0.8
7	Cassia mimosoides	1	1	.	.	.	.	1	.	.	1	.	1	.	.	.	5	5	0.3
17	Stachytarpheta augustifolia	3	1	.	.	.	.	.	3	.	2	.	.	.	.	.	4	9	0.6
28	Acanthospermum hispidum	4	1	1	.	1	.	.	.	.	.	.	.	.	.	.	4	7	0.5
27	Vernonia perrottetii	.	.	.	.	.	1	.	.	.	.	.	2	1	3	.	4	7	0.5
30	Borreria radiata	.	1	.	.	.	.	.	.	.	.	2	.	1	1	.	4	5	0.3
23	Waltheria indica	.	1	.	.	1	.	.	.	.	.	.	1	.	.	3	4	5	0.3
29	Euphorbia hirta	1	1	.	.	.	.	1	.	.	1	.	.	.	.	.	4	4	0.3
31	Indigofera nummulariifolia	.	.	1	.	.	.	.	.	.	.	1	1	.	.	1	4	4	0.3
22	Sphaeranthus senegalensis	1	.	1	.	.	.	.	.	.	2	.	.	.	.	.	3	4	0.3
40	Crotalaria confusa	.	.	.	.	.	.	1	.	.	.	.	1	1	.	.	3	3	0.2
39	Oldenlandia herbacea	.	.	.	.	.	.	.	.	.	1	.	1	.	.	2	3	4	0.3
21	Nelsonia canescens	1	.	.	.	.	.	.	1	.	.	.	.	.	.	2	3	4	0.3
37	Sida linifolia	2	.	.	.	.	.	.	.	.	.	.	.	.	1	2	3	5	0.3
36	Tephrosia linearis	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	2	2	0.1
49	Vernonia ambigua	.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	2	3	0.2
50	Eragrostis ciliaris	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	2	2	0.1
51	Leucas martinicensis	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	2	2	0.1
52	Chrozophora senegalensis	.	.	.	.	.	.	.	2	.	.	1	.	.	.	.	2	3	0.2
32	Ipomoea aquatica	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	2	2	0.1
48	Cassia tora	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	2	2	0.1
35	Ethulia conyzoides	.	.	.	.	.	.	1	.	.	.	.	.	.	.	2	2	3	0.2
38	Sida rhombifolia	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	2	2	0.1
53	Ageratum conyzoides	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	3	0.2

DOMAIN: UPLAND (KAKO VILLAGE) TO GALMA 'FADAMA' FACTOR 1 FLORISTIC CLUSTER DETERMINANTS

IV.1. **Floristic Community Table 13**

Digitaria ciliaris - Imperata cylindrica - Paspalum orbiculare Community

of weeds in 'upland' arable crops (Sorghum, Pennesetum and Arachis) and post-harvest farmlands on level to nearly level middle slope edges of the fadama (Figs. 17 and 18). Soil erosion nil; soil colour yellow; drainage perfect; shallow to deep; slightly acidic to neutral; loamy sand in texture; organic carbon content very low; stoneless to very slightly stony, ridges and furrows distinct or prominent (terraced). Upland farmlands around Kako agricultural Village.

CODE	SPECIES	DOMIN SCORES								EVALUATION		
		16	17	18	19	20	23	22	21	I	II	III
1	Paspalum orbiculare	3	3	9	9	9	9	7	8	8	57	7.1
8	Centella asiatica	7	2	8	8	4	3	6	3	8	41	5.1
9	Eragrostis atrovirens	2	1	3	4	4	3	5	3	8	23	2.9
3	Borreria verticillata	6	4	7	6	6	6	9	.	7	44	5.5
25	Vetiveria nigritana	.	.	.	.	7	1	3	8	4	19	2.4
26	Mimosa pigra	.	.	.	.	2	2	2	5	4	11	1.4
7	Cassia mimosoides	.	.	.	.	1	3	2	4	4	10	1.3
46	Hyparrhenia rufa	8	9	.	.	.	.	.	.	2	17	2.1
41	Hyparrhenia cyanescens	.	.	.	.	.	.	3	7	2	10	1.3
42	Oryza sativa	.	.	.	3	4	.	.	.	2	7	0.9
43	Oryza longistaminata	4	.	3	.	.	.	.	.	2	7	0.9
21	Nelsonia canescens	3	.	2	.	.	.	.	.	2	5	0.6
22	Sphaeranthus senegalensis	1	.	3	.	.	.	.	.	2	4	0.5
33	Scoparia dulcis	2	.	2	.	.	.	.	.	2	4	0.5
45	Cyperus amabilis	.	.	.	2	.	.	2	.	2	4	0.5
44	Sesbania sesban	.	.	.	.	2	.	.	3	2	5	0.6
14	Heliotropium strigosum	.	.	2	.	.	2	.	.	2	4	0.5
34	Indigofera pulchra	.	.	.	1	.	3	.	.	2	4	0.5
32	Ipomoea aquatica	.	.	1	.	.	1	.	.	2	2	0.3
15	Brachiaria stigmatisata	3	.	.	.	.	4	.	.	2	7	0.9

Incidental species having ACV of one are: (38) Sida rhombifolia, (23) Waltheria indica, (18) Thelepogon elegans, (6) Imperata cylindrica, (69) Hyptis specigera, (70) Jussiaea suffruticosa, (71) Tephrosia pedicellata, and (11) Indigofera arrecta.

DOMAIN: UPLAND (KAKO VILLAGE) TO GALMA 'FADAMA' FACTOR 2 FLORISTIC CLUSTER DETERMINANTS.

IV.2. Floristic Community Table 14

Paspalum orbiculare - Borreria verticillata - Centella asiatic Community

of weeds in Oryza sativa arable crop on the stoneless, level 'fadama' soils near Kako agricultural village. Soil colour yellowish or brown; drainage perfect or imperfect at depths. Silty clay in texture; organic carbon content varying from light to moderate. Ridged or terraced. Vegetation vary from herbaceous grassland to dwarf thickets of Mimosa pigra regrowths depending, apparently, on the length of inundation as well as on how recently and frequently the sites had been cleared before the survey. Quadrats with Mimosa pigra are more liable to longer periods of inundation for microtopographical reasons, hence the relative visible two sub-segments in the community.

CODE	SPECIES	DOMIN SCORES													EVALUATION		
		42	44	48	45	46	53	49	50	43	51	47	52	54	I	II	III
10	Terminalia avicennioides	4	3	5	5	5	4	2	3	.	2	4	7	3	12	47	3.6
16	Cochlospermum tinctorium	3	3	2	4	3	1	2	3	3	.	4	2	4	12	34	2.6
28	Loudetia simplex	5	4	6	4	8	6	7	4	4	4	3	4	.	12	59	4.5
31	Stylosanthes mucronata	2	3	3	3	1	2	2	3	1	3	.	.	1	11	24	1.8
32	Elionurus pobequinii	3	4	4	4	2	4	2	8	2	3	2	.	.	11	38	2.9
1	Pennisetum pedicellatum	2	1	1	3	1	2	.	2	2	2	.	.	1	10	16	1.2
2	Piliostigma thonningii	1	2	3	1	1	2	1	2	.	.	1	3	.	10	17	1.3
45	Andropogon ascinodis	.	1	2	3	3	2	2	3	.	.	3	2	4	10	25	1.9
3	Indigotera pulchra	2	2	.	2	2	1	2	.	.	.	5	4	2	9	22	1.7
24	Ctenium newtonii	.	.	.	.	6	3	7	2	3	2	3	3	5	9	34	2.6
26	Butyrospermum paradoxum	1	.	.	.	2	3	1	2	1	2	3	2	.	9	16	1.2
50	Dyschoriste perrottetii	4	5	7	.	2	3	.	4	3	6	.	.	.	8	34	2.6
11	Annona senegalensis	.	.	.	.	1	2	1	1	2	.	7	4	3	8	21	1.6
59	Lannea schimperi	.	1	.	1	1	.	1	1	2	.	3	.	1	8	11	0.8
43	Aspilia africana	.	.	2	2	.	.	.	1	1	.	6	2	3	7	17	1.3
15	Guiera senegalensis	1	1	1	3	.	.	2	4	.	2	.	.	.	7	14	1.1
49	Combretum ghasalense	.	1	.	3	2	.	2	.	.	1	1	.	1	7	11	0.8
77	Schizachyrium sanguineum	.	.	1	2	.	.	2	2	.	.	2	.	3	6	12	0.9
22	Anogeissus leiocarpus	.	.	1	.	1	1	.	3	.	3	1	.	.	6	10	0.8
33	Bridelia ferruginea	1	.	1	.	1	.	.	.	1	.	2	1	.	6	7	0.5
20	Andropogon gayanus	2	2	2	.	.	.	.	2	.	.	2	.	.	5	10	0.8
21	Englerastrum gracillium	.	1	1	.	.	.	.	2	1	3	.	.	.	5	8	0.6
29	Pandiaka heudelotii	2	2	.	1	.	.	.	.	1	1	.	.	.	5	7	0.5
55	Monocymbium ceresiiformis	.	.	.	.	2	3	.	.	1	.	7	.	2	5	15	1.2
53	Tamarindus indica	.	.	2	3	.	1	.	.	.	5	.	.	.	4	11	0.8
63	Lepidagathis collina	.	1	.	.	1	.	3	.	2	.	.	.	.	4	7	0.5
65	Schizachyrium exile	.	1	.	1	.	.	2	.	.	.	.	.	2	4	6	0.5
82	Urelytrum muricatum	.	.	.	.	.	1	2	.	.	.	1	.	2	4	6	0.5
118	Isoberlinia doka	2	3	.	.	.	.	3	.	5	.	.	.	.	4	13	1.0
48	Vitex doniana	1	.	.	.	.	.	.	.	1	.	1	1	.	3	4	0.3
27	Hyparrhenia rufa	.	.	.	.	.	.	.	.	2	8	.	.	9	3	19	1.5
14	Vernonia ambigua	1	.	.	.	.	.	.	1	.	1	.	.	.	3	3	0.2
60	Cassia singueana	1	.	.	.	.	.	.	2	1	.	.	.	.	3	4	0.3
70	Parkia clappertoniana	1	.	.	.	.	.	.	.	1	.	1	.	.	3	3	0.2
71	Entada africana	.	.	.	1	2	.	.	3	.	.	.	.	.	3	6	0.5
87	Ximenia americana	.	1	1	.	.	.	.	.	1	.	.	.	.	3	3	0.2
95	Stereospermum kunthianum	.	.	.	.	.	1	.	.	.	1	.	.	1	3	3	0.2
106	Strychnos innocua	2	.	1	.	.	.	.	.	.	1	.	.	.	3	4	0.3
119	Parinari curatellifolia	.	1	.	.	.	.	1	.	.	.	1	.	.	3	3	0.2
8	Borreria radiata	.	.	2	.	.	.	.	.	.	1	.	.	.	2	3	0.2
44	Crotalaria lachnosema	.	.	.	.	.	.	.	.	.	.	3	2	.	2	5	0.4
56	Diospyros mespiliformis	1	.	.	.	.	1	.	.	.	.	.	.	.	2	2	0.2
62	Sida ovata	.	.	.	.	1	.	.	1	.	.	.	.	.	2	2	0.2
81	Dichrostachys glumerata	.	.	.	.	.	.	.	3	.	1	.	.	.	2	4	0.3
86	Combretum molle	.	.	.	2	2	.	.	.	.	.	.	.	.	2	4	0.3
141	Adina microcephala	2	.	.	.	.	.	.	.	.	.	.	1	.	2	3	0.2
142	Desmodium barbatum	.	5	.	.	.	.	.	.	4	.	.	.	.	2	9	0.7

DOMAIN: SELECTED 'UPLAND' SITES - FACTOR 1 FLORISTIC CLUSTER DETERMINANTS

V.1. Floristic Community Table 15

Loudetia simplex - Terminalia avicennioides - Elionurus pobequinii - Cochlospermum tinctorium - Ctenium newtonii - Dyschoriste perrottetii Community

on uncultivated gullied upland sites on the Dumbi uplands over soils broadly described as "Ferruginous Tropical Soils on crystalline acid rocks and lithosols" (Klinkenberg and Higgins, 1970). This community is sited on middle slopes and on the valley sides of the Kororobi and Kotunbei Streams near Zangon Aya (Fig. 17). The quadrats were distributed on the gully banks, and the gully beds, from the headscarps to their junctions with the streams. Hence some of the species are strictly riverine (see Plates 74 and 77 for examples of such geomorphological-hydrological-floristic complexities). The conspicuous features are: soil colour is red, drainage is variable, with dry banks and fresh or damp beds; depth varies from very shallow to moderately deep; texture silty-sandy, often with moderate clay content; exposed ironstone pavements; low pH, variable organic carbon, high K*. The consistently frequent termitaria is above average within the shrubland community (see also Plates 29, 51 and 70).

CODE	SPECIES	DOMIN SCORES								EVALUATION		
		1	2	6	3	4	5	7	8	I	II	III
1	Pennisetum pedicellatum	3	4	1	7	4	3	9	7	8	38	4.8
3	Indigofera pulchra	1	2	8	2	2	2	3	1	8	21	2.6
7	Vernonia perrottetii	2	2	3	4	7	8	3	7	8	36	4.5
8	Borreria radiata	2	4	2	3	.	3	2	2	7	18	2.3
18	Eragrostis tremula	2	2	1	4	.	2	6	8	7	25	3.1
11	Leucas martinicensis	2	.	.	5	5	5	4	4	6	25	3.1
15	Guiera senegalensis	1	1	3	1	2	1	.	.	6	9	1.1
2	Piliostigma thonningii	1	1	2	1	.	1	.	.	5	6	0.8
6	Paspalum orbiculare	.	3	.	3	3	3	.	4	5	16	2.0
25	Vernonia pauciflora	.	.	.	1	2	2	5	4	5	14	1.8
34	Waltheria indica	2	.	1	.	1	3	2	.	5	9	1.1
35	Digitaria ciliaris	.	.	.	5	3	4	7	3	5	22	2.8
36	Ipomoea eriocarpa	.	.	.	1	3	4	1	1	5	10	1.3
37	Borreria verticillata	.	3	8	5	8	.	.	1	5	25	3.1
61	Brachiaria stigmatisata	6	3	2	.	5	6	.	.	5	22	2.8
78	Combretum sericeum	1	1	.	1	1	1	.	.	5	5	0.6
4	Ageratum conyzoides	2	.	.	4	3	3	.	.	4	12	1.5
5	Andropogon pseudapricus	3	.	2	.	2	1	.	.	4	8	1.0
9	Oldenlandia herbacea	.	.	.	4	4	5	2	.	4	15	1.9
17	Hyptis spicigera	2	.	.	4	.	2	6	8	4	22	2.8
38	Mitracarpus scaber	.	2	.	3	4	3	.	.	4	12	1.5
47	Eleusine indica	.	.	.	3	1	3	4	.	4	11	1.4
12	Nelsonia canescens	2	.	.	2	2	.	.	.	3	6	0.8
13	Annonia senegalensis	1	1	.	1	.	.	.	.	3	3	0.4
20	Andropogon gayanus	.	1	1	.	1	.	.	.	3	3	0.4
23	Setaria pallide-fusca	.	.	.	1	.	1	.	2	3	4	0.5
39	Sphaeranthus senegalensis	.	.	1	2	.	3	.	.	3	6	0.8
46	Alysicarpus glumaceus	.	1	.	.	.	2	.	2	3	5	0.6
52	Biophytum petersianum	.	1	.	1	.	.	1	.	3	3	0.4
62	Sida ovata	.	1	.	.	.	1	2	.	3	4	0.5
100	Indigofera capitata	.	1	1	1	.	.	.	.	3	3	0.4
101	Indigofera macrocalyx	.	.	1	1	.	1	.	.	3	3	0.4
102	Schwenckia americana	.	.	1	3	2	.	.	.	3	6	0.8
10	Terminalia avicennoides	1	.	.	.	.	1	.	.	2	2	0.3
14	Vernonia ambigua	.	.	1	.	.	1	.	.	2	2	0.3
16	Cochlospermum tinctorium	1	1	.	.	.	.	.	.	2	2	0.3
21	Englerastrum gracillimum	1	1	.	.	.	.	.	.	2	2	0.3
41	Stachytarpheta angustifolia	.	.	.	.	3	2	.	.	2	5	0.6
54	Fimbrystylis hispidula	.	.	1	1	.	.	.	.	2	2	0.3
57	Gardenia erubescens	1	.	1	.	.	.	.	.	2	2	0.3
60	Cassia singueana	1	.	.	.	.	1	.	.	2	2	0.3
70	Parkia clappertoniana	5	.	.	.	1	.	.	.	2	6	0.8
84	Hyptis suaveolens	.	.	2	.	.	8	.	.	2	10	1.3
97	Carrisa edulis	1	.	.	1	.	.	.	.	2	2	0.3
98	Crotalaria senegalensis	.	.	.	.	.	.	2	2	2	4	0.5
104	Dactyloctenium aegyptium	.	.	.	2	2	.	.	.	2	4	0.5
151	Vernonia oocephala	.	.	3	.	3	.	.	.	2	6	0.8

Incidental species having an absolute constancy value (ACV) of one are: (19) Sporobolus pyramidalis, (33) Bridelia ferruginea, (40) Ethulia conyzoides, (42) Cassia mimosoides, (43) Aspilia africana, (48) Vitex doniana, (71) Entada africana, (72) Tridax procumbens, (73) Monechma ciliatum, (79) Euphorbia hirta, (80) Acanthospermum hispidum, (81) Dichrostachys glomerata, (82) Urelytrum muricatum, (83) Cassia rotundifolia, (96) Adenodelichos paniculatus, (99) Pseudocedrela kotschyi, (103) Cissampelos mucronata, (120) Eriosema griseum, (121) Tephrosia linearis, (144) Eragrostis turgida, (145) Microchloa indica, (146) Thelepogon elegans, (147) Securida longipedunculata, (148) Polygala petitiana, (149) Corchorus tridens, and (150) Cassia tora.

DOMAIN: SELECTED 'UPLAND' SITES - FACTORS 2/3 FLORISTIC CLUSTER DETERMINANTS.

V.2. Floristic Community Table 16

Pennisetum pedicellatum - *Vernonia perrottetii* - *Eragrostis tremula* - *Leucas martinicensis* - *Borreria verticillata* - *Digitaria ciliaris* - *Brachiaria stigmatisata* - *Oldenlandia herbacea* Community

of weeds in current croplands and post-harvest farmlands associated with *Sorghum*, *Discorea*, *Zea* and *Arachis*. These occur on nearly flat to gentle middle slopes. Erosion absent; soil colour yellow; drainage imperfect (damp) on average; texture loamy-sand; stoneless,

CODE	SPECIES	DOMIN SCORES																						EVALUATION		
		13	14	16	15	17	18	34	35	36	37	40	39	32	33	38	25	26	30	31	27-28	29		I	II	III
4	Ageratum conyzoides	9	3	5	2	3	3	3	1	1	.	2	1	7	7	3	3	2	6	9	8	7	7	21	91	4.1
1	Pennisetum pedicellatum	4	3	4	2	.	.	2	2	2	2	7	3	2	2	2	2	2	.	6	.	1	3	9	18	58	2.6
9	Oldenlandia herbacea	.	2	1	1	1	1	3	2	1	1	.	.	.	2	2	.	.	3	3	3	3	.		15	29	1.3
6	Paspalum orbiculare	3	3	.	4	2	4	.	.	.	.	.	2	.	.	5	3	2	2	2	3	2	.		13	37	1.7
7	Vernonia perrottetii	1	2	2	3	4	2	5	4	.	2	.	.	.	3	.	.	.	1	.	.	.	.		11	29	1.3
11	Leucas martinicensis	5	.	2	3	1	2	.	2	3	2	2	.	.	2	.	.	.	.	.	.	1	.		11	25	1.1
12	Nelsonia canescens	4	3	3	5	3	5	.	.	.	.	.	.	2	.	3	.	2	3	.	2	.	.		11	35	1.6
30	Jussiaea suffruticosa	.	.	.	1	1	2	.	.	.	.	.	.	.	7	.	7	3	3	3	9	8	2		11	46	2.1
17	Hyptis spicigera	.	1	.	3	.	2	.	.	1	.	.	.	4	.	.	3	2	2	.	.	3	5		10	26	1.2
40	Ethulia conyzoides	8	4	2	3	1	1	.	2	1	.	.	.	.	.	1	.	.	.	.	.	.	.		9	23	1.0
50	Cynodon dactylon	7	.	.	.	.	.	9	8	9	3	.	2	3	4	2	.	.	.	.	.	.	.		9	47	2.1
5	Andropogon pseudapricus	.	.	.	1	.	.	1	1	.	1	2	2	.	1	1	.	.	.	.	.	.	.		8	10	0.5
14	Vernonia ambigua	.	1	3	1	3	3	2	.	1	.	.	.	.	3	.	.	.	.	.	.	.	.		8	17	0.8
18	Eragrostis tremula	.	2	.	7	4	.	3	2	.	.	.	2	.	3	.	1	.	.	.	.	.	.		8	24	1.1
27	Hyparrhenia rufa	.	.	.	.	.	.	.	.	.	.	.	2	1	.	4	1	2	1	.	1	2	.		8	14	0.6
41	Stachytarpheta angustifolia	1	2	2	1	1	1	2	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.		8	14	0.6
51	Centella asiatica	.	.	.	.	.	.	.	.	.	7	3	.	.	.	3	5	6	7	4	.	.	2		8	37	1.7
8	Borreria radiata	1	.	1	1	.	.	1	1	.	.	.	2	.	.	.	.	.	.	.	.	.	2		7	9	0.4
25	Vernonia pauciflora	3	.	2	2	1	1	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.		7	11	0.5
39	Sphaeranthus senegalensis	2	.	.	.	.	5	1	1	2	1	.	.	.	3	.	.	.	.	.	.	.	.		7	14	0.6
42	Cassia mimosoides	.	1	.	1	1	.	.	.	.	.	.	1	.	.	1	2	.	1	.	.	.	.		7	8	0.4
44	Crotalaria lachnosema	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	4	1	1	.	2	2	2		7	13	0.6
66	Blumea aurita	2	2	2	1	2	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1		7	11	0.5
67	Eragrostis pilosa	.	.	.	9	9	8	.	.	.	.	.	2	.	.	.	2	.	.	4	3	.			7	37	1.7
68	Sacciolepis africana	.	.	.	.	.	.	.	.	.	.	.	5	.	.	9	6	4	4	6	4	.			7	38	1.7
38	Mitracarpus scaber	.	1	1	1	1	.	6	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.		6	11	0.5
52	Biophytum petersianum	.	2	1	1	2	1	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.		6	10	0.5
69	Urena lobata	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	4	.	1	.	2	.	1		6	12	0.5
35	Digitaria ciliaris	1	2	.	.	.	.	.	2	2	.	1	.	.	.	.	.	.	.	.	.	.	.		5	8	0.4
36	Ipomoea eriocarpa	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	3		5	8	0.4
47	Eleusine indica	.	1	.	.	1	.	1	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.		5	7	0.3
54	Fimbristylis hispidula	.	.	.	2	2	.	1	.	.	.	.	.	5	4	.	.	.	.	.	.	.	.		5	14	0.6
75	Melocnia corchorifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	1	.	2	2		5	9	0.4
74	Hygrophila auriculata	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	2	3	2	.	.	.		5	10	0.5
92	Vicoa leptoclada	.	.	.	.	.	.	1	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.		5	5	0.2
94	Sesbania sesban	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	2	.	.	.	2	1			5	7	0.3
19	Sporobolus pyramidalis	.	1	1	.	.	.	.	.	.	.	.	3	.	.	1	.	.	.	.	.	.	.		4	6	0.3
23	Setaria pallide-fusca	2	.	.	.	.	.	.	.	.	1	1	.	.	1	.	.	.	.	.	.	.	.		4	5	0.2
37	Borreria verticillata	.	.	.	.	.	.	.	.	.	.	.	1	.	.	6	1	.	.	2	.	.	.		4	10	0.5
72	Tridax procumbens	2	.	.	.	.	.	.	2	.	.	.	4	.	.	2	.	.	.	.	.	.	.		4	10	0.5
79	Euphorbia hirta	.	.	.	.	.	.	.	.	.	.	2	3	.	.	.	2	.	2	.	.	.	.		4	9	0.4
80	Acanthospermum hispidum	.	.	.	.	.	.	2	1	.	.	1	.	.	.	1	.	.	.	.	.	.	.		4	5	0.2
93	Indigofera hirsuta	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	1	.	1		4	4	0.2
108	Eragrostis ciliaris	1	.	.	.	.	.	1	.	.	.	.	.	2	.	.	.	.	.	.	.	4	.		4	8	0.4
109	Ipomoea aquatica	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	1		4	4	0.2
112	Setaria anceps	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	2	2	.	.	3	.	.		4	8	0.4
113	Sida unifolia	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	2	1	.	.	.	.	.		4	5	0.2
114	Fimbristylis hispidula	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	1	.	.	.	.	3	.		4	6	0.3
115	Scoparia dulcis	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	1	.	.	.		4	4	0.2
116	Buchnera hispida	.	.	.	.	.	.	.	.	.	1	2	1	1	.	.	.	.	.	.	.	.	.		4	5	0.2
117	Imperata cylindrica	.	.	.	.	.	.	.	.	9	8	6	9	.	.	.	.	.	.	.	.	.	.		4	32	1.5
20	Andropogon gayanus	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.		3	3	0.1
46	Alysicarpus glumaceus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	2	.	.	.		3	5	0.2
58	Dyschoriste perrottetii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	3	.	3	.	.		3	8	0.4
84	Hyptis suaveolens	.	.	8	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.		3	11	0.5
64	Indigofera secundiflora	.	.	.	.	.	.	.	.	.	.	2	.	.	.	1	2	.	.	.	.	.	.		3	5	0.2
83	Crotalaria confusa	.	.	.	.	.	.	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.		3	3	0.1
103	Cissampelos mucronata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	2	3	.	.		3	7	0.3
110	Scleria foliosa	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	3	2	.	.	.	.	.		3	7	0.3
127	Desmodium hirtum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	4	3	.	.	.	.	.		3	9	0.4
128	Oryza sativa	.	.	.	.	.	.	.	.	.	.	.	.	8	.	.	.	7	.	2	.	.	.		3	17	0.8
129	Eragrostis atrovirens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	3	.	2	.		3	7	0.3
130	Phragmites communis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	1	2		3	6	0.3
21	Englerastrum gracillimum	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.		2	2	0.1
62	Sida ovata	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	2	.	.	.	.	.	.		2	4	0.2
73	Nonechma ciliatum	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.		2	2	0.1
74	Nauclea latifolia	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.		2	2	0.1
104	Dactyloctenium aegyptium	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.		2	2	0.1
107	Schizachyrium brevifolium	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.		2	2	0.1
121	Tephrosia linearis	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.		2	2	0.1
132	Heliotropium indicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	6		2	9	0.4
133	Cyperus pustulatus	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	2		2	4	0.2
134	Helichrysum odoratissimum	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	5	.	.	.		2	7	0.3
135	Cynura miniata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	2		2	3	0.1
136	Cyperus amabilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.		2	2	0.1
138	Leersia hexandra	.	.	.	.	.	.	.	.	.	4	2	.	.	.	.	.	.	.	.	.	.	.		2	6	0.3
152	Striga senegalensis	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		2	3	0.1
153	Rottboella exaltata	.	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		2	6	0.3
159	Oryza longistaminata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	2	.	.		2	4	0.2
160	Fuirena umbellata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.		2	4	0.2

DOMAIN: SELECTED 'UPLAND' SITES - MULTIFACTORIAL COMPLEX, AMORPHOUS FLORISTIC CLUSTER: SEE 31, 311 and 3111 FOR FINER ANALYSES

V.3. Floristic Community Table 17

Ageratum conyzoides - Pennisetum pedicellatum - Jussiaea suffruticosa - Cynodon dactylon (Super-) Community

combining weeds of arable crops under different crops in various hydrological states. This is an amorphous floristic cluster as the floristic table suggests. An 'ordination within ordination' was performed. Three more specific segments were indicated. The segments are probably relatively distinct communities within a continuum gradation of flora and environment. See V.3i., ii, iii.

CODE	SPECIES	DOMIN SCORES						EVALUATION		
		13	14	16	15	17	18	I	II	III
4	Ageratum conyzoides	9	3	5	2	3	3	6	25	4.2
7	Vernonia perrottetii	1	2	2	3	4	2	6	14	2.3
12	Nelsonia canescensis	4	3	3	5	3	5	6	23	3.8
40	Ethulia conyzoides	8	4	2	3	1	1	6	19	3.2
41	Stachytarpheta angustifolia	1	2	2	1	1	1	6	8	1.3
6	Paspalum orbiculare	3	3	.	4	2	4	5	16	2.7
9	Oldenlandia herbacea	.	2	1	1	1	1	5	6	1.0
11	*Leucas martinicensis*	5	.	2	3	1	2	5	13	2.2
14	Vernonia ambigua	.	1	3	1	3	3	5	11	1.8
25	Vernonia pauciflora	3	.	2	2	1	1	5	9	1.5
52	Biophytum petersianum	.	2	1	1	2	1	5	7	1.2
66	Blumea aurita	2	2	2	1	2	.	5	9	1.5
1	Pennisetum pedicellatum	4	3	4	2	.	.	4	13	2.2
38	Mitracarpus scaber	.	1	1	1	1	.	4	4	0.7
67	Eragrostis pilosa	.	.	.	9	9	8	3	26	4.3
18	Eragrostis tremula	.	2	.	7	4	.	3	13	2.2
17	Hyptis spicigera	.	1	.	3	.	2	3	6	1.0
30	Jussiaea suffruticosa	.	.	.	1	1	2	3	4	0.7
8	Borreria radiata	1	.	1	1	.	.	3	3	0.5
36	Ipomoea eriocarpa	.	.	1	1	1	.	3	3	0.5
39	Sphaeranthus senegalensis	2	.	.	.	.	5	2	7	1.2
35	*Digitaria ciliaris*	1	2	.	.	.	.	2	3	0.5
47	Eleusine indica	.	1	.	.	1	.	2	2	0.3
54	Fimbristylis hispidula	.	.	.	2	2	.	2	4	0.7
19	Sporobolus pyramidalis	.	1	1	.	.	.	2	2	0.3
152	Striga senegalensis	1	2	.	.	.	.	2	3	0.5
153	Rottboella exaltata	.	4	2	.	.	.	2	6	1.0

Incidental species having ACV equal to unity are: (50) Cynodon dactylon, (58) Dyschoriste perrottetii, (23) Setaria pallide-fusca, (72) Tridax procumbens. (108) *Eragrostis ciliaris*, (84) *Hyptis suaveolens*, (21) *Englerastrum gracillimum*, (104) Dactyloctenium aegyptium, and (121) Tephrosia linearis.

Evaluation Key: I = Absolute Constancy Value (AVC)
II = Total Domin Cover-Abundance Value
III = Mean Domin Cover-Abundance Value

DOMAIN: SELECTED 'UPLAND' SITES - BREAKDOWN OF FACTORIAL COMPLEXITY FACTOR 3ii FLORISTIC CLUSTER DETERMINANTS.

V.3.ii. Floristic Community Table 17, Segment 2.
Ageratum conyzoides - Nelsonia canescensis - Ethulia conyzoides - Paspalum orbiculare - Eragrostis pilosa (Sub-) Community

of weeds on current farmlands associated with monocultures of Sorghum vulgare on flat or nearly flat damp uplands. Soils are largely yellow,occasionally brownish; shallow sandy loam, occasionally underlain by granitic rocks or superficially stoneless. K^+ content moderate or high; organic carbon low, worm casts and termitaria absent. (Plate 20 illustrates this community).

CODE	SPECIES	DOMIN SCORES									EVALUATION		
		34	35	36	37	40	39	32	33	38	I	II	III
1	Pennisetum pedicellatum	2	2	2	2	7	3	2	2	2	9	24	2.7
50	Cynodon dactylon	9	8	9	3	.	2	3	4	2	8	40	4.4
4	Ageratum conyzoides	3	1	1	.	1	1	7	7	3	8	24	2.7
5	*Andropogon pseudapricus*	1	1	.	1	2	2	.	1	1	7	9	1.1
9	Oldenlandia herbacea	3	2	1	1	.	.	.	2	2	6	11	1.2
92	Vicoa leptoclada	1	1	1	1	1	.	.	.	.	5	5	0.6
39	Sphaeranthus senegalensis	1	1	2	1	.	.	.	3	.	5	8	0.9
11	Leucas martinicensis	.	2	3	2	2	.	.	2	.	5	11	1.2
117	Imperata cylindrica	.	.	9	8	6	9	.	.	.	4	32	3.6
116	Buchnera hispida	.	.	.	1	2	1	1	.	.	4	5	0.6
80	Acanthospermum hispidum	2	1	.	.	1	.	.	.	1	4	5	0.6
18	Eragrostis tremula	3	2	.	.	.	2	.	3	.	4	10	1.1
7	Vernonia perrottetii	5	4	.	2	.	.	.	3	.	4	14	1.6
83	Crotalaria confusa	.	1	1	.	1	.	.	.	.	3	3	0.3
20	Andropogon gayanus	1	1	.	1	.	.	.	.	.	3	3	0.3
115	Scoparia dulcis	.	.	.	.	.	1	1	1	.	3	3	0.3
72	Tridax procumbens	.	2	.	.	.	4	.	.	2	3	8	0.9
23	Setaria pallide-fusca	.	.	.	1	1	.	.	1	.	3	3	0.3
54	Fimbristylis hispidula	1	.	.	.	.	.	5	4	.	3	10	1.1
47	Eleusine indica	1	.	.	.	.	.	2	2	.	3	5	0.6
35	Digitaria ciliaris	.	2	2	.	1	.	.	.	.	3	5	0.6
8	Borreria radiata	1	1	.	.	.	2	.	.	.	3	4	0.4
27	Hyperrhenia rufa	.	.	.	.	.	2	1	.	4	3	7	0.8
14	Vernonia ambigua	2	.	1	.	.	.	.	3	.	3	6	0.7
40	Ethulia conyzoides	.	2	1	.	.	.	.	.	1	3	4	0.4
138	Leersia hexandra	.	.	.	4	2	.	.	.	.	2	6	0.7
107	*Schizachyrum brevifolium*	.	1	.	.	.	.	1	.	.	2	2	0.2
74	Nauclea latifolia	1	1	.	.	.	.	.	.	.	2	2	0.2
73	Monechma cilialum	.	.	.	.	.	1	.	.	1	2	2	0.2
108	Eragrestis ciliaris	1	.	.	.	.	.	2	.	.	2	3	0.3
114	Fimbristylis hispidula	1	.	.	.	.	.	.	.	1	2	2	0.2
113	Sida unifolia	.	.	.	.	1	1	.	.	.	2	2	0.2
79	Euphorbia hirta	.	.	.	.	2	3	.	.	.	2	5	0.6
37	Borreria verticillata	.	.	.	.	.	1	.	.	6	2	7	0.8
19	Sporobolus pyramidalis	.	.	.	.	.	3	.	.	1	2	4	0.4
94	Sesbania sesban	.	.	1	.	.	1	.	.	.	2	2	0.2
76	Hygrophilia auriculata	.	.	.	.	.	.	2	1	.	2	3	0.3
69	*Urena lobata*	.	.	.	2	2	.	.	.	.	2	4	0.4
38	Mitracarpus scaber	6	.	.	1	.	.	.	.	.	2	7	0.8
42	Cassia mimosoides	.	.	.	.	.	1	.	.	1	2	2	0.2
25	Vernonia pauciflora	.	2	1	.	.	.	.	.	.	2	3	0.3
51	Centella asiatica	.	.	.	7	3	.	.	.	.	2	10	1.1
41	Stachytarpheta angustifolia	2	.	.	.	.	.	.	4	.	2	6	0.7

DOMAIN: SELECTED 'UPLAND' SITES - BREAKDOWN OF FACTORIAL COMPLEXITY FACTOR 3111 FLORISTIC CLUSTER DETERMINANTS.

V.3.iii

Floristic Community Table 17, Segment 3
Cynodon dactylon - Imperata cylindrica - Pennisetum pedicellatum - Ageratum conyzoides (Sub-) Community

of weeds in current farmlands associated with mainly mixed crops (Discorea, Oryza, Sorghum, Ipomea, Capsicum) as illustrated on Plates 13 and 14. The sites are on flat or nearly flat middle slopes and valleys. Erosion absent. Ridges are very prominent and high or distinct to prominent for non-tuberous crops. Soil colour brown or yellow. Drainage perfect to poor. Mainly very slightly stony with occasional granite or few ironstone. The granitic stones are possibly fragments of impermeable subterranean massive rocks which appear to hold water close to the plant roots. Plate 20 illustrates a similar site during December.

CODE	SPECIES	DOMIN SCORES													EVALUATION		
		9	10	11	12	19	21	24	20	22	23	41	56	55	I	II	III
2	Piliostigma thonningii	4	3	2	2	2	2	1	3	1	.	.	.	1	10	20	1.5
19	Sporobolus pyramidalis	2	.	.	3	3	4	4	3	5	9	.	.	2	9	35	2.7
22	Anogeissus leiocarpus	2	.	1	4	7	5	7	4	3	.	.	.	.	8	33	2.5
3	*Indigofera pulchra*	2	2	4	3	.	.	.	2	2	.	.	.	1	7	16	1.2
23	Setaria pallide-fusca	1	.	.	2	.	3	2	.	3	2	.	.	.	6	13	1.0
29	Pandiaka heudelotii	1	1	.	.	1	1	.	1	1	.	.	.	.	6	6	0.5
57	*Gardenia erubescens*	3	4	1	1	1	.	.	1	.	.	.	.	.	6	11	0.8
21	Englerastrum gracillimum	2	2	.	2	.	.	.	1	2	.	.	.	.	5	9	0.7
34	Waltheria indica	.	.	.	2	.	1	.	2	2	1	.	.	.	5	8	0.6
56	Diospyros mespiliformis	.	.	.	.	.	1	1	1	2	.	.	.	1	5	6	0.5
89	Byroscarpus coccineus	.	.	.	.	1	1	1	1	1	.	.	.	.	5	5	0.4
5	Andropogon pseudapricus	4	4	4	.	.	2	.	.	.	.	.	.	.	4	14	1.1
8	Borreria radiata	4	3	2	2	.	.	.	.	.	.	.	.	.	4	11	0.8
10	*Terminalia avicennioides*	2	2	4	2	.	.	.	.	.	.	.	.	.	4	10	0.8
13	Annona senegalensis	.	3	2	2	.	1	.	.	.	.	.	.	.	4	8	0.6
20	Andropogon gayanus	.	1	.	2	2	.	.	2	.	.	.	.	.	4	7	0.5
24	Ctenium newtonii	3	4	3	3	.	.	.	.	.	.	.	.	.	4	13	1.0
48	Vitex doniana	.	.	.	.	.	1	.	.	.	.	2	2	3	4	8	0.6
64	Indigofera secundiflora	.	.	1	2	.	.	.	.	2	1	.	.	.	4	6	0.5
74	Nauclea latifolia	.	2	1	.	.	.	.	.	.	.	.	1	1	4	5	0.4
90	*Sida urens*	.	.	.	.	2	2	3	1	.	.	.	.	.	4	8	0.6
91	Khaya senegalensis	.	.	.	.	.	.	1	.	1	.	.	2	2	4	6	0.5
111	Paulinia pinnata	.	.	.	.	.	.	1	.	.	.	1	1	1	4	4	0.3
1	Pennisetum pedicellatum	.	2	.	.	4	3	.	.	.	.	.	.	.	3	9	0.7
6	*Paspalum orbiculare*	.	.	.	.	.	.	.	.	.	2	4	.	1	3	7	0.5
12	Nelsonia canescens	.	.	.	.	.	.	.	.	3	.	.	4	2	3	9	0.7
14	Vernonia ambigua	1	.	.	1	.	1	.	.	.	.	.	.	.	3	3	0.2
26	Butyrospermum paradoxum	1	.	2	1	.	.	.	.	.	.	.	.	.	3	4	0.3
33	Bridelia ferruginea	2	1	3	.	.	.	.	.	.	.	.	.	.	3	6	0.5
46	Alysicarpus glumaceus	.	.	.	.	.	1	2	.	.	.	1	.	.	3	4	0.3
53	Tamarindus indica	.	.	.	.	1	.	.	.	1	.	.	.	1	3	3	0.2
63	*Lepidagathis collina*	.	1	1	1	.	.	.	.	.	.	.	.	.	3	3	0.2
65	Schizachyrium exile	.	.	.	.	.	.	.	3	2	.	1	.	.	3	6	0.5
85	Cassia rotunditolia	.	.	.	.	.	.	3	.	4	2	.	.	.	1	9	0.7
86	Combretum molle	2	1	1	.	.	.	.	.	.	.	.	.	.	3	4	0.3
96	Adenodolichos paniculatus	2	2	3	.	.	.	.	.	.	.	.	.	.	3	7	0.5
99	Pseudocedrela kotschyi	2	2	.	1	.	.	.	.	.	.	.	.	.	3	5	0.4
105	Brachiaria jubata	3	2	1	.	.	.	.	.	.	.	.	.	.	3	6	0.5
122	Beckeropis uniseta	2	1	1	.	.	.	.	.	.	.	.	.	.	3	4	0.3
124	Wissadula amplissima	.	.	.	.	3	.	3	.	1	.	.	.	.	3	7	0.5
125	Holarrhenia floribunda	.	.	.	.	.	2	3	.	3	.	.	.	.	3	8	0.6
131	Syzygium guineense	.	.	.	.	.	.	.	.	.	.	3	4	1	3	8	0.6
15	Guiera senegalensis	.	.	.	3	.	.	.	1	.	.	.	.	.	2	4	0.3
42	Cassia mimosoides	.	1	.	.	.	.	1	.	.	.	.	.	.	2	2	0.2
43	Aspilia africana	1	.	.	1	.	.	.	.	.	.	.	.	.	2	2	0.2
49	Combretum ghasalense	.	.	1	1	.	.	.	.	.	.	.	.	.	2	2	0.2
55	*Monocybium ceresiiforme*	.	3	2	.	.	.	.	.	.	.	.	.	.	2	5	0.4
60	Cassia singueana	.	.	.	.	.	.	.	.	.	3	.	.	1	2	4	0.3
61	Brachiaria stigmatisata	.	.	.	6	.	.	.	4	.	.	.	.	.	2	10	0.8
71	Entada africana	3	.	1	.	.	.	.	.	.	.	.	.	.	2	4	0.3
81	Dichrostachys glumerata	.	.	.	.	.	.	.	2	3	.	.	.	.	2	5	0.4
87	Ximenia americana	.	1	.	.	1	.	.	.	.	.	.	.	.	2	2	0.2
107	Schizachyrium brevifolium	.	.	.	2	.	.	.	.	.	4	.	.	.	2	6	0.5
120	Eriosema griseum	1	1	.	.	.	.	.	.	.	.	.	.	.	2	2	0.2
123	Ziziphus mucronata	.	.	.	1	2	.	.	.	.	.	.	.	.	2	3	0.2
126	Hypoestes verticillaris	.	.	.	.	.	.	.	.	1	1	.	.	.	2	2	0.2
154	Acacia ataxacantha	.	.	.	.	3	.	1	.	.	.	.	.	.	2	4	0.3
155	*Triumfetta pentandra*	.	.	.	.	2	1	.	.	.	.	.	.	.	2	3	0.2
156	Elionurus hirtifolius	.	.	.	.	6	4	.	.	.	.	.	.	.	2	10	0.8
157	Sorghastrum bipennatum	.	.	.	.	.	2	.	2	.	.	.	.	.	2	4	0.3
161	Cissus crotalarioides	.	.	.	.	.	.	.	.	.	.	2	2	.	2	4	0.3
162	Hyparrhenia cyanescens	.	.	.	.	.	.	.	.	.	.	2	2	.	2	4	0.3

DOMAIN: SELECTED 'UPLAND' SITES - FACTOR 4 FLORISTIC CLUSTER DETERMINANTS

V.4. Floristic Community Table 18

Sporobolus pyramidalis - Anogeissus leiocarpus - Piliostigma thonningii Community

of uncultivated 'uplands'. They occur as shrublands, tree/shrublands and woodlands with or without grasses or forbs on middle slopes, and as relics of 'kurmi' woodlands on streamsides (Plate 26). The floristic heterogeneity is the result of several factors: hydrological; tree-felling for domestic and commercial reasons, geological reasons which hinder agricultural use, and promote different floral [illegible] (in Plates 55 and 56). Also the floristic variations could be explained in terms of [illegible] to be described here.

| CODE | SPECIES | DOMIN SCORES | | |

CODE	SPECIES	DOMIN SCORES										EVALUATION		
		2	4	5	9	7	10	11	12	16	17	I	II	III
17	Mitracarpus scaber	5	5	4	5	7	7	6	2	2	4	10	47	4.7
47	Oldenlandia herbecea	2	2	2	1	1	1	2	1	2	4	10	16	1.6
1	Paspalum orbiculare	.	2	5	5	6	6	4	2	2	2	9	34	3.4
13	Pennisetum pedicellatum	9	9	6	4	.	5	8	8	6	2	9	57	5.7
22	Schweinckia americana	2	2	2	2	.	.	1	1	1	2	8	13	1.3
34	Stachytarpheta angustifolia	3	3	4	3	.	2	.	3	7	5	8	30	3.0
9	Borreria verticillata	2	4	.	.	6	4	2	.	4	7	7	29	2.9
14	Sida rhombifolia	.	.	1	.	1	1	1	1	1	1	7	7	0.7
30	Erogrostis tremula	3	2	2	.	.	3	2	.	2	6	7	20	2.0
3	Annona senegalensis	.	1	1	2	1	2	.	.	.	1	6	8	0.8
12	Jacquemontia tamnifolia	1	.	5	1	.	.	2	3	2	.	6	14	1.4
16	Terminalia avicennioides	.	.	2	1	1	1	1	5	.	1	6	11	1.1
57	Heliotropium strigosum	2	.	3	.	2	.	1	.	2	3	6	13	1.3
5	Cochlospermum tinctorium	.	.	3	3	1	2	.	.	2	.	5	11	1.1
10	Guiera senegalensis	.	.	.	2	.	.	2	1	1	1	5	7	0.7
18	Waltheria indica	.	.	1	.	2	2	1	.	1	.	5	7	0.7
25	Butyrospermum paradoxum	.	.	1	1	1	.	1	1	.	.	5	5	0.5
27	Chrysanthellum americanum	.	3	.	.	.	1	4	4	1	.	5	13	1.3
59	Vernonia perrottettii	3	.	.	.	1	.	2	.	1	2	5	9	0.9
4	Borreria radiata	.	.	7	.	.	.	.	1	2	3	4	13	1.3
6	Digitaria ciliaris	.	.	.	.	.	.	3	4	2	2	4	11	1.1
15	Andropogon gayanus	1	1	.	1	.	.	.	.	1	.	4	4	0.4
19	Indigofera pulchra	.	.	.	.	.	.	2	1	1	2	4	6	0.6
53	Lasiosiphon kraussianus	.	.	.	2	1	1	.	.	1	.	4	5	0.5
27	Stylochiton lancifolius	.	1	.	.	1	.	.	1	.	.	3	3	0.3
7	Piliostigma thonningii	.	.	1	1	2	.	.	.	.	.	3	4	0.4
11	Dactyloctenium aegyptium	.	.	.	.	.	3	.	.	6	8	3	17	1.7
36	Vitex doniana	.	.	.	1	1	.	2	.	.	.	3	4	0.4
37	Leucas martinicensis	3	.	.	.	.	.	2	.	.	1	3	6	0.6
49	Eleusine indica	.	.	.	.	.	4	2	3	.	.	3	9	0.9
60	Strychnos spinosa	.	.	.	2	.	1	1	.	.	.	3	4	0.4
83	Tephrosia purpurea	.	.	.	.	.	.	1	1	3	.	3	5	0.5
48	Indigofera nummulariifolia	.	.	.	1	.	.	.	.	.	1	2	2	0.2
56	Tridax procumbens	4	1	.	.	.	.	.	.	.	.	2	5	0.5
66	Andropogon pseudaparicus	.	.	.	.	.	.	.	.	3	2	2	5	0.5
72	Adenodelichos paniculatus	.	.	.	2	.	1	.	.	.	.	2	3	0.3
76	Tephrosia linearis	.	.	.	.	.	.	.	.	.	.	2	2	0.2
99	Parinari curatellifolia	.	.	.	.	.	.	.	1	1	.	2	2	0.2
108	Acanthospermum hispidum	.	3	.	.	.	.	1	1	.	.	2	6	0.6
120	Swartzia madagascariensis	.	.	1	.	.	.	.	3	.	.	2	2	0.2
121	Ageratum conyzoides	.	.	.	.	.	.	3	2	.	.	2	5	0.5

Incidental species having an ACV of one are omitted from the community.

DOMAIN: DUMBI TO KAKO TRANSECT ON THE UPLAND PLAINS - FLORISTIC CLUSTER DETERMINANTS OF FACTOR 1, ORDINATION 2 ON NONE (CURRENT) ARABLE LANDS.

VI.2. Floristic Community Table 20

Pennisetum pedicellatum - Mitracarpus scaber - Paspalum orbiculare Community of weed regrowths on 1-4 years fallow farmed lands mainly on damp to moist gently sloping plains and lower slopes, with mottled subsoils. Remnants of old crops often identified as Arachis, Pennesetum, Sorghum or Discorea, during field surveys. Ridges remain distinct or prominent depending on for which crops they were moulded. Soil texture generally loam. Soil often maintained in damp condition, according to my view, by the presence of an impervious granitic rock in the subsoil (Fig. 18).

CODE	SPECIES	DOMIN SCORES																						EVALUATION		
		1	19	93	6	8	14	13	24	32	43	69	75	71	72	96	70	33	94	104	102	87	47	62	I	II	III
8	Brachiaria stigmatisata	.	.	3	.	.	2	2	9	2	9	9	9	7	7	5	8	7	3	8	2	8	.	3	18	97	4.2
1	Paspalum orbiculare	.	.	.	5	7	4	4	3	4	3	2	3	4	8	1	2	3	8	6	7	1	.	.	18	75	3.3
18	Waltheria indica	.	.	.	4	3	2	1	1	1	1	2	1	3	3	3	3	1	1	.	2	1	1	2	.	18	35	1.5
9	Borreria verticillata	.	.	.	4	.	2	8	.	1	8	2	5	7	7	9	4	2	4	7	4	2	.	6	17	82	3.5
15	Andropogon gayanus	3	2	.	5	2	3	2	1	4	2	.	1	2	.	1	3	.	.	.	.	.	2	2	15	35	1.5
4	Borreria radiata	3	.	.	.	1	6	5	2	2	.	5	4	2	2	1	2	.	1	.	.	.	3	.	14	39	1.7
2	Stylochiton lancifolius	3	5	2	.	.	1	1	2	2	1	3	1	.	.	.	.	.	1	2	.	.	1	2	14	27	1.2
3	Annona senegalensis	2	1	.	1	2	2	.	.	1	.	2	.	.	.	1	.	2	.	1	1	1	1	6	14	24	1.0
7	Pilliostigma thonningii	1	1	1	2	2	2	1	.	3	.	2	.	.	1	.	1	3	1	.	.	.	.	1	14	22	1.0
5	Cochlospermum tinctorium	.	1	.	1	2	2	2	1	1	5	1	.	.	.	1	.	1	.	.	.	.	8	7	13	33	1.4
20	Aspilia africana	.	.	.	1	4	5	2	.	.	.	1	3	.	.	.	1	1	2	3	.	1	3	2	13	29	1.3
29	Sporobolus pyramidalis	.	2	.	2	3	1	.	2	1	2	.	1	.	.	.	2	6	.	3	.	.	3	.	12	28	1.3
10	Guiera senegalensis	.	.	.	.	3	1	.	.	.	.	2	.	1	1	3	1	.	.	2	2	3	.	6	11	25	1.1
14	Sida rhombifolia	.	.	.	.	1	2	.	.	.	1	.	.	2	3	.	1	1	.	2	.	1	.	3	10	17	0.7
21	Pedoyis agrestis	.	1	.	.	.	2	.	.	.	3	3	.	.	.	2	.	1	.	1	.	2	1	1	10	17	0.7
11	Combretum micranthum	.	.	.	.	.	.	1	.	.	.	.	1	.	1	.	1	2	.	1	1	.	1	1	9	10	0.4
42	Cassia mimosoides	.	.	1	.	.	.	.	2	1	1	.	.	2	2	.	.	2	1	2	.	.	.	.	9	14	0.6
13	Pennisetum pedicellatum	.	3	.	9	6	6	5	.	.	.	.	.	.	.	.	.	.	.	1	.	.	7	2	8	39	1.7
16	Terminalia avicennioides	.	.	.	1	2	.	1	2	.	.	.	.	.	.	2	.	.	1	.	2	4	.	.	8	15	0.6
19	Indigofera pulchra	.	.	.	.	6	.	2	1	.	.	.	.	3	1	.	2	.	.	3	.	.	3	.	8	21	0.9
22	Schweinfurthia americana	.	.	.	1	.	1	1	.	.	.	.	1	1	1	.	.	.	.	2	3	.	.	.	8	11	0.5
28	Dichrostachys glomerata	5	1	.	1	.	.	1	.	.	.	.	.	.	1	.	.	2	.	.	.	1	.	2	8	14	0.6
36	Vitex doniana	1	.	.	.	1	1	1	.	.	.	.	.	.	.	.	1	2	.	.	.	1	.	.	8	9	0.4
40	Indigofera capitata	.	.	.	1	1	.	.	.	.	.	2	3	.	1	.	1	1	.	.	.	.	.	2	8	12	0.5
50	Fimbristylis pilosa	.	.	.	.	.	.	.	1	.	.	5	1	1	2	1	.	.	4	1	1	.	.	.	8	18	0.8
82	Scoparia dulcis	.	.	.	.	.	.	1	2	1	.	.	.	.	.	1	1	1	1	1	.	.	.	.	8	9	0.4
17	Mitracarpus scaber	.	.	.	.	.	.	.	1	.	1	.	1	1	.	.	5	.	2	.	7	.	.	.	7	18	0.8
24	Bridelia ferruginea	2	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	1	.	1	1	7	8	0.3
30	Eragrostis tremula	.	.	.	.	.	.	3	.	1	3	.	.	.	.	.	.	.	.	2	2	2	8		7	21	0.9
39	Gutenbergia nigritana	.	.	.	.	.	1	.	1	.	1	2	2	.	.	1	.	.	.	4	.	.	.	.	7	12	0.5
48	Indigofera nummulariifolia	.	.	.	.	.	.	.	.	.	.	4	4	2	2	1	.	.	.	.	4	5	.	.	7	22	1.0
25	Butyrospermum paradoxum	.	.	.	1	.	1	1	1	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	6	6	0.3
27	Chrysanthellum americanum	.	.	.	.	.	3	.	2	1	2	.	.	.	.	.	.	.	.	.	1	.	4	.	6	13	0.6
6	Digitaria ciliaris	.	.	.	.	.	3	.	2	1	.	.	.	.	.	.	2	.	.	.	2	.	.	.	5	10	0.4
23	Fimbristylis exilis	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	2	.	.	.	2	1	2	5	8	0.3
34	Stachytarpheta angustifolia	.	.	.	.	.	.	.	1	.	1.	.	.	.	.	.	.	.	2	1	1	.	.	.	5	10	0.4
31	Setaria unceps	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	2	.	2	.	2	2	.	.	5	10	0.4
36	Tridax procumbens	.	.	.	.	.	.	.	.	.	1	2	.	.	2	.	4	.	.	.	8	.	.	.	5	17	0.7
65	Tephrosia bracteolata	3	.	.	.	.	2	.	.	.	.	.	2	.	.	.	.	.	.	.	.	1	1	.	5	13	0.6
11	Dactyloctenium aegyptium	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	7	.	.	7	6	.	.	.	4	23	1.0
12	Jacquemontia tamnifolia	.	.	.	.	.	2	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	1	4	5	0.2
26	Urginea altissima	.	4	7	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	4	17	0.7
32	Elionurus pobeguinii	.	4	.	.	.	.	.	.	.	.	.	.	3	.	2	.	.	.	.	.	2	.	.	4	11	0.5
35	Eriosema griseum	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	1	.	.	.	.	2	.	4	5	0.2
41	Brachiaria jubata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	4	6	.	4	12	0.5
52	Parkia clappertoniana	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	4	4	0.2
56	Tephrosia pedicellata	.	.	.	.	.	.	.	.	.	.	.	2	4	3	.	.	.	1	.	.	.	.	.	4	6	0.3
39	Vernonia perrottetii	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	3	.	1	.	.	.	4	9	0.4
63	Fimbristylis ovata	.	.	2	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	5	.	.	.	.	4	4	0.2
70	Stereospermum kunthianum	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	4	4	0.2
76	Tephrosia linearis	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	1	.	.	.	4	4	0.2
79	Evolvulus alsinoides	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	5	.	.	.	.	.	.	2	4	9	0.4
83	Tephrosia purpurea	.	1	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	0.2
94	Ipomoea argentaurata	.	.	1	.	.	1	2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	4	5	0.2
37	Leucas martinicensis	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	4	.	.	.	.	.	.	3	6	0.3
45	Cissus rufescens	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	0.1
57	Heliotropium strigosum	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	2	1	.	.	.	.	3	4	0.2
61	Melochia corchorifolia	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	2	.	.	.	.	.	.	3	4	0.2
64	Sporobolus festivus	.	.	9	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	2	.	.	3	12	0.5
67	Waltheria indica	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	3	1	0.1
69	Cassia singueana	3	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	3	5	0.2
77	Urelytrum muricatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	3	4	0.2
82	Sida linifolia	.	.	.	.	1	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	3	3	0.1
92	Stylosanthes mucronata	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	2	3	5	0.2
99	Perlnari curatellifolia	.	.	.	.	1	2	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	7	0.3
100	Alysicarpus glumaceus	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	2	3	7	0.3
107	Desmodium velutinum	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	1	.	.	3	6	0.3

Incidental species having an ACV of two or one are omitted from the table of floristic community.

DOMAIN: DUMBI TO KANO TRANSECT ON THE UPLAND PLAINS - FLORISTIC DETERMINANTS OF FACTOR 2 ON ORDINATION 2

v3.3.

Floristic Community Table 21

Brachiaria stigmatisata - Borreria verticillata - Paspalum orbiculare Community

of forb-grasslands mixed with scrublands on old cultivated lands. Last period of cultivation generally greater than four years. Grazed intensively. Cochlospermum tinctorium, for example, suggests use of fire for vegetation clearing, possibly by shifting pastoralists (Plates 27 to 37) based on personal field experience. Borreria verticillata suggests sporadic settlements by the same pastoralists (Plates 29, 30 and 31). Klopfs are often discernible but very faint. The absence of erosion on these flat plains (no Dyschoriste perrottetii) is noteworthy and should be linked with my appraisal attached to Plate 33.

CODE	SPECIES	DOMIN																SCORES														EVALUATION		
		13	38	36	40	37	46	18	20	21	22	23	25	48	45	44	39	33	34	65	66	68	91	88	92	98	99	100	101	107	108	73	74	76	I	II	III
3	Annona senegalensis	1	3	3	2	1	4	5	5	4	2	6	4	6	6	1	4	3	3	5	5	3	2	3	2	4	3	2	5	5	2	1	4	.	32	109	3.3
5	Cochlospermum tinctorium	6	7	5	6	.	.	1	2	2	2	2	5	3	6	8	4	4	4	5	8	2	6	2	3	2	2	2	3	4	3	3	.	2	30	186	5.6
7	Piliostigma thonningii	1	.	3	3	1	2	1	.	.	1	1	2	4	2	2	7	6	2	5	4	2	2	.	.	3	5	.	2	2	1	3	5	.	26	72	2.2
10	Guiera senegalensis	2	1	1	1	5	.	2	.	.	6	3	.	6	2	2	.	1	.	4	.	1	.	1	.	1	1	3	2	1	1	3	8	4	24	62	1.9
33	Cyperus obtusiflorus	4	2	2	2	2	.	2	3	3	4	5	4	4	4	5	4	.	4	4	3	.	.	.	4	2	2	2	3	.	.	.	3	.	24	77	2.3
26	Urginea altissima	.	2	2	3	1	4	.	1	.	2	3	3	2	4	4	2	1	.	3	1	1	2	1	3	2	.	.	.	.	.	2	2	.	23	51	1.5
2	Stylochiton lancifolius	1	2	.	.	1	5	4	2	2	3	2	.	.	.	4	2	.	.	2	2	2	3	.	.	1	2	.	1	1	2	2	2	.	22	48	1.9
24	Bridelia ferruginea	2	2	1	5	1	7	2	2	2	1	1	1	2	.	1	1	1	1	2	1	.	1	.	1	.	.	.	.	.	.	.	.	1	22	39	1.2
32	Elionurus pobeguinii	.	.	.	3	3	.	.	5	6	3	4	5	4	.	2	2	.	.	2	3	4	.	4	4	3	4	5	6	.	.	6	7	.	21	85	2.6
15	Andropogon gayanus	4	3	5	4	4	4	1	1	1	1	.	2	.	.	.	4	.	3	.	.	.	2	.	.	.	.	1	2	.	1	3	3	2	20	51	1.5
21	Fadogia agrestis	1	.	.	4	.	.	.	3	2	2	.	.	2	.	2	7	.	.	5	1	7	.	6	3	.	3	2	.	8	2	1	8	3	20	63	1.9
16	Terminalia avicennioides	.	.	.	.	1	1	1	3	.	5	5	7	.	1	.	.	1	5	.	.	.	6	7	7	1	.	6	2	.	1	1	1	.	19	62	1.9
19	Indigofera pulchra	.	.	2	.	5	.	3	1	2	2	2	1	.	.	1	2	1	1	.	.	.	.	.	.	1	1	2	2	2	.	5	.		18	36	1.1
28	Dichrostachys glomerata	2	.	5	3	1	.	6	.	2	.	.	.	1	.	1	.	.	.	1	2	.	2	.	.	1	.	1	2	2	.	7	.	7	17	46	1.4
4	Borreria radiata	1	.	1	.	1	.	.	.	2	4	3	2	.	.	.	2	.	.	.	.	.	3	.	.	.	1	2	2	2	1	4	.	3	16	34	1.0
20	Aspilia africana	2	.	3	2	.	2	1	.	.	.	2	.	.	.	.	.	.	.	2	1	.	2	2	.	2	.	.	2	3	2	.	2	3	16	33	1.0
25	Butyrospermum paradoxum	2	.	3	2	.	2	1	1	1	1	1	2	1	1	.	1	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	16	22	0.7
41	Entada africana	.	1	.	.	1	2	1	.	.	.	.	1	1	1	3	2	.	.	.	.	.	.	1	1	1	.	.	1	.	.	1	1		15	19	0.6
54	Lepidagathis collina	2	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	3	3	2	3	.	.	2	1	2	1	1	2	2	.	.	14	27	0.8
35	Eriosema griseum	.	.	.	.	.	.	.	.	.	.	.	1	2	2	.	.	.	.	3	2	2	.	.	.	2	2	.	.	4	4	1	2	1	13	28	0.8
43	Brachiaria jubata	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	2	.	.	.	2	.	4	4	5	4	4	3	4	7	2	3	.	13	46	1.4
55	Hyperthelia dissoluta	.	2	3	.	1	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2	3	.	1	2	5	5	4	6	.	.	8	13	44	1.3
73	Monocymbium ceresiiforme	.	.	.	.	.	.	3	.	3	2	.	5	2	.	.	.	.	.	.	2	3	.	.	3	3	2	2	2	.	.	.	.	.	12	32	1.0
8	Brachiaria stigmatisata	2	2	3	3	4	5	.	.	.	.	.	.	.	.	3	.	.	.	4	.	.	.	.	.	.	.	.	.	3	1	.	1	11	31	0.9
39	Gutenbergia nigrita	.	.	.	.	.	4	.	1	.	.	3	.	.	.	.	.	.	.	2	.	3	.	2	.	.	2	1	.	.	.	2	4	3	11	27	0.8
46	Lannea schimperi	.	1	.	.	.	1	1	.	1	.	.	1	1	.	.	.	.	1	1	.	.	1	.	.	.	.	.	.	.	1	1	.	11	11	0.3
64	Sporobolus festivus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	7	5	6	4	2	2	.	2	2	4	5	.	.	.	11	44	1.3
78	Ximenia americana	.	1	.	.	.	.	.	.	.	.	1	1	.	1	1	.	.	.	.	.	2	1	.	.	1	.	1	1	.	.	.	1	.	11	12	0.4
29	Sporobolus pyramidalis	5	6	4	5	5	4	.	.	.	.	.	.	.	5	.	.	.	2	.	.	.	.	.	.	.	.	.	.	1	.	.	2	10	39	0.9
40	Indigofera capitata	.	.	.	.	.	.	1	1	.	.	4	.	1	.	.	.	.	1	.	.	1	1	.	.	.	1	.	1	1	.	.	.	10	13	0.4
45	Cissus rufescens	1	3	.	.	1	1	1	1	.	2	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	10	13	0.4
63	Fimbristylis ovata	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	2	3	3	3	5	4	3	2	.	10	29	0.9
68	Anogeissus leiocarpus	.	.	1	.	1	.	2	1	1	1	1	.	.	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	12	0.4
1	Paspalum orbiculare	.	.	2	7	2	3	.	.	.	.	.	2	.	.	3	2	3	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	10	26	0.8
66	Andropogon pseudapricus	.	.	.	.	.	.	.	.	.	.	.	7	6	2	4	.	.	.	4	3	4	4	.	.	.	.	.	.	.	.	4	5	.	10	43	1.3
18	Waltheria indica	.	.	2	.	1	.	2	.	.	2	.	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	9	12	0.4
50	Fimbristylis pilosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	1	.	3	2	2	1	2	3	.	.	3	9	20	0.6
58	Tephrosia pedicellata	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	3	3	3	.	.	.	2	4	.	3	1	.	.	.	.	9	22	0.7
23	Fimbristylis exile	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	3	4	..	.	.	2	2	2	3	.	.	1	.	.	8	19	0.6
36	Vitex doniana	.	3	2	.	.	1	1	1	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	8	11	0.3
38	Combretum sericeum	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.	1	2	.	.	2	4	2	8	11	0.3
52	Parkia clappertoniana	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	2	2	2	.	2	2	.	.	.	.	8	8	0.2
85	Gardenia erubescens	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	1	.	1	1	1	1	.	1	.	.	.	.	8	8	0.2
53	Lasiosiphon kraussianus	1	.	.	.	.	.	.	.	.	.	.	1	1	.	2	.	.	.	.	.	.	.	.	.	1	.	.	1	2	.	.	.	.	7	9	0.3
60	Strychnos spinosa	2	.	.	.	.	.	.	.	1	.	1	.	1	.	.	1	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	7	8	0.2
69	Cassia singueana	1	.	.	.	1	1	.	1	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	7	11	0.3
72	Adenodolichos paniculatus	.	5	.	.	.	.	.	5	.	1	1	.	.	8	5	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	30	0.9
75	Heeria pulcherrima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	2	.	1	1	.	1	.	.	.	.	.	7	8	0.2
77	Urelytrum muricatum	.	.	.	.	.	.	2	1	.	.	2	.	.	.	.	.	.	.	2	.	.	1	2	.	1	.	.	.	.	.	.	.	.	7	11	0.3
70	Stereospermum kunthianum	.	1	1	.	.	.	.	.	.	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	6	6	0.2
88	Vitex simplicifolia	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	1	.	.	1	.	.	6	6	0.2
86	Daniellia oliveri	.	.	.	7	.	.	.	2	.	.	.	.	.	.	2	.	.	2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	5	14	0.4
95	Lippia chevalieri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2	1	3	.	1	.	.	.	.	5	9	0.3
98	Combretum ghasalense	.	.	1	.	.	.	.	.	1	.	.	.	.	.	3	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	5	7	0.2
14	Sida rhombifolia	.	.	1	.	2	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	4	5	0.2
51	Setaria anceps	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	2	.	.	.	.	.	1	.	.	.	8	4	13	0.4
67	Nauclea lactifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	1	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	4	10	0.3
79	Evolvulus alsinoides	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	2	.	.	4	6	0.2
84	Diospyros mespiliformis	.	1	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	0.1
102	Monechma ciliatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	1	.	.	.	1	.	.	4	6	0.2
105	Elionurus hirtifolius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	2	.	.	5	.	.	.	4	10	0.3
111	Cymbopogon giganteus	2	1	.	.	.	.	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	7	0.2
115	Murdannia simplex	.	2	.	2	.	.	.	.	.	.	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	7	0.2
122	Englerastrum gracillimum	.	.	.	.	.	.	2	1	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	6	0.2
130	Detarium macrocarpum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	1	1	.	.	.	.	1	.	.	.	.	.	4	6	0.2
132	Borreria octodon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	2	3	.	.	.	4	9	0.3
22	Schweinckia americana	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3	4	0.1
42	Cassia mimosoides	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	3	3	0.1
83	Tephrosia purpurea	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1		3	3	0.1
92	Stylosanthes mucronata	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	1		3	6	0.2
96	Terminalia laxiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	1	.	.	.	1	.	.	.	.	1	.	.	3	3	0.1
107	Desmodium velutinum	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	5	0.2
113	Prosopis africana	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	3	3	0.1
117	Loudetia simplex	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	5	3	.	.	.	.	.	3	10	0.3
118	Feretia apodanthera	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	0.1
119	Hoslundia opposita	.	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	4	0.1
124	Fimbristylis dichotoma	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	5	0.2
125	Pseudocedrela kotschyi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	1	.	2	.	.	3	6	0.2
126	Lannea acida	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	0.1
131	Lactuca taraxacifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	1	3	3	0.1
136	Lantana rhodesiensis	.	.	.	.	.	.	1	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	0.1
140	Sclerocarya birrea	.	.	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	0.1

Species having ACV of less than two (i.e. less than 9% recurrence) are omitted from the community table.

DOMAIN: DUMBI TO KAKO TRANSECT ON THE UPLAND PLAINS - FLORISTIC CLUSTER DETERMINANTS OF FACTORS 3/4 ON ORDINATION 2.

VI.4.

Floristic Community Table 22

Cochlospermum tinctorium - Annona senegalensis - Elionurus pobequinii Community

of open scrubs and shrublands with forbs and grasses on seemingly uncultivated plains, situated mainly on the sub-summits of the topographically undulating landscapes which are the "soil catenas" of Morison, et al (1948), and of Keay (1949a, 1949b, 1960). The geological materials under the quadrats consist of granites and ironstones. The Loudetia simplex and Dichrostachys glomerata for example suggest that the ironstone layers are part floral distributional factors. Sporobolus festivus suggest shallow soils, Sporobolus pyramidalis suggest locally deep moist soils; and the isolated scattered trees, Butyrospermum paradoxum, Vitex doniana, Parkia clappertoniana suggest past agricultural use while Cissus rufescens and Anogeissus leiocarpus are linked with granitic outcrops on the plains. The simple catena does not therefore appear to explain the community. The geology, hydrology, and historical land use appear to be necessary factors to be considered. Besides, the prominence of Cochlospermum tinctorium suggests another factor, which is fire.

CODE	SPECIES	DOMIN SCORES															EVALUATION		
		65	66	68	91	88	92	98	99	100	101	107	108	73	74	76	I	II	III
3	Annona senegalensis	5	5	3	2	3	2	4	3	2	5	5	2	1	4	.	14	44	2.9
5	Cochlospermum tinctorium	5	8	2	6	2	3	2	2	2	3	4	3	3	.	2	14	47	3.1
10	Guiera senegalensis	4	.	1	.	1	.	1	1	3	2	1	1	3	8	4	12	30	2.0
21	Fadogia agrestis	5	1	7	.	6	3	.	3	2	.	8	2	1	8	3	12	49	3.2
7	Piliostigma thonningii	5	4	2	2	.	.	3	5	.	2	2	1	3	5	.	11	34	2.3
2	Stylochiton lancifolius	2	2	2	3	.	.	1	2	.	1	1	2	2	2	.	11	20	1.3
32	Elionurus pubeguinii	2	3	4	.	4	4	3	4	5	6	.	.	6	7	.	11	48	3.2
54	Lepidagathis collina	3	3	2	3	.	.	2	1	2	1	1	2	2	.	.	11	22	1.5
43	Brachiaria jubata	.	.	2	.	4	4	5	4	4	3	4	7	2	3	.	11	42	2.8
64	Sporobolus festivus	5	7	5	6	4	2	2	.	2	2	4	5	.	.	.	11	44	2.9
20	Aspilia africana	2	1	.	2	2	.	2	.	.	2	3	2	.	2	3	10	21	1.4
35	Eriosema griseum	3	2	2	.	.	.	2	2	.	.	4	4	1	2	1	10	23	1.5
26	Urginea altissima	3	1	1	2	1	3	2	.	.	.	.	.	2	2	.	9	17	1.1
16	Terminalia avicennioides	.	.	.	6	7	7	1	.	6	2	.	1	1	1	.	9	32	2.1
28	Dichrostachys glomerata	1	2	.	2	.	.	1	.	1	2	2	.	7	.	7	9	25	1.7
55	Hyperthelia dissoluta	.	.	.	2	3	.	1	2	5	5	4	6	.	.	8	9	36	2.4
63	Fimbristylis ovata	.	.	.	.	3	.	2	3	3	3	5	4	3	2	.	9	28	1.9
50	Fimbristylis pilosa	.	.	.	3	1	.	3	2	2	1	2	3	.	.	3	9	20	1.3
33	Cyperus obtusiflorus	4	3	.	.	.	4	2	2	2	3	.	.	.	3	.	8	23	1.5
4	Borreria radiata	.	.	.	3	.	.	.	1	2	2	2	1	4	.	3	8	18	1.2
39	Gutenbergia nigritana	2	.	3	.	2	.	.	2	1	.	.	.	2	4	3	8	19	1.3
23	Fimbristylis exile	2	3	4	.	.	.	2	2	2	3	.	.	1	.	.	8	19	1.3
15	Andropogon gayanus	.	.	.	2	.	.	.	.	1	2	.	1	3	3	2	7	14	0.9
73	Monocymbium ceresiliforme	.	2	3	.	.	3	3	2	2	2	.	.	.	.	.	7	17	1.1
58	Tephrosia pedicellata	3	3	3	.	.	.	2	4	.	3	1	.	.	.	.	7	19	1.3
75	Heeria pulcherima	.	1	1	1	2	.	1	1	.	1	.	.	.	.	.	7	8	0.5
19	Indigofera pulchra	.	.	.	.	.	.	.	.	1	1	2	2	2	.	5	6	13	0.9
41	Entada africana	.	.	.	.	1	1	1	.	.	.	1	.	.	1	1	6	6	0.4
78	Ximenia americana	.	.	2	1	.	.	1	.	1	1	.	.	.	1	.	6	7	0.5
38	Combretum sericeum	.	.	.	.	1	.	.	.	1	2	.	.	1	3	1	6	9	0.6
85	Gardenia erubescens	.	.	.	1	.	1	1	1	1	.	1	.	.	.	.	6	6	0.4
24	Bridelia ferruginea	2	1	.	1	.	1	.	.	.	.	.	.	.	.	1	5	6	0.4
40	Indigofera capitata	.	.	1	1	.	.	.	1	.	1	1	.	.	.	.	5	5	0.3
52	Parkia clappertoniana	.	.	.	.	.	1	1	1	.	1	1	.	.	.	.	5	5	0.3
88	Vitex simplicifolia	.	.	.	.	.	1	1	.	1	1	.	.	1	.	.	5	5	0.3
8	Brachiaria stigmatisata	4	.	.	.	.	.	.	.	.	.	.	.	3	1	1	4	9	0.6
46	Lannea schimperi	1	.	.	1	.	.	.	.	.	.	.	.	1	1	.	4	4	0.3
77	Urelytrum muricatum	.	2	.	.	1	2	.	1	.	.	.	.	.	.	.	4	6	0.4
95	Lippia chevalieri	.	.	.	.	.	.	2	1	3	.	1	.	.	.	.	4	7	0.5
102	Monechma ciliata	.	.	.	.	.	.	2	2	1	.	.	.	1	.	.	4	6	0.4
105	Elionurus hirtifolius	.	.	.	.	.	.	1	2	2	.	.	5	.	.	.	4	10	0.7
130	Detarium macrocarpum	.	.	3	1	1	.	.	.	.	.	1	.	.	..	.	4	6	0.4
132	Borreria octodon	.	.	.	.	.	.	2	2	.	.	2	3	.	.	.	4	9	0.6
53	Lasiosiphon kraussianus	.	.	.	.	.	.	1	.	.	1	2	.	.	.	.	3	4	0.3
51	Setaria anceps	.	.	.	.	2	.	.	.	.	.	1	.	.	.	8	3	11	0.7
79	Evolvulus alsinoides	.	.	.	.	.	.	.	.	1	1	.	.	2	.	.	3	4	0.3
96	Terminalia laciflora	.	.	.	1	.	.	.	1	.	.	.	.	1	.	.	3	3	0.2
117	Loudetia simplex	.	.	.	.	.	.	.	2	5	3	.	.	.	.	.	3	10	0.7
131	Lactuca taraxocifloria	.	.	.	.	.	.	.	1	.	.	1	.	.	.	1	3	3	0.2
25	Butyrospermum paradoxus	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	2	2	0.1
29	Sporobolus pyramidalis	.	.	.	.	.	.	.	.	.	.	.	1	.	.	2	2	3	0.2
45	Cissus rufescens	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	2	2	0.1
1	Paspalum orbiculare	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	2	2	0.1
66	Andropogon pseudapricus	4	3	4	4	.	.	.	.	.	.	.	.	4	5	.	6	24	1.6
18	Waltheria indica	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	2	2	0.1
60	Strychnos spinosa	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	2	2	0.1
98	Combretum ghasalense	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	2	2	0.1
67	Nauclea lactifolia	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	2	2	0.1
22	Schweinckia americana	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	2	3	0.2
83	Tephrosia purpurea	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	2	2	0.1
92	Stylosanthes mucronata	.	.	.	.	.	.	.	.	.	.	.	3	.	.	1	2	4	0.3
125	Pseudocedrela kotschyi	.	.	.	.	.	.	.	.	.	.	1	.	2	.	.	2	3	0.2

Incidental species having absolute constancy value of one are omitted.

DOMAIN: DUMBI TO KAKO TRANSECT ON THE UPLAND PLAINS - FLORISTIC CLUSTER DETERMINANTS OF FACTOR 4 ON ORDINATION 2.

VI.5. Floristic Community Table 23

Fadogia agrestis - Cochlospermum tinctorium - Annona senegalensis - Guiera senegalensis - Elionurus pubeguinii - Sporobolus festivus Community

of shrublands with grasses and forbs on the shallow summits of the minor hills which are the tops of the 'soil catenas' referred to in Community 23. The vegetation mainly consist of hardy dwarf shrubs and grasses on shallow soil deposits over lateritic ironstones. However, minor depressions among the stone boulders contain deep, seasonally moist soil deposits for the species like Piliostigma thonningii, Andropogon gayanus, Sporobolus pyramidalis and Paspalum orbiculare.

CODE	SPECIES	DOMIN SCORES																		EVALUATION		
		13	38	36	40	37	46	18	20	21	22	23	25	48	45	44	39	33	34	I	II	III
3	Annona senegalensis	1	3	3	2	1	4	5	5	4	2	6	4	6	6	1	4	3	3	18	63	3.5
24	Bridelia ferruginea	2	2	1	5	1	7	2	2	2	1	1	1	2	.	1	1	1	1	17	33	1.8
5	Cochlospermum tinctorium	6	7	5	6	.	.	1	2	2	2	2	5	3	6	8	4	4	4	16	67	3.7
33	Cyperus obtusiflorus	4	2	2	2	2	.	2	3	3	4	5	4	4	4	5	4	.	4	16	54	3.0
7	Piliostigma thonningii	1	.	3	3	1	2	1	.	.	1	1	2	4	2	2	7	6	2	15	38	2.1
26	Urginea altissima	.	2	2	3	1	4	.	1	.	2	3	3	2	4	4	2	1	.	14	35	1.9
25	Butyrospermum paradoxum	2	.	3	2	.	2	1	1	1	1	1	2	1	1	.	1	1	.	14	20	1.1
15	Andropogon gayanus	4	3	5	4	4	4	1	1	1	1	.	2	.	.	.	4	.	3	13	37	2.1
10	Guiera senegalensis	2	1	1	1	5	.	2	.	.	6	3	.	6	2	2	.	1	.	12	32	1.6
19	Indigofera pulchra	.	.	2	.	5	.	3	1	2	2	2	1	.	.	1	2	1	1	12	23	1.3
2	Stylochiton lancifolius	1	2	.	.	1	5	4	2	2	3	2	.	.	.	4	2	.	.	11	28	1.6
32	Elionurus pobeguinii	.	.	.	3	3	.	.	5	6	3	4	5	4	.	2	2	.	.	10	37	2.1
16	Terminalia avicennioides	.	.	.	.	1	1	1	3	.	5	5	7	.	1	.	.	1	5	10	30	1.7
48	Anogeissus leiocarpus	.	.	1	.	1	.	2	1	1	1	1	.	.	1	1	2	.	.	10	12	0.7
41	Entada africana	.	1	.	.	1	2	1	.	.	.	.	1	1	1	3	2	.	.	9	13	0.7
21	Fadogia agrestis	1	.	.	4	.	.	.	3	2	2	.	.	2	.	2	7	.	.	8	23	1.3
28	Dichrostachys glomerata	2	.	5	3	1	.	6	.	2	.	.	.	1	.	1	.	.	.	8	21	1.2
4	Borreria radiata	1	.	1	.	1	.	.	.	2	4	3	2	.	.	.	2	.	.	8	16	0.9
29	Sporobolus pyramidalis	5	6	4	5	5	4	.	.	.	.	.	.	.	5	.	.	.	2	8	36	2.0
45	Cissus rufescens	1	3	.	.	1	1	1	1	.	2	.	.	.	.	1	.	.	.	8	11	0.6
1	Paspalum orbiculare	.	.	2	7	2	3	.	.	.	.	.	2	.	.	3	2	3	.	8	24	1.3
8	Brachiaria stigmatisata	2	2	3	3	4	5	.	.	.	.	.	.	.	.	3	.	.	.	7	22	1.2
46	Lannea schimperi	.	1	.	.	.	1	1	.	1	.	.	1	1	.	.	.	.	1	7	7	0.4
18	Waltheria indica	.	.	2	.	1	.	2	.	.	2	.	.	1	.	1	.	1	.	7	10	0.6
72	Adenodelichos paniculatus	.	5	.	.	.	.	.	5	.	1	1	.	.	8	5	5	.	.	7	30	1.7
20	Aspilia africana	2	.	3	2	.	2	1	.	.	.	2	.	.	.	.	.	.	.	6	12	0.7
69	Cassia singuena	1	.	.	.	1	1	.	1	3	2	.	.	.	.	.	.	.	.	6	9	0.5
73	Monocymbium ceresiiformis	.	.	.	.	.	.	.	3	.	3	2	.	5	2	.	.	.	.	5	15	0.8
78	Ximenia americana	.	1	.	.	.	.	.	.	.	1	1	.	1	1	.	.	.	.	5	5	0.3
40	Indigofera capitata	.	.	.	.	.	.	1	1	.	.	4	.	1	.	.	.	.	1	5	8	0.4
60	Strychnos spinosa	2	.	.	.	.	.	.	.	1	.	1	.	1	.	.	1	.	.	5	6	0.3
70	Stereospermum kunthianum	.	1	1	.	.	.	.	.	.	1	.	.	.	.	1	1	.	.	5	5	0.3
55	Hyperthelia dissoluta	.	2	3	.	1	.	.	.	.	.	.	.	.	2	.	.	.	.	4	8	0.4
66	Andropogon pseudapricus	.	.	.	.	.	.	.	.	.	.	.	7	6	2	4	.	.	.	4	19	1.1
53	Lasiosiphon kraussianus	1	.	.	.	.	.	.	.	.	.	.	1	1	.	2	.	.	.	4	5	0.3
86	Daniellia oliveri	.	.	.	7	.	.	.	.	2	.	.	.	.	.	.	2	.	2	4	13	0.7
111	Cymbopogon giganteus	2	1	.	.	.	.	2	.	2	.	.	.	.	.	.	.	.	.	4	7	0.4
115	Murdannia simplex	.	2	.	2	.	.	.	.	.	.	.	.	.	1	.	2	.	.	4	7	0.4
122	Englerastrum gracillimum	.	.	.	.	.	.	2	1	.	1	2	.	.	.	.	.	.	.	4	6	0.3
84	Diospyros mespiliformis	.	1	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	4	4	0.2
54	Lepidagathis collina	2	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	3	5	0.3
35	Eriosema griseum	.	.	.	.	.	.	.	.	.	.	.	1	2	2	.	.	.	.	3	5	0.3
39	Gutenbergia nigritana	.	.	.	.	.	4	.	1	.	.	3	.	.	.	.	.	.	.	3	8	0.4
52	Parkia clappertoniana	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	3	3	0.2
77	Urelytrum muricatum	.	.	.	.	.	.	2	1	.	.	2	.	.	.	.	.	.	.	3	5	0.3
98	Combretum ghasalense	.	.	1	.	.	.	.	.	1	.	.	.	.	.	3	.	.	.	3	5	0.3
14	Sida rhombifolia	.	.	1	.	2	.	.	.	.	1	.	.	.	.	.	.	.	.	3	4	0.2
107	Desmodium velutinum	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	2	.	.	3	5	0.3
124	Fimbristylis dichota	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	3	5	0.3
118	Feretia apodanthera	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	.	.	.	3	3	0.2
119	Hoslundia opposita	.	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	4	0.2
126	Lannea acida	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	3	3	0.2
136	Lantana rhodesiensis	.	.	.	.	.	.	1	.	1	.	.	1	.	.	.	.	.	.	3	3	0.2
140	Sclerocarya birrea	.	.	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	3	3	0.2
43	Brachiaria jubata	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	2	.	2	4	0.2
58	Tephrosia pedicellata	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	2	3	0.2
85	Gardenia erubescens	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	2	2	0.1
67	Nauclea latifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	1	2	8	0.4
42	Cassia mimosoides	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	2	2	0.1
113	Prosopis africana	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	2	2	0.1

species with nCV of one are omitted from the community table.

DOMAIN: DUNBI TO KAKO TRANSECT ON THE UPLAND PLAINS - FLORISTIC CLUSTER DETERMINANTS OF FACTOR 3 ON ORDINATION 2.

VI.6. Floristic Community Table 24

Annona senegalensis - Cochlospermum tinctorium - Piliostigma thonningii - Guiera senegalensis - Andropogon gayanus - Terminalia avicennioides Community

of open woodlands of uncultivated granitic rocks mixed with Tree-shrublands on old farmed lands. The undergrowth grasses (such as Sporobolus pyramidalis and Cissus rufescens are indicative of seasonally high soil moisture content. Andropogon pseudapricus, however, suggest sub-soil ironstone layers.

CODE	SPECIES	DOMIN SCORES																EVALUATION		
		1	2	9	14	11	5	3	18	19	13	4	7	17	12	15	16	I	II	III
1	Borreria radiata	3	3	2	3	2	2	2	2	7	5	2	3	4	6	7	6	16	59	3.7
4	Clerodendron capitatum	2	1	2	1	3	2	1	1	1	1	1	1	1	1	1	1	16	21	1.3
3	Cissus rufescens	6	8	5	5	7	1	3	2	3	.	1	6	6	6	3	4	15	66	4.1
8	Andropogon gayanus	2	3	1	3	1	.	6	5	4	5	3	2	2	3	5	3	15	48	3.0
5	Byroscarpus coccineus	2	1	5	3	1	2	2	2	2	3	1	1	2	1	.	.	14	28	1.8
2	Discorea bulbitera	1	1	2	2	2	2	1	1	1	.	1	1	1	4	.	.	13	20	1.3
14	Tephrosia bracteolata	1	1	2	1	.	.	2	1	2	3	3	4	2	1	.	1	13	29	1.8
7	Bombax costatum	1	.	1	1	.	3	1	1	.	2	1	1	1	3	.	1	12	17	1.1
20	Stereospermum kunthianum	1	1	1	1	.	1	1	2	2	1	.	.	1	1	.	3	12	16	1.0
6	Milletia thonningii	3	1	1	1	3	2	1	.	.	4	.	.	.	1	2	1	11	20	1.3
12	Indigofera dendroides	2	1	1	1	.	.	.	.	1	.	1	1	3	1	1	3	11	16	1.0
9	Ipomoea involucrata	.	.	.	2	.	.	2	.	1	2	1	1	3	.	1	2	9	14	0.9
22	Anogeissus leiocarpus	1	.	.	.	1	4	1	3	.	3	5	3	.	.	.	1	9	22	1.4
10	Cyanotis lanata	2	.	3	.	.	.	1	.	3	.	2	3	.	.	4	2	8	20	1.3
36	Entada africana	.	.	.	1	.	.	1	2	2	.	.	1	2	.	2	2	8	13	0.8
38	Cassia singueana	1	4	1	.	1	1	1	1	.	.	1	.	.	.	.	.	8	11	0.7
11	Cissus aralioides	1	.	2	3	3	3	1	.	.	3	.	.	.	.	.	.	7	16	1.0
15	Pandiaka heudeloti	.	1	1	1	.	.	2	.	.	.	.	1	.	2	.	1	7	9	0.6
19	Tacca involucrata	.	2	.	.	1	5	1	.	1	1	1	.	.	.	.	.	7	12	0.8
25	Commiphora africana	1	1	.	1	.	.	1	.	.	.	1	2	2	.	.	.	7	9	0.6
29	Asparagus africanus	1	2	.	1	.	1	.	.	.	.	.	.	1	1	1	.	7	8	0.5
30	Eulophia quartiniana	2	2	2	2	2	.	.	4	4	.	.	.	.	.	.	.	8	18	1.1
32	Scleria foliosa	.	.	1	1	.	1	.	.	1	.	.	1	.	.	1	1	7	7	0.4
39	Parkia clappertoniana	.	.	1	1	.	1	1	.	3	.	1	1	.	.	.	.	7	9	0.6
41	Annona senegalensis	.	.	1	1	.	1	1	.	.	.	2	1	.	.	.	2	7	9	0.6
26	Diospyros mespiliformis	.	.	2	.	1	1	.	.	1	.	1	.	.	3	.	.	6	9	0.6
33	Sporobolus pyramidalis	2	2	2	4	.	3	.	.	.	.	3	.	.	.	.	.	6	16	1.0
40	Aneilema lanceolatum	.	.	1	2	.	.	.	.	1	3	.	1	.	.	1	.	6	9	0.6
44	Melothria madaraspatana	.	.	.	2	.	.	.	.	1	1	.	.	1	1	1	.	6	7	0.4
52	Khaya senegalensis	.	2	2	1	2	.	3	.	.	.	.	.	1	.	.	.	6	11	0.7
16	Pennisetum pedicellatum	.	.	2	1	3	.	.	.	.	.	.	.	.	.	1	3	5	10	0.6
35	Hackelochloa granularis	.	6	.	.	.	.	.	2	.	2	.	4	.	.	.	2	5	16	1.0
37	Allophylus spicatus	.	.	.	1	2	.	1	.	.	.	.	2	1	.	.	.	5	7	0.4
60	Clematis hirsuta	.	1	.	.	.	.	1	1	1	.	.	.	.	.	.	1	5	5	0.3
21	Brachiara lata	.	.	2	.	3	2	.	.	.	.	.	.	.	5	.	.	4	12	0.8
24	Rottboellia exaltata	2	1	.	.	.	.	5	.	.	.	2	.	.	.	.	.	4	10	0.6
51	Gloriosa superba	1	.	.	2	.	1	.	.	1	.	.	.	.	.	.	.	4	5	0.3
54	Stylochiton lancifolius	.	1	.	.	.	.	1	.	.	.	1	1	.	.	.	.	4	4	0.3
55	Grewia mollis	.	.	.	.	.	.	1	.	1	.	1	.	1	.	.	.	4	4	0.3
70	Cochlospermum tinctorium	2	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	3	5	0.3
72	Bridelia ferruginea	.	.	.	1	1	.	.	.	.	.	1	.	.	.	.	.	3	3	0.2
31	Vigna racemosa	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	2	3	5	0.3
47	Indigofera bracteolata	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	2	3	4	0.3
61	Jasminum dichotomum	.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.	3	6	0.4
13	Achyranthes aspera	1	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	2	5	0.3
17	Acacia ataxacantha	.	.	.	.	.	.	.	.	.	1	.	2	.	.	.	.	2	5	0.3
34	Bidens pilosa	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	2	4	0.3
45	Ficus umbellata	.	.	.	.	1	.	.	.	.	.	.	.	.	.	2	.	2	3	0.2
53	Cassia tora	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	0.1
57	Ziziphus mucronata	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	2	2	0.1
64	Gutenbergia nigritana	.	.	.	.	.	.	.	.	1	.	.	.	5	.	.	.	2	7	0.4
82	Heteropogon contortus	.	.	2	.	.	.	4	.	.	.	.	.	.	.	.	.	2	6	0.4
87	Cissampelos mucronata	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	2	2	0.1
97	Dichrostachys glomerata	.	.	1	.	.	.	.	.	.	.	2	.	.	.	.	.	2	3	0.2
103	Ekebergia senegalensis	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	2	2	0.1
104	Euphorbia convoluloides	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	2	2	0.1
106	Croton macrostachyus	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	1	2	3	0.2

DOMAIN: DUMBI INSELBERG AND ROCKY HILLS - POSITIVE DEFINITE FACTOR 1 FLORISTIC CLUSTER DETERMINANTS

VII.1. Floristic Community Table 25

Cissus rufescens - Borreria radiata - Andropogon gayanus - Anogeissus leiocarpus - Milletia thonningii - Bombax custatum Community

of Dumbi Inselberg fringing woodlands and of wooded cracks in granitic rocky hills on the plains, illustrated on Plates 56 to 61. The geology with the altitudinal changes are related in my sketch in Fig.19. These quadrats occupy the uncultivated 'foot' and the shallow soil deposits of the granitic Inselberg. The soil is loamy silt on average. Canopy closures of woods vary from about an average of 21-40% arboreal cover to occasional 61-80% cover.

CODE	SPECIES	DOMIN SCORES																				EVALUATION		
		28	33	29	43	47	39	42	38	30	44	45	46	35	36	37	55	31	32	40	34	56	I	II	III
18	Dissotis sp.	5	6	3	5	5	8	8	5	4	6	4	6	.	1	6	.	4	6	7	.	.	17	89	4.2
13	Achyranthes aspera	9	5	4	2	2	5	6	4	3	2	.	.	5	2	4	2	.	.	2	.	3	16	60	2.8
11	Cissus aralioides	2	.	.	.	2	3	3	2	2	2	2	3	3	3	.	1	3	2	4	.	.	15	37	1.8
2	Dioscorea bulbifera	.	.	2	3	1	2	3	1	.	2	.	3	.	1	1	.	.	1	2	.	8	13	30	1.4
6	Milletia thonningii	5	6	4	4	4	4	4	6	.	.	1	3	.	2	.	.	.	3	.	.	4	13	50	2.4
27	Dioscorea preusii	2	3	5	5	5	2	4	.	.	.	.	1	4	1	2	1	.	3	.	.	.	13	38	1.8
4	Clerodendron capitatum	1	1	1	.	.	2	2	1	.	.	.	.	.	1	2	1	.	3	.	1	1	12	17	0.8
17	Acacia ataxacantha	7	1	.	4	.	.	.	.	4	.	2	.	2	2	2	3	2	.	4	.	2	12	35	1.7
28	Vissandula amplissima	7	6	1	.	.	3	2	.	3	.	.	3	1	1	.	1	4	4	.	.	.	12	36	1.7
21	Brachiaria lata	6	6	2	.	.	2	.	9	.	.	.	.	6	7	7	8	.	.	.	3	3	11	59	2.8
19	Tacca involucrata	.	1	1	3	2	2	1	.	.	.	.	1	.	5	2	2	.	.	.	.	.	10	20	1.0
7	Bombax costatum	.	1	.	1	3	.	.	.	.	6	3	.	.	.	.	.	1	4	2	.	.	8	18	0.9
9	Andropogon gayanus	3	2	.	.	.	.	1	2	.	.	.	.	.	.	1	.	2	2	3	.	.	8	15	0.7
24	Rottboellia exaltata	1	2	.	.	.	4	2	.	.	.	.	1	.	.	.	.	2	6	3	.	.	8	21	1.0
1	Borreria radiata	.	.	.	.	.	.	.	.	2	3	5	.	.	.	.	.	3	.	5	2	2	7	22	1.0
23	Triumfetta pentadra	.	.	.	.	.	.	3	.	.	.	.	.	1	.	3	.	3	3	8	.	2	7	23	1.1
31	Vigna racemosa	.	.	.	.	.	.	.	1	.	.	1	1	1	3	2	.	.	.	3	.	.	7	12	0.6
10	Cyanotis lanata	1	.	.	.	.	.	.	.	4	2	.	.	.	.	.	.	8	4	7	.	.	6	26	1.2
34	Bidens pilosa	1	2	.	.	1	.	.	.	.	.	.	.	.	.	.	1	2	.	3	.	.	6	10.	0.5
3	Cissus *rufescens*	.	.	.	.	.	.	.	.	.	.	.	1	.	.	2	.	2	2	2	.	.	5	9	0.4
48	Indigofera hirsuta	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	3	1	.	1	1	5	13	0.6
58	Cissus quadrangularis	.	2	.	.	.	.	.	.	2	4	2	.	.	.	.	.	2	.	.	.	.	5	12	0.6
69	Celtis integrifolia	.	.	.	.	.	2	.	.	1	3	.	.	.	.	5	.	.	.	.	1	.	5	12	0.6
5	Byroscarpus coccineus	.	.	1	3	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	4	6	0.3
15	Pandiaka heudelotti	.	.	.	.	.	.	.	.	2	2	1	.	.	.	.	.	.	1	.	.	.	4	6	0.3
16	Pennisetum pedicellatum	.	.	.	.	.	.	1	.	.	2	.	.	.	.	.	.	.	.	.	2	2	4	7	0.3
26	*Diospyros mespiliformis*	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	1	.	4	4	0.2
45	Ficus umbellata	.	2	.	.	3	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	4	8	0.4
56	Holarrhenia floribunda	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	3	.	.	.	2	3	4	10.	0.5
57	Ziziphus mucronata	.	.	2	.	.	.	.	.	.	.	.	.	.	1	2	3	.	.	.	.	.	4	8	0.4
77	Lantana rhodesiensis	.	.	.	.	.	.	7	.	2	.	8	8	.	.	.	.	.	.	.	.	.	4	25	1.2
78	Kyllinga squamulata	.	3	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	2	1	4	7	0.3
12	Indigofera dendroides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	2	.	.	3	5	0.2
30	Eulophia quartiniana	.	2	.	.	.	.	.	.	2	.	2	.	.	.	.	.	.	.	.	.	.	3	6	0.3
49	Crotalaria laragutensis	.	.	.	.	.	.	1	.	.	3	.	.	.	.	.	.	.	.	.	.	1	3	5	0.2
68	Solenostemon mannii	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	4	.	.	3	3	9	0.4
73	Sida urens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	2	.	1	3	4	0.2
76	Cyperus digitatus	.	4	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	4	.	3	11	0.5
22	Anogeissus leiocarpus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	6	2	8	0.4
33	Sporobolus pyramidalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	6	2	8	0.4
46	Brachiaria stigmatisata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	3	2	12	0.6
62	Lannea kerstingii	.	.	.	.	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2	3	0.1
81	*Tephrosia pedicellata*	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	2	6	0.3
85	Albizia zygia	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	0.1
86	Solanum torvum	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	2	2	0.1
95	Mariscus alt ernifolius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	7	2	13	0.6
111	Chrysophyllum albidum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	3	2	7	0.3
112	Diospyros abyssinica	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	3	0.1
113	Pycreus macrostachyos	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	3	.	.	.	2	6	0.3
114	*Jussiaea suffruticosa*	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2	.	.	.	2	4	0.2
115	Setaria anceps	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	3	2	5	0.2
116	Corchorus tridens	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2	.	.	.	.	2	4	0.2
117	Trema guineensis	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	3	.	2	7	0.3
118	Ficus exasperata	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	2	4	0.2
119	Eleusine indica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	2	.	2	3	0.1
120	Saba florida	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	2	.	.	.	.	.	2	7	0.3
121	Boerhavia diffusa	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2	.	.	.	.	.	.	2	9	0.4
124	Synedrella nodiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	.	.	.	.	4	2	11	0.5
126	Ensete gilletii	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	3	2	5	0.2

DOMAIN: DUMBI INSELBERG AND ROCKY HILLS - POSITIVE DEFINITE FACTOR 2 FLORISTIC CLUSTER DETERMINANTS

VII.2.

Floristic Community Table 26.1

Dissotis - Achyranthes aspera - Brachiaria lata - Milletia thonningii - Acacia ataxacantha Community

of the lower middle slopes of the Dumbi Inselberg. The community occupies crevices of the steep slopes with shallow soil deposits (Fig. 19). *Plates 60 and 61 illustrate the effect of possible cultivation in the distant* past in this community, suggested, for example, by Ensete gilletii (wild banana) and possibly by Acacia ataxacantha localized thickets within the woodland.

CODE	SPECIES	DOMIN SCORES												EVALUATION		
		20	25	22	21	27	26	23	24	8	10	6	41	I	II	III
3	Cissus rufescens	2	3	5	1	3	1	1	1	6	7	4	6	12	40	3.3
1	Borreria radiata	1	2	2	1	1	2	.	.	2	2	5	4	10	22	1.8
2	Discorea bulbifera	1	2	.	1	1	.	1	1	1	1	2	2	10	13	1.1
16	*Pennisetum pedicellatum*	1	1	1	2	2	1	4	.	2	2	.	.	9	16	1.3
8	Andropogon gayanus	1	3	2	3	3	.	.	.	2	3	.	.	8	20	1.7
5	Byrsocarpus coccineus	1	1	.	1	1	2	.	1	.	1	4	.	8	12	1.0
15	*Pandiaka heudelottii*	1	.	1	1	2	.	.	.	.	2	2	3	7	12	1.0
10	Cynotis lanata	2	.	.	.	1	.	.	4	4	2	3	.	6	16	1.3
12	Indigofera dendroides	.	3	2	.	.	1	.	.	.	2	2	2	6	12	1.0
25	Commiphora africana	1	1	.	.	2	1	.	.	3	.	3	.	6	11	0.9
29	Asparagus africanus	.	.	.	.	1	1	1	1	.	.	1	1	6	6	0.5
14	Tephrosia bracteolata	.	2	.	.	.	3	.	.	2	.	6	2	5	15	1.3
9	Ipomoea involucrata	3	.	1	.	.	1	.	7	.	.	7	.	5	14	1.2
65	Canthium horizontale	3	3	3	1	1	.	.	.	.	.	.	.	5	11	0.9
66	Landolphia sp.	2	1	.	1	2	1	.	.	.	.	.	.	5	7	0.6
67	Lannea barteri	1	1	.	1	.	.	2	1	.	.	.	.	5	6	0.5
7	Bombax custatum	1	1	1	.	1	.	.	1	.	.	.	.	5	5	0.4
74	Bambusa vulgaris	3	.	4	.	.	.	2	4	.	.	.	.	4	13	1.1
35	Hackelochloa granularis	1	.	2	.	.	.	.	.	1	.	8	.	4	12	1.0
23	Triumfetta pentandra	.	.	1	.	.	.	.	1	.	1	.	8	4	11	0.9
46	Brachiaria stigmatisata	.	.	2	.	.	.	.	.	3	2	.	2	4	9	0.8
22	Anogeissus leiocarpus	.	.	.	.	.	.	.	1	1	1	2	.	4	5	0.4
26	Diospyros mespiliformis	1	1	.	.	2	.	.	1	.	.	.	.	4	5	0.4
20	Stereospermum kunthianum	.	.	1	.	1	1	1	.	.	.	.	.	4	4	0.4
37	Allophyllus spicatus	1	1	.	.	1	.	.	1	.	.	.	.	4	4	0.4
59	Setaria pallide-fusca	.	.	.	.	.	.	3	.	.	2	2	.	3	7	0.6
64	Guttenbergia nigritiana	.	1	.	.	.	3	3	.	.	.	.	.	3	7	0.6
89	Isoberlinia doka	3	6	3	.	.	.	.	.	.	.	.	.	3	12	1.0
90	Adenodolichus paniculatus	1	3	3	.	.	.	.	.	.	.	.	.	3	7	0.6
92	Digitaria homblei	.	1	3	2	.	.	.	.	.	.	.	.	3	6	0.5
42	Cassia mimosoides	.	1	1	.	.	.	.	.	.	.	2	.	3	4	0.4
14	Sporobolus festivus	2	1	.	.	.	.	.	3	.	.	.	.	3	6	0.5
75	*Pterocarpus erinaceus*	.	.	1	1	.	.	.	.	2	.	.	.	3	4	0.4
71	Cussonia barteri	.	.	.	.	1	.	.	1	.	.	1	.	3	3	0.3

DOMAIN: DUMBI INSELBERG AND ROCKY HILLS FLORISTIC CLUSTER 4 DETERMINANTS, POSITIVE SEMI-DEFINITE ON FACTOR 1, NEGATIVE ON FACTORS 2 AND 3.

VII.3. Floristic Community Table 26.2

Cissus rufescens - Borreria radiata - Andropogon gayanus - Discorea bulbifera Community

of the sub-summits rocky, very steep slopes of the Dumbi Inselberg. This is an altitudinal-geological continuum of the floristic community 26.1. However, the relative concentration of climbers and scramblers (Discorea and Cissus respectively) plus their relative distribution mainly on the crevices of the very steeply sloping to precipitously sloping sides of the Inselberg, probably makes this a community as indicated by the Cluster Analysis Dendrogram. My RCFA Floristic Ordination of the Synoptic Matrix data strongly indicates a continuum (see the graphical representations of ordination VII, exemplified by axes 1 and 2, 2 and 3, 4 and 5).

CODE	SPECIES	DOMIN SCORES							EVALUATION		
		49	54	51	52	48	53	50	I	II	III
50	Afrotrilepis pilosa	8	5	.	4	8	8	8	6	41	5.8
1	Borreria radiata	6	6	8	7	.	.	.	4	27	3.9
23	Triumfetta pentandra	7	8	4	2	.	.	.	4	21	3.0
43	Sporobolus festivus	2	4	.	1	2	.	.	4	9	1.3
79	Schizachyrium exile	4	8	9	.	2	.	.	4	23	3.3
10	Cynotis lanata	2	2	1	.	.	.	.	3	5	0.7
42	Cassia mimosoides	2	1	.	2	.	.	.	3	5	0.7
32	Scleria foliosa	.	1	1	1	.	.	.	3	3	0.4
49	Crotalaria naragutensis	3	1	.	.	2	.	.	3	6	0.9
63	Sesbania sesban	2	3	.	.	4	.	.	3	9	1.3
80	Monechma ciliatum	.	.	1	2	1	.	.	3	4	0.6
9	Ipomoea involucrata	3	2	.	.	.	.	.	2	5	0.7
17	Acacia ataxacantha	1	.	.	.	1	.	.	2	2	0.3
53	Cassia tora	1	.	.	.	.	.	1	2	2	0.3
91	Euphorbia lateriflora	.	.	.	.	2	.	8	2	10	1.4
122	Urena lobata	2	3	.	.	.	.	.	2	5	0.7
123	Drosera indica	.	.	1	.	.	1	.	2	2	0.3

DOMAIN: DUMBI INSELBERG AND ROCKY HILLS - POSITIVE DEFINITE FACTOR 3 FLORISTIC DETERMINANTS

VII.4. Floristic Community Table 27

Afrotrilepsis pilosa - Borreria radiata - Schizachyrium exile - Triumfetta pentandra - Sporobolus festivus Community

of the Dumbi Inselberg Crest. Soil depths more or less nil, species very few, restricted to highly adapted species: Afrotrilepis sedge grown on small rock pools, and Sporobolus festivus on very thin layers of soils on the flat rock surfaces. Borreria radiata will, however, grow on any site, dry or waterlogged, lateritic or granitic, rich or poor, farmed or unfarmed. It is an ubiquitous ephemeral rainy season forb in the cerado. Plate 59 and parts of Plate 58 illustrates this restricted granitic hill summit plant community.

CODE	SPECIES	DOMIN SCORES												EVALUATION		
		1	2	16	17	6	9	15	7	8	3	5	4	I	II	III
1	Brachiaria stigmatisata	1	1	1	1	2	3	2	2	3	9	9	.	11	34	2.8
14	Eucalyptus camaldulensis	8	8	4	4	7	7	4	.	.	7	6	7	10	62	5.2
2	Sporobolus pyramidalis	4	4	5	3	3	4	4	4	4	4	.	.	10	39	3.3
20	Imperata cylindrica	3	1	7	7	7	7	.	6	2	.	.	.	8	40	3.3
3	Dyschoriste pedicellata	.	.	2	4	.	3	2	6	3	1	.	1	8	22	1.8
11	Triumfetta pentandra	.	.	2	2	3	2	3	3	2	.	.	1	8	18	1.5
5	Fimbristylis pilosa	1	2	.	2	.	2	.	.	1	1	2	2	8	13	1.1
4	Cassia rotundifolia	.	.	.	.	6	2	1	2	.	8	7	9	7	35	2.9
12	Sida urens	.	.	1	1	.	3	2	.	1	2	.	.	6	10	0.8
21	Andropogon gayanus	.	.	.	1	1	.	1	.	1	1	1	.	6	6	0.5
29	Cassia siamae	.	.	.	.	.	2	2	6	3	2	.	.	5	15	1.3
7	Sida rhombifolia	.	.	.	.	2	2	1	.	1	1	.	.	5	7	0.6
9	Waltheria indica	.	.	.	.	.	3	.	1	.	1	2	1	5	8	0.7
8	Phyllanthus nigericus	.	.	.	1	.	1	1	1	1	.	.	.	5	5	0.4
10	Aspilia africana	.	.	1	2	.	.	2	.	.	1	.	1	5	7	0.6
16	Sida linifolia	.	.	.	1	1	.	.	.	.	1	1	1	5	5	0.4
23	Evolvulus alsinoides	.	.	1	1	.	1	.	.	1	.	1	.	5	5	0.4
25	Blepharis linariifolia	.	.	.	.	.	2	1	1	1	.	2	.	5	7	0.6
32	Ageratum conyzoides	.	.	2	1	.	1	1	.	1	.	.	.	5	6	0.5
38	Clerodendrum capitatum	1	.	.	1	.	.	1	1	1	.	.	.	5	5	0.4
17	Borreria verticillata	.	.	.	.	.	.	2	.	.	1	5	3	4	11	0.9
13	Stylochiton lancifolius	.	.	.	1	.	.	2	.	.	.	1	1	4	5	0.4
30	Annona senegalensis	.	.	.	.	1	.	1	.	.	.	2	1	4	5	0.4
27	Schwenckia americana	.	.	1	1	.	2	.	.	1	.	.	.	4	5	0.4
15	Cassia mimosoides	1	.	1	.	1	1	.	.	.	.	.	.	4	4	0.3
34	Setaria anceps	.	.	.	.	1	1	.	.	.	1	1	.	4	4	0.3
36	Eucalyptus citriodora	.	.	4	.	.	.	.	8	8	.	.	.	3	20	1.5
48	Eragrostis turgida	.	.	.	.	.	.	.	.	.	1	3	2	3	6	0.5
47	Guiera senegalensis	.	.	.	.	.	.	.	.	.	1	1	2	3	4	0.3
18	Borreria radiata	.	.	.	.	1	.	3	.	3	.	.	.	3	7	0.6
19	Desmodium barbatum	.	.	.	1	.	1	.	.	5	.	.	.	3	7	0.6
26	Stylosanthes mucronata	.	.	1	.	.	.	.	.	4	.	2	.	3	7	0.6
43	Bidens pilosa	.	.	.	.	.	2	2	.	4	.	.	.	3	8	0.7
44	Indigofera charlieriana	.	.	2	.	.	1	2	.	.	.	.	.	3	5	0.4
33	Carissa edulis	.	.	.	.	3	.	.	1	.	1	.	.	3	5	0.4
40	Cyperus rotundus	.	.	2	.	1	.	1	.	.	.	.	.	3	4	0.3
50	Scoparia dulcis	.	.	.	1	.	1	.	1	.	.	.	.	3	3	0.3
57	Hoslundia opposita	.	.	.	.	2	.	.	1	2	.	.	.	3	5	0.4
6	Eucalyptus teriticornis	.	.	.	4	.	.	4	.	.	.	.	.	2	8	0.7
55	Cynodon dactylon	3	.	.	.	.	.	.	2	.	.	.	.	2	5	0.4
66	Gutenbergia nigritana	.	.	.	.	.	.	.	.	.	.	.	4	2	6	0.5
70	Acacia ataxacantha	.	.	.	.	2	1	.	.	.	.	.	.	2	3	0.3
28	Crotalaria retusa	.	.	.	2	.	.	1	.	.	.	.	.	2	3	0.3
41	Cissus rufescens	.	.	.	.	1	1	.	.	.	.	.	.	2	2	0.2
42	Euphorbia hirta	.	.	1	.	.	.	.	1	.	.	.	.	2	2	0.2
52	Pennisetum pedicellatum	.	.	.	.	.	1	.	.	2	.	.	.	2	3	0.3
53	Mitracarpus scaber	.	.	.	2	.	2	.	.	.	.	.	.	2	4	0.3
65	Diospyros mespiliformis	.	.	.	.	.	.	1	.	.	1	.	.	2	2	0.2
37	Tephrosia purpurea	.	.	1	.	.	.	1	.	.	.	.	.	2	2	0.2
58	Leucas martinicensis	.	.	.	.	.	1	.	.	1	.	.	.	2	2	0.2
74	Tridax procumbens	.	.	.	.	.	.	2	2	.	.	.	.	2	4	0.3
72	Indigofera arrecta	.	.	.	.	1	2	.	.	.	.	.	.	2	3	0.3
73	Asparagus africanus	.	.	1	.	1	.	.	.	.	.	.	.	2	2	0.2
22	Tephrosia pedicellata	.	.	.	1	.	.	.	.	.	1	.	.	2	2	0.2

DOMAIN: MAIRABO FOREST PLANTATION RESERVE: FACTOR 2 FLORISTIC CLUSTER DETERMINANTS

VIII.1. Floristic Community Table 28

Eucalyptus camaldulensis - Imperata cylindrica - Dyschoriste pedicellata Community

in the Mairabo Forestry Plantation. The paucity of undergrowth flora (Plate 39) and the complete distinction of the flora growing under the two main established species on the more or less geomorphologically uniform landscape (Plate 3d) are particularly striking. The two methods used in the analyses (Cluster Analysis and NCFA ordination) separates them into two absolutely distinct communities with absolutely no ecotonal inter-gradation, which is contrary to expectations from a normal cerado vejetation under different land uses. The primary cause for the community distinctions (communities 2d and 29) was apparently in the established species, and probably not in edaphic differences.

CODE	SPECIES	DOMIN SCORES													EVALUATION		
		10	18	20	19	11	12	21	22	23	24	13	14	25	I	II	III
6	Eucalyptus terticornis	8	8	7	8	7	7	7	7	7	7	4	4	8	13	89	6.8
1	Brachiaria stigmatisata	2	2	5	9	5	7	7	9	9	7	8	9	4	13	83	6.4
2	Sporobolus pyramidalis	4	6	2	5	4	4	4	4	5	4	2	1	2	13	55	4.2
3	Dyschoriste pedicellata	2	3	2	4	1	.	2	1	2	4	.	1	2	11	24	1.8
4	Cassia rotundifolia	.	.	.	.	9	9	3	6	8	5	6	5	3	9	54	4.1
7	Sida rhombifolia	.	.	1	1	1	1	2	.	1	2	.	2	3	9	14	1.1
8	Phyllanthus nigericus	1	1	2	1	1	2	1	.	2	.	.	.	1	9	12	0.9
24	Indigofera pulchra	1	1	1	1	2	1	1	.	.	.	2	3	.	9	13	1.0
22	Tephrosia pedicellata	.	2	.	2	.	.	3	1	2	3	.	5	.	8	18	1.4
9	Waltheria indica	1	2	2	.	2	.	.	.	1	.	3	1	1	8	13	1.0
18	Borreria radiata	.	.	.	.	.	.	2	1	3	4	2	1	3	7	16	1.2
19	Desmodium barbatum	.	2	1	1	.	1	2	.	2	2	.	.	.	7	11	0.8
5	Fimbristylis pilosa	2	.	1	2	4	4	.	.	2	.	2	.	.	7	17	1.3
10	Aspilia africana	.	2	.	2	2	.	1	.	.	3	.	2	1	7	13	1.0
13	Stylocniton lancifolius	.	.	1	1	.	1	.	1	.	2	.	4	3	7	13	1.0
28	Crotalaria retusa	1	.	.	.	.	.	.	.	3	3	2	1	2	6	12	0.9
17	Borreria verticillata	1	.	.	.	1	2	2	.	.	.	3	.	1	6	10	0.8
15	Cassia mimosoides	.	.	.	1	1	.	1	.	1	1	.	1	.	6	6	0.5
26	Blepharis linariifolia	.	.	.	.	1	3	.	.	.	.	3	3	1	5	11	0.8
35	Indigofera nummulariifolia	.	1	.	.	.	.	.	1	.	1	3	2	.	5	8	0.6
46	Khaya senegalensis	.	.	.	.	.	.	1	2	1	1	.	.	1	5	6	0.5
31	Dichrostachys glomerata	1	.	.	.	1	2	.	.	1	.	.	.	4	5	9	0.7
12	Sida urens	2	1	.	1	.	.	1	.	.	.	.	.	1	5	6	0.5
16	Sida linifolia	.	.	.	.	.	1	1	.	.	1	.	1	1	5	5	0.4
37	Tephrosia purpurea	.	.	.	.	.	.	.	1	1	1	.	.	5	4	8	0.6
45	Kyllinga squamulata	.	.	.	1	.	.	.	1	1	1	.	.	.	4	4	0.3
11	Triumfetta pentandra	.	.	.	1	2	.	2	.	.	.	.	.	2	4	5	0.4
23	Evolvulus alsinoides	.	1	.	1	.	2	1	.	.	.	.	.	.	4	5	0.4
27	Schwenckia americana	1	.	1	1	.	.	.	.	.	.	.	1	.	4	4	0.3
39	Paspalum orbiculare	.	.	1	.	2	1	.	.	.	.	.	1	.	4	5	0.4
54	Pandiaka heudelotii	.	.	.	1	1	.	2	.	.	.	.	.	1	4	5	0.4
36	Eucalyptus citriodora	.	.	.	.	.	4	.	.	.	.	3	4	.	3	11	0.8
51	Acanthospermum hispidum	.	.	.	.	.	.	.	2	.	2	.	.	2	3	6	0.5
41	Cissus refescens	.	.	.	.	.	.	.	.	.	1	.	1	1	3	3	0.2
42	Euphorbia hirta	.	.	.	.	.	.	1	.	1	.	.	.	2	3	4	0.3
49	Digitaria ciliaris	.	.	1	2	.	.	.	1	.	.	.	.	.	3	4	0.3
62	Dactyloctenium aegyptium	.	.	.	.	.	.	1	1	2	.	.	.	.	3	4	0.3
63	Sida ovata	.	.	.	.	.	.	1	3	.	.	.	.	1	3	5	0.4
21	Andropogon gayanus	.	2	.	.	.	.	1	.	.	.	3	.	.	3	6	0.5
30	Annona senegalensis	.	.	.	.	.	.	.	1	.	1	.	1	.	3	3	0.2
25	Blepharis linariifolia	.	.	1	.	1	.	.	.	.	.	.	.	1	3	3	0.2
60	Jacquemontia tamnifolia	.	.	.	1	.	.	1	1	.	.	.	.	.	3	3	0.2
61	Cassia tora	.	1	1	.	.	.	.	.	.	.	.	.	1	3	3	0.2

Incidental species with ACV of two are: (29) Cassia siamea, (32) Ageratum conyzoides, (34) Setaria anceps, (40) Cyperus rotundus, (43) Bidens pilosa, (44) Indigofera charlieriana, (53) Mitracarpus scaber, (59) Nelsonia canescens, (52) Pennisetum pedicellatum, (75) Piliostigma thonningii, (78) Fadogia agrestis, (79) Chrysanthelum americanum, and (80) Brachiaria xantholeuca.

DOMAIN: MAIRABO FOREST PLANTATION RESERVE - FACTOR 1 FLORISTIC CLUSTER DETERMINANTS.

VIII.2. Floristic Community Table 29

Eucalyptus terticornis - Brachiaria stigmatisata - Sporobolus pyramidalis - Dyschoriste pedicellata Community

This community is contiguous with Community 28 on the landscape in the Mairabo forestry plantation However, the two Eucalyptus species appeared to have changed the specific composition of the undergrowths. For the time of the year in which the Mairabo Eucalyptus plantation reserve was surveyed, the undergrowth specific diversity was low. (It was surveyed in July.) That Eucalyptus camaldulensis and E. terticornis appear to inhibit the growth of some potential undergrowth species and promote the growth of others, is suggested by comparing Communities 28 and 29.

| CODE | SPECIES | DOMIN SCORES | | |

CODE	SPECIES	DOMIN SCORES																													EVALUATION		
		52	59	73	81	91	92	5	6	7	29	30	39	55	40	66	31	47	56	49	47	48	58	11	26	15	41	23	32	4	50	I	II	III
2	Brachiaria stigmatisata	3	1	4	9	9	8	6	4	5	5	7	7	8	8	8	8	8	7	7	6	5	8	7	6	8	9	8	8	4	8	30	203	6.7
15	Eucalyptus camaldulensis	.	8	7	5	6	5	8	8	8	4	6	6	4	8	4	5	3	8	3	5	2	6	.	2	2	3	8	1	4	1	4	27	168	5.6
16	Borreria verticillata	1	2	.	1	1	.	3	5	7	6	8	9	9	4	5	3	7	3	3	7	7	5	6	7	6	4	5	7	3	4	.	27	99	3.3
1	Cassia rotundifolia	.	.	.	3	.	7	7	7	8	8	2	.	2	4	1	1	4	3	4	3	4	4	1	2	5	3	3	1	2	7	2	25	165	5.5
5	Guttenbergia nigritana	6	2	.	.	.	.	5	3	4	3	2	2	4	6	.	3	6	4	4	4	6	4	6	3	.	5	3	1	1	3	2	25	81	2.7
8	Stylosanthes mucronata	2	4	1	.	.	.	6	3	4	2	2	2	2	2	2	1	2	2	2	3	4	2	2	7	3	.	.	1	.	8	5	25	87	2.9
3	Stylochiton lancifolius	.	.	1	6	4	4	4	3	2	2	4	6	2	2	2	2	1	2	2	3	4	5	2	4	3	1	1	.	5	3	24	72	2.4
10	Blepharis linariifolia	.	2	3	.	.	2	2	3	2	4	4	2	.	2	2	3	1	3	3	4	3	3	2	1	1	3	3	2	1	.	2	24	65	2.2
9	Indigofera pulchra	1	.	.	2	.	.	1	.	1	3	3	1	3	3	7	1	3	1	3	3	3	7	1	6	1	3	3	3	1	6	4	24	50	1.7
29	Zornia glochidiata	.	.	.	1	5	.	6	4	3	4	4	8	7	6	7	.	6	.	8	8	4	3	3	2	3	3	2	2	3	4	3	23	116	3.9
14	Aspilia africana	1	1	.	.	.	.	3	4	3	3	4	5	2	2	1	5	4	3	4	4	3	3	2	6	2	.	.	1	2	.	.	23	51	1.7
4	Fimbristylis ovata	4	.	.	1	.	.	2	2	3	3	2	2	3	3	2	.	5	5	3	3	3	2	3	3	.	3	1	1	2	1	.	22	68	2.3
6	Fimbristylis pilosa	2	.	.	.	.	.	.	1	2	3	3	2	3	1	.	.	3	2	1	1	2	1	1	1	.	3	1	1	2	1	.	21	54	1.8
12	Waltheria indica	.	1	.	4	1	.	1	1	2	2	2	2	3	2	1	.	4	1	1	1	.	3	1	1	.	1	1	.	2	.	1	21	38	1.3
25	Terminalia avicennioides	.	.	.	.	.	.	1	1	2	2	.	1	.	1	.	2	1	1	2	2	1	.	2	3	3	3	3	4	2	2	20	31	1.0
17	Paspalum orbiculare	2	.	.	3	.	.	1	2	2	.	.	1	.	1	.	1	2	2	3	4	2	2	1	3	2	3	1	3	4	.	.	20	38	1.3
22	Evolvulus alsinoides	2	.	.	2	.	1	1	2	.	.	.	1	.	1	.	1	1	2	4	3	2	1	2	3	2	.	3	.	.	3	1	20	41	1.4
13	Sida rhombifolia	.	.	3	3	.	1	1	2	.	.	1	1	1	.	.	.	1	1	1	.	.	.	.	1	.	.	1	4	2	5	1	19	37	1.2
7	Sporobolus pyramidalis	1	5	8	5	1	1	1	.	.	2	3	2	3	1	2	1	2	.	.	3	2	1	.	.	2	.	.	2	3	4	1	18	41	1.4
1	Dyschoriste perrottetii	6	1	.	.	.	.	.	.	.	3	2	1	1	.	3	.	.	2	4	.	3	2	4	.	2	1	.	.	2	3	4	17	40	1.3
32	Indigofera nummulariifolia	.	.	.	.	.	2	3	6	4	.	3	.	1	.	3	.	.	2	4	.	2	4	.	2	1	.	.	5	4	1	1	2	17	50	1.7
31	Fadogia agrestis	.	.	.	2	1	.	2	2	2	1	1	2	1	.	.	.	1	.	.	1	2	.	1	.	.	.	.	1	.	.	.	15	23	0.8
46	Schweinckia americana	.	1	.	.	.	.	1	.	1	.	1	1	2	1	1	1	.	2	2	1	1	2	.	1	.	3	1	6	.	5	2	5	15	19	0.6
26	Brachiaria jubata	.	.	.	.	.	.	4	3	.	1	1	.	.	.	1	1	1	1	.	2	.	1	1	.	.	.	.	.	1	.	.	.	13	35	1.2
35	Annona senegalensis	.	.	1	.	1	2	.	.	.	.	.	1	.	1	1	.	1	.	1	.	3	1	3	2	1	.	2	.	.	.	.	.	13	13	0.4
38	Pandiaka heudelotii	.	.	2	6	3	.	5	.	.	.	.	.	.	.	.	2	.	.	.	1	.	.	.	.	2	.	.	3	.	2	3	1	13	20	0.7
36	Tephrosia pedicellata	6	1	.	2	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	1	.	3	6	.	2	4	.	3	1	1	12	34	1.1
19	Borreria radiata	2	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	1	2	.	.	4	.	.	4	.	2	11	29	0.9
28	Triumfetta dubia	1	.	.	.	.	.	.	.	.	1	.	1	2	2	.	.	.	.	.	.	2	1	.	.	.	.	.	6	5	5	1	2	11	22	0.7
20	Setaria anceps	2	3	.	1	1	.	.	.	.	.	1	.	.	.	1	.	2	.	.	.	.	2	.	2	2	.	.	.	1	.	.	11	29	1.0
30	Cassia mimosoides	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	2	.	1	1	2	3	.	2	11	16	0.5
61	Sporobolus festivus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	1	.	.	.	.	.	1	1	1	11	12	0.4
27	Tacca involucrata	.	1	1	.	.	1	.	1	.	.	.	.	.	.	.	.	1	1	.	.	.	1	1	.	.	.	.	1	1	.	4	11	11	0.4
34	Cissus rufescens	.	1	1	.	.	1	.	.	.	.	.	1	1	1	.	.	.	1	1	.	1	.	1	1	.	.	1	.	.	.	1	10	13	0.4
48	Piliostigma thonningii	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	1	2	1	1	1	.	.	1	.	.	.	.	.	.	.	.	10	10	0.3
65	Gardenia erubescens	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	1	2	1	1	1	.	1	.	.	.	.	.	.	.	.	10	10	0.4
24	Hyperthelia dissoluta	.	.	.	.	.	.	1	.	1	1	1	.	.	.	.	2	.	.	.	.	3	.	1	5	.	2	2	.	.	8	.	10	19	0.6
51	Eucalyptus terticornis	.	8	.	.	.	.	.	2	2	4	.	.	.	.	.	.	8	8	8	8	8	.	.	.	.	.	.	.	.	.	.	9	68	2.3
45	Guiera senegalensis	.	.	.	.	.	.	2	2	3	1	.	.	.	.	.	.	.	.	.	3	.	1	1	.	.	.	.	.	2	.	.	9	16	0.5
21	Sida urens	.	2	1	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	1	2	2	9	13	0.4
55	Entada africana	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	1	.	.	.	.	.	.	.	.	9	9	0.3
62	Combretum ghasalense	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	9	9	0.3
43	Scoparia dulcis	.	1	.	.	.	.	.	.	.	1	1	.	.	1	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	8	13	0.4
40	Asparagus africanus	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	8	8	0.3
18	Isoberlinia doka	4	.	5	.	.	.	1	.	.	7	.	.	.	.	.	.	.	.	.	.	.	.	.	5	6	.	.	5	2	.	.	7	35	1.2
67	Dactyloctenium aegyptium	.	.	.	2	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	5	7	21	0.7
54	Chrysanthellum americanum	2	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	4	.	.	.	.	2	3	1	1	7	16	0.5
23	Andropogon gayanus	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.	.	.	.	2	.	2	7	11	0.4
39	Sida linifolia	.	.	.	.	1	.	.	.	.	.	.	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	7	7	0.2
49	Bridelia ferruginea	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1	1	7	7	0.2
63	Cassia singueana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	1	.	2	7	8	0.3
74	Combretum sericeum	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.	1	.	.	.	.	.	1	.	1	2	.	.	.	1	.	.	7	7	0.2
33	Dichrostachys glomerata	1	.	.	.	.	.	1	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	3	.	.	5	1	2	1	.	4	7	8	0.3
64	Eragrostis turgida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	1	.	1	.	.	.	.	.	.	6	16	0.5
60	Crotalaria senegalensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	2	.	.	.	.	.	.	.	.	.	2	.	6	6	0.2
90	Acanthospermum hispidium	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	1	1	6	10	0.3
53	Diospyros mespiliformis	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	1	.	1	.	6	6	0.2
58	Hoslundia opposita	.	2	1	1	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	1	.	6	7	0.2
52	Ochna afzelii	.	.	.	.	.	.	.	.	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	.	6	6	0.2
59	Nauclea latifolia	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	1	.	1	.	.	.	.	.	.	.	1	1	1	.	.	.	6	6	0.2
77	Lactuca taraxacifolia	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	5	5	0.2
84	Kitracarpus scaber	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	1	.	.	1	1	.	.	.	1	1	.	.	.	.	.	.	5	5	0.2
91	Psorospermum corymbiferum	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	5	5	0.2
47	Gloriosa superba	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2	4	4	0.1
73	Stereospermum kunthianum	.	1	.	.	.	.	.	.	.	1	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	5	0.2
71	Pterocarpus erinaceus	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	.	4	4	0.1
80	Securidaca longipedunculata	.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	4	4	0.1
57	Eragrostis gigantica	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	0.1
81	Kyllinga squamulata	.	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	1	.	.	.	.	1	4	5	0.2
44	Daniellia oliveri	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	4	4	0.1
96	Crombretum glutinosum	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	1	.	.	1	1	.	.	.	.	1	.	4	5	0.2
83	Euphorbia hirta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	4	4	0.1
86	Kaempferia aethiopica	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	0.1
88	Cyperus dilatatus	.	.	.	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	4	0.1
101	Digitaria ciliaris	.	.	.	1	1	2	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	2	3	6	0.2
117	Cyperus obtusiflorus	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	3	3	0.1
116	Momecha ciliatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	1	.	.	3	3	0.1
98	Stachytarpheta augustifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	0.1
94	Cochlospermum tinctorium	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	0.1
107	Vitex simplicifolia	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	3	3	0.1
108	Crotalaria naragutensis	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	1	.	.	1	3	3	0.1
104	Piliostigma reticulatum	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	3	5	0.2
75	Urginea altissima	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	1	3	4	0.1
79	Gladiolus gregarius	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	3	3	0.1
42	Triumfetta pentandra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	3	3	0.1
37	Desmodium barbatum	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	3	3	0.1

DOMAIN: KABAMA FOREST PLANTATION RESERVE - FACTOR 2 FLORISTIC DETERMINANTS.

IX.2. Floristic Community Table 31

Eucalyptus camaldulensis - Brachiaria stigmatisata - Borreria verticillata - Cassia rotundifolia - Zornia glochidiata Community

of forest plantations made in 1968 and 1969 on the Kabama reserve.

CODE	SPECIES	DOMIN SCORES										EVALUATION		
		8	9	18	17	19	16	20	10	21	22	I	II	III
70	Eucalyptus citriodora	8	8	8	7	8	8	8	8	8	8	10	79	7.9
1	Cassia rotundifolia	6	6	6	8	9	7	3	2	2	7	10	56	5.6
2	Brachiaria stigmatisata	3	2	5	3	5	6	6	5	8	9	10	52	5.2
4	Fimbristylis ovata	4	4	5	5	4	7	4	2	2	2	10	39	3.9
10	Blepharis linariifolia	4	7	4	3	3	3	7	7	7	5	10	50	5.0
5	Guttenbergia nigritana	3	4	3	4	1	6	2	1	4	2	10	30	3.0
13	Sida rhombifolia	3	2	2	2	1	1	1	3	1	1	10	17	1.7
8	Stylosanthes mucronata	2	1	1	3	1	6	1	4	2	2	10	23	2.3
21	Sida urens	1	1	1	2	1	1	1	1	1	1	10	11	1.1
18	Isoberlinia doka	2	5	7	4	5	5	5	1	2	.	9	36	3.6
3	Stylochiton lancifolius	2	2	.	4	2	3	5	6	6	3	9	33	3.3
7	Sporobolus pyramidalis	3	1	3	2	3	2	.	1	1	1	9	17	1.7
6	Fimbristylis pilosa	2	1	2	2	2	2	2	.	1	2	9	16	1.6
11	Dyschoriste perrottetii	2	4	2	.	1	2	7	.	4	1	8	23	2.3
41	Pennisetum pedicellatum	5	3	4	3	2	.	2	.	1	2	8	22	2.2
17	Paspalum orbiculare	2	2	3	2	.	3	2	1	.	2	8	17	1.7
23	Andropogon gayanus	1	2	.	1	2	2	2	1	.	1	8	12	1.2
20	Setaria anceps	1	1	2	2	1	1	3	.	.	.	7	11	1.1
16	Borreria verticillata	2	1	1	.	1	2	1	.	.	2	7	10	1.0
24	Hyperthelia dissoluta	.	1	2	1	1	.	1	.	1	1	7	8	0.8
14	Aspilia anceps	2	.	.	2	1	2	2	.	1	2	7	12	1.2
22	Evolvulus alsinoides	.	.	1	2	.	1	.	2	2	2	6	10	1.0
26	Brachiaria jubata	.	.	2	1	2	2	1	.	.	3	6	11	1.1
19	Borreria radiata	.	.	1	1	1	1	1	.	1	.	6	6	0.6
39	Sida linifolia	.	1	1	1	1	1	.	.	.	1	6	6	0.6
28	Triumfetta dubia	1	1	1	1	1	.	.	.	.	.	5	5	0.5
30	Cassia mimosoides	.	1	.	1	1	1	1	.	.	.	5	5	0.5
29	Zornia glochidiata	.	.	.	.	.	.	3	2	2	2	4	9	0.9
33	Dichrostachys glomerata	1	.	.	1	.	.	.	.	1	1	4	4	0.4
9	Indigofera pulchra	1	.	1	.	1	.	.	.	.	1	4	4	0.4
43	Scoparia dulcis	1	.	.	.	1	1	.	1	.	.	4	4	0.4
59	Nauclea latifolia	3	2	.	.	.	.	1	.	.	.	3	6	0.6
36	Tephrosia pedicellata	.	.	.	.	2	.	2	1	.	.	3	5	0.5
27	Tacca involucrata	.	.	1	1	.	.	.	.	.	1	3	3	0.3
46	Schwenckia americana	.	.	.	1	1	.	.	1	.	.	3	3	0.3
47	Gloriosa superba	1	.	.	.	1	.	.	.	1	.	3	3	0.3
72	Hypoxis augustifolia	.	1	1	.	.	.	.	1	.	.	3	3	0.3
52	Ochna afzelii	.	1	1	.	.	.	.	1	.	.	3	3	0.3
40	Asparagus africanus	.	.	.	.	.	.	.	1	.	2	2	3	0.3
31	Fadoga agrestis	.	.	.	.	.	.	.	.	1	1	2	2	0.2
35	Annona senegalensis	1	1	.	.	.	.	.	.	.	.	2	2	0.2
73	Stereospermum kunthianum	.	.	.	.	.	.	1	.	1	.	2	2	0.2
80	Securidaca longepedunculata	.	.	.	.	.	2	.	.	.	1	2	3	0.3
56	Khaya senegalensis	.	.	.	1	.	1	.	.	.	.	2	2	0.2
38	Pandiaka heudelotii	.	.	.	.	1	.	.	1	.	.	2	2	0.2
54	Chrysanthellum americanum	.	.	.	.	.	1	3	.	.	.	2	4	0.4
71	Pterocarpus erinaceus	1	.	.	.	.	.	.	.	.	1	2	2	0.2

DOMAIN: *KABAMA EUCALYPTUS PLANTATION RESERVE - FLORISTIC CLUSTER FACTOR 3*

IX.3. Floristic Community Table 32

Eucalyptus citriodora - Cassia rotundifolia - Brachiaria stigmatisata - Blepharis linariifolia - Stylochiton lancifolius - Isoberlinia doka Community

under the 1968 and 1969 Kabama plantations. The distinction and the compactness of this community loading on the example graphical ordination

scatter diagram IX. axes 2 and 3(C) suggests the relative floristic

CODE	SPECIES	DOMIN SCORES															EVALUATION		
		1	2	3	61	13	14	28	37	36	38	60	62	63	65	64	53	I	II	III
4	Fimbristylis ovata	2	1	4	2	1	2	2	4	4	4	4	3	2	4	4	4	16	47	2.9
5	Guttenbergia nigritana	2	3	5	3	3	3	1	1	3	2	5	4	2	2	2	4	16	45	2.8
7	Sporobolus pyramidalis	3	2	.	2	1	1	2	1	2	1	4	1	2	1	1	3	15	27	1.7
1	Cassia rotundifolia	1	.	8	2	2	4	4	4	8	7	.	6	4	7	7	2	14	66	4.1
3	Stylochiton lancifolius	2	3	6	3	.	1	1	3	3	3	3	.	1	1	3	3	14	36	2.3
11	Dyschoriste perrottetii	1	1	.	2	.	1	3	3	3	3	3	3	5	1	3	3	14	35	2.2
10	*Blepharis linariifolia*	1	1	2	3	.	.	3	1	3	2	2	2	3	3	2	.	13	28	1.8
16	Borreria verticillata	1	1	1	.	2	1	1	2	1	3	.	1	.	2	1	1	13	18	1.1
51	Eucalyptus teriticornis	8	8	8	8	8	8	8	8	7	7	8	6	.	.	.	.	12	92	5.8
6	Fimbristylis pilosa	.	.	.	2	4	.	2	3	3	4	3	2	1	2	2	2	12	30	1.9
9	Indigofera pulchra	1	.	.	1	1	1	2	.	1	.	1	2	2	2	3	2	12	19	1.2
21	Sida urens	1	1	2	.	1	1	1	.	2	2	2	.	1	1	2	.	12	17	1.1
17	Paspalum orbiculare	1	2	1	.	1	.	1	1	1	1	1	.	.	2	1	1	12	14	0.9
31	Fadogia agrestis	.	1	1	1	1	1	1	.	.	.	.	1	1	1	2	1	11	13	0.8
8	Stylosanthes mucronata	.	.	2	1	2	1	1	2	.	3	1	5	.	4	1	.	11	23	1.4
14	Aspilia africana	.	.	1	1	1	.	2	2	1	2	3	1	3	.	3	.	11	20	1.3
18	Isoberlinia doka	.	3	1	3	.	.	3	4	4	1	1	5	.	.	.	3	10	28	1.8
12	Waltheria indica	.	.	.	2	1	1	.	1	.	1	1	2	1	1	.	1	10	12	0.8
13	Sida rhombifolia	1	.	4	.	.	1	2	1	3	2	.	1	1	1	.	.	10	17	1.1
2	Brachiaria stigmatisata	.	.	.	.	.	.	.	2	6	5	5	5	4	5	4	7	9	42	2.6
19	Borreria radiata	.	.	.	2	1	1	1	1	2	1	2	.	1	.	.	.	9	12	0.8
25	Terminalia avicennioides	.	.	.	.	1	1	1	.	1	1	.	1	1	2	1	.	9	10	0.6
22	Evolvulus alsinoides	.	.	.	.	.	2	.	.	2	.	1	1	1	1	2	3	8	13	0.8
24	Hyperthelia dissoluta	.	.	1	.	1	1	1	2	2	.	.	1	2	.	.	.	8	11	0.7
20	Setaria anceps	.	.	.	2	1	1	1	1	1	1	2	.	.	.	.	.	8	10	0.6
35	Annona senegalensis	.	.	.	1	1	1	.	1	.	1	.	.	1	.	1	1	8	8	0.5
23	Andropogon gayanus	1	.	.	4	1	.	.	.	.	.	.	1	1	1	2	.	7	11	0.7
47	Gloriosa superba	.	.	.	.	1	1	1	1	.	2	.	1	1	.	.	.	7	8	0.5
41	Pennisetum pedicellatum	.	.	.	2	.	2	.	.	1	.	.	2	2	.	1	.	6	10	0.6
48	Piliostigma thonningii	.	.	.	.	1	.	.	.	.	1	.	1	1	1	1	.	6	6	0.4
34	Cissus *rufescens*	.	1	.	.	.	.	.	1	1	.	1	1	.	.	.	1	6	6	0.4
50	Carissa edulis	1	.	.	.	.	1	1	.	.	.	1	.	.	1	1	.	6	6	0.4
30	Cassia mimosoides	1	.	1	1	.	.	.	.	.	.	.	1	.	1	.	1	6	6	0.4
59	Nauclea latifolia	2	3	2	.	.	.	.	1	.	.	.	.	.	1	.	.	5	9	0.6
45	Guiera senegalensis	.	.	.	.	2	2	.	.	.	1	.	.	1	1	.	.	5	7	0.4
54	Chrysanthellum americanum	.	.	1	1	.	.	1	.	.	.	1	.	.	.	.	1	5	4	0.3
28	Triumfetta dubia	.	.	.	1	1	.	.	1	.	.	.	2	.	.	1	.	5	6	0.4
32	Indigofera nummulariifolia	.	.	.	1	.	1	.	1	.	.	1	1	.	.	.	.	5	5	0.3
27	Tacca involucrata	.	.	.	.	.	1	1	1	1	2	.	.	.	.	.	.	5	6	0.4
33	Dichrostachys glomerata	.	.	.	1	1	1	.	.	.	.	.	.	.	1	.	.	4	4	0.3
49	Bridelia ferruginea	.	.	.	.	.	.	.	1	1	.	.	.	1	1	.	.	4	4	0.3
60	Crotalaria senegalensis	.	.	.	.	.	.	1	.	.	1	1	1	.	.	.	.	4	4	0.3
40	Asparagus africanus	.	.	.	.	.	1	.	.	1	.	.	.	1	1	.	.	4	4	0.3
26	Brachiaria jubata	.	1	.	.	.	.	.	.	.	.	.	1	.	1	.	2	4	5	0.3
55	Entada africana	.	.	.	.	1	.	.	.	.	1	.	1	.	.	.	.	3	3	0.3
63	Cassia sinjueana	.	.	.	.	.	1	.	.	.	.	.	.	1	1	.	.	3	3	0.3
68	Vitex doniana	.	.	.	.	1	.	.	2	.	.	.	.	1	.	.	.	3	4	0.3
52	Ochna afzelii	.	1	.	.	.	.	1	.	.	1	.	.	.	.	.	.	3	3	0.3
42	*Triumfetta pentandra*	.	.	.	.	1	.	.	1	.	.	1	.	.	.	.	.	3	3	0.3
86	Kaempferia aethiopica	.	.	.	.	.	.	2	1	1	.	.	.	.	.	.	.	3	4	0.3
87	Jasminum dichotomum	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	3	3	0.3
94	Cochlospermum tinctorium	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	.	3	3	0.3

Associated species with ACV of two are: (37) Desmodium barbatum, (39) Sida linifolia, (46) Schwenckia americana, (72) Hypoxis anjustifolia, (62) Combretum ghasalense, (74) Combretum sericeum, (73) Stereospermum kunthianum, (78) Curculigo pilosa, (79) Gladiolus dalenius, (66) Clerodendron capitatum, (53) Diospyros mespiliformis, (56) Khaya senegalensis, (43) Acacia dudgia, (44) Daniellia oliveri, (30) Tephrosia pedicellata, (27) Cornus glochidiata, (82) Eragrostis tremula, and (85) Parkia clappertoniana.

DOMAIN: KABUMA EUCALYPTUS PLANTATION RESERVE - FLORISTIC CLUSTER 4 DETERMINANTS, POSITIVE DEFINITE ON HCFA AXIS 4.

IX.4. *Floristic Community Table 33*

Eucalyptus teriticornis - Cassia rotundifolia - Fimbristylis ovata - Guttenbergia nigritana Community

The first establishment was made during 1968 and 1969. There was no plantation in 1970. From 1971 to 1977, additional plantations were established annually. The continuum indicated by this community on the example graphical representation of HCFA floristic ordination of the synoptic matrix data IX, axes 1 and 4(D) therefore reflects both the distinction of this community under E. teriticornis as well as the trend of floral change from 1968 to 1977.

CODE	SPECIES	DOMIN SCORES																EVALUATION		
		1	3	4	17	19	12	13	20	14	15	16	23	24	18	5	26	6	I	II	III
28	Eucalyptus camaldulensis	7	6	7	8	8	8	8	7	7	7	7	5	4	8	7	2	7	17	113	6.6
7	Andropogon gayanus	2	2	2	4	5	8	7	7	8	7	5	4	5	2	2	7	4	17	81	4.8
1	Pennisetum pedicellatum	7	6	8	4	7	2	3	3	4	4	3	3	3	5	5	2	.	16	69	4.1
34	Eucalyptus citriodora	4	3	3	4	4	4	4	4	3	4	4	3	3	5	6	1	.	16	59	3.5
3	Isoberlinia doka	5	6	5	5	5	2	.	3	4	5	3	7	5	5	.	2	1	15	63	3.7
10	Aspilia africana	1	1	1	.	2	1	3	1	1	.	.	1	1	.	1	.	1	12	15	0.9
5	Andropogon pseudapricus	3	8	.	.	.	1	.	.	2	2	2	2	3	.	8	4	5	11	40	2.4
2	Dichrostachys glomerata	1	1	2	1	.	.	.	.	1	1	.	2	1	1	.	1	1	11	13	0.8
12	Indigofera pulchra	.	1	.	.	.	1	.	2	1	4	3	2	2	.	.	1	2	10	19	1.1
13	Isoberlinia tomentosa	.	.	2	.	1	2	4	1	.	.	.	.	2	.	4	3	4	9	23	1.4
8	Piliostigma thonningii	.	1	1	1	.	.	.	.	.	1	2	.	.	1	.	1	1	8	9	0.5
6	Borreria radiata	1	1	.	.	.	.	.	.	.	2	.	1	2	.	2	3	.	7	19	1.1
19	Sporobolus pyramidalis	2	.	1	3	3	.	.	3	.	.	2	.	.	.	.	.	.	6	14	0.8
4	Terminalia avicennioides	1	1	.	2	.	.	.	.	.	.	.	.	.	1	1	1	.	6	7	0.4
16	Cochlospermum tinctorium	.	.	.	.	.	1	1	.	.	.	.	.	1	.	1	1	.	5	5	0.3
36	Monechma ciliatum	4	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	1	4	7	0.4
33	Dyschoriste perrottetii	.	.	.	.	.	2	.	1	.	.	.	.	.	.	.	1	.	3	4	0.2
63	Securidaca longipedunculata	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	3	3	0.2
37	Swartzia madagascariensis	.	.	.	.	1	.	.	.	.	.	1	.	1	.	.	.	.	3	3	0.2
29	Afrormosia laxiflora	.	1	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	3	3	0.2
15	Ctenium newtonii	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	2	.	3	4	0.2
9	Annona senegalensis	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3	3	0.2

Associated species having an absolute constancy value (ACV) of two are: (14) Butyrospermum paradoxum, (17) Lannea schimperi, (21) Combretum ghasalense, (26) Strychnos spinosa, (30) Sida ovata, (72) Trichilia emetica, (69) Indigofera capitata, (98) Sida linifolia, (87) Desmodium barbatum, (46) Lippia chevalieri, (53) Parinari curatellifolia, (50) Urelytrum muricatum, (55) Anogeissus leiocarpus, (44) Eragrostis tremula, (18) Ximenia americana, (23) Stylosanthes mucronata, (40) Borreria verticillata, (61) Imperata cylindrica, (11) Ellonurus pobeguinii, (137) Commiphora africana, and (77) Pilia celtidifolia.

DOMAIN: GUGA PLANTATION RESERVE AND ENCLAVE - FLORISTIC CLUSTER 1 DISTINCTIVELY HIGHLY POSITIVE-DEFINITE ON FACTOR 1 OF RCFA ORDINATION.

X.1. Floristic Community Table 34

Eucalyptus camaldulensis - Eucalyptus citriodora - Andropogon gayanus - Pennisetum pedicellatum Community

In Guga Forest Reserve plantations, established in 1971 and 1972. Analyses suggest that the community is very distinct from the indigenous vegetation quadrats as a result of forestry land use (see example Graphical Representation RCFA Floristic Ordination Synoptic matrix X, Axes 1 and 2 (A). The analyses were based on systematic sampling crossing the 'catenary' landscape changes and traversing the plantations as well as the the indigenous vegetation types (Plate 40), along a landscape similar to my Fig. 20, in February. The comparison of Community 34 with Communities 34 to 37 which occupy sites marked "unplantable" because the soils were too poor for the Forestry indicates that undergrowths are more diverse than under Eucalyptus.

CODE	SPECIES	DOMIN SCORES																										EVALUATION		
		8	9	40	22	30	87	64	68	82	83	70	84	57	50	63	88	85	86	59	60	76	79	34	38	67	65	I	II	III
1	Pennisetum pedicellatum	2	1	3	4	2	.	4	6	3	7	3	6	4	5	2	3	4	4	3	.	.	3	2	2	4	1	23	75	2.9
3	Isoberlinia doka	5	4	5	5	2	.	.	5	2	2	3	.	3	6	6	5	7	4	4	6	.	.	.	5	.	6		19	90	3.8
2	Dichrostachys glomerata	.	3	.	3	1	1	4	.	1	3	.	.	2	3	4	4	3	4	.	.	4	1	6	4	8	3	19	60	2.3
5	Andropogon pseudapricus	3	1	.	3	2	1	.	.	.	.	.	.	2	4	3	4	5	2	2	3	4	4	2	2	2	.	18	48	1.8
6	Borreria radiata	1	1	.	2	1	.	.	1	2	2	.	.	1	1	.	.	2	1	.	1	6	3	1	1	1	3	18	31	1.2
57	Bridelia ferruginea	.	.	1	.	.	1	1	1	1	1	1	.	.	1	1	1	1	1	.	1	1	.	.	1	1		17	17	0.7
8	Piliostigma thonningii	1	.	1	1	.	1	4	.	.	.	1	1	1	1	2	1	1	.	1	2	3	2	.	.	.	.	16	24	0.9
4	Terminalia avicennioides	.	.	.	1	.	1	.	1	.	1	.	3	2	.	3	1	1	1	1	2	.	.	1	.	1	1	15	21	0.8
7	Andropogon gayanus	2	1	2	4	.	.	.	.	.	.	1	.	.	1	1	.	.	2	.	1	1	.	1	3	2	1	14	23	0.9
22	Waltheria indica	.	.	.	2	1	.	.	.	.	.	1	1	2	.	3	1	1	1	1	.	1	2	.	1	.	.	13	18	0.7
9	Annona senegalensis	.	.	.	.	.	.	.	1	1	1	.	2	.	.	.	1	.	1	.	1	.	1	1	.	.	1	10	11	0.4
18	Ximenia americana	3	1	1	1	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	2	.	.	8	11	0.4
12	Indigofera pulchra	1	.	1	.	.	.	1	.	.	.	.	.	.	.	1	.	.	1	3	.	1	.	.	.	.	1	8	10	0.4
44	Eragrostis tremula	.	.	.	1	.	.	.	.	3	3	.	3	.	.	.	.	3	.	2	.	.	.	.	.	.	1	7	16	0.6
21	Combretum ghasalense	1	.	.	.	1	1	.	.	.	.	.	2	.	.	.	.	.	2	.	.	.	1	1	.	.	.	7	9	0.3
43	Aristida funiculata	.	.	.	.	1	.	.	.	.	.	.	.	4	1	.	2	.	.	.	.	1	2	.	.	.	2	7	13	0.5
14	Butyrospermum paradoxus	1	.	.	.	.	1	.	.	.	.	1	.	.	1	.	.	.	1	.	.	1	.	.	1	.	.	7	7	0.3
40	Borreria verticillata	.	.	.	.	.	.	1	2	.	.	3	7	.	.	.	1	.	.	1	1	.	.	.	.	.	.	7	16	0.6
11	Elionurus pobeguinii	1	1	2	.	.	.	.	.	.	.	.	.	6	1	.	2	.	.	.	.	.	.	.	1	.	.	7	14	0.5
23	Stylosanthes mucronata	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	2	2	3	4	7	17	0.7
75	Schwenckia americana	.	.	.	.	.	2	.	.	2	2	1	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	6	9	0.3
60	Microchloa indica	.	4	.	3	2	2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	3	.	6	15	0.6
10	Aspilia africana	2	.	.	1	.	.	.	.	.	.	.	.	1	.	.	1	1	1	.	.	.	.	.	.	.	.	6	7	0.3
30	Sida ovata	.	1	1	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	6	7	0.3
47	Nelsonia canescens	.	.	.	.	.	.	5	4	.	1	3	.	.	.	.	1	1	1	.	.	.	.	.	.	.	1	5	17	0.7
56	Knaya senegalensis	1	1	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	5	5	0.2
26	Strychnos spinosa	.	.	.	.	.	.	.	.	1	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	1	5	5	0.2
33	Dyschoriste perrottetii	1	.	1	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	7	.	.	5	22	0.8
16	Cochlospermum tinctorius	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	2	5	8	0.3
13	Isoberlinia tomentosa	6	4	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.		4	16	0.6
15	Sporobolus pyramidalis	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	1	1	4	4	0.2
96	Tephrosia linearia	.	.	.	.	.	.	.	.	.	2	.	.	.	3	.	.	.	1	.	1	.	.	.	.	.	.	4	7	0.3
73	Blepharis linariifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	2	2	.	.	.	1	.		4	6	0.2
49	Parkia clappertoniana	.	1	.	.	1	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	0.2
41	Englerastrum gracillimum	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.		4	4	0.2
69	Indigofera capitata	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	3	3	0.1
84	Hymenocardia acida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	2	.	.	.	.	.	1	.	.		3	5	0.2
79	Grewia mollis	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.		3	3	0.1
67	Lannea acida	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		3	3	0.1
91	Schizachyrium exile	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.		3	4	0.2
64	Diospyros mespiliformis	.	1	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		3	3	0.1
70	Cassia minosoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	4	.	.	.	.	1		3	7	0.3
36	Monochoa ciliatum	.	.	.	2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.		3	4	0.2
55	Anogeissus leiocarpus	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	4	.	.	.	.	.		3	9	0.3
45	Dyschoriste pedicellata	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	4	.	.	2	.			3	8	0.3
20	Monotes kerstingii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	1	1		3	4	0.2
37	Swartzia madagascariensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	1		3	3	0.1
52	Asparagus africanus	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1		3	3	0.1
105	Maerua angolensis	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.		3	3	0.1
110	Eragrostis turgida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2	.	.	.	.	.	1		3	4	0.2
111	Leucas martinicensis	.	.	.	.	.	.	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1		3	5	0.2

Associated species with an ACV of two are: (17) Lannea schimperi, (38) Pandiaka heudelotii, (39) Gardenia erubescens, (68) Evolvulus alsinoides, (66) Adenodolichos paniculatus, (63) Securidaca longipedunculata, (85) Alysicarpus glumaceus, (93) Kedria pulcherrima, (77) Cassia occidentalis, (97) Zornia glochidiata, (54) Pasplum orbiculare, (27) Lepidagathis collina, (25) Detarium macrocarpum, (31) Heudelia lotarioides, (61) Imperata cylindrica, (103) Cissus quiescens, (109) Spermacoce senegalensis, and (108) Acacia sieberiana.

DOMAIN: GUGA PLANTATION RESERVE AND ENCLAVE - FLORISTIC CLUSTER 2.

X.2. Floristic Community Table 35

Isoberlinia doka - Pennisetum pedicellatum - Dichrostachys glomerata Community

of agricultural regrowths in the Enclaves of the Guga Forest Reserve. These farmed lands include two main types of agricultural lands: (1) the professional settled 'peasant' farmer's terraced current and post-harvest *farmed fallows*; (2) the pastoralists' sporadic 'farms' around 'rugas' illustrated on Plates 25, 28 and 30. The *Dyschoriste perrottetii forbs* whose specificity to sheet- and rill-erosion I have illustrated on Plates 7d to 8D were found on the 'farms' of the latter. I point this out for ecological conservation reasons which I intend to briefly discuss following Cloge's (1971, 1978) geomorphological theory of "natural causes of erosion" in the 'savanna' and the 'agricultural causes of erosion" theory propounded by Collier and Dundas (1977). Both theories, in my view, demand an ecological 'middle road' explanation, which depends on the knowledge of the floral distribution in the areas *affected*.

CODE	SPECIES	DOMIN SCORES																EVALUATION		
		69	47	48	49	50	51	52	55	53	54	56	71	73	74	75	72	I	II	III
8	Piliostigma thonningii	1	7	3	7	7	8	4	6	5	6	1	.	1	3	5	4	15	68	4.3
31	Nauclea latifolia	1	4	2	2	2	3	4	1	3	1	1	.	.	2	1	3	14	30	1.9
19	Sporobolus pyramidalis	.	2	2	2	1	3	2	3	1	2	2	.	3	3	1	2	14	29	1.8
35	Hyparrhenia rufa	.	2	6	4	6	8	8	8	9	9	9	9	3	.	.	5	13	87	5.4
32	Brachiaria jubata	.	4	3	4	4	4	4	4	4	3	2	.	1	2	.	.	12	39	2.4
9	Annona senegalensis	1	1	1	1	1	3	.	1	3	4	.	.	.	1	.	.	10	17	1.1
6	Borreria radiata	3	.	.	2	1	.	.	1	1	1	.	.	9	1	1	.	9	20	1.3
10	Aspilia africana	.	1	1	2	1	1	1	1	.	1	.	.	.	.	.	.	8	9	0.7
12	Indigofera pulchra	2	1	.	1	1	1	.	.	1	1	.	.	1	.	.	.	8	9	0.7
4	Terminalia avicennioides	3	1	.	.	.	1	1	1	2	1	.	.	.	.	.	.	7	9	0.7
1	Pennisetum pedicellatum	4	2	.	2	.	.	2	.	.	.	.	.	.	1	1	1	7	13	0.8
57	Bridelia ferruginea	1	1	.	.	.	.	.	.	.	.	.	1	1	1	1	1	7	7	0.4
54	Paspalum orbiculare	3	.	.	.	.	.	.	.	1	1	1	3	.	1	.	3	7	13	0.8
47	Nelsonia canescens	4	.	.	.	.	.	1	1	.	.	.	.	4	4	2	4	7	20	1.3
7	Andropogon gayanus	.	6	4	3	1	.	.	.	.	.	.	.	.	4	.	2	6	20	1.3
23	Stylosanthes mucronata	.	1	1	.	1	.	.	.	.	.	.	.	.	3	1	2	6	9	0.7
2	Dichrostachys glomerata	2	.	2	.	.	.	.	.	.	.	1	.	.	1	3	.	5	9	0.7
61	Imperata cylindrica	.	.	.	.	.	.	2	2	.	2	5	.	.	.	.	9	5	20	1.3
17	Lannea schimperi	.	1	2	.	.	.	1	1	.	2	.	.	.	.	.	.	5	7	0.4
30	Sida ovata	.	.	.	1	1	.	.	.	.	.	.	.	1	.	1	1	5	5	0.3
58	Cassia singueana	.	.	1	.	.	1	1	1	.	.	.	.	.	.	.	.	4	4	0.3
25	Detarium macrocarpum	.	.	.	1	.	1	1	.	2	.	.	.	.	.	.	.	4	5	0.3
94	Eriosema psoraleoides	.	.	.	1	.	.	.	.	.	1	1	.	.	2	.	.	4	5	0.3
18	Ximenia americana	.	1	.	.	1	.	.	.	.	.	.	.	1	.	2	.	4	5	0.3
95	Tridax procumbens	1	.	.	.	.	.	.	.	.	.	.	.	1	2	1	.	4	5	0.3
40	Borreria verticillata	5	.	.	.	.	.	.	.	.	.	7	.	.	.	1	9	4	22	1.4
86	Crotalaria retusa	.	2	1	2	.	.	.	.	.	.	.	.	.	.	.	.	3	5	0.3
5	Andropogon pseudapricus	2	.	.	.	.	.	.	2	.	.	.	.	3	.	.	.	3	7	0.4
65	Daniellia oliveri	.	2	1	.	.	.	.	.	.	1	.	.	.	.	.	.	3	4	0.3
71	Vitex doniana	.	.	.	.	.	.	1	1	.	.	.	.	.	.	1	.	3	3	0.2

Associated species with an ACV of two are: (3) Isoberlinia doka, (14) Butyrospermum paradoxum, (48) Entada africana, (39) Gardenia erubescens, (62) Vernonia ambigua, (56) Khaya senegalensis, (67) Lannea acida, (100) Beckeropsis uniseta, (74) Prosopis africana, (36) Monechma ciliatum, ( ) Anogeissus leiocarpus, (43) Aristida funiculata, (22) Waltheria in (7) Andropogon gayanus, and (132) Oryza longistaminata.

DOMAIN: GUGA PLANTATION RESERVE AND ENCLAVE FLORISTIC CLUSTER 3.

X.3.

Floristic Community Table 36

Hyparrhenia rufa - Piliostigma thonningii - Brachiaria jubata Community

on flat 'kurmi' of stream valleys and their adjoining gullied bluffs in the Guga uncultivated Forest Reserve. These are heavily grazed in the dry seasons and most of floristic components were relics from dry season grazing grounds. The sites vary a lot, such as the illustrations on Plates 72, 74, 77. Low level ironstone scarps are often exposed along the ephemeral water courses. Granites, and rubbles of quartz, and mica are common. However, the soils are damp, imperfectly drained at depths. Organic carbon and exchangeable bases are on average moderate to high and the soil samples neutral with respect to pH.

CODE	SPECIES	DOMIN SCORES																												EVALUATION		
		2	21	61	10	43	35	36	37	42	28	29	62	65	44	45	78	32	39	33	41	46	11	26	27	31	77	80	81	?	I	II	III
15	Ctenium newtonii	1	4	4	8	4	3	3	4	3	5	3	3	3	2	4	3	7	6	3	2	3	7	4	4	6	.	2	2	.	27	68	2.5
4	Terminalia avicennioides	.	2	3	2	2	1	2	2	1	3	1	2	1	1	1	1	1	1	.	2	2	1	2	3	5	.	2	1	1	26	46	1.6
11	Elionurus podojuinii	1	2	.	4	3	6	4	5	4	3	4	3	3	2	3	3	4	4	3	2	2	3	4	3	5	.	.	3	.	25	60	2.1
2	Dichrostachys glomerata	1	4	1	.	1	3	2	1	5	3	3	1	1	2	2	3	1	1	1	2	.	3	4	.	.	4	2	2	.	24	53	1.8
20	Monotes kerstingii	3	4	4	2	2	4	4	4	2	.	1	4	.	1	4	1	4	2	2	2	.	1	.	1	.	.	6	7	.	22	43	1.5
14	Butyrospermum paradoxum	.	1	2	1	1	.	1	1	1	1	1	.	1	.	.	1	.	1	1	1	.	1	.	1	1	2	1	1	1	21	25	0.8
3	Isoberlinia doka	4	3	7	3	.	.	.	.	.	4	6	4	6	4	2	2	.	2	1	.	4	4	3	2	1	.	.	1	1	20	64	2.2
16	Cochlospermum tinctorium	.	.	.	1	4	3	2	1	4	2	2	2	3	2	.	3	3	.	2	4	4	1	2	1	.	.	.	4	.	20	50	1.7
6	Borreria radiata	.	.	2	1	1	.	2	2	2	2	2	.	4	1	2	4	.	.	.	3	6	3	.	.	.	1	4	2	3	19	47	1.6
24	Panicum maximum	.	2	1	.	.	2	2	3	2	4	.	2	2	.	1	.	1	.	2	.	1	2	3	1	.	2	2	4	.	19	40	1.4
18	Ximenia americana	.	1	1	1	.	1	1	.	.	1	1	1	.	.	.	.	1	1	1	2	1	.	1	.	2	1	.	.	2	17	21	0.7
25	Detarium macrocarpum	1	2	1	.	.	2	.	.	1	2	.	1	1	.	.	2	.	.	1	.	.	1	2	4	.	1	1	1	2	17	28	1.0
13	Isoberlinia tomentosa	.	.	.	2	4	2	3	2	4	.	.	.	.	1	.	2	6	7	5	4	4	3	.	.	2	.	.	.	8	16	59	2.0
27	Lepidagathis collina	.	.	.	1	2	.	1	.	1	2	3	1	1	.	.	.	1	1	2	.	1	2	3	2	.	.	.	.	.	15	24	0.8
1	Pennisetum pedicellatum	.	.	3	.	.	2	2	.	.	1	2	.	2	.	.	.	1	2	.	1	2	2	2	.	.	.	.	2	4	14	28	1.0
9	Annona senegalensis	2	.	.	.	.	.	.	1	.	.	.	3	.	1	1	2	1	1	2	1	.	.	1	2	3	.	.	.	1	14	22	0.8
7	Andropogon gayanus	3	2	1	.	1	.	.	.	2	.	2	.	1	.	.	.	.	.	.	3	3	1	.	.	1	1	2	.	.	13	23	0.8
21	Combretum ghasalense	1	.	.	.	.	1	1	.	.	1	.	1	2	.	.	.	.	.	.	1	1	.	.	.	2	2	1	1	.	11	16	0.6
17	Lannea schimperi	1	.	.	.	.	.	.	1	1	1	.	1	1	.	.	.	1	1	1	1	.	1	.	.	.	.	.	.	1	12	12	0.4
26	Strychnos spinosa	.	.	1	.	.	.	1	.	.	1	1	.	1	.	.	1	1	1	1	.	.	.	3	1	1	.	.	.	.	12	14	0.5
29	Afrormosia laxiflora	1	.	.	.	.	1	1	1	1	2	.	.	1	.	.	.	.	.	2	1	.	.	2	4	1	.	.	.	.	12	18	0.6
38	Padiska heudelotii	.	.	.	.	.	1	.	.	1	.	.	1	.	1	.	.	1	2	1	1	1	.	.	.	.	.	.	1	2	.	11	13	0.4
42	Gardenia aqualo	1	1	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	1	.	1	1	1	.	.	1	.	1	1	.	11	11	0.4
10	Aspilia africana	.	.	.	.	1	.	1	1	1	.	2	.	.	.	.	.	2	.	1	.	.	.	.	1	2	.	.	.	2	10	14	0.5
46	Lippia chevalieri	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	2	2	2	.	1	2	.	10	14	0.5
51	Monocymbium ceresiiforme	2	.	.	3	.	.	.	2	.	.	.	2	2	.	.	2	1	2	2	.	.	.	.	.	.	.	.	.	.	9	18	0.6
57	Bridelia ferruginea	1	.	1	.	.	.	.	.	.	.	.	.	1	.	.	1	.	1	.	.	.	.	.	.	.	1	1	1	2	9	10	0.3
41	Englerastrum gracilimum	.	.	2	2	.	.	1	.	.	.	.	1	1	.	.	.	.	1	.	.	.	.	.	1	.	1	.	.	1	9	11	0.4
48	Entada africana	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	1	.	1	1	1	.	.	.	.	1	.	.	1	2	9	10	0.3
8	Piliostigma thonningii	.	.	1	.	.	.	.	.	.	1	.	1	1	.	1	.	.	1	.	.	.	.	.	2	.	1	.	.	1	9	10	0.3
39	Gardenia erubescens	.	2	.	1	1	.	.	.	1	1	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	1	8	9	0.3
33	Dyschoriste perrottetii	.	.	.	2	.	5	.	.	.	1	1	.	.	.	.	.	.	.	2	.	.	7	3	.	1	.	.	.	.	8	22	0.8
65	Dyschoriste pedicellata	1	.	.	.	.	.	.	.	2	.	.	.	7	5	.	.	.	.	.	5	.	.	.	.	.	2	1	6	.	8	29	1.0
52	Asparagus africanus	.	.	.	.	1	.	.	1	.	.	.	1	1	.	.	1	.	.	.	1	.	1	.	.	.	.	1	.	.	8	8	0.3
59	Ochna afzelii	.	.	1	.	.	.	.	1	1	.	.	.	1	.	.	.	.	.	1	.	.	.	1	1	.	.	.	.	1	8	8	0.3
37	Swartzia madagascariensis	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	1	1	3	1	.	1	.	1	.	.	.	.	.	.	8	10	0.3
22	Waltheria indica	.	.	.	.	.	.	1	.	.	.	.	2	1	.	.	.	.	.	.	.	1	.	.	.	2	2	1	.	.	7	10	0.3
76	Vernonia glaberrima	1	2	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	6	7	0.2
53	Parinari curatellifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	3	2	2	.	.	.	.	.	1	6	11	0.4
12	Indigofera pulchra	.	.	.	.	.	.	.	.	1	.	1	.	1	.	.	.	2	2	.	.	.	.	.	2	.	.	.	.	.	6	9	0.3
23	Stylosanthes aucromata	.	.	.	.	1	.	.	1	.	.	.	1	1	.	.	.	.	.	1	.	.	.	.	.	.	2	.	.	.	6	7	0.2
62	Vernonia ambigua	.	.	.	.	.	.	.	.	1	1	2	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	5	6	0.2
68	Evolvulus alsinoides	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.	.	5	5	0.2
72	Trichilia emetica	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	1	5	5	0.2
80	Stereospermum kunthianum	.	.	1	.	1	.	.	.	.	.	.	.	.	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	5	5	0.2
49	Parkia clappertoniana	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	2	.	.	1	1	.	2	5	8	0.3
78	Combretum molle	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	1	.	3	3	.	.	4	9	0.3
30	Sida ovata	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	4	4	0.1
81	Schizachyrium sanguineum	2	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3	.	.	.	.	.	.	.	.	4	9	0.3
65	Daniella oliveri	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	4	4	0.1
66	Adenodolichos paniculatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	1	.	.	.	.	.	.	1	4	4	0.1
74	Prosopis africana	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	4	4	0.1
32	Brachiaria jubata	.	.	5	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	4	10	0.3
73	Blepharis linariifolia	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	3	3	0.1
67	Lannea acida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2	.	.	.	1	3	4	0.1
58	Cassia sanguinea	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	3	4	0.1
92	Trachypogon spicatus	.	.	.	.	.	4	2	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	7	0.2
63	Securidaca longepedunculata	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	3	3	0.1
79	Grewia mollis	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	3	3	0.1
82	Fadogia agrestis	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	4	.	3	6	0.2
55	Anogeissus leiocarpus	.	.	.	.	.	.	.	.	1	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	2	.	.	.	3	7	0.2
60	Microchloa indica	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	7	.	3	12	0.4
19	Sporobolus pyramidalis	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	2	3	10	0.3
102	Loudetia simplex	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	3	.	.	.	3	11	0.4

Associated species having an ACV of two are: (43) Aristida funiculata, (69) Indigofera capitata, (71) Vitex doniana, (93) Heeria pulcherrima, (99) Panicum beaumanii, (64) Diospyros mespiliformis, (44) Eragrostis tremula, (118) Crossopteryx febrituga, (113) Polygala petitiana, (127) Crotalaria senegalensis, and (126) Dactyloctenium aegyptium.

DOMAIN: GUGA PLANTATION RESERVE AND ENCLAVE FLORISTIC CLUSTER 4.

X.4. **Floristic Community Table 37**

Ctenium newtonii - Elionurus poposuinii - Isoberlinia doka - Isoberlinia tomentosa - Dichrostachys glomerata - Monotes kerstingii Community

on summits of flat-topped mesas of laterite ironstone (illustrated by Plate 55). Flora occur mainly in cracks and minor depressions overlain by thin soil deposits. The soil is generally slightly eroded; red in colour; perfectly drained; very shallow, silty sand, extremely stony, sometimes with rubbles of quartzite, mica, schist added to the ironstone; low in organic carbon, slightly acidic, and low in exchangeable bases. Termitaria are frequent, with bare areas around them. They form uncultivated but grazed open scrublands and shrublands on the cerado.

CODE	SPECIES	DOMIN SCORES																	EVALUATION		
		1	3	17	18	21	69	2	9	22	73	72	32	4	5	29	6	33	I	II	III
2	Andropogon gayanus	3	4	3	2	5	3	3	4	4	5	6	4	7	4	6	1	2	17	66	3.9
4	Dyschoriste perrottetii	7	4	3	7	5	6	4	6	5	8	8	5	5	4	6	4	4	17	91	5.4
8	Dichrostachys glomerata	5	4	1	2	.	6	3	4	.	.	.	3	2	3	3	1	1	13	38	2.2
1	Borreria radiata	.	.	1	1	1	2	2	.	2	.	.	.	3	4	1	2	4	11	23	1.6
5	Kaempferia aethiopica	1	.	.	.	.	2	.	.	1	.	1	1	1	1	1	1	1	10	10	0.6
9	Zornia glochidiata	2	1	1	.	.	.	1	.	.	.	.	1	7	3	2	6	3	10	22	1.3
10	Cassia mimosoides	1	1	1	.	.	.	3	.	1	.	.	.	1	1	2	2	1	10	14	0.8
20	Isoberlinia doka	3	2	4	4	5	6	4	.	.	.	2	.	2	.	.	.	3	10	22	1.3
42	Hyperthelia dissoluta	3	3	2	2	2	.	1	.	.	.	.	.	2	1	2	.	.	9	15	0.9
3	*Eragrostis turgida*	.	.	.	.	.	.	.	2	1	.	.	1	2	3	3	6	6	9	24	1.4
7	Digitaria lecardii	.	.	.	.	2	2	.	2	2	1	2	.	.	.	2	.	2	8	15	0.9
6	*Stylosanthes mucronata*	1	1	2	1	.	.	.	.	.	.	.	2	1	4	3	.	.	8	15	0.9
11	Cochlospermum tinctorium	4	.	.	1	1	1	.	.	.	.	1	.	.	1	.	3	1	8	13	0.8
18	Isoberlinia tomentosa	.	.	1	.	.	.	.	5	4	4	2	5	4	5	.	.	.	8	29	1.7
22	Brachiaria stigmatisata	1	.	.	.	.	.	1	.	1	1	.	.	1	.	1	2	2	8	10	0.6
21	Pennisetum pedicellatum	.	.	1	.	.	.	.	.	1	2	2	1	.	1	.	.	1	7	9	0.5
31	Asparagus africanus	.	.	.	.	.	1	.	.	.	.	1	1	1	.	1	.	1	6	6	0.4
36	Schizachyrium sanguineum	.	.	3	2	1	.	.	.	2	3	.	.	.	2	.	.	.	6	13	0.8
45	Indigofera nummulariifolia	1	.	1	1	.	.	.	.	.	.	.	.	1	.	.	2	4	6	10	0.6
16	Blepharis linariifolia	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	2	3	5	8	0.5
17	Monotes kerstingii	1	.	.	2	.	.	.	1	2	.	.	.	.	1	.	.	.	5	7	0.4
26	Brachiaria jubata	.	.	1	1	.	.	.	.	1	.	.	.	2	2	.	.		5	7	0.4
34	Sporobolus pyramidalis	.	.	2	1	.	.	.	.	.	.	.	2	.	.	3	.	2	5	10	0.6
54	Ximenia americana	1	1	1	1	.	.	.	.	.	.	.	.	1	.	.	.	.	5	5	0.3
78	Stereospermum kunthianum	2	1	.	.	.	.	1	.	.	.	1	.	.	.	.	1	.	5	6	0.4
84	Lannea schimperi	1	.	.	.	.	.	1	.	.	.	.	.	.	1	.	2	1	5	6	0.4
38	Pandiaka heudelotii	1	1	.	.	.	.	.	.	.	.	.	.	.	.	2	.	1	4	5	0.3
39	Vernonia perrottetii	.	.	.	.	4	.	.	.	.	.	.	.	2	1	.	1	.	4	8	0.5
95	Tephrosia bracteolata	.	1	.	.	.	.	.	1	.	1	.	.	1	.	.	.	.	4	6	0.4
12	Terminalia avicennioides	1	.	.	.	.	.	2	.	.	.	.	.	.	.	1	.	.	3	4	0.2
13	Stylochiton lancifolius	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	3	3	0.2
19	Elionurus pobequinii	.	.	.	2	.	.	.	.	.	.	.	1	.	.	.	.	1	3	4	0.2
35	Urginea altissima	.	.	.	.	.	.	.	.	.	4	1	.	.	.	1	.	.	3	6	0.4
47	Costus spectabilis	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	1	3	3	0.2
48	Commiphora africana	.	.	.	.	2	.	.	.	.	.	.	1	.	.	1	.	.	3	4	0.2
56	Curculigo pilosa	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	3	3	0.2
59	Cassia nigricans	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	1	.	3	3	0.2
67	Anogeissus leiocarpus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3	1	3	5	0.3
77	Diospyros mespiliformis	.	.	.	1	.	.	1	.	.	.	.	.	1	.	.	.	.	3	3	0.2
79	Dactyloctenum aegyptium	.	2	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	3	4	0.2
85	Chloris lampropacla	.	.	.	.	.	.	3	.	.	.	.	.	.	3	1	.	.	3	7	0.4
93	*Setaria pallide-fusca*	.	.	.	.	.	.	1	2	.	.	.	1	.	.	.	.	.	3	4	0.2

Species with an absolute constancy value (ACV) of two are: (14) Microchloa indica, (23) Aspilia africana, (28) Ctenium newtonii, (29) Tephrosia pedicellata, (33) Panicum maximum, (37) Waltheria indica, (46) Sporobolus festivus, (52) Piliostigma thonningii, (55) Evolvulus alsinoides, (58) Lepidagathis collina, (60) Lannea barteri, (66) Paspalum orbiculare, (73) Fimbristylis hispidula, (74) Sida linifolia, (80) Bidens pilosa, (82) Setaria ancops, (96) Crotalaria senegalensis, (98) Lannea acida, (111) Pterocarpus erinaceus, (117) Tephrosia linearis, (118) Parkia clappertoniana, (124) Albizzia chevalieri, (125) Securidaca longipedunculata, and (135) Psorospermum corymbiferum.

DOMAIN: GUGA NON-PLANTATION FOREST RESERVE - FLORISTIC CLUSTER 1 DETERMINANTS FROM THE FACTOR COMPLEX.

XI.1. Floristic Community Table 38

Dyschoriste perrottetii - Andropogon gayanus - Dichrostachys glomerata - Zornia glochidiata - Isoberlinia tomentosa Community

associated with largely bare, dry, eroded, lateritic ironstone mesa summits and sub-summits (Illustrated by Plates 63, 79).

CODE	SPECIES	DOMIN SCORES												EVALUATION		
		7	8	11	13	16	44	63	62	36	14	26	71	I	II	III
1	Borreria radiata	2	1	3	1	1	1	2	2	1	2	3	2	12	21	1.8
3	Eragrostis turgida	5	4	1	8	.	2	2	4	1	5	4	6	11	42	3.5
15	Digitaria gayana	6	4	3	5	6	.	2	6	2	3	5	1	11	43	3.6
4	Dyschoriste perrottetii	3	2	6	6	4	.	.	1	6	2	7	3	10	49	4.1
8	Dichrostachys glomerata	5	3	2	4	2	3	4	.	1	.	2	1	10	27	2.3
9	Zornia glochidiata	.	.	2	5	4	6	6	6	3	4	8	2	10	46	3.8
13	Stylochiton lancifolius	1	.	1	2	.	2	2	1	3	2	1	1	10	16	1.3
14	Microchloa indica	.	2	4	4	.	2	3	5	2	8	4	5	10	39	3.3
16	*Blepharis linarifolia*	.	.	1	2	1	2	.	1	2	2	3	1	9	15	1.3
5	Kaempferia aethiopica	.	.	1	2	1	.	2	1	.	4	2	5	8	18	1.5
6	Stylosanthes mucronata	2	.	.	2	.	2	.	2	3	2	3	1	8	17	1.4
10	Cassia mimosoides	1	.	1	1	1	.	.	1	1	.	2	1	8	9	0.8
11	Cochlospermum tinctorium	.	3	.	1	1	2	2	2	5	.	.	1	8	17	1.4
2	Andropogon gayanus	1	.	.	2	.	2	1	2	1	.	.	1	7	10	0.8
7	Digitaria lecardii	.	.	2	.	.	2	2	2	1	.	2	2	7	13	1.1
22	Brachiaria stigmatisata	.	.	.	.	.	.	.	1	2	2	1	2	5	8	0.7
38	Pandiaka heudelotii	2	.	1	1	.	.	.	.	.	2	2	.	5	8	0.7
35	Urginea altissima	.	.	.	.	1	.	.	.	1	.	1	1	4	4	0.3
46	Sporobolus festivus	.	.	1	3	4	.	1	.	.	.	.	.	4	9	0.8
28	Ctenium *newtonii*	.	.	.	.	.	1	.	1	.	.	2	.	3	4	0.3
30	Detarium microcarpum	.	.	.	.	.	1	.	1	1	.	.	.	3	3	0.3
31	Asparagus *africanus*	.	.	.	.	.	.	.	1	.	1	.	1	3	3	0.3
48	Cosmiphora africana	.	.	.	.	4	.	.	.	.	4	4	.	3	12	1.0
54	Ximenia americana	.	.	.	.	.	1	.	.	.	1	.	1	3	3	0.3
57	Combretum molle	.	.	.	.	.	1	.	1	.	.	.	3	3	5	0.4
59	Cassia nigricans	3	.	.	1	.	.	.	.	.	1	.	.	3	5	0.4
81	Schizachyrium exile	.	.	.	.	4	.	.	.	.	2	2	.	3	8	0.7

Species with an absolute constancy value (ACV) of two are enumerated as follows: (12) Terminalia avicennioides, (18) Isoberlinia tomentosa, (29) Tephrosia pedicellata, (32) Lippia chevalieri, (34) Sporobolus pyramidalis, (45) *Indigofera nummulariifolia*, (55) Evolvulus alsinoides, (49) Strychnos spinosa, (64) Butyrospermum paradoxum, (71) Combretum ghasalense, (77) Diospyros mespiliformis, (80) Dactyloctenium aegyptium, and (98) Lannea acida.

DOMAIN: GUGA NON-PLANTATION FOREST RESERVE - FLORISTIC CLUSTER 2 DETERMINANTS FROM THE FACTOR COMPLEX.

XI.2. *Floristic Community Table 39*

Dyschoriste perrottetii - Zornia glochidiata - Eragrostis turgida - Digitaria gayana - Microchloa indica Community

associated with sheet erosion on middle slopes and shallow soils underlain by quartzite and schist. (Plate 76 exemplifies this Community).

CODE	SPECIES	DOMIN SCORES																		EVALUATION		
		53	74	23	24	25	15	35	38	39	12	20	27	10	41	45	42	47	48	57	I	II	Ii
2	Andropogon gayanus	4	3	3	7	7	3	3	5	3	1	1	2	3	4	5	.	5	6	3	18	68	3.
1	Borreria radiata	3	2	2	3	5	1	.	4	.	3	3	3	2	4	2	2	1	1	1	17	42	2.
7	Digitaria lecardii	.	3	2	3	1	2	.	2	3	2	1	3	2	3	3	3	3	1	2	17	39	2.
3	Eragrostis turgida	.	6	2	2	5	7	1	2	.	5	6	8	6	4	4	1	4	4	.	16	67	3.
4	Dyschoriste perrottetii	6	6	8	8	5	3	.	.	.	7	8	8	2	2	2	2	2	3	4	16	75	3.
6	Stylosanthes mucronata	.	2	2	.	3	1	4	2	3	4	2	2	2	3	3	2	.	1	1	16	37	1.
5	Kaempferia aethiopica	2	4	1	.	.	2	.	3	2	1	1	2	1	1	1	1	1	2	.	15	25	1.
10	Cassia mimosoides	1	2	3	.	.	2	1	2	.	2	1	2	1	1	1	1	.	1	2	15	23	1.
9	Zornia glochidiata	.	1	.	.	1	3	5	4	.	6	7	6	.	5	2	3	3	1	.	13	47	2.
11	Cochlospermum tinctorium	.	2	.	1	1	.	3	.	3	1	1	.	4	.	2	2	2	3	3	13	34	1.
12	Terminalia avicennioides	.	1	1	1	3	.	.	2	.	.	.	5	3	1	2	2	2	2	4	13	29	1.
13	Stylochiton lancifolius	2	1	.	.	.	1	2	1	.	1	.	.	.	.	2	2	1	.	2	13	15	0.
14	Microchloa indica	.	.	7	3	4	4	3	4	4	.	.	.	.	3	2	1	4	3	2	12	44	2.
16	Blepharis linariifolia	4	1	1	.	4	2	1	.	.	2	.	.	2	4	.	1	2	.	.	11	24	1.
21	Pennisetum pedicellatum	2	2	3	2	2	.	.	2	.	.	2	2	.	.	2	1	1	.	.	11	21	1.
8	Dichrostachys glomerata	4	3	.	.	5	1	1	.	.	.	1	1	.	.	1	1	.	.	2	10	20	1.
23	Aspilia africana	2	2	.	.	.	.	.	2	3	.	.	.	1	.	3	1	1	2	2	10	19	1.
15	Digitaria gayana	.	.	4	4	7	3	1	2	.	6	6	4	.	.	.	.	.	.	.	9	37	3.
29	Tephrosia pedicellata	2	1	.	.	.	1	.	3	3	.	.	1	.	.	1	1	1	.	.	9	14	0.
17	Monotes kerstingii	.	1	2	5	1	.	.	2	2	.	.	.	.	1	.	1	.	.	3	9	18	0.
18	Isoberlinia tomentosa	4	2	.	.	.	1	.	.	3	.	.	.	.	4	5	.	2	.	2	9	21	1.
27	Fimbristylis pilosa	.	.	.	.	.	.	.	.	3	.	.	.	3	3	3	2	3	2	3	9	24	1.
20	Isoberlinia doka	.	.	1	.	.	3	1	.	2	.	.	.	.	2	1	3	2	.	.	8	17	0.
25	Puttenbergia nigratana	.	.	.	.	.	.	.	.	3	.	.	.	.	2	3	1	1	2	2	7	14	0.
32	Lippia chevalieri	.	.	.	.	.	.	3	2	3	.	.	1	.	1	.	1	2	.	.	7	13	0.
52	Piliostigma thonningii	1	.	.	.	.	.	.	.	.	2	.	1	.	1	1	1	.	1	.	7	8	0.
53	Gardenia ecubescens	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2	1	1	2	6	8	0.
22	Brachiaria stigmatisata	.	1	.	.	2	.	.	.	.	1	6	3	5	.	.	.	.	.	.	6	18	0.
34	Sporobolus pyramidalis	6	2	.	.	.	3	.	.	1	.	.	2	.	.	4	.	.	.	.	6	22	1.
38	Pandiaka heudelotii	.	.	.	2	.	1	.	.	.	4	2	1	1	.	.	.	.	.	.	6	13	0.
55	Evolvulus alsinoides	.	1	1	.	2	1	1	.	.	1	.	.	.	.	.	.	.	.	.	6	7	0.
47	Costus spectabilis	.	1	.	.	.	1	.	.	1	.	.	.	.	.	1	.	.	.	3	5	7	0.
43	Indigofera pulchra	.	.	.	3	4	.	.	.	.	.	.	.	.	2	.	1	.	1	.	5	11	0.
28	Ctenium newtonii	.	.	.	2	.	.	3	.	2	.	.	.	.	.	.	.	.	2	4	5	13	0.
31	Asparagus africanus	.	.	1	.	.	1	.	.	.	.	.	1	.	2	1	.	.	.	.	5	6	0.
60	Gladiolus greyarius	.	.	.	.	.	.	1	.	.	.	.	.	1	1	.	.	1	1	.	5	5	0.
46	Sporobolus festivus	.	.	.	.	.	3	.	.	2	5	1	.	.	.	.	.	3	.	.	5	14	0.
48	Commiphora africana	.	.	1	1	.	2	.	.	.	.	4	1	.	.	.	.	.	.	.	5	9	0.
60	Lannea barteri	.	.	1	.	1	1	.	.	.	.	3	.	.	1	.	.	.	.	.	5	5	0.
68	Fadogia agrestis	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	1	1	.	.	5	5	0.
24	Andropogon schirensis	.	.	.	.	.	.	.	.	6	.	.	.	.	2	.	.	2	.	1	4	11	0.
26	Brachiaria jubata	.	.	.	.	.	.	.	.	.	1	.	.	3	1	.	3	.	.	.	4	8	0.
30	Detarium microcarpum	.	.	.	.	2	.	.	1	.	.	.	.	.	1	.	1	.	.	.	4	5	0.
33	Panicum maximum	.	4	.	.	.	.	6	4	3	.	.	.	.	.	.	.	.	.	.	4	13	0.
41	Monocymbium ceresiiforme	.	.	.	.	.	.	.	.	5	.	.	.	2	2	.	2	.	.	.	4	11	0.
51	Annona senegalensis	.	.	.	.	.	.	.	2	.	.	.	1	.	1	.	.	.	2	.	4	6	0.
57	Combretum molle	.	.	.	.	.	.	.	.	1	.	.	2	3	.	1	.	.	.	.	4	7	0.
59	Cassia nigricans	.	.	.	.	.	2	.	.	.	.	1	.	2	.	.	1	.	.	.	4	6	0.
42	Hyperthelia dissoluta	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	2	.	4	3	8	0.
35	Urginea altissima	.	.	.	.	.	1	.	.	.	2	.	.	.	.	2	.	.	.	.	3	5	0.
36	Schizachyrium sanguineum	.	.	.	4	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	3	6	0.
39	Vernonia perrottetii	.	.	.	.	.	.	.	.	.	.	2	.	.	.	1	1	.	.	.	3	4	0.
49	Strychnos spinosa	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	3	3	0.
70	Pavetta glaucescens	.	.	.	.	.	1	.	.	.	.	1	1	.	.	.	.	.	.	.	3	3	0.
72	Monechma ciliatum	1	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	3	4	0.
81	Schizachyrium exile	.	.	4	.	3	.	.	.	.	5	.	.	.	.	.	.	.	.	.	3	12	0.
87	Faretia apondathera	.	.	1	.	.	1	.	.	.	.	2	.	.	.	.	.	.	.	.	3	4	0.
100	Hypoxis angustifolia	.	.	.	.	.	1	.	.	.	1	.	1	.	.	.	.	.	.	.	3	3	0.
101	Entada africana	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	3	3	0.
50	Swartzia madagascariensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	3	2	3	7	0.
66	Paspalum orbiculare	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	2	3	4	0.

Species having an absolute constancy value (ACV) of two are enumerated as (45) Indigofera nummulariifolia, (58) Lepidagathis collina, (63) Ochna afzelii, (64) Butyrospermum paradoxum, (71) Combretum ghasalense, (74) Sida linifolia, (86) Sida ovata, (88) Terminalia laxiflora, (90) Vitex simplicifolia, (94) Jacquemontia tamnifolia, (97) Hackelochloa granularis, (112) Cassia sieberiana, (129) Ficus gnaphalocarpa, and (130) Cassia tora.

DOMAIN: GUGA NON-PLANTATION FOREST RESERVE - FLORISTIC CLUSTER 3 DETERMINANTS FROM THE FACTOR COMPLEX.

XI.3. Floristic Community Table 40

Dyschoriste perrottetii - Andropogon gayanus - Eragrostis turgida Community

Associated mainly with rill erosion or small dissected drainage channels along the middle slopes.

CODE	SPECIES	DOMIN SCORES																	EVALUATION		
		19	49	37	54	40	43	46	68	55	75	76	58	60	70	61	77	78	79	80	I	II	III
12	Terminalia avicennioides	1	1	.	1	1	1	1	4	2	1	1	2	1	1	3	1	.	1	1	17	24	1.3
19	Elionurus pobequinii	2	6	4	4	2	4	1	.	4	1	.	2	4	3	4	.	3	4	5	16	52	2.7
24	Andropogon schirensis	.	2	5	3	4	4	1	6	4	4	2	.	2	4	3	4	6	.	6	16	62	3.1
1	Borreria radiata	2	.	.	.	1	3	6	3	3	2	1	4	5	1	2	1	2	.	1	15	37	1.9
7	Digitaria lecardi	.	.	.	.	1	3	1	2	2	2	1	2	2	2	3	2	3	3	1	15	29	1.5
17	*Monotes kerstingii*	1	.	.	1	2	.	4	3	2	3	2	2	4	7	.	4	4	6	7	15	52	2.7
6	Stylosanthes mucronata	1	2	1	.	2	3	4	1	2	.	1	2	2	1	.	.	.	2	3	14	27	1.4
5	*Kaempferia aethiopica*	.	1	.	.	.	1	2	1	2	1	.	3	2	1	2	.	2	3	1	13	22	1.2
9	Zornia glochidiata	.	.	.	.	2	2	4	1	2	.	.	4	3	2	2	2	.	4	3	12	31	1.6
33	Panicum maximum	.	.	.	.	2	.	1	.	.	1	2	4	6	5	4	2	3	4	7	12	41	2.2
10	Cassia mimosoides	.	.	2	.	1	1	.	.	2	.	1	2	2	1	.	.	1	1	1	11	15	0.8
30	Detarium microcarpum	.	.	1	.	2	1	.	.	.	.	4	1	1	.	1	7	6	3	4	11	31	1.6
41	Monocrymbium ceresiiforme	2	2	3	3	2	6	1	.	.	.	1	.	.	.	2	3	3	.	.	11	28	1.5
3	Eragrostis turgica	.	.	.	.	2	1	8	3	.	.	1	2	3	3	2	.	.	.	1	10	26	1.4
11	*Cochlospermum tinctorium*	1	4	.	3	2	2	.	2	6	1	.	.	3	.	2	.	.	.	.	10	26	1.4
14	Microchloa indica	.	2	.	.	.	2	1	3	.	.	2	4	.	.	.	2	7	9	8	10	40	2.1
25	Guttenbergia nigritana	.	.	1	3	1	1	.	2	.	.	.	.	.	.	2	2	2	2	2	10	12	0.6
28	Ctenium newtonii	2	2	4	2	5	2	.	.	.	.	.	.	2	.	.	3	3	1	.	10	26	1.4
32	Lippia chevalieri	.	.	.	2	1	1	3	.	.	.	1	2	.	.	3	.	2	1	1	10	17	0.9
8	Dichrostachys glomerata	.	.	.	.	.	.	1	1	.	3	3	.	1	1	.	2	.	1	4	9	17	0.9
18	Isoberlinia tomentosa	3	4	6	6	2	4	.	.	1	.	.	.	.	3	.	.	.	.	1	9	30	1.6
27	*Fimbristylis pilosa*	.	2	3	4	3	1	2	2	2	.	2	.	.	.	.	.	.	.	.	9	21	1.1
13	Stylochiton lancifolia	.	.	.	.	1	1	1	.	.	1	.	1	.	.	.	.	1	3	3	8	12	0.6
21	*Pennisetum pedicellata*	.	1	.	.	.	2	.	.	.	.	.	2	.	2	.	1	2	2	1	8	13	0.7
26	Brachiaria jubata	1	2	2	2	3	.	1	2	.	1	.	.	.	.	.	.	.	.	.	6	14	0.7
36	Schizachyrium sanguineum	5	1	2	3	1	1	.	2	.	1	.	.	.	.	.	.	.	.	.	8	16	0.8
58	Lepidagathis collina	.	1	.	3	.	1	.	1	.	.	1	1	.	.	.	.	2	.	.	7	10	0.5
62	Loudetia simplex	.	.	.	6	.	.	.	.	5	3	4	.	.	.	.	8	8	2	.	7	36	1.9
2	Andropogon gayanus	2	6	.	.	.	.	1	.	.	.	.	5	3	.	2	.	.	.	.	6	19	1.0
4	Dyschoriste perrottetii	4	3	.	.	.	.	.	.	.	8	4	.	.	.	1	.	2	.	.	6	22	1.2
40	Gladiolus *gregarius*	1	.	1	.	.	1	1	.	2	.	1	.	.	.	.	.	.	.	.	6	7	0.4
39	Vernonia perrottetii	1	.	.	.	.	.	.	.	.	.	.	.	.	1	2	2	2	.	2	6	10	0.5
61	*Gardenia aqualla*	.	1	.	1	1	.	1	.	.	.	.	1	.	.	.	.	.	1	.	6	6	0.3
63	Ochna afzelii	.	.	1	.	1	.	.	.	.	.	.	.	1	1	.	.	1	.	1	6	6	0.3
65	Cryptolepis sanguinoleuta	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	1	1	1	1	6	6	0.3
76	Vernonia glaberrima	.	.	2	.	1	.	.	.	2	.	1	.	.	.	.	.	3	.	2	6	11	0.6
20	Isoberlinia doka	1	1	.	.	.	1	.	.	1	.	.	.	.	.	1	.	.	.	.	5	5	0.3
23	Aspilia africana	.	.	.	.	.	.	.	.	2	.	.	2	.	1	1	.	.	2	.	5	8	0.4
31	*Asparagus africanus*	1	.	1	.	.	.	1	.	2	.	.	.	2	.	.	.	.	.	.	5	7	0.4
64	Butyrospermum paradoxum	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	1	5	5	0.3
73	*Fimbristylis hispidula*	.	.	2	2	.	1	.	.	.	.	.	.	.	.	.	2	4	.	.	5	11	0.6
43	Indigofera pulchra	.	.	1	.	2	1	1	1	.	.	.	.	.	.	.	.	.	.	.	5	6	0.3
49	Strychnos spinosa	.	1	.	.	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	4	4	0.2
75	Urelytrum muricatum	.	.	3	.	.	1	1	.	.	.	.	.	.	.	.	.	2	.	.	4	7	0.4
29	Tephrosia pedicellata	.	.	.	.	.	.	.	.	.	.	.	3	3	2	.	.	.	.	.	3	8	0.4
35	Urginea altissima	.	2	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	3	4	0.2
37	Waltheria indica	.	.	.	.	.	.	1	2	.	.	.	2	.	.	.	.	.	.	.	3	5	0.3
42	Hyperthelia dissoluta	.	.	.	.	.	.	.	3	.	.	.	2	.	.	2	.	.	.	.	3	7	0.4
50	Swartzia madagascariensis	.	.	.	.	.	.	1	.	.	.	.	.	.	2	1	.	.	.	.	3	4	0.2
53	*Gardenia ecubescens*	.	.	.	.	.	.	.	.	.	1	1	.	.	.	1	.	.	.	.	3	3	0.2
54	Ximenia americana	.	.	.	.	.	1	.	.	.	.	.	.	1	.	1	.	.	.	.	3	3	0.2
57	Combretum molle	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	3	3	0.2
69	Fimbristylis ovata	.	2	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3	5	0.3
70	Pavetta glaucescens	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3	3	0.2
90	Vitex simplicifolia	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	1	.	.	3	3	0.2
103	Hymenocardia acida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	1	3	4	0.2

Associated species having an absolute constancy value of two are: (15) Digitaria gayana, (16) Blepharis linariifolia, (44) *Sida rhombifolia*, (47) Costus spectabilis, (51) *Annona senegalensis*, (56) Curculigo pilosa, (60) *Fadogia agrestis*, (71) Combretum glutinosum, (72) Panicum ciliatum, (89) Bridelia ferruginea, (91) Parinari curatellifolia, (92) Aloe barteri, (103) Hymenocardia acida, (107) Striga asiatica, (115) Crotalaria glauca, and (133) Crossopteryx febrifuga.

DOMAIN: GUGA NON-PLANTATION FOREST RESERVE - FLORISTIC CLUSTER 4 DETERMINANTS FROM THE FACTOR COMPLEX.

XI.4. Floristic Community Table 41

Andropogon schirensis - Elionurus pobequinii - Monotes kerstingii Community

on uncultivated, dry, deep, red, lower middle slope soils.

CODE	SPECIES	DOMIN SCORES													EVALUATION		
		34	64	65	52	30	31	28	50	51	56	59	66	67	I	II	III
2	Andropogon gayanus	2	1	2	.	2	1	8	4	4	.	3	2	1	11	30	2.3
5	Kaempferia aethiopica	1	1	2	.	1	2	1	2	.	3	2	2	3	11	20	1.5
13	Stylochiton lancifolius	1	.	1	3	3	3	1	4	2	3	.	1	1	11	23	1.8
23	Aspilia africana	1	3	1	.	1	.	1	3	3	3	3	3	2	11	24	1.8
3	Eragrostis turgida	7	7	7	.	8	9	4	2	2	.	.	2	2	10	50	3.8
1	Borreria radiata	1	2	3	.	3	3	5	1	.	.	.	1	1	9	20	1.5
8	Dichrostachys glomerata	7	3	2	1	2	.	.	.	1	1	.	2	3	9	22	1.7
34	Sporobolus pyramidalis	2	2	3	5	.	.	6	.	.	2	3	9	6	9	38	2.9
6	Stylosanthes mucronata	.	1	1	.	5	4	1	.	1	.	3	1	.	8	17	1.3
12	Terminalia avicennioides	.	1	4	.	.	.	3	5	4	.	.	1	2	8	20	1.5
20	Isoberlinia doka	.	1	.	1	.	.	3	.	1	3	2	3	2	8	16	1.2
25	Guttenbergia nigritana	.	4	2	.	.	.	.	2	2	2	3	2	2	8	19	1.5
29	Tephrosia pedicellata	6	.	3	.	2	5	.	.	1	.	3	4	2	8	26	2.0
7	Digitaria iecardii	.	1	.	.	2	2	3	.	.	.	3	4	3	7	18	1.4
14	Microchloa indica	3	8	3	.	.	.	.	6	.	.	4	1	7	7	32	2.5
35	Urginea altissima	.	1	1	.	.	1	1	1	2	.	.	.	3	7	10	0.8
9	Zornia glochidiata	4	5	4	.	2	2	.	.	.	.	.	.	1	6	18	1.4
22	Brachiaria stigmatisata	6	.	2	5	9	3	5	.	.	.	.	.	.	6	30	2.3
26	Brachiaria jubata	.	.	.	4	.	1	.	3	3	.	.	3	3	6	17	1.3
27	Fimbristylis pilosa	.	.	.	6	.	.	.	.	2	2	3	1	2	6	16	1.2
37	Waltheria indica	1	3	2	.	.	1	.	.	.	.	.	1	3	6	11	0.8
44	Sida rhombifolia	2	2	2	.	1	1	.	.	.	.	.	1	.	6	9	0.7
51	Annona senegalensis	.	2	1	.	.	.	.	.	1	.	2	1	2	6	9	0.7
11	Cochlospermum tinctorium	.	.	1	.	.	.	.	3	1	.	3	.	2	5	10	0.8
16	Blepharis linariifolia	2	.	1	.	3	3	2	.	.	.	.	.	.	5	11	0.8
24	Andropogon schirensis	.	1	.	.	.	.	.	4	6	5	6	.	.	5	22	1.7
33	Panicum maximum	.	2	.	.	.	.	.	.	.	3	3	2	1	5	11	0.8
50	Swartzia madagascarensis	.	1	.	.	.	.	.	2	1	2	.	1	.	5	7	0.5
4	Dyschoristes perrottetii	.	.	.	.	4	3	6	2	.	.	.	.	.	4	15	1.1
17	Monotes kerstingii	.	.	1	.	.	.	.	.	.	2	2	.	4	4	9	0.7
18	Isoberlinia tomentosa	.	.	.	.	.	.	.	2	5	8	3	.	.	4	18	1.4
30	Detarium microcarpum	.	2	1	.	.	.	1	.	.	.	.	3	.	4	7	0.5
32	Lippia chevalieri	.	.	2	.	1	.	2	.	.	.	3	.	.	4	8	0.6
52	Piliostigma thonningii	.	.	.	4	.	.	1	1	1	.	.	.	.	4	7	0.5
60	Lannea barteri	.	2	.	.	1	.	1	.	.	.	.	1	.	4	5	0.4
66	Paspalum orbiculare	.	.	.	5	.	.	.	2	2	.	.	1	.	4	10	0.8
83	Cissus rufescens	3	.	.	.	3	2	.	.	.	.	.	.	1	4	9	0.7
10	Cassia mimosoides	2	.	.	.	.	2	2	.	.	.	.	.	.	3	6	0.5
28	Ctenium newtonii	.	.	.	.	.	.	.	3	1	.	2	.	.	3	6	0.5
31	Asparagus africanus	.	.	1	.	.	.	.	.	1	.	.	.	2	3	4	0.3
36	Schizachyrium sanguineum	.	.	.	.	.	.	.	2	3	.	.	.	1	3	6	0.5
43	Indigofera pulchra	.	.	.	.	2	.	.	.	.	.	.	.	.	3	2	0.2
47	Costus spectabilis	.	.	.	.	1	.	1	.	.	.	.	.	1	3	3	0.2
65	Cryptolepis sanguinoleuta	.	.	.	.	.	.	.	1	1	1	.	.	.	3	3	0.2
67	Anogeissus leiocarpus	.	.	.	.	2	.	5	.	1	.	.	.	.	3	8	0.6

Associated species having an ACV of two are: (15) Digitaria gayana, (19) Elionurus pobequinii, (21) Pennisetum pedicellatum, (38) Pandiaka heudelotii, (40) Gladiolus gregarius, (41) Monocymbium ceresiiforme, (46) Sporobolus festivus, (48) Commiphora africana, (49) Strychnos spinosa, (53) Gardenia erubescens, (57) Combretum molle, (61) Gardenia aqualla, (62) Loudetia simplex, (68) Pachyla egrestis, (69) Fimbristylis ovata, (70) Pavetta glaucescens, (71) Combretum ghasalense, (72) Monechma ciliatum, (79) Ductyloctenium aegyptium, (82) Setaria anceps, (88) Terminalia laxiflora, (96) Crotalaria senegalensis, (102) Polygala petitiana, (106) Blophytum petersianum, (110) Grewia mollis, (113) Aristida adscensionis, and (114) Afrormosia laxiflora.

DOMAIN: GUGA NON-PLANTATION FOREST RESERVE - FLORISTIC CLUSTER 5 DETERMINANTS FROM THE FACTOR COMPLEX.

XI.5.

Floristic Community Table 42
Eragrostis turgida - Sporobolus pyramidalis - Andropogon gayanus Community

on uncultivated, nearly level, 'Kurmi' valley.



62

le of an abrupt landscape change from the uplands to a
ank. The result is a relatively sharp floristic discon-
Leersia hexandra, a rhizomatous water-loving grass
the bank. Mairabo Stream. June 1978.



63

Dichrostachys glomerata on the sub-summit of an eroded ironstone mesa. Guga Forest Reserve. July 1978.



64

lappertoniana in a Sorghum vulgare farm on the edge of
r Galma Fadama. May 1978.



65

A roadside erosion along the Zaria-Funtua road which forms the northern boundary with Guga Forest Reserve. August 1978.

CODE	SPECIES	DOMIN SCORES							EVALUATION		
		55	42	64	41	63	46	47	I	II	III
30	Loudetia simplex	8	6	6	6	6	6	5	7	43	6.1
1	Isoberlinia doka	2	2	3	3	5	2	1	7	18	5.6
9	Monotes kerstingii	4	3	4	2	4	.	4	6	21	3.0
3	Andropogon gayanus	1	2	1	1	1	3	.	6	9	1.3
12	Adenodolichos paniculatus	1	2	1	.	1	1	1	6	7	1.0
13	Monocymbium ceresiiformis	.	2	4	2	3	.	5	5	16	2.3
29	Pterocarpus erinaceus	1	1	.	.	1	2	1	5	6	0.9
45	Ochna rhizomatosa	1	1	1	1	.	1	.	5	5	0.7
6	Annona senegalensis	1	.	1	.	1	1	1	5	5	0.7
10	Panicum maximum	.	1	1	1	2	.	1	5	6	0.9
8	Andropogon pseudapricus	.	2	1	.	1	3	.	4	7	1.0
39	Detarium microcarpum	.	1	1	.	2	2	.	4	6	0.9
19	Parinari curatellifolia	1	1	.	2	.	1	.	4	5	0.7
11	Lepidagathis collina	.	1	1	1	.	.	1	4	4	0.6
17	Cassia mimosoides	.	1	1	.	.	1	1	4	4	0.6
57	Swartzia madagascariensis	.	1	.	1	1	.	2	4	5	0.7
25	Ximenia americana	.	1	1	.	1	1	.	4	4	0.6
22	Uapaca togoensis	.	2	2	.	1	.	.	3	5	0.7
4	Borreria radiata	.	2	.	.	.	2	1	3	5	0.7
53	Vernonia glaberrima	1	.	.	.	.	1	1	3	3	0.4
59	Gardenia aqualla	1	.	.	1	1	.	.	3	3	0.4
2	Pennisetum pedicellatum	.	1	1	.	.	1	.	3	3	0.4
64	Ficus capensis	.	1	.	.	1	1	.	3	3	0.4
23	Afrormosia laxiflora	.	.	.	1	.	1	1	3	3	0.4
24	Elionurus pobeguinii	.	.	.	.	2	1	1	3	4	0.6
77	Echinops longifolius	1	1	.	.	.	.	1	3	3	0.4
106	Pseudocedrela kotschyi	3	1	.	.	.	.	.	2	4	0.6
73	Vernonia oocephala	3	.	.	1	.	.	.	2	4	0.6
28	Isoberlinia tomentosa	1	.	.	.	2	.	.	2	3	0.4
14	Daniellia oliveri	1	.	.	.	.	1	.	2	2	0.3
74	Lannea schimperi	1	.	1	.	.	.	.	2	2	0.3
108	Strychnos innocua	1	.	.	.	1	.	.	2	2	0.3
20	Ctenium newtonii	.	3	.	1	.	.	.	2	4	0.6
36	Prosopis africana	.	1	1	.	.	.	.	2	2	0.3
52	Crossopteryx febrifuga	.	1	.	.	.	1	.	2	2	0.3

DOMAIN: KUYELLO COMPOSITE SURVEY - FLORISTIC CLUSTER 1

XII.1. Floristic Community Table 43

Loudetia simplex - Isoberlinia doka - Monotes kerstingii Community

on uncultivated lateritic ironstone mesa tops.

CODE	SPECIES	DOMIN SCORES										EVALUATION		
		77	57	78	61	72	49	48	35	36	39	I	II	III
9	Monotes kerstingii	9	7	4	4	3	3	3	3	3	2	10	31	3.1
13	Monocymbium ceresiiformis	1	4	4	.	3	1	2	3	1	3	9	22	2.2
1	Isoberlinia doka	1	3	.	.	3	2	2	4	1	4	8	20	2.0
3	Andropogon gayanus	1	1	1	2	.	1	4	1	1	2	9	14	1.4
11	Lepidagathis collina	.	1	1	1	1	1	1	1	1	1	9	9	0.9
10	Panicum maximum	.	1	3	1	.	1	1	3	1	.	7	10	1.0
20	Ctenium newtonii	5	3	1	.	1	.	.	2	3	.	6	15	1.5
12	Adenodolichos paniculatus	.	1	1	.	1	1	2	.	.	1	6	7	0.7
30	Loudetia simplex	2	.	.	2	.	3	2	.	2	.	5	11	1.1
19	Parinari curatelifolia	1	2	1	.	.	.	.	2	1	.	5	7	0.7
39	Detarium microcarpum	1	2	.	.	1	.	.	1	1	.	5	6	0.6
2	Pennisetum pedicellatum	.	1	.	.	2	1	.	6	1	.	5	11	1.1
25	Ximenia americana	.	1	1	.	1	1	.	1	.	.	5	5	0.5
8	Andropogon pseudapricus	1	1	1	.	.	.	.	.	.	3	4	6	0.6
17	Cassia mimosoides	1	.	.	.	.	1	1	.	.	1	4	4	0.4
72	Monechma ciliatum	1	1	.	.	.	.	.	.	1	1	4	4	0.4
52	Crossopteryx febrifuga	.	.	1	.	.	1	1	1	.	.	4	4	0.4
7	Butyrospermum paradoxum	.	.	.	1	1	2	2	.	.	.	4	6	0.6
21	Cymbopogon giganteus	.	.	.	1	.	1	3	.	.	1	4	6	0.6
22	Uapaca togoensis	.	.	.	1	6	.	.	1	1	.	4	9	0.9
5	Alysicarpus glumaceus	1	1	.	.	.	1	.	.	.	.	3	3	0.3
36	Prosopis africana	1	1	.	.	.	1	.	.	.	.	3	3	0.3
37	Pavetta gloucescens	1	.	1	.	.	.	1	.	.	.	3	3	0.3
51	Eriosema griseum	1	.	.	.	.	.	.	1	.	1	3	3	0.3
61	Gardenia erubescens	1	1	.	.	1	.	.	.	.	.	3	3	0.3
23	Afrormosia laxiflora	.	.	1	.	2	.	.	1	.	.	3	4	0.4
6	Annona senegalensis	.	.	.	1	1	.	.	.	.	1	3	3	0.3
66	Pandiaka heudelotii	.	.	.	.	1	1	1	.	.	.	3	3	0.3
15	Piliostigma thonningii	1	.	.	.	.	.	.	.	1	.	2	2	0.2
26	Aspilia africana	1	.	.	.	.	.	1	.	.	.	2	2	0.2
43	Bridellia ferruginea	1	.	.	.	.	1	.	.	.	.	2	2	0.2
58	Terminalia avicennioides	1	.	.	.	.	.	.	.	1	.	2	2	0.2
59	Gardenia aquala	1	.	1	.	.	.	.	.	.	.	2	2	0.2
69	Lophira lanceolata	1	1	.	.	1	.	.	.	.	.	3	3	0.3
73	Vernonia oocephala	1	.	.	.	.	.	.	.	3	.	2	4	0.4
65	Combretum ghasalense	1	.	1	.	.	.	.	.	.	.	2	2	0.2
45	Ochna rhizomatosa	.	.	1	.	2	.	.	1	.	.	3	4	0.4
57	Swartzia madagascariensis	.	.	1	.	.	.	.	.	.	1	2	2	0.2
67	Cussonia barteri	.	.	1	.	.	.	.	.	.	1	2	2	0.2
4	Borreria radiata	.	.	.	.	.	.	.	2	.	1	2	3	0.3
16	Terminalia laxiflora	.	.	.	.	.	.	.	1	3	.	2	4	0.4
28	Isoberlinia tomentosa	.	.	.	2	.	3	.	.	.	.	2	5	0.5
14	Daniellia oliveri	.	.	.	.	1	.	.	1	.	.	2	2	0.2

DOMAIN: KUYELLO COMPOSITE SURVEY - FLORISTIC CLUSTER 2

XII.2. Floristic Community Table 44

Monotes kerstingii - *Monocymbium ceresiiformis* - *Isoberlinia doka* Community.

associated with uncultivated severely gullied stream heads having exposures of lateritic ironpan. (Exemplified by Plates 40 and 74).

CODE	SPECIES	DOMIN SCORES												EVALUATION		
		45	62	73	71	70	37	50	75	60	76	74	40	I	II	III
9	Monotes kerstingii	1	1	6	2	4	1	1	7	.	2	4	2	11	31	2.6
10	Panicum maximum	2	2	1	.	1	2	2	4	.	3	3	2	10	22	1.8
22	Uapaca togoensis	3	2	1	1	3	1	.	3	2	1	2	.	10	19	1.6
1	Isoberlinia doka	9	2	6	1	7	1	.	.	5	2	4	.	9	37	3.1
30	Loudetia simplex	.	2	4	5	3	3	2	.	.	3	4	2	9	28	2.3
3	Andropogon gayanus	1	2	.	2	1	1	.	1	1	1	1	.	9	11	0.9
13	Monocymbium ceresiiformis	5	2	1	2	.	3	.	7	.	2	6	.	8	28	2.3
11	Lepidagathis collina	2	1	1	1	.	1	.	.	2	1	2	.	8	11	0.9
12	Adenodolichos paniculatus	2	1	1	1	.	1	1	.	.	1	.	.	7	8	0.7
19	Parinari curatelifolia	1	1	.	2	.	1	.	3	.	2	3	.	7	13	1.1
23	Afrormosia laxiflora	1	.	1	1	.	.	.	1	.	1	1	1	7	7	0.6
7	Butyrospermum paradoxum	.	1	.	.	1	.	1	.	1	1	1	1	7	7	0.6
37	Pavetta gloucescens	.	.	1	1	1	.	.	1	1	1	1	.	7	7	0.6
20	Ctenium newtonii	3	3	4	1	3	.	.	.	3	.	.	.	6	17	1.4
6	Annona senegalensis	.	.	.	1	1	1	1	.	1	.	1	1	7	7	0.6
28	Isoberlinia tomentosa	.	2	.	5	3	.	3	.	.	5	.	3	6	21	1.8
2	Pennisetum pedicellatum	1	1	.	.	1	.	4	.	1	.	.	3	6	11	0.9
8	Andropogon pseudapricus	.	1	.	1	.	.	3	.	2	1	.	2	6	10	0.8
16	Terminalia laxiflora	2	.	1	1	1	.	.	1	.	.	1	.	6	7	0.6
25	Ximenia americana	.	.	1	1	.	.	1	.	.	1	.	2	6	7	0.6
27	Strychnos spinosa	.	.	1	1	.	.	1	1	.	1	1	.	6	6	0.5
43	Bridelia ferruginea	1	.	.	.	1	.	.	1	1	1	.	.	5	5	0.4
39	Detarium microcarpum	.	.	2	.	2	.	1	.	.	.	2	.	4	7	0.6
5	Alysicarpus glumaceus	1	.	.	.	1	.	1	.	1	.	.	.	4	4	0.3
36	Prosopis africana	2	.	1	.	1	.	.	.	.	.	1	.	4	5	0.4
58	Terminalia avicennioides	1	.	1	.	.	.	1	.	.	.	1	.	4	4	0.3
65	Combretum ghasalense	1	1	.	.	.	.	.	.	.	.	1	1	4	4	0.3
4	Borreria radiata	.	1	.	.	.	.	1	.	1	.	.	2	4	5	0.4
69	Lophira lanceolata	.	.	1	1	1	.	.	1	.	.	.	.	4	4	0.3
86	Combretum molle	.	.	2	.	1	1	1	.	.	.	.	.	4	5	0.4
26	Aspilia africana	.	.	.	.	1	.	1	.	1	.	.	1	4	4	0.3
53	Vernonia glaberrima	.	.	.	.	1	1	.	1	.	1	.	.	4	4	0.3
41	Beckeropsis uniseta	1	.	.	.	.	.	.	.	1	2	.	.	3	4	0.3
52	Crossopteryx febrifuga	1	.	5	.	.	.	.	.	.	1	.	.	3	7	0.6
59	Gardenia aqualla	2	.	.	.	.	.	.	.	1	.	1	.	3	4	0.3
74	Lannea schimperi	1	.	.	.	1	.	.	.	1	.	.	.	3	3	0.3
21	Cymbopogon giganteus	.	1	.	.	.	.	.	.	1	1	.	.	3	3	0.3
79	Hyparrhenia involucrata	.	4	.	1	2	.	.	.	.	.	.	.	3	7	0.6
57	Swartzia madagascariensis	.	1	1	.	.	.	.	1	.	.	.	.	3	3	0.3
113	Urelytrum muricatum	.	1	1	.	1	.	.	.	.	.	.	.	3	3	0.3
14	Daniellia oliveri	.	.	1	1	.	.	.	.	1	.	.	.	3	3	0.3
83	Ochna afzelii	.	.	1	1	.	1	.	.	.	.	.	.	3	3	0.3
108	Strychnos innocua	.	.	1	.	1	.	1	.	.	.	.	.	3	3	0.3
45	Ochna rhizomatosa	.	.	.	1	1	.	.	.	1	.	.	.	3	3	0.3
71	Trichilia emetica	.	.	.	.	1	.	.	1	.	.	.	1	3	3	0.3
66	Pandiaka heudelotii	1	1	.	.	.	1	.	.	.	.	.	.	2	2	0.2
72	Monechma ciliatum	1	.	1	.	.	.	.	.	.	.	.	.	2	2	0.2
101	Ficus platyphyla	1	.	.	.	.	.	.	.	1	.	.	.	2	2	0.2
85	Schizachyrium sanguineum	1	1	.	.	.	.	.	.	.	.	.	.	2	3	0.3
29	Pterocarpus erinaceus	.	.	1	2	.	.	.	.	.	.	.	.	2	2	0.2
51	Eriosema griseum	.	.	1	.	1	.	.	.	.	.	.	.	2	2	0.2
61	Gardenia erubescens	.	.	1	.	1	.	.	.	.	.	.	.	2	5	0.4
99	Diospyros mespilifomis	.	.	3	.	.	.	.	2	.	.	.	.	2	2	0.2
78	Grewia mollis	.	.	.	1	.	.	1	.	.	.	.	.	2	2	0.2
91	Aeschynomene indica	.	.	.	.	1	.	.	.	.	1	.	.	2	2	0.2
105	Panicum baumanii	.	.	.	.	1	.	1	.	.	.	.	.	2	3	0.3
24	Elionurus pobeguinii	.	.	.	.	.	2	.	.	.	.	.	1	2	2	0.2
17	Cassia mimosoides	.	.	.	.	.	.	1	.	.	.	.	1	2	3	0.3
18	Vernonia ambigua	.	.	.	.	.	.	.	.	1	2	.	.			

DOMAIN: KUYELLO COMPOSITE SURVEY - FLORISTIC CLUSTER 3

XII.3.

Floristic Community Table 45
Isoberlinia doka - Monotes kerstingii - Loudetia simplex - Uapaca togoensis Community

associated with uncultivated to hardly cultivated ironstone mesa - fringing colluvia deposits (Illustrated by Plate 53).

CODE	SPECIES	DOMIN SCORES																				I	II	III
		38	25	27	7	26	43	53	56	67	28	33	34	68	69	11	44	58	59	65	66			
3	Andropogon gayanus	5	4	4	3	3	4	3	3	.	3	2	2	2	2	.	1	1	1	1	1	18	45	2.3
1	Isoberlinia doka	2	3	1	2	3	5	3	.	4	4	.	2	2	1	.	.	3	2	2	1	16	38	1.9
4	Borreria radiata	1	.	1	3	.	1	2	.	1	.	3	3	.	1	4	1	3	2	2	3	15	30	1.5
7	Butyrospermum paradoxum	1	1	.	1	.	.	1	1	4	2	.	.	4	2	.	1	2	1	.	2	13	23	1.2
8	*Andropogon pseudapricus*	2	1	4	4	.	.	.	2	5	.	.	.	.	1	.	4	5	8	1	3	12	40	2.0
21	Cymbopogon giganteum	1	2	2	.	4	1	1	4	.	1	.	.	1	3	.	.	2	.	.	.	11	20	1.0
12	Adenodolichos paniculatus	1	1	.	1	.	.	.	1	.	2	1	1	.	.	.	.	.	.	1	.	8	9	0.5
54	*Dichrostachys glomerata*	1	.	.	.	.	.	1	.	1	.	.	.	2	2	.	2	1	3	.	.	8	13	0.7
27	Strychnos spinosa	.	.	1	.	.	1	1	1	1	.	.	1	.	1	.	.	.	.	.	1	8	8	0.4
112	Beckeropsis uniseta	.	.	1	.	2	1	1	1	.	1	.	.	.	.	.	1	3	.	.	.	8	11	0.6
15	Piliostigma thonningii	.	.	.	.	1	.	2	.	.	.	.	.	1	2	1	.	4	4	1	.	8	16	0.8
10	Panicum maximum	1	2	.	.	.	1	2	3	.	3	.	.	2	.	.	.	.	.	.	.	7	14	0.7
24	Elionurus pobeguinii	1	2	.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	.	2	.	7	9	0.5
26	Aspilia africana	1	.	1	3	.	.	.	1	2	.	.	.	.	.	.	.	1	.	.	2	7	11	0.6
36	Prosopis africana	1	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	1	1	1	1	7	7	0.4
31	Parkia clappertoniana	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	1	2	1	1	1	7	8	0.4
44	Entada africana	.	.	.	.	1	.	1	.	1	.	.	.	1	.	.	1	.	1	.	4	7	12	0.6
55	Psorospermum corymbiferum	.	.	.	.	.	.	1	.	.	1	.	.	1	.	.	1	1	1	1	.	7	7	0.4
35	Hyparrhenia rufa	.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	.	2	3	1	1	7	10	0.5
13	Monocymbium ceresiiformis	.	1	.	.	.	1	.	1	.	2	.	.	2	3	.	.	.	.	.	.	6	10	0.5
17	Cassia mimosoides	1	1	.	.	.	1	.	.	.	1	.	.	.	1	.	.	.	.	2	.	6	7	0.4
23	Afrormosia laxiflora	1	.	.	.	.	.	.	1	.	.	.	1	.	.	.	2	1	.	1	.	6	7	0.4
11	Lepidagathis collina	.	1	1	.	.	1	.	1	.	1	1	.	.	.	.	.	.	.	.	.	6	6	0.3
20	Ctenium *newtonii*	.	3	.	.	.	2	3	.	.	2	.	.	3	4	.	.	.	.	.	.	6	17	0.9
56	Polygala petitiana	.	.	.	1	1	.	.	.	1	.	.	.	.	.	1	.	.	1	1	.	6	6	0.3
16	Terminalia laxiflora	.	.	.	.	.	1	2	.	.	1	.	1	.	.	1	.	1	.	.	.	6	7	0.4
39	Detarium microcarpum	1	.	.	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	1	.	5	5	0.3
43	Bridellia ferruginea	.	1	.	.	.	1	.	1	.	.	.	.	.	1	.	.	1	.	.	.	5	5	0.3
53	Vernonia glaberrima	.	.	1	1	.	.	.	1	.	.	1	.	.	1	.	.	.	.	.	.	5	5	0.3
28	*Isoberlinia tomentosa*	.	.	.	1	1	.	.	3	.	.	.	1	1	.	.	.	.	.	.	.	5	7	0.4
49	Schweinkia americana	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	1	1	1	5	5	0.3
37	Pavetta gloucescens	.	.	.	.	1	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	5	5	0.3
60	Vitex *doniana*	.	.	.	.	.	1	.	.	.	.	.	.	1	1	.	1	1	.	.	.	5	5	0.3
51	Eriosema griseum	.	.	.	.	.	.	3	.	.	1	.	.	.	.	1	.	.	.	2	1	5	8	0.4
59	*Gardenia aqualla*	1	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	0.2
18	Vernonia ambigua	.	1	.	1	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	4	4	0.2
45	Ochna rhizomatosa	.	1	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	1	.	4	4	0.2
58	Terminalia avicennioides	.	2	.	1	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	4	5	0.3
84	Indigofera capitata	.	1	.	.	.	2	2	.	.	.	.	.	.	2	.	.	.	.	.	.	4	7	0.4
2	Pennisetum pedicellatum	.	.	3	6	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4	11	0.6
33	Lactuca glandulifera	.	.	1	.	.	.	.	.	.	.	1	.	.	4	.	.	.	1	.	.	4	7	0.4
67	Cussonia barteri	.	.	.	1	.	.	1	.	1	.	.	1	.	.	.	.	.	.	.	.	4	4	0.2
25	Ximenia americana	.	.	.	.	1	1	.	.	1	.	.	.	.	1	.	.	.	.	.	.	4	4	0.2
14	Daniellia oliveri	.	.	.	.	.	1	.	.	1	.	.	.	.	1	.	.	1	.	.	.	4	4	0.2
22	Uapaca togoensis	.	.	.	.	.	2	1	.	.	2	.	1	.	.	.	.	.	.	.	.	4	6	0.3
78	Grewia mollis	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	1	1	.	.	1	4	4	0.2
29	*Pterocarpus erinaceus*	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	1	.	1	.	4	4	0.2
40	Imperata cylindrica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	7	1	5	.	.	4	16	0.8
61	Gardenia erubescens	1	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	3	3	0.2
87	Terminalia gloucescens	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	3	.	.	.	3	5	0.3
32	Hyptis spectigera	.	2	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	1	.	3	6	0.3
9	Monotes kerstingii	.	2	.	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	4	5	0.3
121	Euphorbia hirta	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	0.1
19	Parinari curatellifolia	.	.	1	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	3	3	0.2
52	Crossopteryx febrifuga	.	.	.	1	.	.	.	2	.	.	.	.	.	1	.	.	.	.	.	.	3	4	0.2
81	Stereospermum kunthianum	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	3	3	0.2
102	*Cryptolepis sanguinolento*	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	3	3	0.2
68	Nauclea latifolia	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	.	3	3	0.2
79	Hyparrhenia involucrata	.	.	.	.	.	.	4	1	.	.	.	.	.	2	.	.	.	.	.	.	3	7	0.4
64	*Ficus capensis*	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	1	.	.	.	.	3	3	0.2
128	Microchloa indica	4	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	2	7	0.4
6	Annona senegalensis	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	0.1
19	*Parinari curatellifolia*	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	0.1
5	Alysicarpus glumaceus	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	3	3	0.2
42	Vernonia pauciflora	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	0.1
73	Vernonia oocephala	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	2	2	0.1
48	Jacquemontia tamnifolia	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	2	2	0.1
134	Pseudarthria hookeri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	2	2	0.1
47	Paspalum orbiculare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	2	0.1
104	Byrsocarpus coccineus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	2	0.1

DOMAIN: KUYELLO COMPOSITE SURVEY - FLORISTIC CLUSTER 4

XII.4. Floristic Community Table 46

Andropogon gayanus - Andropogon pseudapricus - Isoberlinia doka - Borreria radiata - Butyrospermum paradoxum Community

regrowths on old farmed, currently abandoned, arable lands. Sites uncultivated for over four years. Soils often contain rubbles of ironstone, quartzite, or schist.

CODE	SPECIES	DOMIN SCORES														EVALUATION		
		1	5	8	9	13	14	15	16	22	30	31	32	54	51	I	II	III
2	Pennisetum pedicellatum	2	4	5	3	6	8	6	3	3	5	8	8	.	.	12	63	4.5
5	Alysicarpus glumaceus	1	1	1	7	2	6	.	3	1	2	.	2	1	.	11	27	1.9
1	Isoberlinia doka	.	.	3	.	2	1	1	2	1	2	2	1	4	.	10	19	1.4
4	Borreria radiata	.	2	.	1	1	1	1	1	2	.	.	2	2	.	9	13	0.9
7	Butyrospermum paradoxum	2	.	2	1	.	1	1	1	1	1	.	1	1	.	10	12	0.9
50	Mitracarpus scaber	.	.	1	1	1	.	1	1	1	1	1	1	.	.	9	9	0.6
18	Vernonia ambigua	.	1	3	3	1	1	3	1	2	.	.	.	.	.	8	15	1.1
15	Piliostigma thonningii	1	4	1	1	1	.	.	.	4	.	.	.	3	.	7	14	1.0
40	Imperata cylindrica	.	2	2	.	5	4	.	4	.	3	3	.	.	.	7	23	1.6
38	Leucas martinicensis	.	1	1	.	1	.	.	1	.	1	2	2	.	.	7	9	0.6
46	Scoparia dulcis	.	.	1	.	1	1	2	.	4	2	.	1	.	.	7	12	0.9
49	Schweinkia americana	.	.	4	1	2	2	1	1	.	1	.	.	.	.	7	12	0.9
14	Daniellia oliveri	.	1	.	.	3	1	1	.	.	1	2	.	.	.	6	9	0.6
34	Ageratum conyzoides	.	3	.	7	1	.	1	.	.	2	1	.	.	.	6	15	1.1
42	Vernonia pauciflora	.	.	.	.	1	.	4	.	1	4	3	1	.	.	6	14	1.0
31	Parkia clappertoniana	1	.	.	1	.	.	1	1	.	1	1	.	.	.	6	6	0.4
48	Jacquemontia tamnifolia	.	.	1	1	.	1	.	.	.	1	1	1	1	.	7	7	0.5
8	Andropogon pseudapricus	1	.	.	1	.	.	.	.	.	3	.	3	.	5	5	13	0.9
6	Annona senegalensis	.	1	1	.	.	.	.	.	.	1	1	.	1	.	5	5	0.4
16	Terminalia laxiflora	1	1	1	1	.	.	.	.	.	.	.	.	1	.	5	5	0.4
27	Strychnos spinosa	1	.	.	.	.	1	.	.	.	1	1	1	.	.	5	5	0.4
47	Paspalum orbiculare	.	1	.	.	2	1	.	.	2	1	.	.	.	.	5	8	0.5
17	Cassia mimosoides	1	.	.	.	1	4	.	.	.	4	.	.	.	.	4	12	0.9
33	Lactuca ghandulifera	.	.	.	2	2	.	.	.	.	1	1	.	.	.	4	6	0.4
56	Polygala petitiana	.	.	1	1	.	.	.	.	.	1	1	.	.	.	4	4	0.3
62	Tridax procumbens	1	.	.	.	1	.	1	.	.	.	3	.	.	.	4	5	0.4
63	Vernonia perrottetii	.	.	.	.	1	.	.	.	1	.	2	2	.	.	4	6	0.4
89	Striga senegalensis	.	.	.	.	1	2	.	.	.	1	1	.	.	.	4	5	0.4
24	*Elionuros pobeguinii*	.	.	.	.	.	.	1	.	.	.	3	2	.	.	3	6	0.4
23	Afrormosia laxiflora	.	.	.	.	.	.	.	1	.	.	.	.	1	1	3	3	0.2
88	Crotalaria senegalensis	.	.	1	.	.	.	1	.	.	.	1	.	.	.	3	3	0.2
20	Ctenium newtonii	.	.	.	.	.	.	.	.	.	.	.	.	2	7	2	9	0.6
26	Aspilia africana	1	.	.	.	.	1	.	.	.	.	.	.	.	.	2	2	0.1
28	Isoberlinia tomentosa	.	.	.	.	.	.	.	.	1	.	.	1	.	.	2	2	0.1
29	Pterocarpus erinaceus	.	.	.	1	.	.	.	.	.	.	.	.	1	.	2	2	0.1
43	Bridelia ferruginea	.	1	.	.	.	.	.	.	.	.	.	.	1	.	2	2	0.1
51	Eriosema griseum	.	.	.	.	.	.	.	.	.	.	1	.	3	.	2	4	0.3
52	Crossopteryx febrifuga	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	2	0.1
58	Terminalia avicennioides	.	.	.	.	.	1	.	.	.	.	.	1	.	.	2	2	0.1
55	Psorospermum corymbiferum	.	.	.	.	.	1	.	.	.	.	1	.	.	.	2	2	0.1
60	Vitex doniana	.	.	.	.	.	.	2	.	.	.	.	.	1	.	2	3	0.2
68	Nauclea latifolia	.	.	.	.	.	.	1	.	.	.	.	.	1	.	2	2	0.1
70	Eragrostis ciliaris	1	.	1	.	.	.	.	.	.	.	.	.	.	.	2	2	0.1
71	Trichilia emetica	1	.	.	.	.	.	.	.	.	.	1	.	.	.	2	2	0.1
76	Nelsonia canescens	.	1	.	.	.	.	1	.	.	.	.	.	.	.	2	2	0.1
80	Oldenlandia herbecea	.	.	2	.	.	.	.	.	.	1	.	.	.	.	2	3	0.2
81	Stereospermum kunthianum	.	.	.	.	.	1	.	.	.	.	.	.	.	1	2	2	0.1
87	Terminalia glaucescens	.	1	.	.	.	.	.	.	.	.	.	.	1	.	2	2	0.1
93	Guizotia scabra	.	.	1	.	.	.	.	.	.	.	.	1	.	.	2	2	0.1
95	Hymenocardia acida	.	2	.	.	.	.	.	.	.	.	.	.	1	.	2	3	0.2
96	Ficus congensis	.	.	1	1	.	.	.	.	.	.	.	.	.	.	2	2	0.1
78	Grewia mollis	1	1	.	.	.	.	.	.	.	.	.	.	.	.	2	2	0.1
122	Chloris pilosa	.	.	1	.	.	.	.	.	.	.	1	.	.	.	2	2	0.1

DOMAIN: KUYELLO COMPOSITE SURVEY - FLORISTIC CLUSTER 5

XII.5.

Floristic Community Table 47
Pennisetum pedicellatum Community

of cleared and abandoned 'Model Farm Settlement Scheme' (similar to Plate 22). Third Year Fallow.

CODE	SPECIES	DOMIN SCORES										EVALUATION		
		23	18	24	10	17	19	21	20	12	29	I	II	III
32	Hyptis specigera	6	5	4	3	3	3	3	2	7	2	10	38	3.8
2	Pennisetum pedicellatum	4	3	5	1	4	1	9	.	8	2	9	37	3.7
38	Leucas martinicensis	1	2	3	2	3	1	.	1	2	1	9	16	1.6
34	Ageratum conyzoides	6	.	1	3	3	.	7	1	2	.	7	23	2.3
42	Vernonia pauciflora	1	.	1	1	1	4	.	1	3	.	7	12	1.2
18	Vernonia ambigua	1	2	.	1	4	1	1	.	1	.	7	11	1.1
4	Borreria radiata	1	.	1	1	2	1	3	.	2	.	7	11	1.1
33	Lactuca glandulifera	2	2	1	2	3	2	.	.	.	.	6	12	1.2
5	Alysicarpus glumaceus	1	5	.	.	1	1	.	1	1	.	6	10	1.0
31	Parkia clappertoniana	.	1	.	1	1	2	.	1	1	.	6	7	0.7
48	Jacquemontia tamnifolia	1	4	.	.	1	1	1	1	.	.	6	9	0.9
1	Isoberlinia doka	2	.	.	1	4	.	1	.	1	.	5	9	0.9
46	Scoparia dulcis	.	1	.	3	1	.	.	2	1	.	5	8	0.8
62	Tridax procumbens	2	.	.	.	.	2	.	1	.	1	4	6	0.6
80	Oldenlandia herbecea	.	.	1	5	1	.	.	1	.	.	4	8	0.8
16	Terminalia laxiflora	.	1	.	.	1	.	.	1	1	.	4	4	0.4
3	Andropogon gayanus	1	.	.	.	.	.	1	.	.	1	3	3	0.3
6	Annona senegalensis	1	1	.	.	1	.	.	.	.	.	3	3	0.3
63	Vernonia perrottetii	1	.	.	.	1	1	.	.	.	.	3	3	0.3
7	Butyrospermum paradoxum	.	1	.	.	1	.	.	2	.	.	3	4	0.4
14	Daniellia oliveri	.	1	.	.	1	.	.	.	1	.	3	3	0.3
50	Mitracarpus scaber	.	1	.	.	1	1	.	.	.	.	3	3	0.3
70	Eragrostis ciliaris	.	.	.	1	.	1	.	1	.	.	3	3	0.3
100	Asparagus africanus	.	1	.	.	1	1	.	.	.	.	3	3	0.3
8	Andropogon pseudapricus	.	.	1	.	.	.	.	.	3	1	3	5	0.5
49	Schwenkia americana	.	1	4	.	1	.	.	.	.	.	3	6	0.6
40	Imperata cylindrica	.	.	.	.	3	2	.	4	.	.	3	9	0.9
17	Cassia mimosoides	.	1	.	.	.	.	2	4	.	.	3	7	0.7
19	Parinari curatellifolia	1	.	.	.	1	.	.	.	.	.	2	2	0.2
71	Trichilia emetica	1	.	.	.	.	.	.	.	1	.	2	2	0.2
15	Piliostigma thonningii	.	6	.	.	.	.	.	1	.	.	2	7	0.7
24	Elionuros pobeguinii	.	1	1	.	.	.	.	.	.	.	2	2	0.2
37	Pavetta gloucescens	.	1	.	.	.	.	.	.	.	1	2	2	0.2
44	Entada africana	.	1	.	.	.	.	.	.	1	.	2	2	0.2
54	Dichrostachys glomerata	.	1	.	.	.	.	.	.	1	.	2	2	0.2
93	Guizotia scabra	.	2	.	.	.	1	.	.	.	.	2	3	0.3
47	Paspalum orbiculare	.	.	1	.	.	.	.	2	.	.	2	3	0.3
126	Sphaeranthus senegalensis	.	.	1	.	.	.	.	1	.	.	2	2	0.2
77	Echinops longifolius	.	.	1	.	.	.	.	1	.	.	2	2	0.2
55	Psorospermum corymbiferum	.	.	.	.	1	.	1	.	.	.	2	2	0.2
124	Lannea kerstingii	.	.	.	.	1	.	.	1	.	.	2	2	0.2
27	Strychnos spinosa	.	.	.	.	1	.	.	.	.	1	2	2	0.2
96	Ficus congensis	.	.	.	.	.	.	.	1	1	.	2	2	0.2

DOMAIN: KUYELLO COMPOSITE SURVEY - FLORISTIC CLUSTER 6

XII.6. Floristic Community Table 48

Hyptis specigera - Pennisetum pedicellatum - Ageratum conyzoides Community

of agricultural regrowths on 1-2 year farmed fallows on stoneless, imperfectly drained, flat middle slope plains.

CODE	SPECIES	DOMIN SCORES 6	2	3	4	EVALUATION I	II	III
32	Hyptis specigera	9	7	6	6	4	28	7.0
33	Lactuca glandulifera	6	4	5	4	4	19	4.8
34	Ageratum conyzoides	3	7	5	7	4	22	5.5
94	Jussiaea suffruticosa	5	1	2	1	4	9	2.3
40	Imperata cylindrica	.	5	7	7	3	19	4.8
76	Nelsonia canescens	2	.	2	3	3	7	1.8
35	Hyparrhenia rufa	1	.	2	1	3	4	1.0
2	Pennisetum pedicellatum	.	1	1	2	3	4	1.0
70	Eragrostis ciliaris	8	.	1	.	2	9	2.3
47	Paspalum orbiculare	1	.	2	.	2	3	0.8
5	Alysicarpus glumaceus	.	2	.	1	2	3	0.8
119	Bacopa floribunda	.	1	2	.	2	3	0.8
18	Vernonia ambigua	.	.	1	1	2	2	0.5

DOMAIN: KUYELLO COMPOSITE SURVEY - FLORISTIC CLUSTER 7

XII.7 Floristic Community Table 49
Hyptis specigera - Ageratum conyzoides - Lactuca glandulifera - Imperata cylindrica Community

of 'weeds' on currently cultivated 'fadama'. All quadrats contained Oryza sativa crop.

CODE	SPECIES	DOMIN SCORES 82	85	83	80	84	81	79	52	EVALUATION I	II	III
75	Hyparrhenia cyanescens	6	9	9	8	3	3	1	2	8	41	5.1
92	Mitragyna inermis	6	3	2	8	2	2	.	.	6	23	2.9
15	Piliostigma thonningii	1	1	1	1	2	1	.	.	6	17	0.9
35	Hyparrhenia rufa	2	3	.	.	9	2	4	.	5	20	2.5
117	Sesbania sesban	2	.	2	1	.	2	1	.	5	8	1.0
82	Syzgium guineense	1	1	5	.	.	6	.	.	4	13	1.6
140	Polygonum limbatum	4	.	1	.	.	1	.	4	4	10	1.3
60	Vitex doniana	2	1	.	.	.	1	1	.	4	5	0.6
141	Schizachyrium brevifolium	2	5	.	.	6	.	.	.	3	13	1.6
28	Isoberlinia tomentosa	.	.	.	5	.	1	.	4	3	10	1.3
47	Paspalum orbiculare	.	.	2	6	.	1	.	.	3	9	1.1
115	Khaya senegalensis	.	.	.	.	.	5	1	1	3	7	0.9
135	Mimosa pigra	2	.	1	.	.	2	.	.	3	5	0.6
136	Antidesma venosum	2	.	2	.	.	1	.	.	3	5	0.6
137	Strophanthus preusii	3	.	1	.	.	1	.	.	3	5	0.6
17	Cassia mimosoides	1	3	.	.	1	.	.	.	3	5	0.6
14	Daniellia oliveri	2	1	.	.	.	.	1	.	3	4	0.5
138	Paulinia pinnata	2	1	.	.	.	1	.	.	3	4	0.5
32	Hyptis specigera	.	.	.	2	1	1	.	.	3	4	0.5
68	Nauclea latifolia	.	.	.	.	1	.	1	1	3	3	0.4
116	Ficus sp.	.	.	.	.	1	.	1	1	3	3	0.4
112	Beckeropsis uniseta	.	.	.	.	2	3	.	1	3	6	0.8
111	Eriosema psoraleoides	.	3	.	.	2	.	.	.	2	5	0.6
107	Gardenia ternifolia	.	1	.	.	2	.	.	.	2	3	0.4
6	Annona senegalensis	1	1	.	.	.	.	.	.	2	2	0.3
97	Securinega virosa	1	1	.	.	.	.	.	.	2	2	0.3
5	Alysicarpus glumaceus	.	.	.	.	1	.	.	1	2	2	0.3
7	Butyrospermum paradoxum	.	.	.	.	.	.	1	1	2	2	0.3
12	Adenodolichos paniculatus	.	.	.	.	.	.	1	1	2	2	0.3

DOMAIN: KUYELLO COMPOSITE SURVEY - FLORISTIC CLUSTER 8

XII.8. Floristic Community Table 50
Hyparrhenia cyanescens - Mitragyna inermis - Hyparrhenia rufa Community

of uncultivated 'fadama' (Illustrated by Plates 46 and 54).

CHAPTER 9 DISCUSSIONS AND CONCLUSIONS

The merits and the demerits of the usefulness of aerial photo-interpretations can be inferred from several suggestions: Avery pointed out in connection with British soils that individual soils do not exist in nature and mapped soil series should be regarded as landscape units. "In defining and mapping the soil series, a wide margin of variation is allowed in such features as slope, stoniness, degree of truncation by erosion, and depth of bedrock." (Avery 1956).

But Moss (1968) on the soil resources of tropical Africa equated the soil series to habitat sites: "The land facet is a habitat-site, a unit of the land surface with a characteristic slope and form which constitutes a distinct habitat for plant growth." However, Moss appeared to acknowledge that land facets constitute areas with different limitations and possibilities for floral continuum distribution: "It is a practical unit which represents an attempt to use the clear, though complex, relationship between soils and slopes as a basis for land use planning." (Moss 1968).

Thereafter, Moss concluded that "land facets are more useful in judging morphological soil characteristics related to weathering process, geomorphological history, and regional hydrological characteristics, but they are not useful in assessing the ecological soil properties and the activities of the organisms which are more intimately related to the plant and animal components of the ecosystem".

Webster and Beckett (1964) suggested that a number of statistical tests have been carried out which show that land facets mapped at the scale of at least 1:50,000 are "reasonably homogeneous with respect to certain soil parameters" which are "mostly physical properties" and partly chemical parameters such as soil pH.

I have referred to Valette (1977) who pointed out that "the classification used in Northern Nigeria can be regarded as a qualitative classification of land for current suitability for mechanized cultivation of arable crops".

Each of my five discontinuous domains were stratified into relatively homogeneous geomorphological subsets using, where possible, previous available base maps (Figs. 11 to 23) or my own constructions (Figs. 18 to 21, and 23). The associated surveys were however quantitatively assessed by ground studies.

Proctor (1966) had pointed out that "Ecology grew up largely as a descriptive science, and even now descriptive work makes a substantial part of the ecological literature", perhaps because while plant ecology has, to a high degree, successfully emerged into a quantitative form, particularly at the analytic levels (Beals, 1973), the related environmental data have not and may probably not fully emerge from that pioneer qualitative descriptive phase, at least in my study area. (See my Conclusion, Factor 5 on pastoralism and 'farming'.)

The guide lines from the literature and experience from the soil-vegetation survey, however, do support the use of aerial photographic interpretations for the stratifications of study areas into some basic 'strata' or 'domains' prior to progressively more detailed ground surveys in the 'Northern Guinea savanna' zone, partly as recommended by Goodall (1952), Dawkins (1970), Whittaker (1973), Hopkins (1974).

Broadly, aerial photo studies tend to indicate areas with similar land use potential and soils that can be put to the same use under the same cultural or mechanized management practices, "They provide the bases of broad categories of erosion limitations, water limitations, or soil limitations" (Valette, 1977); plus the possible divisibility of land facets which might probably be regarded as "habitat-sites" (Moss, 1968) having a relatively distinct floral continuum distribution. The remote sensing method also probably indicates the "regional hydrological and geomorphological soil characteristics" (Moss, 1969); they also probably "indicate areas with statistically significant correlations with respect to some physico-chemical soil parameters" (Webster and Beckett, 1964). In

of the aerial photographic interpretations and 'catenary' cross-section crossing the landscapes in my studies here.

The mapping of the 'fadama' areas of central northern Nigeria was a subject of a recent study by Turner (1977). Her method consisted of interpreting 1:100,000 aerial photographs to cover 19,000 sq. km. distributed in the 'Sudan' and 'Northern Guinea Savanna' zones of Keay and Clayton. The area covered by her geomorphological map is thus far the only para-ecological detailed work which incorporates my study areas on the Galma Basin. The base map of Fig. 17 on which the areas traversed by my systematically-placed transects and semi-random surveys derives from her geomorphological map.

My vegetation-environment surveys on the Galma Basin are of course, like in all other cases, based on 'true' ground data collection. My areas of the surveys are marked and numbered 1, 2, 3, 4, 5, 6 and 7 on the Basin.

The correlation of her geomorphological units with the contours of the landscape (Fig. 16), in my view, suggest a broad topographical-geomorphological concatenation. I used it, and other maps, because:

1. it facilitates the preliminary geographical classification or segmentation of floristic data associated with each stratum of the partly continuous and partly heterogeneous landscape based on interpreted aerial photographs;

2. to some extent, the factors controlling the environment and floral distribution do not seem to always vary entirely independently, but sometimes show some degree of inter-correlation which considerably reduces the number of possibilities to be considered into a few major environmental factors within a geomorphological stratum. In other words, the transition from one environment to another is sometimes fairly abrupt. I noticed that such 'sometimes fairly abrupt' changes tend to occur at

geomorpnological or topographical contacts, favouring certain species combinations, and apparently suppressing others (Plate 62).

Turner's (1977) geomorphological terms are retained on the base map. But notwithstanding its convenience and advantage for providing a preliminary framework with which to stratify the landscape, her usage of certain terms is seldom entirely synonymous with my usage of them for ecological interpretations. Her classification with the aerial photographic method "based on joint geomorphological and hydrological characteristics" (Turner, 1977), in my view, caused some confusion which needs rectification in terms of the environmental factors controlling floral distribution in my survey areas on the Galma Basin.

Thus I have used 'fadama' only in her geomorphological sense of the term. Her hydrologically defined 'fadama' is, in my opinion, sometimes inapplicable or confusing, ecologically. 'Fadama' here, has been restricted to the extensive low-lying alluvial plain along large rivers, such as the River Galma, which she identified as "distinct from 'uplands'". My reason for this restricted geomorphological use of the term is that the Hausa sense of the original word implies the idea of a more precise basic centre for a relatively homogeneous floristic continuum on the landscape as my Floristic Community Tables 1 to 5, 10 to 14, 49 and 50 suggest.

There are other reasons too: the geomorphologically defined 'fadama' is a centre for some relatively defined types of land use in the environment, such as

1) damming for public water supply near urban centres;
2) large-scale irrigation schemes such as the site of my Domain III on the Basin;

3) dry season production of vegetable crops (e.g. Lycopersicum esculentum, Capsicum spp., Hibiscus esculentum, Amaranthus hybridus, and Allium cepa), as my environmental data matrices involving 'fadamas' suggest;

4) rainy season production of certain graminoid crops (e.g. Saccharum officinarum, and Oryza sativa);

5) dry season production of commercial crops (e.g. Nicotiana tabacum);

6) farming tuberous crops (e.g. Discorea spp., Manihot esculenta, and Colocasia spp.); and it is a centre for

7) the main dry season grazing ground by pastoralists' cattle.

Besides, several soil scientists (Ramsay 1963, Higgins 1964, Tomlinson 1965, Klinkenberg and Higgins 1970 , Hope 1976, Valette 1977) have made descriptions of soils in different areas of the northern Nigeria (unfortunately without concurrent floristic surveys) and have, with a general unanimity, described soils of the topographic depressions influenced by permanent or seasonal waterlogging along large rivers like the River Galma as a relatively uniform but complex type of soil.

Higgins (1964), for example, identified "River Sokoto Fadama Alluvial Complex" and pointed out that "the variation within the complex does not allow detailed descriptions of all combinations of the various deposited materials". He suggested that "three series are adequate to cover the range within the complex". Higgins named the three series as

A. Light sandy loam and coarser subsoils;

B. Heavy sandy loam to light clay loam subsoils;

C. Heavy clay loam and clay subsoils.

Klinkenberg and Higgins (1970) referred to such soils of geomorhologically identified 'fadama' as "Mineral Hydromorphic Soils and Organic Hydromorphic Soils" and described their spatial distribution as: "their occurrence is widespread on transported material in association with rivers". Unfortunately again, no associated botanical compositions

were named but the authors pointed out that "it carries an aquatic type of vegetation", though that is quite botanically meaningless: for an aquatic vegetation can range from any of my communities of farmed 'fadama' forblands to 'fadama' thickets to 'fadama' woodland (Community Tables 1, 2, 3, 4, 8 or 50, for example).

To Turner (1977) "fadamas without stream channels are associated with Inselbergs such as the Dumbi"! The transplanting of 'fadamas' from permanently or seasonally waterlogged river valleys to a geological centre of a relatively homogeneous floristic continuum around inselbergs because of a so-called "hydrological" factor per se appears to be over-stretching the limits of 'fadamas' on the landscape. My illustrations on Plates 8, 9, 10, 56 and 58 to 61 do not suggest the idea of "fadamas without stream channels". The overall botanical composition associated with the seasonally to permanently inundated valley 'fadama' is also too distinct from those associated with the Dumbi Inselberg for the areas around inselbergs to be called a 'fadama' of any sort.

'Fadamas' are strictly riverine and are of alluvial origin. They represent edaphic complexities apart from being centres for complex forms of land use. 'Fadamas' also exhibit great variations in soils. Super-imposed upon the whole 'fadama' complexities are the diversities of floristic compositions which may be called a continuum, but which may be objectively segmented or clustered into plant communities.

The factors controlling the floristic distribution will probably vary from place to place. In the particular area of the 'fadama' on which I concentrated on the Galma River terrace, my Stratum 1, the factor scores (in their descending order of importance as estimated using my R-ordination method on the environmental data matrix I) were:

Factor 1 scored 49% of the total variation. Drainage has the highest loading on it. Site and silt have the second highest loadings on the same

factor, respectively. I name this factor the Inundation-Alluviation Factor.

At this stage, I ought to point out that though the items in a matrix are grouped into clusters, or factors, and their estimated importance is given by my methods when they are inter-correlated and factor analysed, the names given to the objectively derived clusters or factors still depend on the judgement of the ecologist. On this account, the names of my factors may be criticized as quite arbitrary. However, their main function is to give the general idea of the content of the factor, and to enable me to correlate a factor with my plant communities. Other names may suggest themselves and may be substituted in some cases. This can be done by correlating my five-point scale environmental data property entries with the results computed for the environmental data matrices. The R-ordinated results summarize the factor scores in the order of their importance. The inversely clustered results indicate which properties are linked together in a dendrogram. All of these are incorporated here.

The second most significant factor in the 'fadama', for example, scored 22%. Total meq. and Base Saturation are the two environmental properties which are highly significant (or positive-definite) on the factor. This implies that the 'fadama' is rich in exchangeable bases, which I do not consider strange because by virtue of its low-lying position, its geomorphological relation with the 'uplands' is that of an action and reaction. Eroded 'upland' sites probably lose their exchangeable minerals to the low-lying alluvial plains through lateral drainage.

The subsequent factors on the six axes tested on the R-ordination were estimated as 10.6%, 7.3%, 6.1% and 5.0% of the proportion of variation accounted for by the six environmental factors explored. None of the 34

environmental properties may be regarded as having positive-definite scores on these last four factors. The rest of the tabulated inverse cluster and R-ordination results for the rest of the environmental matrices should be interpreted together as illustrated.

Drainage (or relative inundation), site, silt, total meq., and base saturation, in co-operation, in a heterogeneous spatial distribution, or in a continuum distribution in the 'fadama' thus appear to be major environmental factors under the plant communities identified in my Stratum I on the geomorphologically defined 'fadama'.

Okali (1971) stated that "evidence exists to show that plant distribution in West Africa is to a great extent controlled by some aspect of the moisture factor of the environment.... The major division of the natural vegetation of this area into savanna and forest is believed to reflect this control, savanna species having, among other features, a greater adaptation to drought than forest species.... These observations are so frequent that there is probably little cause to question their general validity". My questions to Okali would have been

1) Is the West African vegetation natural, or are they only relics of agricultural land use which dates back to the first few millenia B.C.?

2) If the division of the so-called 'natural vegetation' of this area into the so-called 'savanna' and 'forest' indeed reflects the so-called 'moisture factor' per se, would not the 'fadama', which is inundated for the most part of the year be a forest like the moist areas?

3) Does the fact that these observations are so frequent really give it little cause to question their validity?

To these questions I borrow the words of Goodall (1963) for a comprehensive answer: "The widespread recognition does not validate the hypothesis any more than the once general acceptance of a flat earth proved that it was flat". Following the example interpretation of the clustered and ordinated

On the primary factors controlling indigenous floral distribution in the environment, it is concluded that:

1. Alluvial plains, and Erosion in the forms of gullies, dissected drainage channels, sheet erosion, or their variants, behave like distinctive edaphic centres for relatively characteristic floral continua in the landscape. Both the edaphic centres for floral continuities exhibit many varied forms, though the relationship between erosional land surfaces and the alluvial surfaces may be regarded as the result of an action and a reaction between denudation and deposition from hills to depressions or valleys.
2. Basement complex inselbergs, solid outcrops and broken boulders of granitic/gneissic rocks with their associated geological materials act as geological centres which promote relatively distinct floral assemblages. Their floral continua are reliably distinct from those on lateritic ironstone mesas and plains containing subterranean ironstones, ironpans, or gravely iron-concretions.
3. Drainage as a factor makes several recombinations possible, creating a continuum gradient and factorial complexities from one centre of relatively distinctive floral continuum to another. The impact of the drainage factor in causing the confusion among the relatively distinctive centres of floral continua is most marked in surveys carried out in the rainy season, probably because ubiquitously distributed ephemeral ground floras have emerged.
4. Topographic gradients and catenary continua are hardly separable from geological and drainage continua. They are also related to soil depth and the distribution of minerals (particularly organic carbon) in the soil.

One of the ideas behind the holistic surveys and analyses presented here is that ground flora should be as good (if not better) an indicator of the general environmental factors and for monitoring soils and land use types in particular. The reason is because the trees and shrubs have been highly modified by the historic and current methods of land use. The main types of the land use are described and the history of agricultural use in particular is traced back to the first few millenia B.C.

Judging by the distribution of the degree of erosion which was coded from nil to extreme, according to its severity, and their quantitative analyses and interpretations with farmland or farmed land 'weeds', I demarcate the settled farmer from the shifting pastoralist-'farmer'. The former is called 'professional'. The latter is referred to as 'farmer'. Plates 9 to 16 compared to Plate 36 explains this point.

5. Shifting pastoralism and 'farming' apparently became part of the land use in the environment around A.D.1000. It has probably not yet fully adapted to the environment, scientifically, compared to professional farming. The characteristics of these forms of land use are overgrazing, burning, free roaming of stock, temporary overstocking of too many animals on an area, pollarding of trees in the dry season, free ranging and browsing, herding of hoofed phytophages, shifting inhabitation in the countryside, and sporadic agriculture with minimum effort. 'Farms' are often ridgeless or ridges are very low without or with very shallow furrows. Erosion is not controlled by contouring. In the rainy season, the shelters are located on the mesas, or on the summits of low hills and their subsummits. Paths are numerous, diffuse,

faint, and narrow, radiating to several directions.

Therefore shifting pastoral land use has represented a difficult and confusing type of land use to put into the quantitative terms with which plant communities could be related. Yet the activities of the pastoralists are often one of the most important biological factors controlling the distribution of species, particularly in the whole of Guga Forest Reserve, my strata 10 and 11 as well as in parts of the seven strata examined on the Galma Basin. The long period of work needed to formulate quantifiable definitions of plant communities and to elucidate their relationships with the relative abundance of mobile fauna, including pastoralism could not be attempted during the time available for field work. I have, however, profusely illustrated their possible impacts on the environment in my photographs taken during the field work. By inference, rather than by quantitative results, I have related pastoralism and the 'farmer' to erosions. I therefore suggest that the causes of erosion are not entirely "natural" as an authority on this topic (Ologe, 1971) has previously suggested based on his geomorphological experiments in the same sub-region of Nigeria. Were my data on shifting pastoralism based on quantitative examinations, I might have come to the same conclusion as the South African conservationist who declared:

> Muddy water we have become accustomed to, but it is a most dangerous symptom of progressive destruction. Gullies we are used to, but most of them were once where some greenness remains well into winter. The greenness is dying; and Africa with it. Her lifeblood is spilling from the deep wounds.
>
> Richard C. Haw (1959).

Parts of the causes of the "deep wounds" by which Haw referred to gullies, might have been correlated in my field survey areas to

mobile phytophagous ungulates and their owners (Plates 25 to 32, 34 to 37, and 71, 76); and to other forms of land use mentioned in factor 7.

6. Professional agricultural land use is associated with ridging and furrowing, contoured to conserve and control water. On dry upland soils, ridges are lower. In wet areas, the ridges are deep and relatively steep (Plates 9 to 16) and many crops are arranged on them according to their known water preferences.

The professional agricultural land use creates distinct floral continuum centres on the landscape. Different floristic continua start and develop on them in a successional trend. The composition of the successive floral regrowths have been associated with the length of last cultivation and the length of fallow; to the position of the farm in relation to the geomorphology of the environment, such as the 'kurmi', the poorly-drained valley bottomland 'fadama', and to the upland plain.

The successional trend has also been associated with proximity to geological materials, such as the ironstone pavement and the granitic rocks; and to the level of the scrupulousness with which the farmer manages his farmland.

Notwithstanding the 'weedy' nature of the floristic assemblages on the farm- and farmed lands, therefore, agricultural use has given rise to recognizable botanical communities detected by the Cluster Analytic technique used and supported by the Rao's Canonical Factor Analytic ordination employed.

7. In contrast to the mobile anthropo-zoological factor in number 5, because of the fixed nature of termitaria, their presence was quantified at the ground surface level in order to observe their correlation with floral distribution.

The data subjected to quantitative evaluation with the rest of the environmental properties from ten out of the twelve domains of study, using inverse cluster analysis and R-ordination suggest that 1) the relative significance of termitaria as a factor vary at different sites; 2) that the species which form tall (about 2-3m.) cathedral-like mounds occurs largely on the uncultivated well-drained sloping uplands (Plates 29, 70). The termite species were identified as Macrotermes bellicosus (Smeathman). The species appeared to feed on woods and grasses, for their mounds are invariably surrounded by large bare areas on the uncultivated field. They are often associated with areas affected by sheet erosion. The M. bellicosus were not found on arable lands, possibly because they were broken down by the farmers.

The species illustrated on Plate 51 were identified as Macrotermes subhyalinus (Rambur). It also occupies the uncultivated lands but on poorly drained sites. Its feeding habit and its effect upon the flora is similar to that of M. bellicosus. Five other types of termites were identified[1] but they were not restricted to uncultivated lands alone. They were Trinervitermes geminatus (Wasman), Trinervitermes trinervius (Rambur), T. togoensis (Sjostdet), T. occidentalis (Sjostdet) and T. oeconomus (Traghardh).

From the viewpoint that the ground cover of the flora around the termitaria are destroyed and sheet erosion are promoted around them in unfarmed lands, the wood-eating and grass-eating herbivorous termites must be considered as part of the natural biological components of the environment which are controlling plant distribution. Kowal and Kassam (1978) pointed out that termites occur in extensive

---

1 The identification of the termites were done for me by Professor G.H.

numbers as "crop-damaging pests on cultivated lands". According to the authors "variable losses due to termite attack range from 20-40% in cassava and guinea corn, and up to 60-70% in maize and yams".

It is therefore unfortunate that some ecologists do not appear to recognize that "native fauna" can be called pests on some grounds. Woodell (1980), for example, asserted that "Termites are not pests in natural ecosystems, but part of the native fauna" (personal comm.) Locusts are "native fauna" to some environments, yet they become pests when they damage crops or flora. Similarly, Macrotermes bellicosus and Macrotermes subhyalinus are pests in parts of the environment which I surveyed. My analyses of the environmental factors substantiate the observable evidence that I illustrated pictorially. They show that scores for termitaria are positive-definitely related to sheet erosion. The analyses also indicate that the scores for termitaria are positive semi-definite on some areas less affected by erosion. And where the termites are the primary factors controlling flora distribution, the scores for termitaria receive highly significant positive scores on the analysis of the associated environmental data matrix. It thus suggests that the termites which I called pests of uncultivated eroded sites are the fauna equivalents of those termites which Kowal and Kassam (1978) termed "crop-damaging termite pests" on cultivated lands.

The establishment of forest reserves and of forest plantations, using exotic species started just from 1903. However most plantations started after 1960 in my study areas. The potential consequences of the plantations of the exotics on the ground flora and the environment are therefore probably just beginning to show up.

8. Nominally reserved forests involve governmental orders restricting pastoralists and farmers into limited areas in 'enclaves' without the concurrent provision of the essential amenities for which the pastoralists shift after. The pastoralists therefore appear to shift after flora and severe habitat degradations within the enclaves tend to be common (Plates 32, 37). Governmental restrictions are therefore probably also a factor, as suggested by my observations in domains 10 and 11. The enclaving of pastoralists seems to lead to overstocking with herds by the pastoralists until the herds have locally defoliated the floristic cover beyond repair, especially along slopes and depressions. This eighth factor which I may call forestry mismanagement factor, derives from observations rather than from quantitative assessments. Like factor 5, with which this factor is linked, I did not find a method of quantifying it. Areas within the enclaves on flat or level grounds, however, do not seem susceptible to easy degradation and they carry a much more diverse flora than the plantations (Plates 32, 37, 40).

9. Forestry plantations with exotic species change the course of the undergrowth floral development. The specific undergrowths vary with each species established into a plantation. Each exotic Eucalyptus species therefore appears to be a centre of relatively distinct undergrowth species. Each Eucalyptus species seems to inhibit certain undergrowth species, and to promote others. The inhibitory and promotory effects of the planted species on the undergrowth flora also appear to be related to the age of the plantation. Thus younger Eucalyptus camaldulensis plantations appear to support some ubiquitously and locally distributed species. However, with increasing age, a near-total annihilation of the potential undergrowths seems to appear (Plate 39). The other introduced Eucalyptus species (E. teriticornis,

E. citriodora) examined appear to exhibit the same promotory and inhibitory roles on the undergrowth species in nearly every location in which they were examined, Mairabo, Kabama and in Guga, regardless of the season and in spite of the preference conferred upon them over the indigenous species and over other forms of land use (Plates 41, 42, 43, 44). This suggests that before any single tree species or group of species is selected for large-scale planting, a proper assessment should be made of its environmental impact as well as its commercial value.

The Forestry Division personnel in Zaria (Mohammed 1978), personal comm., have explained the causes of the floral changes under the Eucalyptus plantations in terms of the shading cast by the floral cover. But I noticed that the leaves of Eucalyptus spp. generally hang down on the branches in an approximately vertical alignment to the ground so that looking upwards, the crown of the Eucalyptus appears thin and casts only light shade even at mid-day.

Woodell (1978), personal comm., on the field, suggested chemical roles as the possible factors controlling the undergrowths under the plantations because Del Moral and Muller (1970) in California noted that the distribution of herbaceous plants around Eucalyptus camaldulensis were destroyed by chemical factors.

In my environmental data matrix analyses under the Kabama Plantations, for example, the major factor scored 53.6% in the estimated ordination factor scores. K^+, C.E.C., base saturation, and organic carbon together are significantly loaded to this major factor. The second major factor scored 24.0% and canopy closure was the only positive-definite environmental factor attached to it. Subsequent factor scores may be regarded as negligible, being 8.0%,

6.2%, 4.8% and 3.3% in their descending order of importance on the proportion of variations accounted for by the environmental data matrix factor sequences estimated in their descending order of importance, using the inverse or R-ordination method of analysis.

On the causal factor(s) operating on the forest plantations in my survey areas, therefore, my conclusions are not definite. This is probably because the plantations are still young. Rice (1974) however pointed out that "it seems highly likely that allelopathy is very important in forestry". Theron (1951) in South Africa pointed out that "Normally, a luxuriant growth of grass takes place during the first seasons after the plantations are established, but growth soon deteriorates and the sward is so poor that it hardly affords any grazing and appears to be valueless as a rebuilder of soil".

Biochemical experiments by del Moral and Muller (1970) caused them to point out that "the presence of strong toxic volatile inhibitors produced in the leaves of E. camaldulensis and released into the soil litter zone soil profile was the responsible factor for bare zone soils around the Eucalyptus". The authors identified the "strong toxic volatile inhibitors" as terpenes, pinene, phellandrene and cineole.

My work here is based on synecological field surveys, not on laboratory biochemical experimental tests. I can therefore only cautiously interpret the major factor controlling forestry plantations as the "allelopathic factor" based on the more detailed work by the plant physiologists and biochemists. Muller (1966) defined allelopathy as "the deleterious effect that one higher plant has on another plant through the production of chemical retardants that escape into the environment".

Briefly, therefore, my sampling scheme was designed to provide a comprehensive coverage of the variation in the environment and their associated floristic compositions. 714 quadrats containing 419 variously distributed species were encountered in the twelve stratas or domains of the environment. One of the standard agglomerative Cluster Analytic techniques currently in use at the Oxford University Computing Laboratory was used for agglomerating the floristic community types collected from different areas at various seasons from the 'Northern Guinea Savanna' of Keay and of Clayton which I described.

The analyses by the Cluster Analysis was cross-checked with the Rao's Canonical Factor Analytic ordination which I introduced from the Statistical Packages for the Social Sciences of Nie, Hull, Jenkins, Steinbrenner and Bent (1975) into synecology in order to cross-check and rectify boundaries between plant communities should doubtful fragmentations arise. Large floristic data were often involved notwithstanding the preliminary stratifications of the environment into relatively homogeneous twelve domains, partly based on geomorphologically identified differences in the environment, and partly based on visible distinct forms of land use.

Seven out of my twelve floristic data matrices representing the different domains had to be computed, using the Rao's Canonical Factor Analysis ordination from the University of Manchester Regional Computer Centre where the maximum computer workspace was available.

Fifty relatively distinct communities of different sizes plus four relatively indistinct segments of communities were mutually detected by the two multivariate numerical analytic methods employed on the floristic data matrices which I preliminarily arranged into sets of Synthetized Synoptic Floristic Raw Data Matrices from I to XII. Each plant community and plant community segment is tabulated. They represent relatively distinct floral assemblages which may or may not be contiguously distributed on the environment.

The roles of 1) denudation and deposition in the forms of erosion and alluviation; 2) granitic as distinct lateritic geological factors; 3) drainage; 4) topographic or catenary gradients; 5) shifting pastoralism and 'farming'; 6) professional farming; 7) termitaria; 8) forestry mismanagement, and 9) allelopathy in forest plantations, were inferred, largely through quantitatively interpreted sets of environmental data, except where otherwise stated, to be responsible for the floristic distributions in the strata surveyed.

Each of these factors identified exhibit variations in their quantitative intensities and in their qualitative forms. They are unequally distributed in the environments examined. Their roles as floral distribution factors and as relative centres of particular types of species aggregations do inter-correlate, except where decisive land uses and occasional geomorphological features create sharp lines for discontinuities.

I therefore conclude that:

a) the so-called 'Northern Guinea Savanna of Nigeria', exemplified by my work here, has no ecological homogeneity in the absence of climate;

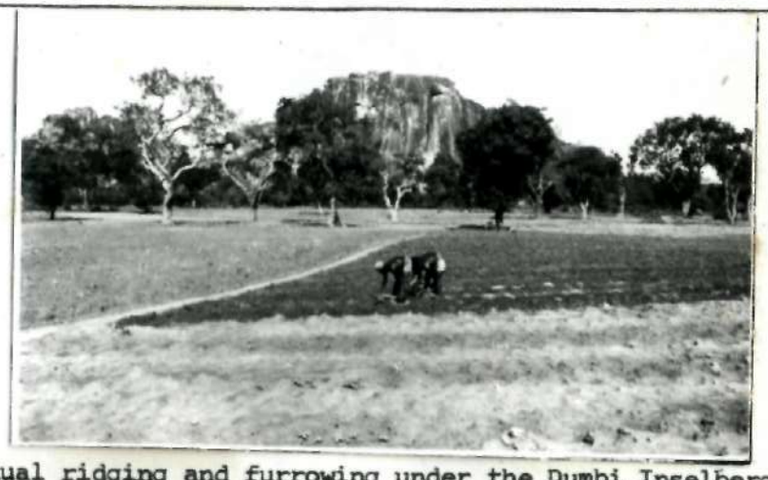
b) that the climate apparently only has a seasonal phenological effect on plant growth in the area, and its use alone as a reason for de-limiting the zone from the rest of the Country's vegetation is inconsistent with the very bases of ecology which seeks to study and analyse the community of plants and animals in their relationships with one another plus their inter-connections with the totality of the diverse, complex, animate or inanimate, large or small environment in which the plants and animals live and with which they also interact;

c) that the use of physiognomy as a basis for the definition of a 'Northern Guinea Savanna' or any savanna is hardly beneficial in the face of the dynamic variation which has occurred in vegetation structure with the millenia of human land use, and in the face of the recent and continuing

For these reasons, I suggest that the word 'savanna' be changed to 'cerrado' in Nigeria. This suggestion is not original. I borrow it from Goodland (1969, 1970a, 1970b, 1971) who has extensively, perhaps more than anybody else, discussed "The Savanna Controversy" and to whom the introduction of the 'savanna' into Brazil represents "the catachrestic word, savanna, which is applied to nearly every type of tropical vegetation from swamps to forests" (Goodland, 1971). I suggest his 'cerado' for the so-called 'Nigerian Savanna Zones' because it is particularly appropriate to the several combinations of the open to the nearly closed mixture of vegetation which I have broken down into floristic communities in this thesis and have had to combine some of the communities into confused physiognomic terms, such as 'woodlands and three-shrub savanna'.

Finally, perhaps no survey or analytic methods are perfect. There are likely to be some rare types which have not been considered. Partly for this obvious reason, I have incorporated eighty pictorial illustrations from some of my landscape photographs. All photographs were composed by me during my field work in colour, but the colours are retained mainly where seasonal effects are considered necessary for a sound general picture of the range of variation covered in the cerado.

For some pragmatic soil conservation reasons rather than for purely intellectual reasons, a few species have been given special illustrative attention plus my ecological opinion, or the opinions gathered from other ecologists, where stated. Often these are meant to suggest that they require to be studied separately by a non-synecological approach.



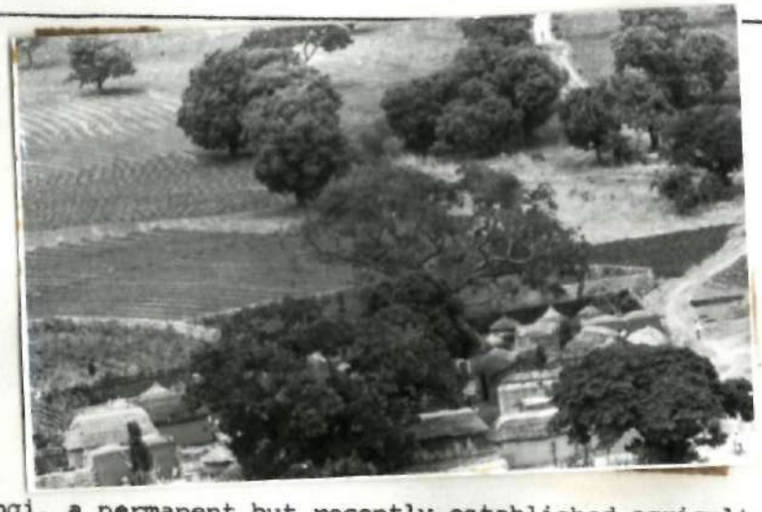
1

Manual ridging and furrowing under the Dumbi Inselberg. It involves tedious, time-consuming, back-breaking labour. Useful trees are saved, like Parkia clappertoniana and Butyrospermum paradoxum here. When possible, fire is used as an aid to clearing the land. Plate 8. May 1978.



2

The useful trees retained in farmed lands and current farm lands are not indicators of soils. For example, Parkia clappertoniana are even retained here under mechanical tractor cultivation. Domain VI. May 1978.



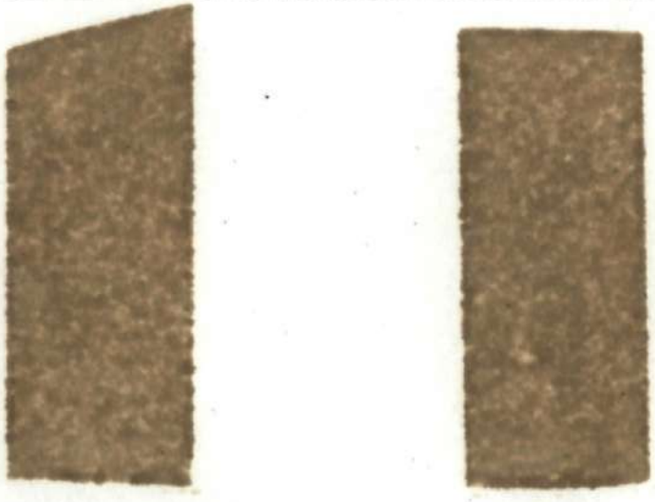
3

Mangi, a permanent but recently established agricultural Village at the foot of the Dumbi Inselberg. Mangifera indica, Ficus sp., Butyrospermum paradoxum and Parkia clappertoniana are planted or saved around the houses. May 1978.



4

An example of the so-called 'Savanna Parkland' near Zaria City with Adansonia digitata, Ceiba pentandra and Parkia clappertoniana. In practice it is a seasonable arable land. It is not a recreational 'park'.



5

nual ridging and furrowing. The huge hoe in use is designed
r heavy 'fadama' soils. The small unused hoe is for culti-
tion and weeding on upland light soils. April 1978.



6

Manual 'shaduf' irrigation in the dry season along River Sayen Dumbi. Crops: Allium cepa and Lycopersicum esculentum. February 1978.



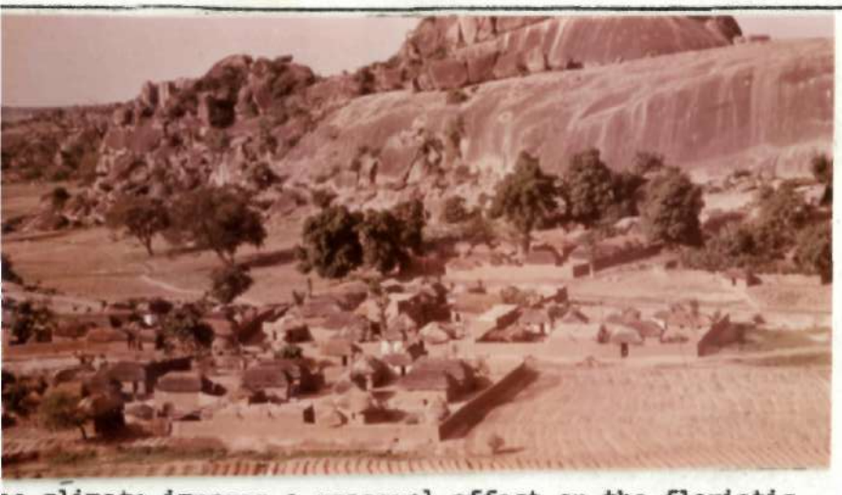
7

rvested Sorghum vulgare being prepared for manual threshing,
rage or markets. October 1978.



8

Background: Extensions of the Dumbi Inselberg. Foreground: arable land cleared again with fire before the next manual tillage during the next onset of the rainy season. January 1978.



9

he climate imposes a seasonal effect on the floristic composition mainly on the ground cover species layer. A view f arable lands from the top of Kufena Inselberg on 30th arch 1976.



10

A repeat view of the arable lands from the same top of Kufena Inselberg on 15th May 1976. The scattered trees around the agricultural village are the ubiquitous farm land trees.



rable lands of the professional 'peasant' farmers at ifferent floristic cover stages on the same day. Remains f, or new, ridges and furrows are contoured to prevent erosion cf. Plate 36). The scattered trees are Parkia clappertoniana. ay 1976.

11



12

A manual harvest of Capsicum in operation on the upland plains This one-by-one hand picking operation, like the manual cultivation and weeding, is a tedious, time-consuming labour. November 1978.

526



13

xed cropping at an early stage under the professional (or easant') farmer. Domain 6, June 1978. Discorea sp. and a mays occupy the top of the ridges. Oryza sativa occupy e furrows. Parkia clappertoniana and Butyrospermum radoxum are the standing useful trees.



14

The same mixed crops in Plate 13 during August 1978. Note that Oryza sativa enjoys its required damp condition in the furrows, while Discorea and Zea find the fresh tops of the ridges hospitable.



15

monoculture of Arachis hypogea on a well-drained, loose, riable, sand loam soil on the upland plain. September 1978. e ridges are low and furrows are shallow. Mangifera indica d Butyrospermum paradoxum are the standing trees. The shrubs wsonia inermis are hedges.



16

A monoculture of Sorghum vulgare on a fresh upland plain. Like the case of Arachis, ridges are low and furrows are shallow. The standing trees are Parkia clappertoniana. July 1978.



Oryza sativa in the inundated 'Fadama' of the Galma Irrigation Scheme Centre. August 1978. The associated serious vigorous semi-aquatic weeds are Setaria anceps, Oryza longistaminata, Eriochloa nubica, Cyperus pustulatus, etc.

17



18 Saccharum officinarum on damp cultivated 'kurmi' near Dambo with Leersia hexandra, Centella asiatica, Digitaria ciliaris as some of its major weeds. September 1978.

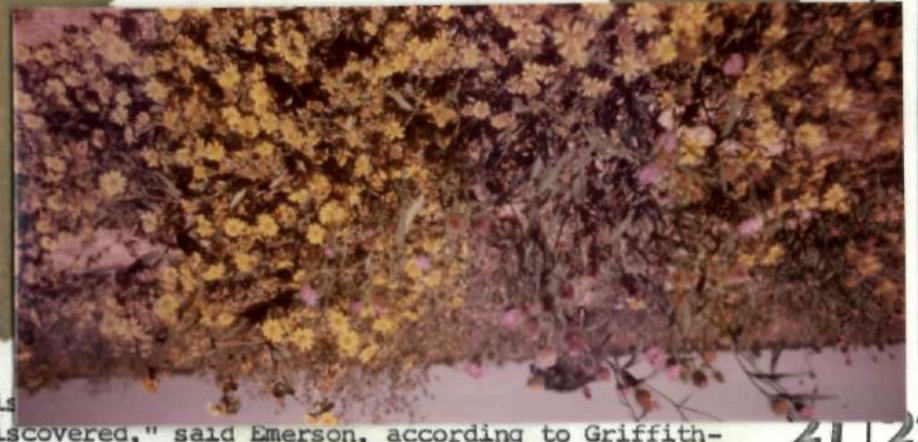


Post-harvest weed regrowths on the upland plains. Ipomoea batatas and Vigna unguiculata were the crops. The dry weeds were mainly Vernonia pauciflora, Digitaria ciliaris, etc. December 1978.

19



20 Sorghum vulgare on the fresh upland plains and its attendant weeds, e.g. Striga senegalensis, Thelepogon elegans, Digitaria ciliaris and Vernonia ambigua. September 1978.



at is
n discovered," said Emerson, according to Griffith-
es (1977). Post-harvest beautiful weeds of a recently
vested Discorea/Vigna arable land. Guizotia scabra and
nonia pauciflora are the prominent weeds here. Domain 6.
October 1978.

21



22 Background: Sorghum vulgare is the standing crop. Foreground: Arable land in its second year fallow, dominated by Pennisetum pedicellatum. Upland Sites, November 1978.



arable land in its first year fallow with a mixture
weeds: Pennisetum pedicellatum, Vernonia perrottetii,
ratum conyzoides, etc. Upland Sites. November 1978.

23



24 Arable land in third year fallow outside Zangon Aya. February 1978. Crop unknown. Weeds: Imperata cylindrica, Pennisetum pedicellatum and Kohautia grandiflora, etc.

329



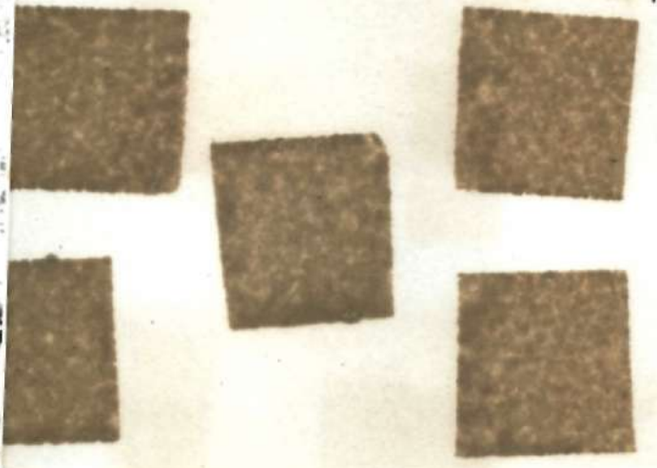
25

Khaya senegalensis pollarded for browsing by cattle, sheep and goats near Fulani shelters.

Guga Forest Reserve Enclave.
March 1978.



Khaya
recen
are p
heavy
its b
from
River
Janua





27

hifting Fulani Pastoralists en route to a new site on the alma Basin Upland Plains. March 1978.



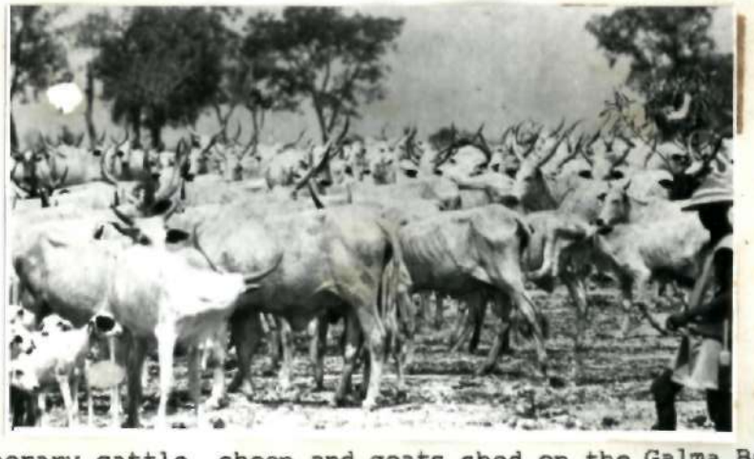
28

Rainy season pastoralists' 'rugas', or shelters, in Guga Forest Reserve Enclave. This site had been recurrently settled upon for years. Note the bare lands and erosion around the shelters. August 1978



29

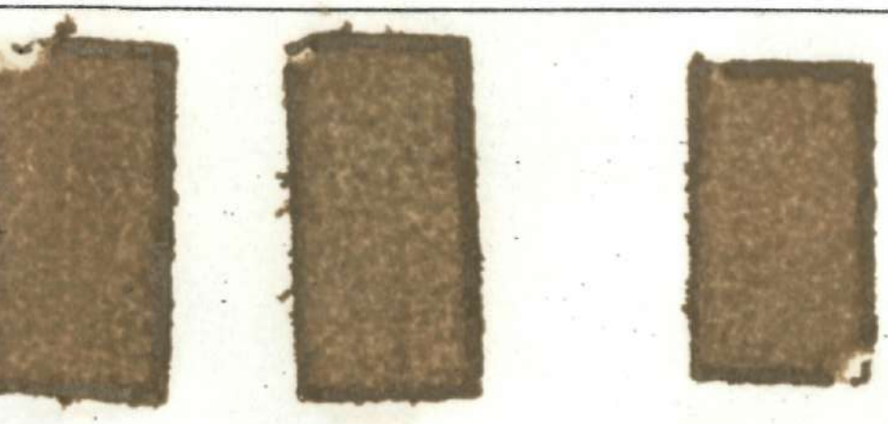
ackground: Scattered trees in the current fallow land: Centre: razing cattle and sheep avoid Borreria verticillata. Fore- round: Old termite hill surrounded by locally bare land. Guga on-plantation Forest Reserve. July 1978.



30

A temporary cattle, sheep and goats shed on the Galma Basin upland. February 1978. This is an obvious temporary over- stocking and overgrazing which causes accelerated erosion.

331



31

n incidental Fulani pastoralist settlement on the
pland Plains. June 1978. In the absence of reliable data
n differences in the palatability of plants to herds in the
erado, the abundance of Borreria verticillata is possibly
ecause the herds avoid it.



32

Gully erosion in Guga Forest Reserve. September 1978. This is at least partly due to the continual grazing by the goats plus the other domestic phytophagous ungulates.



at
ns and on ridged and furrowed farmed lands where there is
danger of erosion, but not on slopes.



34

Pastoralists' sheep and cattle returning home at dusk. Note the intercalation of ground cover by vegetation and the bare diffused tracks. Galma Basin Upland. October 1978.







36

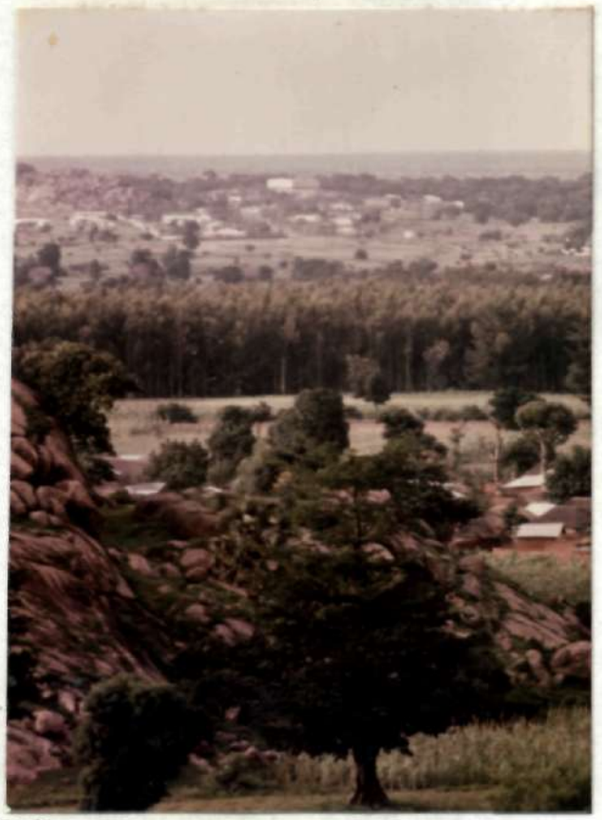
Sheet erosion in a Fulani pastoralist's 'farm'. Crops: Sorghum vulgare and Hibiscus cannabinus. Unlike the case with professional farmers, ridges and furrows by which erosion is mechanically prevented are absent. Guga. August 1978.





37

Habitat degradation through overstocking with herds by pastoralists in Guga Forest Reserve. August 1978. Note the bare area of concentrated herds and the locally destroyed floristic cover.



38

A panorama of the Mairabo Eucalyptus Plantation Reserve from Tukur Tukur granite hill top. July 1978.



39

A total collapse of indigenous under-growths under the introduced 'superior' exotic Eucalyptus spp. in Mairabo Forest Plantation Reserve. 11th July 1978.



40

Isoberlinia doka and Isoberlinia tomentosa shrubs in the nominally reserved non-plantation in Guga Forest Reserve. February 1978. The indigenous shrubs appear to 'live and let others live'. The introduced Eucalyptus exotics seem to want to 'live, others may diminish or die out'.



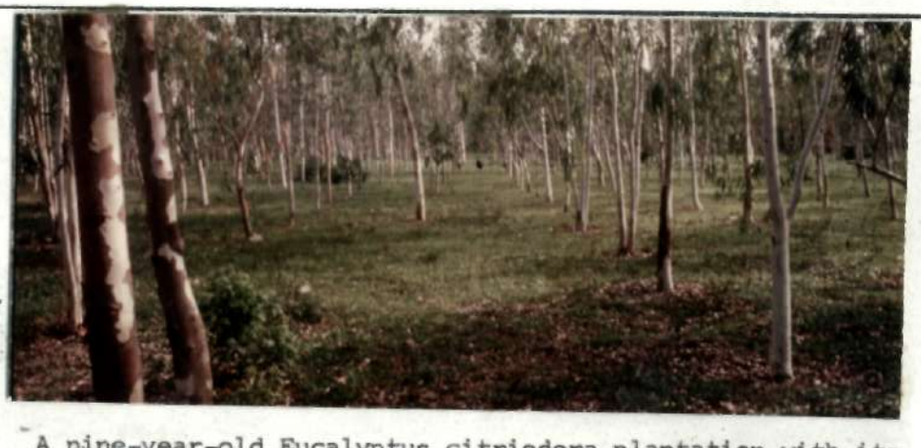
41 ...laria stigmatisata, Stylochiton lancifolius, Isoberlinia ... Borreria verticillata are the prominent ground covers ... this eight-year-old Eucalyptus camaldulensis plantation ... These undergrowths tend to be avoided by grazing herds. ...oriste perrottetii, the erosion indicator, are common. Kabama, July 1978.



42 Eucalyptus tereticornis woodland in Kabama Plantation Forest Reserve. June 1978. Brachiaria stigmatisata, Stylochiton lancifolius, Guttenbergia nigritana and the Dyschoriste perrottetii, are the main undergrowths.



43 ...nd ... The profession... ...ively drier upper slopes. The Eucalyptus spp. ... the ...er lower slopes of the River Kabama.



44 A nine-year-old Eucalyptus citriodora plantation with its undergrowths in Kabama Forest Plantation Reserve. June 1978. Cassia rotundifolia constitutes the major associated weed. Dyschoriste perrottetii, an erosion indicator, is also common in it.

335



ama' swamp forbland of sedges and grasses. Fuirena llata (sedge) and Leersia hexandra (grass) are the main species he Galma River Fadama north of the bridge of Plate 48. 1978.

45



46 Background: a relatively natural 'Fadama' woodland dominated by Mitragyna inermis. Foreground: Inundated 'Fadama' terrace grassland with Hyparrhenia cyanescens along River Damari, Kuyello environ. August 1978.



aba
ve.
a sudanica, Syzygium guineense, Sporobolus pyramidalis,
phila auriculata and Rauvolfia caffra, etc.



48 The Galma Irrigation Scheme Centre. Site of my Domin III. It occupies the River Galma terrace south of the first bridge from Zaria on the road to Jos. May 1978.



Borassus aethiopum, scattered Parkia clappertoniana, Butyrospermum paradoxum and Ficus gnaphalocarpa on a post-harvest Sorghum vulgare farm. Edge of River Waragu in Anguwan Jamo Enclave, Guga Forest Reserve Enclave. January 1978.

49



50 Securidaca longepedunculata on gullied concretions of lateritic ironpan. Guga Forest Reserve. November 1978.



51 River bank sheet erosion in co-operation with termite-induced bared land. Termites possibly bared the riverside first. The soil, unprotected by flora cover, then probably enabled water waves to lap against the bank. The soil was then loosened and carried downwards into the river. Notice that the erosion stops where the vegetation cover remain intact. Edge of River Waragu, Guga non-plantation Forest Reserve. August 1978.



52

oil profile descriptive equipment in the field within the quadrats distributed in the first eleven domains or strata Fadama I to Guga XI. cf. the pits dug for the other 85 rats around Kuyello, Plates 53 and 54.



53

Background: A mixture of Monotes kerstingii, Uapaca togoensis and Loudetia simplex co-abundant wooded grassland on the colluvial deposits below an ironstone mesa. Kuyello environ. January 1977.



54

Background: Hyparrhenia cyanescens 'Fadama' grassland along River Damari. Kuyello environ. January 1977. Note the grey 'fadama' soil in contrast to the red sub-summit colluvial soil in Plate 53.



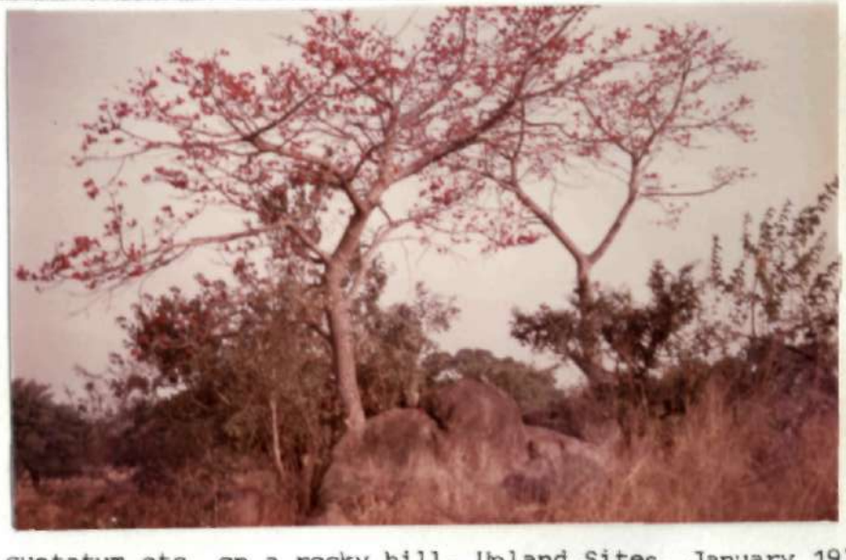
55

teritic ironstone mesa in Guga non-plantation Forest Reserve
n 1978, with Butyrospermum paradoxum, Ctenium newtonii,
etia simplex, Dyschoriste pedicellata, Dyschoriste
ottetii, Detarium macrocarpum, Strychnos spinosa,
ochloa indica, etc.



56

Milletia thonningii, Anogeissus leiocarpus, Entada africana, Cochlospermum tinctorium, Cissus rufescens, Brachiaria lata, etc. in cracks among granitic boulders of rocky hills below the Dumbi Inselberg. July 1978.



57

Bombax custatum etc. on a rocky hill. Upland Sites. January 1978.



58

panoramic view from the crest of the Dumbi Inselberg, my
ratum No. 7. July 1978..



59

The Dumbi Inselberg rock pools and crevices in which Afrotrilepis pilosa, Sporobolus festivus, etc. grow. July 1978.



60

Dumbi Inselberg fringing woodland. Foreground: The effect of
cultivation: sharp transition in physiognomy, abundance of
obolus pyramidalis, Ensete gilletii and Acacia ataxacantha.



61

Another side of the Dumbi Inselberg fringing woodland. Foreground: A recent tree clearance using more drastic equipment. Background: Parts of the remains of the diminishing Dumbi wood. Anogeissus leiocarpus and Khaya senegalensis remain standing. July 1978.

340



66

lexities & Complications (1): Note 1) the newly cultivated
le land; 2) the burning; 3) the grasses and forbs, under
he dry seasonal effect; 5) the line of grazing cattle, and
he minor physiognomic variation in the 'fadama'. January 1978.



67

Complexities & Complications (2): Concentrated assembly of Phragmites karka on the depression to the Galma 'Fadama'. However, the species was encountered once in the total of 714 quadrats sampled. May 1978.



68

tivated with Sorghum vulgare before my visit for a
istic flora survey in the systematic manner. May 1978.



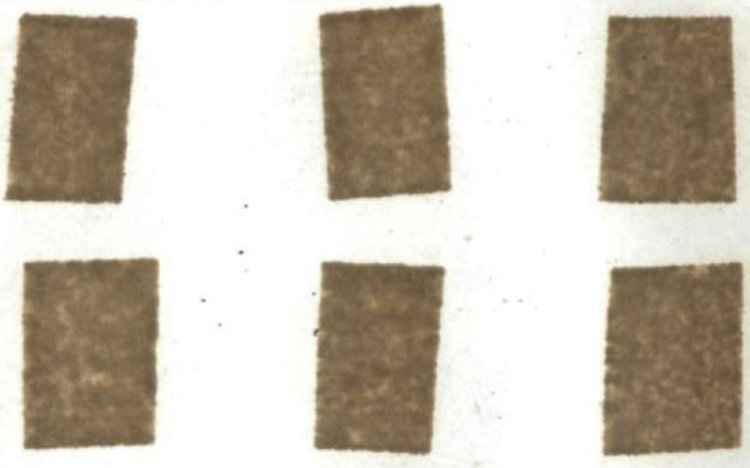
69

Complexities & Complications (4): This colony of Adenodolichos paniculatus was perhaps 'atypical' for I have never seen the species to be so gregarious elsewhere. August 1978.



70

example of an erosion-complex with [illegible] es' which
d possibly be attributed to one 'cause'. Guga Forest Reserve.
st 1978. 1) termite pests; 2) (mis)management by the Forestry
, 3) firewood collection; 4)uncontrolled phytophagous domestic
iates; 5) topography, and 6) rainfall or climate.



71

The bases of Tamarindus indica, Sclerocarya birrea and Cussonia barteri trees raised above the general bare surroundings. The developing gully is possibly related to overgrazing. Guga Forest Reserve. August 1978.



72

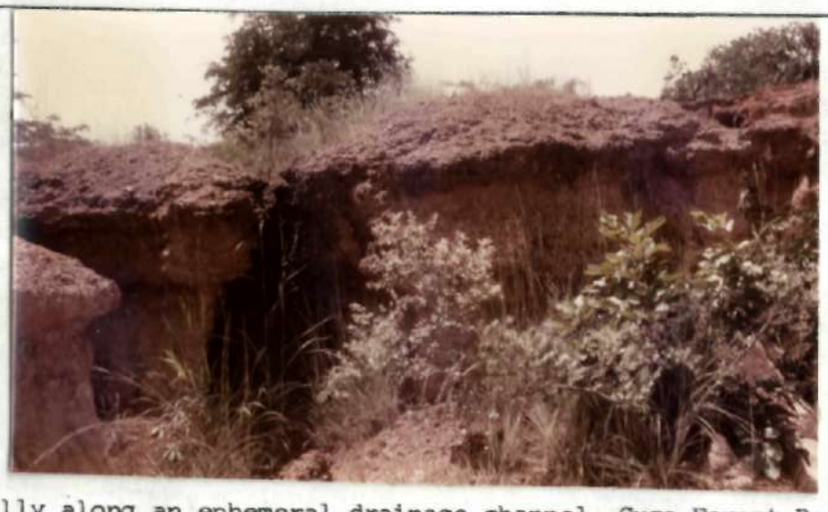
ly ver
r-cutt
bretum
ber 197
and
shrubs
tosa) in Guga Forest Reserve.



73

This spectacular erosion is located along the recently constructed highway along Zaria to Kano road. Galma Basin Upland. November 1978.

343



74

gully along an ephemeral drainage channel. Guga Forest Reserve. vember 1978. The flora along the channel is an unexpected xture of moist sites flora and those of dry sites: Vitex niana, Securinega virosa, Daniellia oliveri with Guiera senegalensis.



75

- Mairabo Stream below the Eucalyptus plantation. August 1978. The stream bank is incised to the granitic bedrock. The vertical gully wall was 2.5m. deep. Coffee-brown water flows in depressions among bedrock until filtered by the Leersia hexandra.



76

eet erosion in Guga Non-Plantation Reserve. September 1978, anites aegyptiaca & Dyschoriste petrottetii appear to ure the overgrazing.



77

An ephemeral stream which flows intermittently following each torrential rain. Guga Forest Reserve. August 1978. The gully floor carries Sesbania sesban, a tall, quick-growing annual forb of damp soils.



78

An isolated Dyschoriste perrottetii on a dry bare eroded ferruginous soil. Guga Forest Reserve. September 1978. This is one of the forbs most specific to eroded sites in the parts of the cerado ('savanna') examined. It is a hardy, woody drought-resistant perennial forb. Its numerous deep roots bind the soil together. It was never recorded as a weed in arable crops. Its potential value as a ground cover to provide vegetative control for gully-sides, sheet erosion, roadside erosion and other forms of erosion is worthy of investigation.



79

A demonstra[illegible]uring power and sympathetic distribution o[illegible]e perrottetii with another drought-enduring species, Di[illegible]stachys glomerata, under multiple stress. Guga Forest Reserve. March 1978.



80

A demonstration of the power of resurrection with the onset of the rainy season and of the intra-species gregariousness possessed by Dyschoriste perrottetii. May 1978.

345

PLATE NOS.	DESCRIPTIONS WITH ECOLOGICAL COMMENTS AND APPRAISALS
1	Manual ridging and furrowing under the Dumbi Inselberg. It involves tedious, time-consuming, back-breaking labour. Useful trees are saved, like Parkia clappertoniana and Butyrospermum paradoxum here. When possible, fire is used as an aid to clearing the land, Plate 8. May 1978.
2	The useful trees retained in farmed lands and current farm lands are not indicators of soils. For example, Parkia clappertoniana are even retained here under mechanical tractor cultivation. Domain VI. May 1978.
3	Mangi, a permanent but recently established agricultural Village at the foot of the Dumbi Inselberg. Mangifera indica, Ficus sp., Butyrospermum paradoxum and Parkia clappertoniana are planted or saved around the houses. May 1978.
4	An example of the so-called 'Savanna Parkland' near Zaria City with Adansonia digitata, Ceiba pentandra and Parkia clappertoniana. In practice it is a seasonal arable land. It is not a recreational 'park'.
5	Manual ridging and furrowing. The huge hoe in use is designed for heavy 'fadama' soils. The small unused hoe is for cultivation and weeding on upland light soils. April 1978.
6	Manual 'shaduf' irrigation in the dry season along River Sayen Dumbi. Crops: Allium cepa and Lycopersicum esculentum. February 1978.
7	Harvested Sorghum vulgare being prepared for manual threshing, storage or markets. October 1978.
8	Background: Extensions of the Dumbi Inselberg. Foreground: arable land cleared again with fire before the next manual tillage during the next onset of the rainy season. January 1978.
9	The climate imposes a seasonal effect on the floristic composition mainly on the ground cover species layer. A view of arable lands from the top of Kufena Inselberg on 30th March 1976.

PLATE NOS.

10 A repeat view of the arable lands from the same top of Kufena Inselberg on 15th May 1976. The scattered trees around the agricultural village are the ubiquitous farm land trees.

11 Arable lands of the professional 'peasant' farmers at different floristic cover stages on the same day. Remains of, or new, ridges and furrows are contoured to prevent erosion (cf. Plate 36). The scattered trees are Parkia clappertoniana. May 1976.

12 A manual harvest of Capsicum in operation on the upland plains. This one-by-one hand picking operation, like the manual cultivation and weeding, is a tedious, time-consuming labour. November 1978.

13 Mixed cropping at an early stage under the professional (or 'peasant') farmer. Domain 6, June 1978. Discorea sp. and Zea mays occupy the top of the ridges. Oryza sativa occupy the furrows. Parkia clappertoniana and Butyrospermum paradoxum are the standing useful trees.

14 The same mixed crops in Plate 13 during August 1978. Note that Oryza sativa enjoys its required damp condition in the furrows, while Discorea and Zea find the fresh tops of the ridges hospitable.

15 A monoculture of Arachis hypogea on a well-drained, loose, friable, sand loam soil on the upland plain. September 1978. The ridges are low and furrows are shallow. Mangifera indica and Butyrospermum paradoxum are the standing trees. The shrubs, Lawsonia inermis are hedges.

16 A monoculture of Sorghum vulgare on a fresh upland plain. Like the case of Arachis, ridges are low and furrows are shallow. The standing trees are Parkia clappertoniana. July 1978.

17 Oryza sativa in the inundated 'Fadama' of the Galma Irrigation Scheme Centre. August 1978. The associated serious vigorous semi-aquatic weeds are Setaria anceps, Oryza longistaminata, Eriochloa nubica, Cyperus pustulatus, etc.

PLATE NOS.

18 Saccharum officinarum on damp cultivated 'kurmi' near Dambo with Leersia hexandra, Centella asiatica, Digitaria ciliaris as some of its major weeds. September 1978.

19 Post-harvest weed regrowths on the upland plains. Ipomoea batatas and Vigna unguiculata were the crops. The dry weeds were mainly Vernonia pauciflora, Digitaria ciliaris, etc. December 1978.

20 Sorghum vulgare on the fresh upland plains and its attendant weeds, e.g. Striga senegalensis, Thelepogon elegans, Digitaria ciliaris and Vernonia ambigua. September 1978.

21 "What is a weed but a plant whose virtues have not yet been discovered," said Emerson, according to Griffith-Jones (1977). Post-harvest beautiful weeds of a recently harvested Discorea/ Vigna arable land. Guizotia scabra and Vernonia pauciflora are the prominent weeds here. Domain 6, October 1978.

22 Background: Sorghum vulgare is the standing crop. Foreground: Arable land in its second year fallow, dominated by Pennisetum pedicellatum. Upland Sites, November 1978.

23 An arable land in its first year fallow with a mixture of weeds: Pennisetum pedicellatum, Vernonia perrottetii, Ageratum conyzoides, etc. Upland Sites. November 1978.

24 Arable land in third year fallow outside Zangon Aya. February 1978. Crop unknown. Weeds: Imperata cylindrica, Pennisetum pedicellatum, and Kohautia grandiflora, etc.

25 Khaya senegalensis pollarded for browsing by cattle, sheep and goats near Fulani shelters. Guga Forest Reserve Enclave. March 1978.

26 Khaya senegalensis recently felled. Mortars are produced from its heavy boles; fuel from its branchlets; timber from its trunk. River Yashi 'Kurmi'. January 1978.

27 Shifting Fulani Pastoralists en route to a new site on the Galma Basin Upland Plains. March 1978.

PLATE NOS.

28 Rainy season pastoralists' 'rugas', or shelters, in Guga Forest Reserve Enclave. This site had been recurrently settled upon for years. Note the bare lands and erosion around the shelters. August 1978.

29 Background: Scattered trees in the current fallow land: Centre: Grazing cattle and sheep avoid Borreria verticillata. Foreground: Old termite hill surrounded by locally bare land. Guga Non-plantation Forest Reserve. July 1978.

30 A temporary cattle, sheep and goats shed on the Galma Basin upland. February 1978. This is an obvious temporary over-stocking and overgrazing which aids accelerated erosion.

31 An incidental Fulani pastoralist settlement on the Upland Plains. June 1978. In the absence of reliable data on differences in the palatability of plants to herds in the cerado, the abundance of Borreria verticillata is possibly because the herds avoid it.

32 Gully erosion in Guga Forest Reserve. September 1978. This is at least partly due to the continual grazing by the goats plus the other domestic phytophagous ungulates.

33 Herders and farmers live in close co-operation. However, this co-operation is perhaps ecologically rational mainly on the flat plains and on ridged and furrowed farmed lands where there is less danger of erosion, but not on slopes.

34 Pastoralists' sheep and cattle returning home at dusk. Note the intercalation of ground cover by vegetation and the bare diffused tracks. Galma Basin Upland. October 1978.

35 A close look at a cause of accelerated erosion in the cerado. The Fulani cattle are selectively grazing the floristic cover of the soil. Their hooves also trample and stir the vegetation and soil. The flora suffers first. Consequently the soil suffers. It takes time for the effects of grazing, trampling, and stirring to become visible, but this is often how environmental degradation starts. Guga Forest Reserve, August 1978.

PLATE NOS.

36 Sheet erosion in a Fulani pastoralists 'farm'. Crops: Sorghum vulgare and Hibiscus cannabinus. Unlike the case with professional farmers, ridges and furrows by which erosion is mechanically prevented are absent. Guga. August 1978.

37 Habitat degradation through overstocking with herds by pastoralists in Guga Forest Reserve. August 1978. Note the bare area of concentrated herds and the locally destroyed floristic cover.

38 A panorama of the Mairabo Eucalyptus Plantation Reserve from Tukur Tukur granite hill top. July 1978. The establishment of exotic plantations at the vicinity of towns and villages appears to compete with farming villagers' land use interests. See also Plate 43.

39 A total collapse of indigenous undergrowths under the introduced 'superior' exotic Eucalyptus spp. in Mairabo Forest Plantation Reserve. I worked on, and photographed, this site on 11th July 1978 under a 15m. high Eucalyptus camaldulensis plantation stand, having only 40% canopy closure. Just four stunted scanty types of undergrowth species could be observed in my 10m. x 10m. quadrat, namely: Sporobolus pyramidalis, Fimbristylis pilosa, Imperata cylindrica and Brachiaria stigmatisata. During July, the vegetation outside the Plantation Reserves was everywhere green, vigorous and luxuriant (see Plate 38). The adverse ecological implication of the exotic introduction is possibly a potential regrettable provocation of erosion; for the ground flora cover are being reduced or wiped out under them. See also Plates 40-44.

40 Isoberlinia doka and Isoberlinia tomentosa shrubs in the nominally reserved non-plantation in Guga Forest Reserve. February 1978. The indigenous shrubs appear to 'live and let others live'. The introduced Eucalyptus exotics seem to want to 'live, others may diminish or die out'.

PLATE NOS.

41 The successful introduction and establishment of Eucalyptus spp. into the cerrado ('savanna') may appear to be an initial success to the Forestry Department. The 'success' may become ecological and economic failures with yet unpredictable disasters. Brachiaria stigmatisata, Stylochiton lancifolius, Isoberlinia doka, Borreria verticillata are the prominent ground covers under this eight-year-old Eucalyptus camaldulensis plantation stand. These undergrowths are usually avoided by grazing herds of cattle. Besides, sheep and goats, perhaps unlike kangaroos, do not appear to feed on the Eucalyptus spp. introduced from Australia. Neither the Eucalyptus nor many of its undergrowths therefore seem to be useful to the domesticated animals in the cerrado. Dyschoriste perrottetii, the erosion indicator (demonstrated in Plates 78 to 80) are appearing and suggest promotion of habitat denudation by the Eucalyptus camaldulensis. Kabama. June 1978.

42 Eucalyptus tereticornis woodland in Kabama Plantation Forest Reserve. June 1978. This ten-year-old stand is associated with a large number of undergrowths, such as the Brachiaria stigmatisata, Stylochiton lancifolius, Guttenbergia nigritana and the Dyschoriste perrottetii, some of which are similar to those illustrated on Plates 41 and 44. The recurrence of some of the species, e.g. Dyschoriste perrottetii, gives a cause to prescribe caution on their uncontrolled propagation in this zone until more research has been done. As Curry-Lindahl (1972) pointed out "One can never forsee in detail what the ecological consequences of introducing an exotic species will be. Even if an introduction initially appears to be a success, it can later turn out to be detrimental. The long-term ecological effects of a new component in a habitat are almost always too unpredictable to justify any introduction".

PLATE NOS.

43 Competition between arable land use and exotic forestry land use: the professional ('peasant') farmer occupies the relatively drier upper slopes. The Eucalyptus spp. occupy the moister lower slopes of the River Kabama.

44 An established Eucalyptus citriodora with its undergrowths in Kabama Forest Plantation Reserve. June 1978. This plantation was established in 1969, nine years before my field study, according to the official Forestry Division's records in Zaria. Cassia rotundifolia constitutes the major associated weed. Dyschoriste perrottetii is also common in it, as an erosion indicator. The Eucalyptus trees themselves are neither too uniform in size; neither do they enrich the local flora; nor are they too superior in their growth rate to some of the 120 species as described by Lely (1925) in Useful Trees of Northern Nigeria. They probably show the quality of resistance to disease partly because they have been removed from kangaroos and pests associated with them in Australia, where they are indigenous, and partly because they receive preferential intensive care in Nigeria. They are not often resistant to unfavourable environmental factors. On the contrary, they seem to promote erosion. On the bases of Plates 38 to 44 and on the bases of my Factor 9, explained in association with the Plant Communities delineated from existing forest plantations, the reasons propounded for "the need for exotics" and the "superiority" attributed to exotics by Ojo (1973) appear to be serious fallacies.

45 'Fadama' swamp forblands of sedges and grasses. Fuirena umbellata (sedge) and Leersia hexandra (grass) are the main species. It occupied the Galma River Fadama north of the bridges referred to on Plate 48. May 1978.

46 Farming intensities generally decrease from sub-urban more or less continuous arable lands to longer-term fallow lands around rural areas in the cerrado. Background: a relatively natural 'Fadama' woodland dominated by Mitragyna inermis. Foreground: Inundated 'Fadama' terrace grassland with Hyparrhenia cyanescens along the River Damari, Kuyello environ. (Vegetation was surveyed in January 1977. It was revisited and photographed in August 1978.) See Plate 53.

PLATE NOS.

47 The flora along the Kabama water course below the Kabama Forest Plantation Reserve. June 1978. There come times when a classifier is confused due to the continuity in the vegetation and the environment. Is this a 'fadama' or is it a 'kurmi'? i.e. When does a stream become a river? An easy way around it will simply be to lump them together under an imprecise umbrella term like the 'riverine' or 'riparian' vegetation. I do not claim to know what geomorphological, hydrological, or physiognomic adjective should be attached to this vegetation stand, but the flora are mainly Leersia hexandra, Raphia sudanica, Syzygium guineense, Sporobolus pyramidalis, Hygrophila auriculata, and Rauvolfia caffra, etc.

48 The Galma Irrigation Scheme Centre. Site of my Domin III. It occupies the River Galma terrace south of the first bridge from Zaria on the road to Jos. May 1978.

49 Borassus aethiopum, scattered Parkia clappertoniana, Butyrospermum paradoxum and Ficus gnaphalocarpa on a post-harvest Sorghum vulgare farm. Edge of River Waragu in Anguwan Jamo Enclave, Guga Forest Reserve Enclave. January 1978.

50 Securidaca longepedunculata on gullied concretions of lateritic ironpan. Guga Forest Reserve. November 1978. Its buried extensive root systems, its hardiness, drought endurance, ability to grow in soils with very low organic matter and its ability to withstand this type of inhospitable gullied site deserves its consideration for gully control. However, it is often solitary on the field for yet unknown reason(s).

51 River bank sheet erosion in co-operation with termite-induced bared land. Termites possibly bared the riverside first. The soil, unprotected by flora cover, then probably enabled water waves to lap against the bank. The soil was then loosened and carried downwards into the river. Notice that the erosion stops where the vegetation cover remains intact. Edge of River Waragu, Guga non-plantation Forest Reserve. August 1978.

PLATE NOS.

52 My soil profile descriptive equipment in the field within the 629 quadrats distributed in the first eleven domains or strata from Fadama I to Guga XI. The equipment was the core or screw auger, the Munsell Colour Code Book, formats for soil description at each soil horizon, soil sample bags, and a distilled waterbottle. Minimum manual labour and the least disturbance to the flora were specific advantages of my method. Potential causes for pit erosion were also negligible, cf. the pits dug for the other 85 quadrats around Kuyello, Plates 53 and 54.

53 Background: A mixture of Monotes kerstingii, Uapaca togoensis and Loudetia simplex co-abundant wooded grassland on the colluvial deposits below an ironstone mesa. Kuyello environ. January 1977. Foreground: The deep and wide grave-like type of pits dug for soil descriptions by the specialist pedologist - a potential cause of man-induced pit erosion.

54 Background: Hyparrhenia cyanescens 'Fadama' grassland along River Damari, Kuyello environ. January 1977. The grassland is unlikely to have been the natural floristic cover. It is possibly the result of past cultivations of the Mitragyna inermis woodland type in Plate 46. The shrub is Gardenia ternifolia. Note the grey 'fadama' soil in contrast to the red sub-summit colluvial soil in Plate 53.

55 A lateritic ironstone mesa in Guga non-plantation Forest Reserve, March 1978, with Butyrospermum paradoxum, Ctenium newtonii, Loudetia simplex, Dyschoriste pedicellata, Dyschoriste perrottetii, Detarium macrocarpum, Strychnos spinosa, Microchloa indica, etc.

56 Melletia thonningii, Anogeissus leiocarpus, Entada africana, Cochlospermum tinctorium, Cissus rufescens, Brachiaria lata, etc. in cracks among granitic boulders of rocky hills below the Dumbi Inselberg. July 1978.

57 My 'rocky hills' represent low rock outcrops. The geological composition is mainly granite. Their associated flora vary but they are distinct from those of the lateritic ironstone mesa. Bombax custatum, etc., on a rocky hill. Upland Sites. January 1978.

PLATE NOS.

58 A panoramic view from the crest of the Dumbi Inselberg, my Stratum No. 7. Notice the solid very steep rocky slopes, the Inselberg Fringing Woodland at the base, and what ecological poets called "the sea of savanna". July 1978.

59 Below the crest or summit of the Dumbi Inselberg, rock pools and crevices store water from rainfalls in the rainy season. This is the zone of Afrotrilepis pilosa, Sporobolus festivus Triumfetta pentandra, Schichyrium exile, etc. July 1978.

60 The Dumbi Inselberg 'Foot' or fringing woodland. Foreground: The effect of past cultivation is certainly responsible for the sharp transition in physiognomy, the abundance of Sporobolus pyramidalis, and possibly for Ensete gilletii and the Acacia ataxacantha. Background: the remaining fringing woodland with Commiphora kerstingii, Milletia thonningii, Khaya senegalensis, Diospyros mespiliformis, etc.

61 Another side of the Dumbi Inselberg fringing woodland. Foreground: A recent tree clearance by the use of more drastic equipment. Bulldozing tractors, by which trees were uprooted, were used. Piliostigma thonningii shrubs and weeds now replace the fallen trees. Background: Parts of the remains of the diminishing Dumbi wood. Anogeissus leiocarpus and Khaya senegalensis remain standing (yet). July 1978.

62 An example of an abrupt landscape change from the uplands to a stream bank. The result is a relatively sharp floristic discontinuity. Leersia hexandra, a rhizomatous water-loving grass occupies the bank. Mairabo Stream. June 1978.

63 Dichrostachys glomerata on the sub-summit of an eroded ironstone mesa. Guga Forest Reserve. July 1978. This shrub is a relatively reliable indicator of erosion and of an iron-rich soil. It is gregarious (Plate 79), spreading, hardy, drought-enduring, and it is usually avoided by firewood hewers because it has spines. Besides, it is attractive when flowering and its fruit is a fodder for herds. It is worth studying for the purpose of propagation for various uses, such as roadside hedges and vegetative monitor and control of erosion.

PLATE NOS.

64 Parkia clappertoniana in a Sorghum vulgare farm on the edge of the Galma River Fadama. May 1978. The use of such species consciously preserved in current or past arable lands, as soil indicators is, of course, worthless. Their potential uses thus far not exploited should perhaps be to replace further introductions of exotic species with them as plantations. They have the ecological advantages of nativity and ubiquitous distributions on their side, in addition to the numerous reasons for which they have been culturally preserved in the cerado ('savanna') for at least several thousands of years.

65 "Paths are necessary evil forms of land use with respect to plants and soils", said Macmillan (1943). A road side erosion along the Zaria-Funtua road which forms the northern boundary with Guga Forest Reserve. August 1978. The road was mechanically reconstructed, expanded and tarred during 1975/76. There was, however, no botanical or flora protection of the roadsides. In the absence of a plant cover, erosion is now eating up the two-year-old highway. A mechanical construction of roads without a flora protection of its sides is a costly waste of land and money under the torrential rains of the cerado ('savanna').

66 Complexities of floristic communities with edaphic and land use features (1): A unit of plant community could easily be a continuum or a mosaic of floristic communities because numerous land use and other features are simultaneously interwoven. For example, though 'fadama' has been employed as a realtively distinct geomorphologic and edaphic unit within the cerado environment, note (1) the newly cultivated arable land; (2) the burning; (3) the grasses and forbs, under (4) the dry seasonal effect; (5) the line of grazing cattle, and (6) the minor physiognomic variation. Thus, in practice the 'fadama' is both a diversity of land use and a mosaic and continua of flora superimposed on the same relatively edaphically uniform area.

PLATE NOS.

67 Complexities of floristic communities with edaphic and land use features (2): Flora are unequally distributed in the landscape. This assembly of concentrated Phragmites karka on the depression to the Galma Fadama might suggest that the species is abundant in the cerado. However, the species was encountered once in the total of 714 quadrats sampled. May 1978.

68 Complexities of floristic communities with edaphic and land use features (3): This arable land was just cultivated with Sorghum vulgare before my visit for a survey in the systematic manner. There was no weed to record. The trees could not be of any use for my holistic objectives of survey. May 1978.

69 Complexities of floristic communities with edaphic and land use features (4): This colony of Adenodolichos paniculatus was perhaps peculiar, or 'atypical' for I have never seen the species to be so gregarious on a spot during my preceding eight years of professional ecological surveys, or during my amateur botanical trips. August 1978.

70 An example of an erosion-complex with the multiple 'causes' which could possibly be attributed to one 'cause'. Guga Forest Reserve. August 1978. The giant termite hill contains a web of subterranean cavities filled with termites, whose diets are plants. Behind the termite hill is a series of spectacular vertical-sided headscarp gullies, as deep as two or three meters in places. The termite pests devour the ground flora cover around their hill. Only Dyschoriste perrotetii forbs remain. The Forestry Division has recently removed all the indigenous shrubs and trees in the vicinity, but the removal of the floristic cover was not followed by an early implementation of the intended plantation of the exotics. Permanent human inhabitations are located in the main Enclaves and temporary Fulani 'rugas' are scattered in the Guga Forest Reserve. The

PLATE NOS.

is a period of heavy torrential rainfall. Other subtle edaphic factors are probably involved, but the accelerated erosion is now linked with (1) termite pests; (2) (mis)management by the Forestry Division; (3) firewood collection; (4) uncontrolled phytophagous domestic ungulates; (5) topography, and (6) rainfall or climate. Of the six possible 'causes', four are anthropozoological, and the last two are perhaps geographical and natural. But none of the 'natural causes' would probably be effective if the floristic cover were maintained intact either decisively by ecological management, or naturally, by other numerous possible methods. The removal without replacement of the floristic cover by the several agents therefore appears to be the one 'cause' of the erosion-complex. And erosion is the main form of habitat degradation, sometimes called "desert encroachment" by alarmists in this cerado environment.

71 The bases of Tamarindus indica, Sclerocarya birrea and Cussonia barteri trees raised above the general bare surroundings, suggest that there is an active accelerated soil removal leading to a gully here. There is a cluster of 'rugas' in the vicinity of the site. The developing gully is possibly related to overgrazing. Guga Forest Reserve. August 1978.

72 Nearly vertical erosion scarps plus collapsing retreating and under-cutting of soils from the roots of standing shrubs (Combretum molle and Isoberlinia tomentosa) in Guga Forest Reserve. October 1978. The sliding soils towards the gully depression seem to trail the chang footpath linking a chain of 'rugas', to the Funtua to Zaria main road. The accelerated gullying is probably primarily the result of devegetation along the path though other processes might be involved, such as grazing and trampling mammals.

PLATE NOS.

73 This spectacular erosion is located along the recently constructed highway along the Zaria to Kano road. The road trails the summit of the topography, which minimises the number of bridges to be built during its mecahnical construction. The roadside gullies form nearly series of vertical steps from the exposed ironpan bedrock in the foreground to the roadside in the background. Galma Basin Upland. November 1978.

74 A gully along an ephemeral drainage channel. Guga Forest Reserve. November 1978. The bluff consists of soils capped by indurated lateritic ironpan. The channel consists of accumulations of ironstone boulders and concretions. The flora along the channel is an unexpected mixture of moist site flora and those of dry sites: Vitex doniana, Securinega virosa, Daniellia oliveri with Guiera senegalensis.

75 Mairabo Stream below the Eucalyptus Plantation. August 1978. The stream bank is incised to the granitic bedrock. The vertical gully wall was 2.5m. deep. Coffee-brown water flows in the depressions among the bedrock until filtered by the Leersia hexandra.

76 Sheet erosion in Guga Non-Plantation Reserve. September 1978. It is largely bare though it is a peak month of the rainy season. It is possibly the beginning of the more spectacular gully form of erosion. Balanites aegyptiaca and Dyschoriste perrottetii appear to endure the over-grazing.

77 An ephemeral stream which flows intermittently following each torrential rain. Guga Forest Reserve. August 1978. The banks consist of soft schist, quartzites and mica. The gully floor carries Sesbania sesban, a tall, quick-growing annual forb of damp soils.

78 An isolated Dyschoriste perrottetii on a dry bare eroded ferruginous soil. Guga Forest Reserve. September 1978. This is one of the forbs most specific to eroded sites in the parts of the cerado ('savanna') examined. It is a hardy, woody, drought-resistant perennial forb. Its numerous deep roots bind the soil

PLATE NOS.

together. It was never recorded as a weed in arable crops. Its potential value as a ground cover to provide vegetative control for gully-sides, sheet erosion, roadside erosion and other forms of erosion, is worthy of investigation.

79 A demonstration of the drought-enduring power and the sympathetic distribution of Dyschoriste perrottetii with another drought-enduring species, Dichrostachys glomerata, under the multiple stresses of the seasonal drought, grazing, sheet erosion, and a poor ferruginous soil. Guga Forest Reserve. March 1978.

80 A demonstration of the power of resurrection with the onset of the rainy season and of the intra-species gregariousness possessed by Dyschoriste perrottetii. In view of the environmental degradation of habitats which seems to take the form of various erosions with the cerado (or 'savanna'), the investigation of some hardly noticed perennial forbs, like the Dyschoriste should probably not be overlooked. The main current method of using exotic species to provide a vegetative cover should perhaps be reconsidered (as misguided). In my ecological opinion, a good ground cover of perennials is what much of the degraded environment in the cerado needs, not just species which provide sky-high umbrella cover but destroy or decimate the floristic diversity at the ground-layer.

APPENDICES

No.	Species	Score per quadrant
01	Paspalum orbiculare	1 11445562978 57686 445443 45 22
02	Borreria verticillata	29752413 8 47 2 1 74777 253 42
03	Nelsonia canescens	1296116 27 1 74777 253 42
04	Vetiveria nigritana	1 9972 12278 79418 5
05	Vernonia perrottetii	217187 5 1 1 92131 1
06	Sporobolus pyramidalis	511423 1 4 15433 2
07	Ageratum conyzoides	29 27 71 1 31 24 85
08	Borreria radiata	111 2541 1 18321
09	Ipomoea eriocarpa	42 331 2113 1 2
10	Pennisetum pedicellatum	21 2 1 253 25 14
11	Indigofera pulchra	1 5 2 33 2 12133
12	Mimosa pigra	28 94 544772 2
13	Centella asiatica	22 365 53 67 6
14	Andropogon pseudapricus	8 2 244 4347
15	Waltheria indica	1 1 1 222 1 1 1
16	Oldenlandia herbacea	1 1 3 2 7 1 1 1 2
17	Cassia rotundifolia	7 4 21431 1 1
18	Eragrostis tremula	4 1 2 33231 1
19	Ethulia conyzoides	211151 3 3 7
20	Hyparrhenia rufa	5222 2 11 2
21	Jussiaea suffruticosa	3 41 1 1 322
22	Scleria foliosa	45 1 2 1 4 23
23	Leucas martinicensis	3 3 2 6 2 25 2
24	Stachytarpheta angustifolia	2 1 5 1 3 1 22
25	Mitracarpus scaber	1 1 2 2 11 32
26	Scoparia dulcis	11 11 1 1 31
27	Eragrostis atrovirens	86 2 4 65
28	Schweinckia americana	1 1 1 1 1 1 4
29	Monechma ciliatum	1 332 74 1
30	Cassia tora	91 1 1 21
31	Hygrophila auriculata	12212 2
32	Guizotia scabra	2 4 1 11 1
33	Thelepogon elegans	1 1 1 23 1
34	Glinus lotoides	61 3131
35	Alysicarpus glumaceus	2 11 12
36	Sphaeranthus senegalensis	2 11 11
37	Urena lobata	1 3 213
38	Aspilia africana	3 333 3
39	Imperata cylindrica	19 7 4 1
40	Brachiaria stigmatisata	9 6752
41	Cynodon dactylon	4 3124
42	Hypoestes verticillaris	3 1 12
43	Vernonia ambigua	2 2 6 1
44	Vernonia pauciflora	2 22 2
45	Crotalaria senegalensis	11 11
46	Crotalaria macrocalyx	1 11 1
47	Panicum subalbidum	333 2
48	Cassia mimosoides	2 1 1 2
49	Crotalaria lachnosema	343 2
50	Elionurus pobeguinii	131 1
51	Gardenia erubescens	3121
52	Polygala petitiana	1111
53	Euphorbia hirta	1 1 31
54	Sida linifolia	1 1 2 2
55	Digitaria longiflora	493 3
56	Setaria anceps	4 11 1
57	Cyperus digitatus	2 11 2
58	Sida ovata	8 1 1
59	Indigofera secundiflora	2 1 1
60	Chloris pilosa	5 2 3
61	Fimbristylis hispidula	5 2 4
62	Melochia corchorifolia	2 1 1
63	Chrozophora senegalensis	2 11
64	Acanthospermum hispidum	1 1 2
65	Blumea aurita	1 1 3
66	Sida rhombifolia	1 1 1
67	Crotalaria glauca	1 1 2
68	Hyptis spectigera	8 1 4
69	Guiera senegalensis	567
70	Eriosema griseum	234
71	Urelytrum muricatum	122
72	Hyparrhenia cyanescens	23 1
73	Eclipta prostrata	1 1 2
74	Sesbania sesban	41 1
75	Heliotropium supinum	1 2 2
76	Annona senegalensis	311
77	Triumfetta pentandra	1 1 3
78	Cyperus dilatatus	469
79	Englerastrum gracillimum	323
80	Helichrysum odoratissimum	2 11
81	Sida urens	2 1
82	Senecio abyssinicus	12
83	Evolvulus alsinioides	1 1
84	Tephrosia linearis	2 2
85	Pandiaka heudelotii	1 1
86	Lactuca taraxacifolia	12
87	Securinega virosa	1 1
88	Piliostigma thonningii	44
89	Fadogia agrestis	53
90	Lepidagathis collina	33
91	Schizachyrium sanguineum	12
92	Ctenium newtonii	11
93	Carissa edulis	11
94	Asparagus africanus	11
95	Panicum maximum	12
96	Biophytum petersianum	1 1
97	Andropogon gayanus	1 1
98	Eleusine indica	1 1
99	Solanum torvum	1 1
100	Alternanthera nodiflora	1 1
101	Dactyloctenium aegyptium	1 4
102	Commelina forskalaei	12
103	Rhytachne triaristata	43
104	Leersia hexandra	25
105	Uvaria chamae	1 1

SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX I.
GALMA 'FADAMA' VEGETATION

Species with ACV of one are omitted from the 36 quadrats examined.

| No. | Species | | |

No.	Species	
01	Panicum subalbidum	2 1332 124888121 6
02	Digitaria ciliaris	2 1164331 2 684242
03	Paspalum orbiculare	2 324 1 21 22211112
04	Melochia corchorifolia	12331 1111 111
05	Setaria pallide - fusca	2334 111 332 2
06	Eleusine indica	21141 3112
07	Eriochloa nubica	46666 11 1
08	Cyperus rotundus	42441 64
09	Cyperus pustulatus	622 2 4 2
10	Brachiaria stigmatisata	4 2 1 111
11	Commelina forskalaei	1 1 12 1 1
12	Ageratum conyzoides	12 11 12
13	Alternanthera nodiflora	1112 1 1
14	Eclipta prostrata	111 1 1
15	Ethulia conyzoides	122 11
16	Fimbristylis pilosa	4 2 12
17	Digitaria acuminatissima	332
18	Eragrostis pilosa	22 1
19	Physalis angulata	1 1
20	Oryza longistaminata	51
21	Cassia mimosaides	22
22	Vernonia pauciflora	1 1
23	Commelina benghalensis	3 4
24	Fimbristylis hispidula	21
25	Oldenlandia herbacea	1 1
26	Sacciolepis africana	22
27	Kyllinga squamulata	2 2
28	Leucas martinicensis	11
29	Scleria foliosa	1
30	Echinochloa colona	3
31	Mariscus squarrosus	1
32	Euphorbia heterophylla	1
33	Jussiaea suffruticosa	2
34	Indigofera nummulariifolia	1
35	Dyschoriste pedicellata	1
36	Eragrostis tremula	1
37	Indigofera hirsuta	1
38	Lipocarpha sphacelata	1
39	Sida ovata	1
40	Buchnera hispida	1
41	Pennisetum pedicellatum	1
42	Setaria anceps	2
43	Sesbania sesban	1
44	Chloris pilosa	2
45	Imperata cylindrica	1
46	Sida rhombifolia	1

SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX III.
GALMA IRRIGATION SCHEME SITE

All species enumerated are included in the 20 quadrats examined.

No.	Species	
01	Paspalum orbiculare	4 2 443 11226933999879
02	Digitaria ciliaris	856885637688345
03	Borreria verticillata	1112 21 2 64766 96
04	Dactyloctenium aegyptium	32445 53224
05	Mitracarpus scaber	14261423 4
06	Imperata cylindrica	944359846
07	Cassia mimosoides	1 11 1 1 13 42
08	Centella asiatica	72884363
09	Eragrostis atrovirens	21344353
10	Eragrostis tremula	23 1 2221 5
11	Indigofera arrecta	111 12 1 1 1
12	Schwenckia americana	1 111 2 1 114
13	Cynodon dactylon	3 242 4 62
14	Heliotropium strigosum	313 3 4 2 2
15	Brachiaria stigmatisata	242 2 33 4
16	Jacquemontia tamnifolia	1 1 1 11 3 2
17	Stachytarpheta angustifolia	3312 3 1
18	Thelepogon elegans	6 2 1 11 2
19	Tridax procumbens	1 2152 1
20	Crotalaria senegalensis	1 1 1 111
21	Nelsonia canescens	11 23 2
22	Sphaeranthus senegalensis	1 21 1 3
23	Waltheria indica	1 1 1 31
24	Pennisetum pedicellatum	1 17 21
25	Vetiveria nigritana	7831
26	Mimosa pigra	2522
27	Vernonia perrottetii	21 13
28	Acanthospermum hispidum	4 1 1 1
29	Euphorbia hirta	1 11 1
30	Borreria radiata	1 2 11
31	Indigofera nummulariifolia	1 11 1
32	Ipomoea equatica	11 1 1
33	Scoparia dulcis	12 2
34	Indigofera pulchra	1 1 1 3
35	Ethulia conyzoides	1 2 2
36	Tephrosia linearis	1 1 3
37	Sida linifolia	2 12
38	Sida rhombifolia	1 1 2
39	Oldenlandia herbacea	1 1 2
40	Crotalaria confusa	1 11
41	Hyparrhenia cyanescens	73
42	Oryza sativa	34
43	Oryza longistaminata	4 3
44	Sesbania sesban	23
45	Cyperus amabilis	2 2
46	Hyparrhenia rufa	89
47	Crotalaria glauca	3 3
48	Cassia tora	1 1
49	Vernonia ambigua	21
50	Eragrostis cillaris	1 1
51	Leucas martinicensis	1 1
52	Chrozophora senegalensis	2 1
53	Ageratum conyzoides	1 2
54	Evolvulus alsinoides	1
55	Cleome aculiata	1
56	Chrysanthellum americanum	1
57	Indigofera secundiflora	1
58	Hyperrthelia dissoluta	1
59	Indigofera hirsuta	2
60	Portulaca oleracea	1
61	Corchorus tridens	1
62	Cyperus esculentus	1
63	Fimbristylis exilis	1
64	Cassia nigricans	1
65	Urena lobata	1
66	Lepidagathis collina	1
67	Stylosanthes mucronata	2
68	Panicum repens	1
69	Hyptis specigera	3
70	Jussiaea suffruticosa	1
71	Tephrosia pedicellata	2
72	Tamarindus indica	1
73	Diospyros mespiliformis	1
74	Pennisetum typhoides	++ +++
75	Sorghum vulgare	++

SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX IV.
UPLAND KAKO VILLAGE TO GALMA 'FADAMA'

All species enumerated are included in the 23 quadrats examined.

| | | |

No.	Species	
01	Pennisetum pedicellatum	34743197 2 4324 4 3 2 1396 222222237 22131 1 22 21
02	Piliostigma thonningii	111 12 4322 2321 1 1 2111312 32 1
03	Indigofera pulchra	122228312243 2 2 2 2 2225 2 4121
04	Ageratum conyzoides	2 433 932533 328776977311 311
05	Andropogon pseudapricus	3 212 444 1 2 111 1122 3 2 222 3
06	Paspalum orbiculare	3333 4 334 24 2 3232 22 52 4 1
07	Vernonia perrottetii	22478337 123242 1 354 2
08	Borreria radiata	243 322243221 11 2 11 2 2 1
09	Oldenlandia herbacea	445 2 21111 33 33 232112
10	Terminalia avicennioides	1 1 2242 4 35545232743
11	Leucas martinicensis	2 555 44 5 3212 1 2 232 2
12	Nelsonia canescens	2 22 435335 3 22 3 2 3 24
13	Annona senegalensis	111 322 1 1 2 17 11 423
14	Vernonia ambigua	11 1 1 11333 1 32 1 1 11
15	Guiera senegalensis	111213 3 1 1 13 1242
16	Cochlospermum tinctorium	11 2 1333434223 214
17	Hyptis specigera	2 15 5 13 2 3 32 352 4 1
18	Eragrostis tremula	224 2168 27 4 1 332 2
19	Sporobolus pyramidalis	1 2 3 1 1 334594 13 3 2
20	Andropogon gayanus	1 1 1 1 2 22 11 1 2 2 22 2
21	Englerastrum gracillimum	11 22 2 1 1 2 1 11 1 23
22	Anogeissus leiocarpus	2 14 7453 7 111 33 1
23	Setaria pallide-fusca	1 1 21 22 3322 1 1 1
24	Ctenium newtonii	3433 3 63 722335
25	Vernonia pauciflora	122 54 3 2211 21
26	Butyrospermum paradoxum	1.21 11 23 12223
27	Hyparrhenia rufa	2 1212 1 1 42 2 8 9
28	Loudetia simplex	5444836 74446
29	Pandiaka heudelotii	11 1111 2121 1
30	Jussiaea suffruticosa	1 12 7398233 7
31	Stylosanthes mucronata	21331 3233 21
32	Elionurus pobeguinii	3244224283 4
33	Bridelia ferruginea	1 213 11 121 1
34	Waltheria indica	2 1312 2 2121
35	Digitaria ciliaris	534 73 12 22 1
36	Ipomoea eriocarpa	134 11 111 32
37	Borreria verticillata	358 8 1 1 2 61 1
38	Mitracarpus scaber	2343 1111 6 1
39	Sphaerathus senegalensis	2 31 2 5 31121
40	Ethulia conyzoides	1 843211 21 1
41	Stachytarpheta angustifolia	32 121211 42
42	Cassia mimosoides	1 1 11 1 12 1 11
43	Aspilia africana	1 1 1 1 2 62 1 2 3
44	Crotalaria lachnosema	3412221 1 3 2
45	Andropogon ascinodis	1333223 224
46	Alysicarpus Glumaceus	1 2 2 1 22 2 1 1
47	Eleusine indica	313 4 1 1 221
48	Vitex doniana	1 1 211 1 1 32
49	Combretum ghasalense	11 1321 2 1 1
50	Cynodon dactylon	7 34989322
51	Centella asiatica	356 274 73 3
52	Biophytum petersianunum	11 1 21121 3
53	Tamarindus indica	1 1 1 3 2 5 1 1
54	Fimbristylis hispidula	1 1 2 2 2 541
55	Monocymbium ceresiiforme	32 1 27 32
56	Diospyros mespiliformis	112 1 1 1 1
57	Gardenia erubescens	1 1 3411 11
58	Dyschoriste perrottetii	23 3 435 2 7 46 3
59	Lannea schimperi	21113 11 1
60	Cassia singueana	1 1 3 11 2 1
61	Brachiaria stigmatisata	63 562 6 4
62	Sida ovata	1 1 2 2 2 1 1
63	Lepidagathis collina	111 21 1 3
64	Indigofera secundiflora	12 21 2 1 2
65	Schizachyrium exile	3 2 1 11 2 2
66	Blumea aurita	22122 1 1
67	Eragrostis pilosa	9 98 243 2
68	Sacciolepis africana	9664 445
69	Urena lobata	4 2 11 2 2 3
70	Parkia clappertoniana	5 1 2 11 1
71	Entada africana	1 3 1 12 3
72	Tridax procumbens	2 32 2 24
73	Monechma ciliatum	2 2 11 1
74	Nauclea latifolia	21 11 11
75	Melochia corchorifolia	1 21 22 1
76	Hygrophila auriculata	2 3221 3
77	Schizachyrium sanguinium	2 2122 3
78	Combretum sericeum	11111
79	Euphorbia hirta	1 2 2 32
80	Acanthospermum hispidum	1 21 1 1
81	Dichrostachys glomerata	5 2 3 31

101	*Indigofera dendroides*	....1....1.12....1....1....1....1
102	*Monechma ciliatum*	....2....1....1....1.221....
103	*Commelina benghalensis*	....4....2....1....7....1....
104	Thelepogon elegans	....1....1....2..2.1....3....
105	Elionurus hirtifolius	....1..1....122....5...
106	Scleria foliosa	....33....1212.....
107	Desmodium velutinum	....212.2....1....3....
108	Acanthospermum hispidum	...3....3....2...2....1
109	Sida urens	.....1....3....1....1....1..
110	Crotalaria senegalensis	.....1.....1....1....1....1....
111	Cymbopogon giganteus	....2.1..2..2....1....
112	Psorospermum corymbiferum	....1....1....1.11....
113	Prosopis africana	....1....1....1....1....
114	Cynodon dactylon	23....1....6.1....
115	Murdannia simplex	....2222...1....
116	Melothria maderaspatana	....1....11....11
117	Loudetia simplex	....5....2533....
118	Feretia apodenthera	....1..1..1....
119	Hoslundia opposita	4....2.1.1....
120	Swartzia madagascariensis	....1....1....1..2....
121	Ageratum conyzoides	.....32....1....3....
122	*Englerastrum gracillium*	....2.1.12....
123	*Hyptis spectigera*	....2....1....4....1....
124	*Fimbristylis dichotoma*	....2.12.2....
125	*Pseudocedrela kotschyi*	....3....2....2....1....
126	Lannea acida	....1.1.1...1....
127	*Eragrostis pilosa*	....1....1.1....1....
128	Corchorus tridens	....1....4....2....
129	Vernonia pauciflora	....2....3...11
130	Detarium macrocarpum	....3....1..1....1....
131	Lactuca taraxacifolia	....21....1....1....
132	Borreria octodon	....22....23...
133	Pandiaka heudelottii	....22.1....1....
134	Jussiaea suffruticosa	....2...241....
135	Zornia glochidiata	....2....1....2....
136	Lantana rhodensiensis	....1..1...1....
137	Cussonia barteri	....1....1..1....
138	Vernonia nigritana	....1....11....
139	Isoberlinia doka	....5....12....
140	Sclerocarya birrea	....1....11....
141	Heliotropium pterocarpum	....121....
142	*Eragrostis turgida*	....3....2....2..
143	Gardenia ternifolia	....11....1....
144	*Ficus ingens*	....1....1....1....
145	*Heeria pulcherrima*	....2....22....
146	Echinops longifolius	....1....1....1.
147	Ficus platyphyla	....1....
148	Commiphora africana	....1....
149	Uvaria chamae	1....2....
150	Paullinia pinnata	1....1....
151	Ceiba pentandra	....1....1....
152	Grewia mollis	....1.1....
153	Schizachyrium sanguinum	....5....2....
154	Dyschoriste perrottetii	....2..1....
155	Asparagus africanus	....1....1....
156	Boswellia dalzielii	....1.1....
157	Schizachyrium brevifolium	....23....1....
158	Ziziphus mucronata	....1....1....
159	Euphorbia convolvuloides	....1....1....
160	Hyparrhenia rufa	....96....
161	Anellema lanceolatum	....21....
162	Holarrenia floribunda	....1....1....
163	Commelina forskalaei	....1....1....
164	Ipomoea aquatica	....1....1....
165	Blepharis linariifolia	....3....1....
166	Costus spectabilis	....1....1....
167	*Alternanthera nodiflora*	....2....1....

SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX VI
DUMBI TO KAKO TRANSECT ON THE UPLAND PLAINS

Species with ACV of one are omitted from the 111 quadrats sampled along the 11.1 km. long transect.

No.	Species	
01	Paspalum orbiculare	...255675642.4422.....32 21.32343.322.27.223.3.8.5..322...1...31..2.2248..3.1..2..52441.11...811....1721371.65.
02	Stylochiton lancifolius	3..1..1....1111..4522322. ..422.2....122.4354.512.22..1.2.111.21.22123...221.21.....1...13.211.212.1...1112221
03	Annona senegalensis	2..1111222..12..151542614 11..11133231342.1.16411621.....6..55.32...14.....13..22...1.43251....521..
04	Borreria radiata	3...7..1...116523...243422..21.2...11.2.21....31..2.1.2.....1..1..1.52224.4321...22.12..213..111..122.2...21.2.
05	Cochlospermum tinctorium	....311232..6222.11222215.1.11114415.746...86.8132.....75.58.21...3..2.....2..63...112223.....43...
06	Digitaria ciliaris	.....34.3.22.....7.5352761.....945....7.963547687683..9..5..2.....7844786375..57....8.7....24666...48
07	Piliostigma thonningii	1...12221...121..11..11.2.....362331.73...222.141..1.....1.154.221.135.....2.11...35.2.1.1.21...
08	Brachiaria stigmatisata	.....222.....32.9322..7342.3...3.5.3.37..2.....73974.7.98771.91...7.....68.33..33.51....2622..389.
09	Borreria verticillata	.2.4.46..42..2847.....393.211..2.....3...132.....681..212477..5....2...1122..1...419.....41123.273.
10	Guiera senegalensis	.....32.2121.112...631.....1..151.1...22...62212.....6.14..1211138.4.....31.....3.11322...11221
11	Dactyloctenium aegyptium	.....3.....68.....6.444.933.....867....7.232725536.46..5..8..7.....26325584.5..78.....1....62323..726
12	Jacquemontia tamnifolia	.11.5...1.23.2.2.....112.11...1.....112....1.13.1.31..11.1.2....1.....111..11332..11....2.2.....212...11
13	Pennisetum pedicellatum	.92969.6458846562.3....4.4...3.....4..738...72.21.822.2..7.2.....1...1126..1.....1.....1.3..12.
14	Sida rhombifolia	..1.1.11.111.2.11....1.1.....11...112...2.....2.1..1.....1131...1..123....11....112.1.11....1.....1.....222
15	Andropogon gayanus	31.1.5.21...4321.12111..2...1..4.3.5434411...42.....22.....32.3312.....2....1...12.....1...
16	Terminalia avicennioides	.....1122115..1.11.3.55.7.1.2...15..1.....11....1.....11.....147..67.1.2.1.6223.1..1.11
17	Mitracarpus scaber	.5254.7.5762...24.....7.92.122.....2....3311...54.1.....51...1..211..35.....2.....7.....1
18	Waltheria indica	....1423.21..211.2...2.1....1..11.121...4..1..2.1.....1.1.....2333..1.....111.....3...111.....2..
19	Indigofera pulchra	.....6..21..2123.1222.11..1...11.25.2.2..1..3..1.....1.....231.5.....1.....112.1...223..
20	Aspilia africana	.....1.42...252..1....2.....11...13...2.....23..2.....2..21..11...233.....112..2..2...2..2.....3231.
21	Fadogia agrestis	.....12....1322.....1...74...2..1.2.....13151173...18.3.....26...3..22..32..2...8211.
22	Schweinckia americana	.21221..2.11.1112.....1.....1.....2.....1....1..112..2.211..11..1.....3.11...211
23	Fimbristylis exile	.....1.....1...11.....1236381.2..23.4.2..1...52..68.2442..3....3..2223..2.....2.
24	Bridelia ferruginea	2.....2.1..2.2211.1...111111.11215...1.71.2.1.....1.121.....1.....11.....1.....
25	Butyrospermum paradoxum	....111.1..12111.1.1111.2..21...1.13..121...12..11.....1.1.....1.....
26	Urginea altissima	.....41.23.3...1...1..21223.124445.2.....31.1....22.....1..237.1..2.....
27	Chrysanthellum americanum	...3.....144.3.1.....2.3.22631.....326..244.2.....2...2.....1.....2.....1.....3.3....1.....1
28	Dichrostachys glomerata	5....1.....2.11.61.2.....251..3...1....111.....2..12.....17..7.....1...2.....1.12.....2....
29	Sprobolus pyramidalis	...2.2.3....51....2.....2111.26456.5.1..543.....2.....2...12.....1.....13..
30	Eragrostis tremula	.3.22....32...326....1...2....11.....2.....21.2.....831..2.....1.2.....2.1....2.....1.
31	Ctenium newtonii	.....4....2.3345.4.....4.22242...54...4.....3..43.....3.....4.....2223.....
32	Elionurus pobeguinii	.....45634.5.....3.23...2....4.....23.4..3.67.....24...4...2.3456.....
33	Cyperus obtusiflorus	.....22..1.....2.232...46...4.....32.6....31.5.....12..5.....3444.....42...
34	Stachytarpheta angustifolia	.3134...32.3...75.....3.3..126.....2....32.....11.....41.....2.....3.....3..
35	Eriosema griseum	.....1.....1.....2.2.2.....32.211..12.1.....3.....322.....44...
36	Vitex doniana	1.....111.2..11..1.1.....122.31.....1...11.....1.....11.....1..1.....
37	Leucas martinicensis	.3.....2.....1.1.....1.....2.1.....3.2.34.2.3..13....4.1.....114...12
38	Combretum sericeum	.....12.....1.....2.....1.1.1.1.....1.....1.11311.....1.....1....1211.....1..
39	Gutenbergia nigritana	.....1.....1..3.....1.....4.....1.2..32...2423.....2.....1..21.....4..
40	Indigofera capitata	.....1.1.....1.1..4.....11.....1.....1.....2.....121.1..3.....1....1.....1.1.....1....
41	Entada africana	....1.....1...1.....1.....112....312..11.....1.....1.1.....1...1.....1.....1....
42	Cassia mimosoides	.....1...11..1....2..1..2.....1.....11.....22.....1...111.....1.....21.
43	Brachiaria jubata	.....2.....2.....6.....2.....23.....244...4.1.1.5443.....47...
44	Physalis angulata	.....2.....11121.....321.1132.2..13....1.....11
45	Cissus rufescens	.....1.1....111.2.....13....31.11...1.....1....1....1.....11.....
46	Lannea schimperi	1.....1..1...1....1...1...1...1...1..1.....1.....11.....1..1.1....1.1.....
47	Oldenlandia herbacea	.2.22.1.1121...24.....3.3...321.....1.....3.....3.....
48	Indigofera nummulariifolia	.....2.....1.....1..2.....1.....4.222.4.....15..1.....1.....4.....2.
49	Eleusine indica	.....423.....2.....5..924221..1...23..2.....22....1.....
50	Fimbristylis pilosa	.....1.....113..53.....11..3....2.3221.....234.4
51	Setaria anceps	.....2.....2....28.....232264...23.....224131....
52	Parkia clappertoniana	1....11.....1.....1...1..1..1.....1.....1.....1.....1.....1.....11.1.1....1....
53	Lasiosiphon kraussianus	.....1121..11.1.....1.2.....2...112...1.....1..1.....2....
54	Lepidagathis collina	.....2.....211.....1..33.2....2.....6...3.....2121.....12...
55	Hyperthelia dissoluta	.....312.....1.2.....78.....1.3..2.....1255.....46.3.
56	Tridax procumbens	.4.1.....1...3.1.....3..2.....14....24.2.....73.....8...1.....
57	Heliotropium strigosum	.21.3.2...1....23.....1....1.....1.....1.....1....1....1.....1.....21.
58	Tephrosia pedicellata	.....2.....1.....2.....33.3..43..2.....1.....1..24.3.....1.1..
59	Vernonia perrottetii	.3.....12....112.....1.....1...3111....1...2...7.
60	Strychnos spinosa	.....1..211.2.....1.1.....11.....1.....21.....1..1.....
61	Nelsonia canescens	.....2.....4..52127.....2....1.....2.....1.....1....1.....2.....
62	Scoparia dulcis	.....1.....2..2131..1.....1.....1..1.....1.1.....11.
63	Fimbristylis ovata	.....1.....1.32.....3....2..1.2333.....545..
64	Sporobolus festivus	.....57.5..1.....24..629....2.22.....45...
65	Tephrosia bracteolata	3.....5.....2.....2.....31.1.....1.....3.1.....2.....1..1.....
66	Andropogon pseudapricus	.....32.....7.....42...6.....43.4....45.....6...4.....
67	Nauclea latifolia	.....11.121171.....1.....111.....1.....
68	Anogeissus leiocarpus	6.....271111.....11.2....11.....
69	Cassia singueana	3.....1.....132.....1.....1...11.1.....1.....2.1.....
70	Stereospermum kunthianum	.....1.....1.....1.11....1.....1.....11....1.....
71	Euphorbia hirta	.1.....3.....1.....1...1.....1.....11..121.....1
72	Adenodelichos paniculatus	.....21.....25.11.....55.1..58.....1.....
73	Monocymbium ceresiiforme	.....3.32.....2...5.....2.3.....3.....3222.....
74	Acalypha brachystachys	.....2.....1.2.....611.32.22....4.....3
75	Heeria pulcherrima	.....1.....1.....1.1.....2..1....1.11.1.....
76	Tephrosia linearis	.....1...1.....2.....1...1.....1...1.1.....1.....1.....1.....
77	Urelytrum muricatum	.....2.1..2.....1.....2...2.....11...2.....1.....
78	Ximenia americana	.....1.1.....1.....11.....2.....1.....1.....1.11.....
79	Evolvulus alsinoides	.....1....2.....2.....2.....112.....5...11.....
80	Ethulia conyzoides	.2.....2...21111.....1.....1.....1.....
81	Imperata cylindrica	.....7.....8.1..36.....822.7.....
82	Sida linifolia	.....1.1.....2...1.....1.....11....1..1.....1.....
83	Tephrosia purpurea	.....1..11.113.11.....1.....1.....
84	Diospyros mespiliformis	.....1.1.....1.1.....11...11.....1.....1.....
85	Gardenia erubescens	.....1...11.....1.....11.....111.....1....
86	Daniellia oliveri	.....1.2....2....1.1.....26...27.....1.....
87	Sida ovata	.....2.1.....12.13..12.....1.....1.....
88	Vitex doniana	....1.....1.....1.....1.....1.....1.....1.....1.11.....
89	Chrozophora senegalensis	.....3.....1.....1.....11..1...1..1.....1.....
90	Vernonia ambigua	.....111..3..1....1.....1.....11
91	Crotalaria confusa	...1.....1.....1..1.1111.....
92	Stylosanthes mucronata	.....1.....2.....2.....11.....2.....3...
93	Indigofera arrecta	.....1.....1.1.....1.....11.....1.....
94	Ipomoea argentaurata	.....12.....1.....1....1...1.....1....1.....
95	Lippia chevalieri	.....2.....1.3213.....71.....
96	Terminalia laxiflora	.....1.....1....1.1.1.1.1....1.....
97	Cassia tora	.11.....1.....11.11.....
98	Combretum ghasalense	.....1.....1.....1.....1.....3.....1.....1.....
99	Parinari curatellifolia	.....1..11324.....1.....

No.	Species	
01	Borreria radiata	3323222275234676122112 22546687 235 3 522
02	Dioscorea bulbifera	112222111 1114 12 11 1 11122 231231 2 3 11 12 8
03	Cissus rufescens	685571323 1666342351311 16746 1 2 222
04	Clerodendron capitatum	2121321111111111 11 111 221 121 3 11
05	Byrsocarpus coccineus	21531222231121 11 112 1 14 13 1 1
06	Milletia thonningii	3111321 4 121 1 56444446 13 2 3 4
07	Bombax costatum	1 11 311 21113 1111 1 1 1 13 63 142
08	Andropogon gayanus	23131 6545322353132333 23 2
09	Ipomoea involucrata	2 2 12113 123 1 1 7 2 32 32 12 1 223
10	Cyanotis lanata	2 3 1 3 23 422 1 4423 22 1 42 847
11	Cissus aralioides	1 23331 3 2 2332222333 1324
12	Indigofera dendroides	2111 1 113113 32 1 1 222 12 2
13	Achyranthes aspera	1 2 1 9542256432 5242 2 3
14	Tephrosia bracteolata	1121 21233421 1 2 3 2 62 3
15	Pandiaka heudelotii	111 2 1 2 11 1112 223 221 1
16	Pennisetum pedicellatum	213 131112214 22 1 2 22
17	Acacia ataxacantha	1 2 1 131 71 4 4 2 22232 4 2
18	Dissotis sp.	563558854646 16 467
19	Tacca involucrata	2 151 111 113221 1 522
20	Stereospermum kunthianum	1111 11221 11 3 1 111
21	Brachiaria lata	2 32 5 3 662 2 9 6778 33
22	Anogeissus leiocarpus	1 1413 353 1 1112 2 6
23	Triumfetta pentandra	1 1 87842 3 1 3 338 2
24	Rottboellia exaltata	21 5 2 33 12 42 1 263
25	Commiphora africana	11 1 1 122 11 21 3 3 1
26	Diospyros mespiliformis	2 11 1 1 3 11 2 1 111 1
27	Dioscorea preusii	2355524 14121 3
28	Wissandula amplissima	3 761 32 3 311 144
29	Asparagus africanus	12 1 1 111 111 1 11
30	Eulophia quartiniana	22222 44 2 3 2 2 2
31	Vigna racemosa	212 1 3 1 11132 3
32	Scleria foliosa	11 1 1 1 11 1 111
33	Sporobolus pyramidalis	2224 3 3 2 2 26
34	Bidens pilosa	1 3 2 2 12 1 12 3
35	Hackelochloa granularis	6 2 2 4 21 2 2 1 8
36	Entada africana	1 122 12 221 1
37	Allophylus spicatus	12 1 21 11 1 1 1
38	Cassia singueana	141 1111 1 2
39	Parkia clappertoniana	11 11 3 11 1 1
40	Aneilema lanceolatum	12 13 1 1 1 1 2
41	Annona senegalensis	11 11 21 2 1 1
42	Cassia mimosoides	1 11 2 21 2 2
43	Sporobolus festivus	21 12 3 24 2
44	Melothria madaraspatana	2 11 111 1 1
45	Ficus umbellata	1 2 1 2 2 3 12
46	Brachiaria stigmatisata	2 32 2 1 93
47	Indigofera bracteolata	1 1 22 2 2 1
48	Indigofera hirsuta	2 2 31 11
49	Crotalaria naragutensis	2 31 1 3 1
50	Afrotrilepis pilosa	888 85 4
51	Gloriosa superba	1 2 1 1 1 2
52	Khaya senegalensis	2212 3 1
53	Cassia tora	11 1 11 2
54	Stylochiton lancifolius	1 1 11 4 1
55	Grewia mollis	1 1 1 1 2 1
56	Holarrhenia floribunda	3 1 23 23
57	Ziziphus mucronata	11 1 2 123
58	Cissus quadrangularis	3 2 242 2
59	Setaria pallide-fusca	2 3 22 6
60	Clematis hirsuta	1 111 1
61	Jasminum dichotomum	1 1 1 1 1
62	Lannea kerstingii	1 1 1 1 2
63	Sesbania sesbans	1 23 4 1
64	Gutenbergia nigritana	1 5 1 33
65	Canthium horizontale	33311
66	Landolphia sp.	21 121
67	Lannea barteri	11 1 2 1
68	Solenostemon manii	1 2 2 4 3
69	Celtis integrifolia	2 13 5 1
70	Cochlospermum tinctorium	2 21 3
71	Cussonia barteri	1 1 1 1
72	Bridelia ferruginea	11 1 1
73	Sida urens	1 1 2 1
74	Bambusa vulgaris	3 4 2 4
75	Pterocarpus erinceous	11 2 3
76	Cyperus digitatus	2 4 3 4
77	Lantana rhodesiensis	7 2 88
78	Kyllinga squamulata	3 1 21
79	Schizachyrium exile	2 489
80	Monechma ciliatum	121 4
81	Tephrosia pedicellata	3 2 4
82	Heteropogon contortus	2 4 2
83	Lannea schimperi	1 1 1
84	Hyperthelia dissoluta	2 1
85	Albizia zygia	1 1 1
86	Solanum torvum	2 1 1
87	Cissampelos mucronata	1 1 1
88	Fadogia agrestis	1 1 1
89	Isoberlinia doka	363
90	Adenodelichos paniculatus	133
91	Euphorbia laterifolia	3 2 8
92	Digitaria homblei	132
93	Uvaria chamae	12 2
94	Urginea altissima	1 1 2
95	Mariscus alternifolius	2 6 7
96	Securinega virosa	11 1
97	Dichrostachys glomerata	1 2
98	Strychnos spinosa	1 1
99	Crotalaria senegalensis	1 1
100	Tamarindus indica	1 2
101	Sclerocarya birrea	24
102	Jacquemontia tamnifolia	1 1
103	Ekebergia senegalensis	1 1
104	Euphorbia convolvuloides	1 1
105	Eurphorbia hirta	1 2
106	Croton macrostachyus	2 1
107	Allophylus africanus	1 1
108	Kaempferia aethiopica	1 1
109	Combretum molle	11
110	Desmodium velutinum	1 2
111	Chrysophyllum albidum	22
112	Diospyros abyssinica	1 2
113	Pycreus macrostachyos	3 3
114	Jussiaea suffruticosa	2 2
115	Setaria anceps	2 3
116	Corchorus tridens	2 2
117	Trema guineensis	4 3
118	Ficus exasperata	2 2
119	Eleusine indica	1 2
120	Saba florida	5 2
121	Boerhavia diffusa	32
122	Urena lobata	23
123	Drosera indica	1 1
124	Synedrella nodiflora	7 4
125	Acalypha brachystachya	1 1
126	Ensete gilletii	2 3

SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX VII.
DUMBI INSELBERG AND ROCKY HILLS

Species with ACV of one are omitted from the 56 quadrats examined.

No.	Species	
01	Brachiaria stigmatisata	119 92233257892112957 9974
02	Sporobolus pyramidalis	4444 3444442145365244542
03	Dyschoriste pedicellata	11 63321 122434221242
04	Cassia rotundifolia	89762 2 99651 36853
05	Fimbristylis pilosa	12122 122442 2 21 2
06	Eucaplytus teriticornis	877444 488777778
07	Sida rhombifolia	1 2 12 11 21 112 123
08	Phyllanthus nigericus	111112 1 11121 2 1
09	Waltheria indica	112 1 312 31 2 2 1 1
10	Aspilia africana	11 2 221222 1 31
11	Triumfetta pentandra	1 3322 2 322 1 2 2
12	Sida urens	2 132 21111 1 1
13	Stylochiton lancifolius	11 1 42 1 11 1 23
14	Eucalyptus camadulensis	887767 7 444
15	Cassia mimosoides	1 1 1 1 1 1 1 1 11
16	Sida linifolia	1111 1111 1 1
17	Borreria verticillata	135 1123 2 2 1
18	Borreria radiata	1 3 213 21343
19	Desmodium barbatum	51 1 12112 22
20	Imperata cylindrica	31 7627 77 1
21	Adropogon gayanus	1 11 1 3 1 12 1
22	Tephrosia pedicellata	1 5 122 3123
23	Evolvulus alsinoides	1 11 2 1111 1
24	Indigofera pulchra	1223 11111
25	Blepharis linariifolia	2 112 1 2 1 1
26	Stylosanthes mucronata	2 4 1333 1 1
27	Schweinckia americana	121 1 11 11
28	Crotalaria retusa	1 211 2 332
29	Cassia siamae	2 632 2 2 2
30	Annona senegalensis	2 11 11 1 1
31	Dichrostachys glomerata	2 112 1 1 4
32	Ageratum conyzoides	11 1212 1
33	Carissa edulis	1 31 1 1 1
34	Setaria anceps	1 11 1 11
35	Indigofera nummulariifolia	2 32 1 1 1
36	Eucalyptus citriodora	88 434 4
37	Tephrosia purpurea	11 1115
38	Clerodendron capitatum	1 11 1 1
39	Paspalum orbiculare	1 21 1 1
40	Cyperus rotundus	1 12 11
41	Cissus rufescens	1 1 1 11
42	Euphorbia hirta	1 1 1 1 2
43	Bidens pilosa	421 2 1
44	Indigofera chalieriana	1 22 46
45	Kyllinga squamulata	1 1 111
46	Khaya senegalensis	12111
47	Guiera senegalensis	121 1
48	Eragrostis turgida	123 4
49	Digitaria ciliaris	1 21 1
50	Scoparia dulcis	1 1 1 1
51	Acanthospermum hispidum	1 2 22
52	Pennisetum pedicellatum	21 2 1
53	Nitracarpus scaber	2 2 1 2
54	Pandiaka heudolotii	1 1 2 1
55	Cynodon dactylon	3 2 4
56	Gutenbergia nigritana	4 2 1
57	Hoslundia opposita	212
58	Leucas martinicensis	111
59	Nelsonia canescens	2 1 2
60	Jacquemontia tamnifolia	1 11
61	Cassia tora	11 1
62	Dactyloctenium aegyptium	112
63	Sida ovata	13 1
64	Balanites aegyptiaca	1 1
65	Diospyros mespiliformis	1 1
66	Parkia clappertoniana	1 1
67	Eragrostis tremula	1 1
68	Brachiaria jubata	9 1
69	Zornia glochidiata	1 1
70	Acacia ataxacantha	2 1
71	Jasminum dichotomum	1 1
72	Indigofera arrecta	1 2
73	Asparagus africanus	1 1
74	Tridax procumbens	2 2
75	Piliostigma thonningii	1 1
76	Cissampelos mucronata	1 1
77	Stachytarpheta angustifolia	1 1
78	Vadogia agrestis	11
79	Chrysanthellum americanum	1 2
80	Brachiaria xantholeuca	11

SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX VIII.
MAIRABO FOREST PLANTATION RESERVE

78	Curculigo pilosa	11 11 1 1 1
79	Gladiolus gregarius	22 1 12 111
80	Securidaca longepedunculata	1 2 1 1 1 1 1 1
81	Kyllinga squamulata	1 1 2 1 2.1 1
82	Eragrostis tremula	1 1 1 1 1 1 1 1 1
83	Euphorbia hirta	1 1 1 1 3 1
84	Mitracarpus scarber	1 1 1 1 1 1 1 1
85	Parkia clappertoniana	1 1 1 1 1 1
86	Kaempferia aethiopica	2 11 1 1 1 1
87	Jasminum dichotomum	111 111 1
88	Cyperus dilatatus	1 11 211 1
89	Eucalyptus robusta	22 2 344
90	Acanthospermum hispidum	2 2 1 1 31
91	Psorospermum corymbiferum	1 1 1 1 1 1 1
92	Cassia tora	2 1 1 1 1 2
93	Lannea schimperi	1 1 1 1 1 1 1
94	Cochlospermum tinctorium	1 1 1 1 1
95	Lannea acida	1 11 1 1
96	Combretum glutinosum	1 11 1 2
97	Ficus ingens	1 11 11
98	Stachytarpheta angustifolia	1 2 1 1 1 1 1 1
99	Euphorbia heterophylla	11
100	Nelsonia canescena	1 1 1 12
101	Digitaria ciliaris	4 1
102	Eriosema psoraleoides	1 11
103	Anogeissus leiocarpus	2 1 2 1
104	Piliostigma reticulatum	1 1 1 1 1
105	Erythrina senegalensis	1 1 1 1
106	Indigofera arrecta	2 1 2 2
107	Vitex simplicifolia	1 11 1
108	Crotalaria naragutensis	11 1 1
109	Acacia staxacantha	1 1 11
110	Pseudocedrela kotschyi	1 5 1 1
111	Indigofera charlieriana	61 1 1
112	Feretia apodanthera	11 1 1
113	Sida ovata	1 1 1
114	Lasiosiphon kraussianus	1 1 1 1
115	Ageratum conyzoides	1 1 1
116	Monechma ciliatum	1 11
117	Cyperus obtusiflorus	3 2 1
118	Clematis hirsuta	1 1 1
119	Opilia celtidifolia	1 1 1 1
120	Tridax procumbens	1 1 1
121	Discorea bulbifera	11 1
122	Indigofera capitata	11 1
123	Urena lobata	1 11
124	Jacquemontia tamnifolia	1 1
125	Cassia siamae	1 1
126	Eleusine indica	1 1
127	Abrus precatorius	2 1
128	Swartzia madagascariensis	1 1
129	Indigofera dendroides	1 1
130	Cryptolepis sanguinolenta	1 1
131	Steganotaenia araliacea	1 1
132	Tephrosia purporea	1 1
133	Afrormosia laxiflora	1 4
134	Eriosema griseum	1 1
135	Crossopteryx febrifuga	1 1
136	Combretum molle	11
137	Crotalaria lachnosema	2 1
138	Borassus aethiopum	1 1
139	Grewia mollis	1 1
140	Securinega virosa	1 1
141	Tephrosia bracteolata	2
142	Spigelia anthelmia	4
143	Schizachyrium platyphyllum	3
144	Mariscus alternifolius	3
145	Murdania simplex	2
146	Chrozophora senegalensis	1
147	Ipomoea eriocarpa	1
148	Ctenium newtonii	1
149	Hyptis specigera	1
150	Ipomea argentaurata	1
151	Lippia chevalieri	1
152	Hymenocardia acida	1
153	Ipomoea vagans	1
154	Trema guineensis	1
155	Paulinia pinnata	1
156	Parinari curatelifolia	1
157	Englerastrum gracillium	1
158	Maytenus senegalensis	1
159	Syzygium guineense	1
160	Borreria octidon	2
161	Eragrostis atrovirens	1
162	Detarium microcarpum	1
163	Cyperus rotundus	4
164	Butyrospermum paradoxum	1
165	Crotalaria retusa	4
166	Maerua angolensis	1
167	Euphorbia convolvuloides	1
168	Feretia apodanthera	1
169	Byrsocarpus coccineus	1
170	Terminalia laxiflora	1
171	Vernonia ambigua	1
172	Imperata cylindrica	2
173	Cassia sieberiana	1
174	Phyllanthus nigericus	1
175	Canthium venosum	1
176	Ekebergia senegalensis	1
177	Cussonia barteri	1
178	Balanites aegyptiaca	1
179	Chloris pilosa	3
180	Boerhavia diffusa	1
181	Wissandula amplissima	1
182	Brachiaria xantholeuca	2
183	Ceiba pentandra	1
184	Sida acuta	1
185	Eucalyptus grandis	1

SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX IX.
KABAMA FOREST PLANTATION RESERVE

All species enumerated are included in the 100 quadrats examined.

No.	Species	
01	Cassia rotundifolia	1 847786627324478693277786848873778847975385448572 299876 264778354172 7161249347378346 7778812 8
02	Brachiaria stigmatisata	7464532583 863556898 65 57886846257893 785887823 7877715 5445857417346332334965443234498667611 22
03	Stylochiton lancifolius	236843222674 1 34 2563153341211 22333332 14 2222353 3322 2 33 13122321221441231162 22 2 434442413232
04	Fimbristylis ovata	21423434426312 7554422174262345 44644452 35231434 34462342 4232441322252 1421111 31332 33 12321 1
05	Gutenbergia nigritana	2357554341223336431242176531224226631 2 4314543343246442441253422 21 31 2 14312 1 1225212 22211
06	Fimbristylis pilosa	222321 4 1222221216533222 44433423243332533 12243533 3221222222241 2321123 122322232 22421111
07	Sporobolus pyramidalis	32 51 3111211 2233 11422 12 1 22222111 1312331 1613211 5421211 47365184312 1 535524324211432 86 22
08	Stylosanthes mucronata	2363421431215631112212 4132312 2 23263214336442 2 544664115 14 13212111 3 232 31322244 22 213
09	Indigofera pulchra	1 1 11 11113 11 12111123311 11 1331121 333211223132 1122323 2 12 12111112122122221 22341211
10	Blepharis linariifolia	112523247741 13343775 35363443 34231222212213625331 5 24222323232343 3 3112 2 1 23111 2 2 2
11	Dyschoriste perrottetii	11 3 24 122 21741 3 33231263 33321 5453322 426323 311323531212421 2315 11 11216265 2111431
12	Waltheria indica	11121 1 1113 1 1 21133 1 32 2111 11 1111 11321 11322111221 1 111111111 1142121211121 111 1
13	Sida rhombifolia	1 4312 3233 1 1221111 21222 1 1 13121131211211 31 2 232 11 1 52 1 32 21 13112111 1 1 1111111
14	Aspilia africana	1412 2 311 222 12122223 222232221222 211322222331 3 422131133 212621 3331 122 2 1121
15	Eucalyptus camaldulensis	888 88 7 78887 4636866 643888788566 887658 667837776555565575447776656656778 6
16	Borreria verticillata	111135721 2 2132 111 21 22 16674 21123458111113654 113432 2 1 123211 2 1 11 1 111 1 1 1 1
17	Paspalum orbiculare	1212122221211 3323 2 23223 1 24212111113111111122221 2 1 12 11 113 11 31 322 11 21 1
18	Isoberlinia doka	317 2615 547552 676437 356441 52544 3435 135 2435157567 7 2526742 3 163544744
19	Borreria radiata	1 61112111111 22 11 313 211 421111 3 322 1 22 1 213221 1311 11 11 122112
20	Setaria anceps	1 11 111 12213 51 1 125223111 61111 252 1 322 1 11 461 112233 1 11 122221
21	Sida urens	1122 1111111 1211111 1 21 11212 2 11222 2 2 122 121 221 1111 2121 1 1 1
22	Evolvulus alsinoides	212 231 23121 222 2 2 12 131 324 231 22 1 11211 3 11 1 1211 1 12 11
23	Andropogon gayanus	1 1 121 11 21 22 121 132 11 1 2 41121 1113 21433 2 2 333 111132
24	Hyperthelia dissoluta	1 1 1 1 1111 1211112215211125 322 2411 1 3 1 12 21 322 1 1 1 1
25	Terminalia avicennioides	112 12111 2 1 1224 1 122 11 111 1113 111211 1 111 1 1 1111 1 1
26	Brachiaria jubata	12243 121221 3 2131 1115 637 21 251 1 1 1 1 2 1 141 2 1 1 1 21
27	Tacca involucrata	11 1 1 11 1 1 1 11 112 1 11 11 1 11 1 1111 11 111112 1 11 1 1
28	Triumfetta dubia	111 1 111 114 42 1 12 212 222 1 2 1 12 1 11 1 1 11 11 2 221
29	Zornia glochidiata	46643 21 1 32232565 44 1 863 6784 7 87 1 7 1 3 11 3 5 24
30	Cassia mimosoides	1 13 1 2 111 11 1 21 1 2 2 1 11 1 1 1 1 11 1111 1111 1 11
31	Fadogia agrestis	11 222 1111 1111 1121 2 2 121 12 11121 1 21 1 1 2
32	Indigofera nummulariifolia	164 15 1 12 1 3 1 1 134 124 4 42 111 1 11 2 1 2 232
33	Dichrostachys glomerata	1 1 2111 1 11111 1 1 2 1 2 1 1 1 1 1 1 2 11 21 1 1 11 1
34	Cissus rufescens	1 1 1 1 1 11 1 1 1 1 4 1 1 11 111 11 1 1 11 1 12 1 11 1 1
35	Annona senegalensis	11 11 11 111 11 1111 1111 1 1 1 1 11 1 1 12 1 1
36	Tephrosia pedicellata	1 3 5 12 22 2 3 1 11 6 1 1 12 1 111 2 1 1 63 12
37	Desmodium barbatum	4 1 1 1 1 1 1 1 1111111 11 1 1111 22 12
38	Pandiaka heudelotii	11 2 1 2 1 11 1 133 11 12 11 12 1 1 1 12 1 1
39	Sida linifolia	1 1 1111 1 111 1 1 1 1 1 1 11 1 11 111 1 1
40	Asparagus africanus	1 1 11 2 1 1 1 1 1 1 1 1 11 1 11 11 1 2 1 11 1
41	Pennisetum pedicellatum	1 53 1 2 342212 1 22 2 2221 1 1 1 1 1 1
42	Triumfetta pentandra	1 11 1 1 1 11 1 1 42212 21 1 122 1 2 1
43	Scoparia dulcis	1 11 1 11 1 1 1 1 1151 1 1 1 11 1 1 1 1 1 1
44	Daniellia oliveri	1 1111 123 1212 1 1 1.1 11 11 1 1 1
45	Guiera senegalensis	223 1122 22 1 1 1 1 1 31 1 1 1 1 1 2
46	Schwenckia americana	1 1 1 1 1 1 11 1 1111 221 221 1 1 1
47	Gloriosa superba	1 11 1 1 1 2 12 1112 111 1 11 1 1 1
48	Piliostigma thonningii	1 1 1 1 1 1 11 1 1 1 1 111 1111 1 1 1 1
49	Bridelia ferruginea	1 11 11 1 1 1 1 1 11 1 1 1111 1 1
50	Carissa edulis	1 1 1 1 1 1 1 1 1 1 1 1 11 11 1 1 11 1 1
51	Eucalyptus teriticornis	8888 88 84 787 888 8888886
52	Ochna afzelii	1 11 1 1 1 111 21 11 1 1 1 1 1 1 1
53	Diospyros mespiliformis	1 1 1 1 1 11 11 1111 1 1 2 1 11 1
54	Chrysanthelum americanum	12 4 1 3 2 1 3123 4221 111 1
55	Entada africana	1 1 1 1 2 1 1 1 11 1 111 1 1 1 1 1
56	Khaya senegalensis	11 11 111 1 111 31 1 112 1
57	Eragrostis gigantica	1 1 1 1 111 11 1 1 1 1 1 1 1 11
58	Hoslundia opposita	11 1 2 1 11111 1 1 11 1 1 1 1
59	Nauclea latifolia	232 32 1 1 1 1 1 1 11 1 1 1
60	Crotalaria senegalensis	1 1111 11 1 1 1 1 1 1 11
61	Sporobolus festivus	22 2 1 1 2 3 1 1 2 121 1
62	Combretum ghasalense	11 11 11 11 1 11 1 1
63	Cassia singueana	11 1 1 1 1 2 11 1 1 1
64	Eragrostis turgida	5 2 1 1 4 3 2 2 11 2 1
65	Gardenia erubescens	1 11 12 1 1111 1 1
66	Clerodendron capitatum	11 1 1 1 1 1 2 3 2 1
67	Dactyloctenium aegyptium	13 5 2 2 2 5 2 222
68	Vitex doniana	1 1 1 2 1 1 1 1 11 1
69	Uvaria chamae	1 1 2 1 1 2 1 2 1 1 1
70	Eucalyptus citriodora	888 8788888 4
71	Pterocarpus erinaceus	1 111 1 1 1 1 1 1
72	Hypoxis angustifolia	1 11 1 11 1 1 1 1
73	Stereospermum kunthianum	1 1 1 11 1 1 1 2 1
74	Combretum sericeum	11 111 11 1 1 1 1
75	Urginea altissima	1 1 1 1 1 2 11 1 1
76	Bidens pilosa	1 1 13 1411 1
77	Lactuca taraxacifolia	1 11 1 1 1 1 1

01	Pennisetum pedicellatum	7 685 421 2234434573 43322 122 1 222 2231 22 2 2 453 3 24214643 1 11 3 237644 3
02	Dichrostachys glomerata	1112 1 3 3 11 11 432114 331 11632141 25122 2 123 1144138 2 1344312213 1414
03	Isoberlinia doka	5465 1154342 4535553337523246211 525 424 5 3646746 66 523 2 122 74 5
04	Terminalia avicennioides	1 1 1 1 21 12 21 12331 51 1122 1 2121121 11211 2 12323 11113 1 21 131111
05	Adropogon pseudapricus	3 8 85331231 222 3234332322 2 4 2 312134 2 2423143 4 2 2 3 412443 5214
06	Borreria radiata	1 1 2 31113 2 2123 221 1 221 321126 21 111 11 12 43113 91161434222 21
07	Andropogon gayanus	232224 21 187875425724457 2 1 1 3 2321 36431 1 11 1 112 1 2 4 11 2 2
08	Piliostigma thonningii	1 11 111 12 1 1 1 2 1 1 1 1 737784566111121 241 11 41353112 11 11
09	Annona senegalensis	211 11 12 3121 1 1 1 11 11113 341 1 3 1 11 1 21 112 1 1
10	Aspilia africana	1 111122 131 21 111 1 2 221 11 11 112111 11 1 11 1
11	Elionurus pobeguinii	1 1143 22 2 4334 543 645142243232 61 3 3 3 3 2
12	Indigofera pulchra	1 2 1 1 143 2 221 2 1 2 21 1 1 111 11 1 1 111 2 1 13
13	Isoberlinia tomentosa	2448642324 11 23 2651232 754441 424 2 2
14	Butyrospermum paradoxum	11 11 1 1 1 111 1 1 1111 111 1 1 1 2 1 1 121 11 11
15	Ctenium newtonii	111 87 42 24453 673 334 6 234243 43 3 3 22
16	Cochlospermum tinctorius	1 1111 1 1121221 3223212 4442 4 2 32 3 4
17	Lannea schimperi	1 111 1 1 11 1 111 1 1111 12 1 21 11 1 111 1
18	Ximenia americana	2311 1 11 1 1 111211 11 2112 11 1 1 11 1 1
19	Sporobolus pyramidalis	2 1 2 23 332 2221321232 11 1 2331 6 1
20	Monotes kerstingii	3 21 4 1 1 422444 2 22214 44 11 1 67
21	Combretum ghasalense	1 111 1 21 12 1111 1 2 1 2 1 11 2 21
22	Waltheria indica	2 2 12 1 1 1 3 1 21 1 1 1122 1 1211 1
23	Stylosanthes mucronata	11 22 2 12 1 1 11 1 1 143 2 31 2 2
24	Panicum maximum	2 2 314 12 223 2 11 12 2 2 24 1
25	Detarium macrocarpum	1 1 2 1 2 242 112 1 1 112 11 1 1 32 11
26	Strychnos spinosa	11 3111 111 1 1 1 11 1 111 1
27	Lepidagathis collina	1 12 3223 12 1 12 12 1 1 1 1
28	Eucalyptus camaldulensis	7 6777 887778887 542
29	Afromorsia laxiflora	11 1 1 242 11 2 111 11 1 1
30	Sida ovata	1 1 1 11 11 1 211 11 1 1
31	Nauclea latifolia	1 14222343111 1 3 21 1
32	Brachiaria jubata	4344444342 5 1 12 22
33	Dyschoriste perrottetii	1 27 21 13 1141 295 7 1
34	Eucalyptus citriodora	4 336 443444544 331
35	Hyparrhenia rufa	2 1 2646889989 963
36	Monechma ciliatum	41 11 1 11 2 2 2 1 1 1 1
37	Swartzia madagascariensis	1 1 1 1 1 1 13 11 11 1 1
38	Pandiaka heudelotii	1 1 1 11 1 111 1 1 11
39	Gardenia erubescens	11 1 21 1 11 1 11 11
40	Borreria verticillata	1 3 7 11 1 253 9 1 7 1
41	Englerastrum gracillimum	1 12 1 1 111 21 1 1 1
42	Gardenia aqualla	11 1 12 11 1 1 1 12
43	Aristida funiculata	3 1 41 2 1 313 21 2
44	Eragrostis tremula	2 2 1 1 1 2 1 3 333
45	Dyschoriste pedicellata	1 52 75 2 2 1 2 416
46	Lippia chevalieri	1 1 1 222 2 1 1 1 12
47	Nelsonia canescens	1 1 25 443 4442 1
48	Entada africana	21 1 1 1 1 1 1 11 1 1
49	Parkia clappertoniana	11 2 2 1 1 1 1 1 1 1 1
50	Urelytrum muricatum	3 2 1 2 2 132 2 1 1
51	Monocymbium ceresiiforme	21 3 12 2 2 2 2 1 2
52	Asparagus africanus	1 1 11 1 1 1 11 1 1
53	Parinari curatellifolia	1 1 2 4 2 123 1 1
54	Paspalum orbiculare	2 11 1 1 3133 1
55	Anogeissus leiocarpus	1 1 1 4 3 1 244 1
56	Khaya senegalensis	111 1 1 1 1 1
57	Bridelia ferruginea	1 2 1 11 1 1 1 1
58	Cassia singueana	1 12 1 1 1 11 1
59	Ochna afzelii	1 1 1 1 1 1 1 1
60	Michrochloa indica	4 23 2 1 3 37 2
61	Imperata cylindrica	8 4 2 225 98 9
62	Vernonia ambigua	1 1 12 1 11 1 1
63	Securidaca longepedunculata	1 1 11 11 1 1
64	Diospyros mespiliformis	11 1 3 1 1 2 1
65	Daniellia oliveri	1 1 11 1 21 1
66	Adenodelichos paniculatus	1 1 1 1 11 1 1
67	Lannea acida	11 1 12 1 1 1
68	Evolvulus alsinoides	11 11 1 1 1 1
69	Indigofera capitata	1 1 1 1 11 1 1
70	Cassia mimosoides	1 1 1 1 43 2
71	Vitex doniana	1 1 1 1 11 1
72	Trichilia emetica	1 1 1 1 1 1 1
73	Blepharis linariifolia	1 1 1 2 21 1
74	Prosopis africana	11 1 1 3 1 1
75	Schwenckia americana	1 2 12 21 1
76	Vernonia glaberrima	1 2 1 1 1 1
77	Opilia celtidifolia	1 11 1 1 1
78	Combretum molle	12 1 2 33
79	Grewia mollis	1 1 1 1 1 1
80	Stereospermum kunthianum	1 111 1 1
81	Schizachyrium sanguineum	2 3 1 3 2
82	Fadogia agrestis	1 1 1 1 4
83	Gardenia ternifolia	1 1 2 1 1
84	Hymenocardia acida	1 1 1 2 2
85	Alysicarpus glumaceus	1 1 11
86	Crotalaria retusa	2 212
87	Desmodium barbatum	1 2 1 1
88	Terminalia laxiflora	1 1 1 2
89	Vitex simplicifolia	1 1 1 1
90	Strychnos innocua	1 1 1
91	Schizachyrium exile	1 2 15
92	Trachypogon spicatus	421 1
93	Heeria pulcherrima	1 1 11
94	Eriosema psoraleoides	1 1 1 2
95	Tridax procumbens	1 121
96	Tephrosia linearia	3 1 2 1
97	Zornia glochidiata	12 12
98	Sida linifolia	11 2 1
99	Panicum baumanii	12 1
100	Beckeropsis uniseta	1 1 1
101	Buchnera hispida	2 1 1
102	Loudetia simplex	3 5 3
103	Cissus rufescens	1 1 1
104	Burkea africana	12 1
105	Maerua angolensis	1 1 1
106	Setaria anceps	2 2 1
107	Centella asiatica	6 31
108	Acacia sieberiana	1 1 1
109	Sphaerathus senegalensis	1 23
110	Eragrostis turgida	2 1 1
111	Leucas martinicensis	1 2 2
112	Clerodendron capitata	1 4 1
113	Polygala petitiana	1 1 1
114	Uapaca togoensis	1 1
115	Pavetta glaucescens	1 1
116	Aristida adacensionis	1 1
117	Pterocarpus erinaceus	1 1
118	Crossopteryx febrifuga	1 1
119	Aloe barteri	1 1
120	Maytenus senegalensis	1 1
121	Cassia nigricans	11
122	Hyperthelia dissoluta	2 1
123	Hygrophila auriculata	1 2
124	Ipomoea argentaurata	1 1
125	Oldenlandia herbacea	1 1
126	Terminalia glaucescens	1 1
127	Crotalaria senegalensis	1 1
128	Dactyloctenium aegyptium	1 4
129	Tephrosia pedicellata	11
130	Ipomoea aquatica	1 1
131	Euphorbia hirta	1 1 41
132	Oryza longistaminata	1 1
133	Feretia apodanthera	1 1
134	Vernonia perrottetii	1 1
135	Indigofera secundiflora	1
136	Setaria pallide-fusca	2 1

No.	Species	
01	Borretia radiata	2 34221 233121111231223533513 3 41 1 22142312611 1 3 3 14 522223113212 22112 1
02	Andropogon gayanus	3347411 43 12 3 322154377 2862142231 11 4 25 56644 4 3533221122113 1653
03	Eragrostis turgida	236542615857 6 122548438916711 27241124844 22 2 324277223 36 6 1 1
04	Dyschoriste perrottetii	7445443262676234374855885786664354 6 23 22 2 2332 6 4 11 6 388684 2
05	Kaempferia aethiopica	1 111 1112421 1 11 221112111 111 121212 2 23 3222121223121511 41 231
06	Stylosanthes mucronata	1 114 2 2 4221 2112 2 33213542 431762323234 12 1 2 1232 2 111 1 11 2 1 23
07	Digitaria lecardii	2222 2 122231233222 2 1 3133323131 2 22323221 4322222132123 31
08	Dichrostachys glomerata	534231534 2 4 1212 1 521 32 31711 1 1 311 114 12 1 432231611 3332 14
09	Zornia glochidiata	211736 2654341 7 186 22213453 88253262431 2 4 326654 11 22 1 2 43
10	Cassia mimosoides	1311121 1121 211 1 13 2222 2 12112111111 1 1 1 2 22 2 1 11 2 1 111
11	Cochlospermum tinctorium	4 13 3 4 71 1 1111 11 1 35 332 2222 23431 36 3 33222 1 221 11 21
12	Terminalia avicennioides	12 32 1 113 531 321121 2122154 12 42 13 214124 1 1111 11
13	Stylochiton lancifolius	11 11221 1 11331 123 111211221 4232 321 12 111 1 11 133
14	Microchloa indica	22 4 484 7344 332 6 3122214326 244 53831732 5 22798
15	Digitaria gayana	21 324643 365336 6 4475443 2 4 12 32 2 62 213
16	Blepharis linariifolia	2 2122221 1 43 213313212 1 41 2 2 4 2 1 1 11 1 1
17	Monotes kerstingii	1 1 1 1 21 2251 211 4 1223224 1 43 7 1324467
18	Isoberlinia tomentosa	45 5 1 1 3 4 5 61 24 415 2 425 46182 3 2 31242 1
19	Elionurus pobeguinii	3 22 1 1 11 2 4 2234 21 163 44 22444 3 21 346
20	Isoberlinia doka	3422 5 441 5 1 3 3 1 231 1 2 1 11 13 2 1 1 32 6 2
21	Pennisetum pedicellatum	1 1 2 1322 2 11 12 2 1 1 2 2 111 21222 1221
22	Brachiaria stigmatisata	11 1 2 5 1 2 6 1 2135193 26 2 1 5 3 1 2 2 11
23	Aspilia africana	1 1 1 211 1 3 12 33 2 23223 1 3132 1 2 2
24	Andropogon schirensis	5 242 4 12 246 3451 623 1 6 4 4246 6
25	Guttenbergia nigritana	1 1211 3 12 22 3 22 3 2 42222 2222
26	Brachiaria jubata	2 3 1 111 1 2 1 2 2313 1 2334 2 332 1
27	Fimbristylis pilosa	5 2 3 13321 32322 26 4223 3 122 2
28	Ctenium newtonii	2 2 2 2 2 3 4 25 21 24231 2 22 1 331
29	Tephrosia pedicellata	11 1 1 1 25 16 1 1 1 1 2 333 342 2 1
30	Detarium microcarpum	2 11 11 121111 1 111 213 47634
31	Asparagus africanus	1 11 1 1 1 1 11 1 2 11 1 2 2 1 1 2 1 11
32	Lippia chevalieri	12 1 3 1 1111 32 2 23 311 2 1 211
33	Panicum maximum	1 6 2 1 3 43643 2 21 15 4122347
34	Sporobolus pyramidalis	1 23 21 263 222 4 56 2 3 2396 2
35	Urginea altissima	2 11 1 11 1 1 1 2 212 11 31 1114
36	Schizachyrium sanguineum	2 325 12 4 2 1111 123 3 12 3 1
37	Waltheria indica	1 1 1 1 21 2 2 112 12 232132
38	Pandiaka heudelotii	1 1 2 114121 2 2 2332 1 1
39	Vernonia perrottetii	211 124 11 1 1 21 1 22 2
40	Gladiolus gregarius	1 1 11111 1 1 111 1 2 1
41	Monocymbium ceresiiforme	2 2 3 32226 1 2 3 4 5 2 133
42	Hyperthelia dissoluta	31321 22 2 2 2 42 2 23
43	Indigofera pulchra	2 34 22 11 2 1 111 12 1
44	Sida rhombifolia	1 1 11 12 1 1 11 1 221 1
45	Indigofera nummulariifolia	1 1 21 11 5 2 4 2 41 1 2
46	Sporobolus festivus	3 2 153 34 1 13 2 1 21
47	Costus spectabilis	2 1 111 11 1 1 1 3 1 1 3
48	Commiphora africana	424 142 11 4121 71
49	Strychnos spinosa	111 1 1 11 1 11 1 2 1
50	Swartzia madagascariensis	2 2 123 21 22 1 1 1 2
51	Annona senegalensis	1 1 1 2 1 2 1 2112 1
52	Piliostigma thonningii	2 111 11 1 1 1141 1
53	Gardenia erubescens	1 12 11 1 2 1 1 1 11 1
54	Ximenia americana	1 11 1 11 11 11 1 1
55	Evolvulus alsinoides	11 1 11 1 2 11 1 1 1
56	Curculigo pilosa	1 1 1 11 1 1 32 11
57	Combretum molle	3 2 11 3 11 1 3 1 1 1
58	Lepidagathis collina	2 1 1 1 11 3 1 1 1 1 2
59	Cassia nigricans	1 113 2 112 1 1 1
60	Lannea barteri	1 1 1 1 1 1 1 1 2 1 1
61	Gardenia aqualla	1 1 11 1 11 1 1 1
62	Loudetia simplex	2 656 234882
63	Ochna afzelii	1 1 11 1 2 1 1 1 1
64	Butyrospermum paradoxum	1 1 1 11 1 1 1 1 1
65	Cryptolepis sanguinolenta	1 1 11 1 11111
66	Paspalum orbiculare	2 2 1 225 22 1
67	Anogeissus leiocarpus	3 1512 1 1 1 1
68	Fadogia agrestis	1 1 111 1 1 2 3
69	Fimbristylis ovata	1 12 1 3 252 4
70	Pavetta glaucescens	1 11 1 1 1 1 1 1
71	Combretum ghasalense	11 1 11 1 1 1
72	Monechma ciliatum	1 1 1 1 2 2 1 2
73	Fimbristylis hispidula	1 2 1 2 1 2 24
74	Sida linifolia	1 1 2 1 11 2
75	Urelytrum muricatum	1 3 1 1 1 2 2
76	Vernonia glaberrima	1 2 1 2 13 2
77	Diospyros mespiliformis	1 1 1 1 1 1 1 1
78	Stereospermum kunthianum	211 1 1 1
79	Dactyloctenium aegyptium	121 3 1 2
80	Bidens pilosa	2 1 1 1 1 1
81	Schizachyrium exile	5 2 4 4 32
82	Setaria anceps	1 1 31 43
83	Cissus rufescens	132 3 1 1
84	Lannea schimperi	11 12 1 1
85	Chloris lamproparia	3 3 8 2 1 1
86	Sida ovata	3 1 1 1 3
87	Feretia apodanthera	1 1 2 1 5 1
88	Terminalia laxiflora	3 11 1 1
89	Bridelia ferruginea	1 1 1 1 1
90	Vitex simplicifolia	1 1 1 1 1 1
91	Parinari curatellifolia	1 1 1 1 1
92	Aloe barteri	11 11
93	Setaria pallidefusca	1 2 2 1
94	Jacquemontia tamnifolia	1 1 1 1 3
95	Tephrosia bracteolata	11 1
96	Crotalaria senegalensis	1 3 1 2
97	Hackelochloa granularis	1 1 1 1 1
98	Lannea acida	1 1 1 1
99	Chrysanthellum americanum	3 3 1 1
100	Hypoxis angustifolia	11 1 1
101	Entada africana	1 1 1 1
102	Polygala petitiana	11 1 1 21 1
103	Hymenocardia acida	1 1
104	Adenodelichos paniculatus	1 1 1 1
105	Tacca involucrata	1 1 1
106	Biophytum petersianum	1 1 1
107	Striga asiatica	2 31
108	Burkea africana	1 1 1
109	Khaya senegalensis	1 1 1
110	Grewia mollis	1 1 1
111	Pterocarpus erinaceus	1 1 1
112	Cassia sieberiana	2 1 1
113	Aristida adscensionis	321
114	Afrormosia laxiflora	1 1 1
115	Crotalaria glauca	1 1 1 1
116	Tephrosia purpurea	1 1
117	Tephrosia linearis	11
118	Parkia clappertoniana	1 1
119	Maerua angolensis	1 1 1
120	Tamarindus indica	1 1
121	Cassia singueana	11
122	Pseudocedrella kotschyi	1 1
123	Gardenia ternifolia	1 1
124	Albizzia chevalieri	1 3
125	Securidaca logipedunculata	1 1
126	Dioscorea bulbifera	1 1
127	Cissus araliolides	1 1

SYNTHETIZED SYNOPTIC FLORISTIC RAW DATA MATRIX XI: GUGA PLANTATION RESERVES AND ENCLAVES

Species with absolute constancy of one are omitted in the 60 quadrats.

No.	Species
01	Isoberlinia doka
02	Pennisetum pedicellatum
03	Andropogon gayanus
04	Borreria radiata
05	Alysicarpus glumaceus
06	Annona senegalensis
07	Butyrospermum paradoxum
08	Andropogon pseudapricus
09	Monotes kerstingii
10	Panicum maximum
11	Lepidagathis collina
12	Adenodelichos paniculatus
13	Monocymbium ceresiiformis
14	Daniellia oliveri
15	Piliostigma thonningii
16	Terminalia laxiflora
17	Cassia mimosoides
18	Vernonia ambigua
19	Parinari curatellifolia
20	Ctenium newtonii
21	Cymbopogon giganteus
22	Uapaca togoensis
23	Afromorsia laxiflora
24	Elionurus pobeguinii
25	Ximenia americana
26	Aspilia africana
27	Strychnos spinosa
28	Isoberlinia tomentosa
29	Pterocarpus erinaceus
30	Loudetia simplex
31	Parkia clappertoniana
32	Hyptis spectigera
33	Lactuca glandulifera
34	Ageratum conyzoides
35	Hyparrhenia rufa
36	Prosopis africana
37	Pavetta glaucescens
38	Leucas martinicensis
39	Detarium microcarpum
40	Imperata cylindrica
41	Beckeropsis uniseta
42	Vernonia pauciflora
43	Bridelia ferruginea
44	Entada africana
45	Ochna rhizomatosa
46	Scoparia dulcis
47	Paspalum orbiculare
48	Jacquemontia tamnifolia
49	Schwenckia americana
50	Mitracarpus scaber
51	Eriosema griseum
52	Crossopteryx febrifuga
53	Vernonia glaberrima
54	Dichrostachys glomerata
55	Psorospermum corymbiferum
56	Polygala petitiana
57	Swartzia madagascariensis
58	Terminalia avicennioides
59	Gardenia aqualla
60	Vitex doniana
61	Gardenia erubescens
62	Tridax procumbens
63	Vernonia perrottetii
64	Ficus capensis
65	Combretum ghasalense
66	Pandiaka heudelotii
67	Cussonia barteri
68	Nauclea latifolia
69	Lophira lanceolata
70	Eragrostis ciliaris
71	Trichilia emetica
72	Monechma ciliatum
73	Vernonia cocephala
74	Lannea schimperi
75	Hyparrhenia cyanescens
76	Nelsonia canescens
77	Echinops longifolius
78	Grewia mollis
79	Hyparrhenia involucrata
80	Oldenlandia herbacea
81	Stereospermum kunthianum
82	Syzygium guineensis
83	Ochna afzelii
84	Indigofera capitata
85	Schizachyrium sanguineum
86	Combretum molle
87	Terminalia glaucescens
88	Crotalaria senegalensis
89	Striga senegalensis
90	Loudetia togoensis
91	Aeschynomene indica
92	Mitragyna inermis
93	Guizotia scabra
94	Jussiaea suffruticosa
95	Hymenocardia acida
96	Ficus congensis
97	Securinega virosa
98	Afzelia africana
99	Diospyros mespiliformis
100	Asparagus africanus
101	Ficus platyphylla
102	Cryptolepis sanguinolenta
103	Vernonia nigritana
104	Byroscarpus coccineus
105	Panicum baumannii
106	Pseudocedrela kotschyi
107	Gardenia ternifolia
108	Strychnos innocua
109	Rottboellia exaltata
110	Harrnoa undulata
111	Eriosema psoraleoides
112	Beckeropsis uniseta
113	Urelytrum muricatum
114	Tephrosia bractolata
115	Khaya senegalensis
116	Ficus sp.
117	Sesbania sesbans
118	Tamarindus indica
119	Bacopa floribunda
120	Indigofera charlieriana
121	Euphorbia hirta
122	Chloris pilosa
123	Mangifera indica
124	Lannea kerstingii
125	Cassia tora
126	Sphaeranthus senegalensis
127	Securidaca longepedunculata
128	Microchloa indica
129	Protea elliottii
130	Acacia sieberiana
131	Fadogia agrestis
132	Oxytenanthera abyssinica

Field Quadrat No.:	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	40	41	42	43	44	45
Vegn. Comptn. No.:	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
Auger Depth (in.):	12	24	12	3	3	18	3	30	12	18	24	30	30	30	18	24	3	3	3	30	30	30	30	3	30	30	3	3	30	3	3	24	30	30	30	30
Auger Depth (cm.):	30.5	61	30.5	7.6	7.6	45.7	7.6	76	30.5	45.7	61	76	76	76	45.7	61	7.6	7.6	7.6	76	76	76	76	7.6	76	76	7.6	7.6	76	7.6	7.6	61	76	76	76	76
Clay (L.T. 0.002mm) %:	28	22	22	16	8	6	4	8	30	28	2	28	10	0	4	6	4	4	14	6	6	8	14	14	4	6	10	10	4	2	6	8	10	6	0	4
Silt (0.002 - 0.05mm) %:	40	44	46	52	50	56	56	46	34	38	30	38	32	30	34	38	20	54	48	48	40	48	44	50	34	38	32	46	36	42	38	46	52	46	40	32
Sand (0.05 - 2.0mm) %:	32	34	32	32	42	38	40	46	36	34	68	34	58	70	62	56	76	42	38	46	54	44	32	36	62	56	58	44	60	56	56	46	38	48	60	64
Stone (G.T. 2.0mm) %:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pH (H_2O):	5.7	5.4	5.2	6.2	5.8	5.6	5.3	5.0	4.9	5.0	5.1	4.7	5.3	5.4	5.2	5.2	5.3	5.0	4.8	4.4	4.8	4.7	4.4	5.2	5.4	5.3	5.5	5.4	5.6	6.8	5.7	5.8	5.3	5.6	6.5	6.1
Organic Carbon %:	1.4	1.1	.67	.94	.62	.21	.50	1.2	1.3	1.5	.55	1.5	.57	.42	1.5	1.2	.84	.64	.66	.58	.47	.60	.92	.67	.55	.83	.23	.71	.35	.94	.80	.63	2.0	3.0	.51	.52
Na (meq/100 g):	.13	.08	.06	.06	.04	.05	.11	.02	.05	.07	.02	.06	.07	.03	.03	.03	.04	.04	.05	.04	.03	.04	.05	.06	.03	.03	.08	.05	.12	.04	.03	.20	.17	.09	.08	.05
K (meq/100 g):	.27	.16	.17	.13	.17	.10	.12	.12	.17	.17	.08	.02	.09	.08	.10	.11	.17	.10	.11	.10	.09	.09	.12	.17	.11	.09	.13	.16	.14	1.1	.17	.17	.23	.25	.18	.23
Ca @ Mg (meq/100 g):	9.56	3.20	2.32	3.40	2.72	1.68	1.24	.94	1.80	1.76	1.00	2.08	1.28	0.56	1.00	.80	1.28	3.12	1.84	.80	1.12	1.44	1.36	2.04	2.84	1.84	2.56	3.04	2.00	3.52	2.20	2.04	2.80	2.08	2.08	0.96
Total meq/100 g soil:	9.9	3.44	2.55	3.59	2.93	1.83	1.47	1.08	2.02	2.00	1.10	2.34	1.44	0.67	1.13	.94	1.49	3.26	2.00	.94	1.24	1.57	1.53	2.27	2.98	1.96	2.77	3.25	2.26	3.67	2.40	2.41	3.20	2.42	2.34	1.24
C.E.C. (meq/100 g):	10.9	8.0	8.3	5.9	7.8	7.1	6.1	6.5	8.9	11.3	6.1	8.2	9.2	4.4	7.8	5.0	6.3	6.8	9.0	7.4	7.1	7.3	8.0	7.5	4.6	6.5	5.4	6.6	5.9	6.1	5.7	6.8	7.3	7.9	5.8	5.9
Base Saturation %:	90	43	31	61	35	26	24	17	23	18	18	29	16	15	15	19	24	48	22	13	18	22	19	30	65	30	51	49	38	60	41	35	44	31	40	21

FADAMA1: Physico - chemical Analytic Data of Augered Soil Samples

Field Quadrat No.:	216B	217	218	219	220	221	222	223	224	225	226	227	228	229	230	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259
Vegn. Comptn. No.:	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
Auger Depth (in.):	30	30	30	12	30	24	24	30	30	30	30	30	30	30	30	30	30	18	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Auger Depth (cm.):	76	76	76	30.5	76	61	61	76	76	76	76	76	76	76	76	76	76	45.7	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76
Clay (L.T. 0.002mm) %:	4	14	22	10	16	24	6	14	14	20	20	12	6	10	4	18	10	24	24	26	10	22	12	14	18	26	18	14	8	4	4	6	6	6
Silt (0.002 - 0.05mm) %:	20	28	12	40	44	36	48	48	50	38	32	38	28	30	50	42	40	40	36	36	34	30	38	38	38	34	18	38	34	12	46	48	34	32
Sand (0.05 - 2.0mm) %;	76	58	66	50	40	40	46	36	36	42	48	50	66	60	46	40	50	36	4	38	56	48	47	48	44	40	64	48	58	74	50	46	60	62
Stone (G.T. 2.0mm) %:	22	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	13
pH (H_2O):	7.5	7.1	4.5	5.3	6.5	5.1	5.5	5.3	5.3	4.8	5.0	4.6	5.2	5.0	5.8	4.6	5.2	4.9	4.6	4.7	4.4	4.5	5.6	5.1	5.8	5.5	5.6	5.1	5.4	5.9	6.0	7.3	5.1	5.4
Organic Carbon %:	.62	.63	4.3	.52	1.0	.88	.45	.86	.63	.61	.56	.50	.48	.57	.66	.74	.54	1.1	.55	.55	1.8	1.9	1.1	.50	.27	1.3	.37	1.8	.60	.27	.65	.84	.64	.61
Na (meq/100 g):	.07	.05	.15	.05	.04	.06	.02	.06	.07	.07	.07	.07	.06	.02	.02	.04	.02	.03	.04	.03	.02	.04	.03	.06	.08	.07	.02	.03	.02	.05	.06	.04	.03	.03
K (meq/100 g):	.16	.15	.33	.08	.12	.12	.06	.07	.10	.12	.12	.14	.17	.10	.10	.13	.10	.15	.20	.11	.12	.21	.11	.12	.09	.16	.05	.13	.13	.12	.11	.26	.13	.11
Ca & Mg (meq/100 g):	6.72	5.04	4.20	2.24	6.48	3.44	1.16	2.00	1.76	2.24	2.24	1.72	1.44	1.36	0.84	1.40	1.76	2.48	1.36	1.44	0.64	1.88	1.44	1.08	1.60	0.92	1.60	0.80	1.40	0.64	1.68	4.92	0.64	2.12
Total meq/100 g soil):	6.95	5.24	4.68	2.37	6.64	3.62	1.24	2.13	1.93	2.43	2.43	1.93	1.67	1.48	0.96	1.57	1.88	2.66	1.60	1.58	0.78	2.13	1.58	1.26	1.77	1.15	1.67	0.96	1.55	0.81	1.85	5.22	0.80	2.26
C.E.C. (meq/100 g):	1.3	0.4	0.6	2.5	2.1	2.1	1.1	1.5	1.3	3.0	2.0	0.9	0.8	1.0	0.8	1.7	1.4	3.1	3.1	2.7	3.2	4.1	1.3	1.2	1.2	3.0	1.2	1.9	0.80	0.10	1.2	1.1	0.5	0.90
Base Saturation %:	100+	100+	100+	95	100+	100+	100+	100+	100+	81	100+	100+	100+	100+	100+	92	100+	86	52	59	24	52	100+	100+	100+	38	100+	51	100+	100+	100+	100+	100+	100+

DAMBO 2: Physico - chemical Analytic Data of Augered Soil Samples

d Quadrat No.:	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216A
. Comptn. No.:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
r Depth (in.):	12	12	12	12	12	30	30	18	30	12	24	30	12	12	30	36	18	18	30	24	18	30	18
r Depth (cm.):	30.5	30.5	30.5	30.5	30.5	76	76	45.7	76	30.5	61	76	30.5	30.5	76	91.4	45.7	45.7	76	61	45.7	76	45.7
(L.T. 0.002mm) %:	4	12	4	4	6	4	4	6	4	4	4	4	6	4	4	14	38	26	14	14	38	6	16
(0.002 - 0.05mm) %:	22	28	26	34	34	26	30	32	30	28	20	26	32	34	30	44	40	46	36	48	28	32	28
(0.05 - 2.0mm) %:	74	60	70	62	60	60	66	62	66	68	76	70	62	62	61	42	30	28	50	38	34	62	56
e (L.T. 2.0mm) %:	2	1	0	0	0	3	0	0	0	1	0	1	0	3	4	0	0	0	0	0	0	0	0
H_2O):	6.0	5.8	5.5	6.1	5.8	5.9	6.0	5.9	5.8	6.2	6.2	6.6	5.9	6.1	5.2	5.5	5.3	5.2	5.2	6.8	4.9	4.9	4.9
nic Carbon %:	.39	.29	.22	.24	.28	.25	.28	.39	.32	.40	.43	.34	.30	.30	.32	.88	1.1	.72	.43	.22	1.3	.46	.66
meq/100 g):	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.03	.02	.02	.02	.02	.07	.04	.03	.02	.03	.04	.02	.04
eq/100 g):	.13	.08	.21	.14	.10	.07	.09	.09	.10	.12	.21.	.15	.12	.11	.08	.12	.18	.10	.09	.24	.16	.07	.10
Mg (meq/100 g):	1.48	2.96	1.80	0.96	1.40	0.96	0.96	0.84	0.88	1.44	2.64	1.76	1.96	1.36	0.64	2.52	2.60	2.20	1.04	1.32	3.32	0.72	2.0
l meq/100 g soil:	1.63	3.06	2.03	1.12	1.52	1.05	1.07	0.95	1.00	1.58	2.88	1.93	2.10	1.49	0.74	2.71	2.82	2.33	1.15	1.59	3.52	0.81	2.14
C. (meq/100 g):	.5	2.0	.9	.6	1.0	0.6	1.0	0.6	0.6	0.7	0.7	0.6	0.3	1.3	1.6	3.2	4.0	3.3	2.1	1.2	3.6	0.6	2.4
Saturation %:	100+	100+	100+	100+	87	100+	100+	100+	100+	100+	100+	100+	100+	100+	46	85	71	71	55	100+	98	100+	89

4: Physico - chemical Analytic Data of Augered Soil Samples

	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	
	3	3	12	3	3	30	30	30	30	30	30	12	30	30	3	12	12	30	30	3	30	12	3	24	24	18	12	3	12	12	
6	7.6	7.6	30.5	7.6	7.6	76	76	76	76	76	76	30.5	76	76	7.6	30.5	30.5	76	76	7.6	76	30.5	7.6	61	61	45.7	30.5	7.6	30.5	30.5	
	4	4	30	4	18	18	12	18	24	26	14	24	0	4	4	6	16	14	4	0	14	22	18	26	22	26	14	12	12	4	
	24	36	24	28	40	36	50	36	36	34	30	38	32	46	18	32	24	34	26	16	40	36	34	32	30	32	38	32	22	26	
	72	60	48	68	42	46	48	46	40	40	56	38	68	50	78	62	60	52	70	84	46	48	48	42	48	42	48	56	66	70	
	12	3	0	10	0	0	0	0	0	3	5	0	3	1	2	7	0	4	6	16	0	0	0	0	0	0	0	15	29	9	
0	5.7	7.0	5.4	5.6	4.8	5.	4.9	5.1	5.0	5.2	5.0	5.1	5.7	5.6	6.3	5.7	6.0	5.5	6.9	6.6	5.0	6.0	6.1	5.7	5.6	6.0	6.0	5.7	6.0	5.9	
3	1.1	1.7	5.5	1.2	1.4	1.	1.0	1.4	1.4	2.0	1.1	.82	.31	.23	.24	.44	.33	1.2	.64	2.5	.54	.61	.22	.31	1.1	.35	1.4	.49	.49	.67	
5	.03	.07	.06	.03	.09	.1	.04	.07	.06	.08	.07	.07	.04	.03	.03	.03	.03	.08	.03	.14	.03	.05	.06	.05	.04	.04	.03	.04	.02	.02	
6	.14	.41	.70	.23	.28	.1	.12	.15	.30	.29	.20	.15	.08	.08	.09	.20	.15	.30	.10	.28	.16	.35	.18	.23	.25	.15	.20	.11	.12	.19	
18	2.56	10.6	7.08	2.88	2.48	3.	0.24	2.96	2.08	2.28	1.52	2.64	1.20	1.56	1.68	2.36	2.96	1.44	2.52	1.56	2.52	2.68	2.40	1.84	3.16	2.72	3.16	1.64	1.56	.96	
6	2.73	11.1	7.84	3.14	2.85	3.	0.40	3.18	2.44	2.65	1.79	2.83	1.32	1.67	1.80	2.59	3.14	1.82	2.65	1.98	2.71	3.08	2.64	2.12	3.45	2.91	3.39	1.75	1.70	1.17	
	9.4	8.5	15.7	8.0	11.5	10	8.3	8.8	5.4	5.7	2.8	3.7	2.6	1.8	2.2	2.5	2.0	3.1	2.9	4.5	2.96	6.0	2.5	7.2	3.5	8.7	3.2	1.7	2.2	1.5	
	29	100+	50	39	25	32	5	36	45	46	64	76	50	93	82	100+	100+	58	91	44	93	51	100	29	99	34	100	100	77	78	

Field Quadrat No.:	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73
Vegn. Comptn. No.:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Auger Depth (in.):	6	6	6	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	6	3	3	3	12	3
Auger Depth (cm.):	15.3	15.3	15.3	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	15.3	7.6	7.6	7.6	30.5	7.6
Clay (L.T. 0.002mm) %:	20	8	10	6	12	6	18	16	6	4	2	10	10	4	2	2	0	8	4	4	4	4	30	4
Silt (0.002 - 0.5mm) %:	20	26	36	38	38	32	30	26	36	36	24	40	30	34	36	36	36	26	28	26	24	36	24	28
Sand (0.05 - 2.0mm) %:	60	68	54	56	51	62	52	58	58	60	74	50	60	62	62	62	64	66	68	70	72	60	48	68
Stone (G.T. 2.0mm) %:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	10	20	26	12	3	0	10
pH (H_2O):	5.7	5.5	5.8	5.4	5.7	5.9	5.3	5.6	5.9	5.8	6.6	6.0	5.7	6.0	5.6	5.9	5.6	5.1	5.5	6.0	5.7	7.0	5.4	5.6
Organic Carbon %:	.64	1.4	.55	.60	2.0	.68	.98	.61	1.3	1.3	1.2	1.7	.42	.96	.67	1.0	.80	.90	1.2	1.3	1.1	1.7	5.5	1.2
Na (meq/100 g):	.02	.02	.02	.02	.03	.03	.03	.03	.04	.03	.04	.04	.04	.04	.03	.03	.02	.02	.03	.03	.03	.07	.06	.03
K (meq/100 g):	.15	.18	.19	.22	.31	.23	.26	.19	.19	.19	.23	.18	.19	.23	.13	.17	.14	.19	.15	.15	.14	.41	.70	.23
Ca & Mg (meq/100 g):	1.36	0.96	1.36	1.00	2.80	1.64	3.12	2.72	3.20	2.28	4.28	3.64	2.20	3.08	1.08	2.16	1.12	3.64	3.96	2.88	2.56	10.6	7.08	2.88
Total meq/100 g soil:	1.53	1.16	1.57	1.24	3.14	1.90	3.41	2.94	3.43	2.50	4.59	3.86	2.43	3.35	1.24	2.35	1.28	3.85	4.14	3.06	2.73	11.1	7.84	3.14
C.E.C. (meq/100 g):	2.2	2.3	1.7	1.6	1.1	1.7	2.3	1.8	2.7	2.3	2.3	2.7	2.0	2.4	8.1	8.4	9.3	9.0	10.0	8.9	9.4	8.5	15.7	8.0
Base Saturation %:	70	50	92	78	100	100	100	100	100	100	100	100	100	100	15	28	14	43	41	34	29	100+	50	39

UPLAND 5: Physico - chemical Analytic Data of Augered Soil Samples

3	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	371	372	373	374	375	376	377	378	379
	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
	30	30	30	6	30	30	6	6	6	30	30	12	30	6	24	30	6	18	30	30	30	30	12	30	30	30	30
	76	76	76	15.2	76	76	15.2	15.2	15.2	76	76	30.5	76	15.2	61	76	15.2	45.7	76	76	76	76	30.5	76	76	76	76
	8	10	26	10	26	14	6	10	10	4	10	6	8	6	6	14	4	10	8	8	24	6	22	8	24	30	12
	36	34	28	38	24	34	30	30	28	26	16	22	18	20	28	24	26	24	44	34	34	32	28	18	32	26	38
	56	56	46	52	50	52	64	60	62	70	74	72	74	74	66	62	70	66	48	58	42	62	50	74	44	44	50
	0	0	0	0	0	0	0	2	0	0	3	0	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0
5	6.0	5.7	5.6	5.8	5.6	5.3	6.1	5.7	6.3	5.7	6.1	5.8	5.9	5.6	5.9	5.8	5.2	5.3	5.8	5.5	6.0	5.6	5.4	6.0	5.6	5.8	6.1
6	.27	.61	.25	1.2	.51	.47	.61	.94	.54	.43	.52	.58	.64	.57	.78	.62	.54	.44	.90	.64	1.3	.46	.34	.57	.32	.23	.98
2	.02	.02	.02	.03	.02	.02	.02	.02	.09	.02	.02	.02	.02	.02	.02	.02	.02	.02	.03	.02	.03	.02	.02	.02	.02	.02	.04
9	.14	.11	.11	.10	.28	.14	.10	.10	.17	.07	.09	.12	.15	.07	.08	.06	.07	.09	.17	.06	.10	.11	.04	.12	.10	.11	.20
92	1.76	1.44	1.24	2.60	2.08	1.92	1.76	1.68	2.64	0.96	1.60	1.32	2.04	1.36	1.96	1.44	1.44	1.52	3.40	1.72	3.36	2.00	1.20	1.52	3.56	1.92	4.36
23	1.92	1.59	1.37	2.73	2.38	2.08	1.88	1.80	2.90	1.05	1.71	1.46	2.21	1.45	2.06	1.52	1.53	1.63	3.60	1.80	3.49	2.13	1.26	1.66	3.68	2.05	4.60
3	14	12.0	*	2.8	2.6	4.4	10.7	1.8	1.5	2.7	3.9	2.8	1.6	2.0	2.1	7.8	1.2	1.6	3.0	2.4	2.9	1.9	3.3	2.6	3.5	3.1	5.2
	100+	13	*	98	92	47	18	100	100+	39	44	52	100+	73	78	19	100+	100+	100+	75	100+	100+	38	64	100+	66	88

314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342
5	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
4	30	30	30	30	30	18	6	18	30	12	6	12	18	18	30	30	30	12	30	24	30	18	30	30	24	30	30	30
1	76	76	76	76	76	45.7	15.2	45.7	76	30.5	15.2	30.5	45.7	45.7	76	76	76	30.5	76	61	76	45.7	76	76	61	76	76	76
	8	4	4	30	6	34	14	4	30	26	16	8	14	4	20	32	30	32	26	18	22	28	22	26	20	4	4	14
6	34	20	36	34	38	24	10	22	22	22	26	16	26	22	26	28	22	28	28	22	38	28	18	24	18	26	30	30
6	60	76	60	36	56	42	76	74	48	52	56	76	60	74	54	40	48	40	46	60	40	44	60	50	62	70	66	56
	0	0	0	0	0	3	6	0	0	2	25	1	0	0	9	0	0	0	0	0	0	0	0	0	0	1	0	0
.7	6.6	6.1	5.5	5.8	5.7	6.2	6.5	6.0	5.7	5.9	5.4	5.9	6.0	5.7	5.4	5.7	5.9	6.1	5.6	5.6	5.8	5.9	6.0	5.8	6.5	6.0	5.6	6.2
47	.62	.51	.32	.18	.46	.21	.36	.43	.29	.14	.35	.58	.27	.56	.28	.15	.21	.18	.39	.28	.20	.19	.26	.18	.22	.34	.35	.40
02	.02	.02	.02	.02	.02	.02	.02	.02	.03	.03	.02	.02	.03	.02	.02	.02	.03	.03	.04	.03	.03	.03	.03	.02	.02	.02	.02	.02
13	.16	.19	.05	.08	.13	.15	.06	.09	.06	.11	.08	.06	.08	.16	.08	.12	.17	.18	.13	.08	.15	.11	.16	.15	.09	.12	.11	.13
.72	2.20	1.56	1.20	3.00	1.20	2.12	2.08	0.80	1.36	2.96	2.88	1.16	2.40	1.96	1.40	2.80	4.28	4.88	2.40	1.64	2.92	3.44	4.60	3.08	2.40	1.28	1.24	1.12
.87	2.38	1.77	1.27	3.10	1.35	2.29	2.16	0.91	1.45	3.10	2.98	1.24	2.51	2.14	1.50	2.94	4.48	5.09	2.57	1.75	3.10	3.58	4.79	3.25	2.51	1.42	1.37	1.27
.4	2.2	2.5	2.3	4.5	4.1	5.4	3.2	2.7	4.2	4.9	3.3	5.2	2.6	3.4	8.3	3.3	4.1	5.7	6.8	3.9	2.3	3.9	3.3	9.7	2.5	1.7	0.3	2.6
8	100+	71	55	69	33	42	68	34	35	63	90	24	97	63	18	89	100+	89	38	45	100+	92	100+	34	100+	84	100+	49

11	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	3
2	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	5
8	24	24	18	18	18	30	18	24	18	30	18	12	18	6	24	6	6	24	12	30	24	18	6	18	12	12	12	24	24	18	3
6.7	61	61	45.7	45.7	45.7	76	45.7	61	45.7	76	45.7	30.5	45.7	15.2	61	15.2	15.2	61	30.5	76	61	45.7	15.2	45.7	30.5	30.5	30.5	61	61	45.7	7
	10	6	6	4	4	8	6	8	10	10	8	6	26	8	18	*	*	4	4	8	4	4	4	6	6	10	4	8	10	6	6
5	20	38	24	26	22	22	24	30	22	34	34	28	12	34	16	*	*	26	26	22	20	22	40	34	34	30	20	32	30	26	3
0	70	56	70	70	74	70	70	62	68	56	58	66	62	58	56	*	*	70	70	70	76	74	56	60	60	60	76	60	60	68	6
	0	0	2	1	0	2	2	4	4	0	2	2	3	4	2	*	*	6	5	2	2	16	6	2	2	2	2	0	0	0	0
.1	6.1	6.0	5.8	5.8	5.7	6.1	5.7	5.5	5.6	5.0	5.5	6.0	6.0	5.8	5.6	*	*	6.0	5.9	5.7	6.0	5.9	6.0	5.6	5.8	5.7	5.8	5.3	5.1	5.6	
48	.57	.61	.53	.46	.33	.42	.65	1.1	.37	.53	.90	.46	.52	1.0	.71	*	*	.66	.70	.60	.61	.66	.65	.85	.60	.66	.64	.38	.38	.42	
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.03	.02	.02	.02	.02	*	*	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	
.08	.12	.11	.09	.06	.08	.21	.21	.15	.08	.09	.08	.05	.15	.09	.09	*	*	.09	.11	.10	.12	.09	.08	.12	.12	.09	.07	.09	.06	.10	
0.92	1.56	1.68	1.50	1.04	1.44	2.60	1.68	2.20	0.56	1.96	0.68	0.32	1.20	1.76	1.04	*	*	1.84	2.16	2.00	1.68	1.20	1.44	1.28	1.76	2.24	1.28	0.96	0.72	1.44	
1.02	1.70	1.81	1.71	1.12	1.54	2.83	1.82	2.37	0.66	2.07	0.79	0.39	1.37	1.87	1.15	*	*	1.95	2.29	3.12	1.82	1.31	1.54	1.42	1.90	2.35	1.37	1.07	0.80	1.56	
.4	6.5	1.7	8.5	1.6	3.1	3.9	2.7	4.4	2.6	3.5	2.7	1.6	2.5	2.6	6.7	*	*	4.0	2.7	1.9	6.7	1.3	4.6	3.0	2.4	6.3	2.1	2.0	2.4	1.7	
23	26	100+	20	70	50	73	67	54	25	59	29	24	55	72	17	*	*	49	85	100+	27	100	33	47	79	37	65	54	33	92	

Field Quadrat No.:	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283
Vegn. Comptn. No.:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Auger Depth (in.):	3	30	18	24	30	30	18	18	30	30	30	30	30	30	18	30	24	18	6	24	18	18	24	24
Auger Depth (cm.):	7.6	76	45.7	61	76	76	45.7	45.7	76	76	76	76	76	76	45.7	76	61	45.7	15.2	61	45.7	45.7	61	61
Clay (L.T. 0.002mm) %:	12	18	4	4	8	4	10	4	8	8	4	6	4	8	8	24	4	16	8	14	4	4	10	6
Silt (0.002 - 0.05mm) %:	14	24	24	24	22	36	30	34	30	30	30	26	26	24	30	26	18	32	32	30	30	26	20	38
Sand (0.05 - 2.0mm) %:	74	58	72	72	70	60	60	62	62	62	66	68	70	68	62	50	78	52	60	56	66	70	70	56
Stone (G.T. 2.0mm) %:	0	0	4	0	0	0	0	0	3	1	1	2	2	0	1	0	4	0	0	1	5	6	0	0
pH (H_2O):	5.6	5.8	4.7	5.5	5.4	5.7	5.6	5.7	5.3	5.5	5.4	5.7	6.0	6.1	6.7	6.1	6.5	6.1	6.3	6.2	6.2	6.1	6.1	6.0
Organic Carbon %:	2.4	.34	.43	.44	.63	.70	.37	.69	.38	.48	.43	.43	.63	.53	.61	.44	.23	.98	1.4	.66	.61	.48	.57	.61
Na (meq/100 g):	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
K (meq/100 g):	.21	.11	.10	.11	.13	.13	.14	.10	.06	.10	.09	.22	.13	.19	.11	.13	.08	.10	.15	.11	.08	.08	.12	.11
Ca & Mg (meq/100 g):	4.60	2.00	1.52	2.16	2.08	2.72	2.04	2.36	1.44	1.36	1.48	2.08	1.96	1.60	1.92	2.56	1.12	2.12	2.80	2.72	1.68	0.92	1.56	1.68
Total meq/100 g soil:	4.83	2.13	1.64	2.29	2.23	2.87	2.20	2.48	1.52	1.48	1.59	2.32	2.11	1.81	2.06	2.71	1.22	2.28	2.97	2.85	1.78	1.02	1.70	1.81
C.E.C. (meq/100 g):	2.6	6.3	.6	.5	1.5	.9	.8	.9	.3	.9	2.3	.9	1.4	3.1	2.4	2.8	.3	3.4	3.2	2.1	8.1	4.4	6.5	1.7
Base Saturation %:	100+	30	100+	100+	100+	100+	100+	100+	100+	100+	69	100+	100+	58	88	97	100+	67	93	100+	22	23	26	100+

PLAINS 6: Physico - chemical Analytic Data of Augered Soil Samples

537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562A	562B	563	564	565	5
22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	5
6	24	6	6	18	3	18	12	3	3	6	3	30	18	30	18	6	6	3	6	12	3	3	6	6	6	*	*	*	*	*
15.2	61	15.2	15.2	45.7	7.6	45.7	30.5	7.6	7.6	15.2	7.6	76	45.7	76	45.7	15.2	15.2	7.6	15.2	30.5	7.6	7.6	15.2	15.2	15.2	*	*	*	*	*
6	6	6	24	4	4	8	8	6	6	10	6	10	6	6	6	20	4	10	4	4	4	6	10	4	14	*	*	*	*	*
24	20	24	20	20	38	20	32	28	24	30	34	34	24	32	20	40	34	20	22	22	36	56	20	44	32	*	*	*	*	*
70	74	70	56	76	58	72	60	66	70	60	60	56	70	62	74	40	62	70	74	74	60	38	70	52	54	*	*	*	*	*
0	3	1	0	6	2	32	5	0	35	2	1	1	0	1	1	0	0	42	0	15	0	0	15	1	12	*	*	*	*	*
5.7	5.8	5.6	5.3	5.1	5.7	5.2	5.2	4.8	5.2	6.0	5.5	6.5	6.4	7.2	5.9	5.8	5.5	5.2	4.6	7.0	6.8	5.1	4.3	5.1	5.4	*	*	*	*	*
3.4	1.2	3.8	.84	.90	2.9	2.6	5.0	*	2.2	4.3	4.1	2.5	2.9	2.8	2.8	.25	.65	.67	.52	2.2	*	*	2.0	.68	2.8	*	*	*	*	*
.04	.03	.04	.05	.02	.05	.03	.04	.04	.05	.05	.04	.04	.05	.06	.05	.05	.04	.06	.02	.08	.12	.10	.04	.03	.07	*	*	*	*	*
.22	.23	.24	.11	.08	.28	.12	.28	.32	.18	.26	.17	.17	.40	.25	.43	.17	.19	.31	.16	.50	.80	.65	.18	.19	.28	*	*	*	*	*
4.00	1.88	7.36	2.32	1.16	7.20	3.80	5.72	9.72	2.56	7.76	6.68	5.04	7.68	8.04	6.28	4.28	2.08	7.92	8.29	13.4	20.4	15.8	1.80	2.32	9.20	*	*	*	*	*
4.26	2.14	7.64	2.48	1.26	7.53	3.95	6.04	10.08	2.79	8.07	6.89	5.25	8.13	8.35	6.76	4.50	2.31	1.20	1.38	13.98	21.32	16.55	2.02	2.54	9.53	*	*	*	*	*
5.5	2.0	4.7	1.8	0.9	3.6	2.8	4.7	5.0	3.1	3.7	4.4	4.2	3.4	4.0	3.9	3.4	1.2	2.6	0.6	3.3	*	*	2.8	1.0	2.9	*	*	*	*	*
77	100+	100+	100+	100+	100+	100+	100+	100+	90	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	*	*	72	100+	100+	*	*	*	*	*

Field Quadrat No.:	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	5
Vegn. Comptn. No.:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	2
Auger Depth (in.):	3	6	3	6	6	6	6	6	6	3	3	12	6	6	6	6	6	6	3	3	3	6	24	6	6
Auger Depth (cm.):	7.6	15.2	7.6	15.2	15.2	15.2	15.2	15.2	15.2	7.6	7.6	30.5	15.2	15.2	15.2	15.2	15.2	15.2	7.6	7.6	7.6	15.2	61	15.2	1
Clay (L.T. 0.002mm) %:	26	6	10	8	4	6	4	4	6	10	4	6	6	10	10	6	6	4	4	6	4	6	6	6	2
Silt (0.002 - 0.05mm) %:	34	16	20	18	36	20	26	28	36	30	26	28	24	16	16	28	14	26	12	14	26	24	20	24	2
Sand (0.05 - 2.0mm) %:	40	78	70	74	60	74	70	68	58	60	70	66	70	74	74	66	80	70	84	80	70	70	74	70	5
Stone (G.T. 2.0mm) %:	0	13	7	30	0	22	11	3	13	7	17	8	11	21	25	3	15	10	32	15	0	0	3	1	0
pH (H_2O):	5.9	7.0	6.2	5.7	6.0	5.5	5.5	5.6	6.5	5.1	5.6	6.1	5.2	5.6	6.6	5.9	6.6	7.8	6.5	5.0	5.1	5.7	5.8	5.6	5
Organic Carbon %:	.07	2.4	2.9	2.4	5.9	1.4	2.4	1.3	3.4	3.4	4.6	2.2	2.8	2.4	2.4	5.5	2.2	2.6	2.7	1.3	1.1	3.4	1.2	3.8	.
Na (meq/100 g):	.06	.05	.05	.04	.06	.02	.03	.03	.05	.04	.06	.04	.02	.03	.05	.07	.04	.07	.05	.03	.03	.04	.03	.04	.
K (meq/100 g):	.15	.30	.24	.17	.10	.21	.15	.20	.36	.21	.31	.15	.13	.17	.16	.30	.23	.33	.26	.15	.13	.22	.23	.24	.
Ca @ Mg (meq/100 g):	1.20	7.60	9.08	6.08	10.0	3.16	4.60	9.84	6.08	10.9	6.16	1.76	2.36	6.40	7.12	12.6	4.16	11.1	7.36	1.60	1.52	4.00	1.88	7.36	2
Total meq/100 g soil:	1.41	7.95	9.37	6.29	10.16	3.39	4.88	10.07	6.49	11.15	6.53	1.95	2.51	6.60	7.33	12.97	4.43	11.5	7.67	1.78	1.68	4.26	2.14	7.64	2
C.E.C. (meq/100 g):	2.5	3.0	3.6	3.0	8.9	2.7	2.4	2.0	4.7	5.8	6.1	4.5	3.5	2.7	3.1	11.9	2.0	3.3	3.7	1.6	1.3	5.5	2.0	4.7	1
Base Saturation %:	56	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	43	72	100+	100+	100+	100+	100+	100+	100+	100+	77	100+	100+	1

ROCKY 7: Physico - chemical Analytic Data of Augered Soil Samples

456	457	458	459	460	461	462	463	464	465	466	467	468	469	470
86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
30	30	30	30	12	30	30	30	30	18	30	30	30	30	6
76	76	76	76	30.5	76	76	76	76	45.7	76	76	76	76	15.2
10	6	22	19	*	*	20	10	10						
44	44	34	44	*	*	20	50	40						
46	50	44	46	*	*	60	40	50						
0	0	0	0	*	*	0	7	0						
5.9	5.3	5.6	5.5	*	*	5.7	5.6	5.6						
0.49	0.61	0.21	0.72	*	*	0.15	0.61	0.15						
.04	.03	.03	.03	*	*	2.16	2.41	1.87						
.17	.15	.13	.17	*	*	.12	.16	.13						
1.28	2.28	2.44	1.08	*	*	2.16	2.41	1.87						
1.49	2.46	2.60	1.28	*	*	2.16	2.41	1.87						
1.0	1.1	1.7	1.7	*	*	1.5	1.4	0.9						
100+	100+	100+	75	*	*	100+	100+	100+						

31	432	433	434	435	436	437	438	439	450	441	442	443	444	445	446	447	448	449	450	451	452
1	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
0	18	6	30	12	18	18	12	30	12	30	24	24	30	30	30	24	6	30	30	30	30
6	45.7	15.2	76	30.5	45.7	45.7	30.5	76	30.5	76	61	61	76	76	76	61	15.2	76	76	76	76
8	30	30	14	18	30	20	20	10	16	14	26	26	30	30	16	14	26	*	6	10	16
0	24	30	26	26	20	30	30	40	36	36	28	32	30	30	34	36	30	*	24	48	28
2	46	40	60	56	50	50	50	50	48	50	46	42	40	40	50	50	44	*	70	42	56
)	0	0	0	0	2	0	4	0	0	0	0	0	0	0	0	0	0	*	0	0	0
5.6	5.9	5.4	6.5	5.1	5.8	5.8	5.6	5.7	5.5	6.2	5.4	5.7	5.8	5.8	6.2	5.7	5.7	*	5.6	5.2	5.7
.62	.25	0.28	1.1	0.35	0.30	0.35	0.33	0.46	0.33	0.64	0.42	0.29	0.26	0.21	0.33	0.98	0.30	*	0.47	0.61	0.92
.02	.03	.04	.03	.02	.04	.03	.03	.02	.04	.09	.04	.04	.05	.05	.05	.03	.03	*	.02	.03	.05
.15	.14	.14	.18	.08	.29	.19	.17	.17	.17	.28	.14	.13	.21	.22	.24	.17	.12	*	.11	.09	.19
2.48	3.60	3.12	3.28	1.76	4.84	3.80	2.44	1.76	2.88	6.96	3.48	2.92	4.32	5.32	2.88	2.80	2.16	*	1.52	1.44	4.3
2.65	3.77	3.30	3.49	1.86	5.17	4.08	2.44	1.95	3.09	7.33	3.66	3.09	4.58	5.59	3.17	3.00	2.31	*	1.65	1.56	4.5
2.8	3.7	3.2	2.9	2.1	4.2	2.8	1.4	1.8	2.3	4.8	1.8	3.8	3.6	9.1	2.8	3.2	4.3	*	1.65	1.56	4.5
95	100+	100+	100+	86	100+	100+	100+	100+	100+	100+	100+	81	100+	61	100+	94	54	*	83	74	100

411	412	423	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	43
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
30	12	18	30	30	30	30	30	24	30	30	30	30	24	18	24	18	30	12	18	30	18
76	30.5	45.7	76	76	76	76	76	61	76	76	76	76	61	45.7	61	45.7	76	30.5	45.7	76	45.
6	6	30	26	26	6	20	32	10	30	30	10	30	24	14	10	8	6	22	26	18	30
24	26	24	36	32	44	34	34	36	28	32	28	20	24	36	34	36	38	32	28	40	24
70	68	46	38	42	50	46	34	54	42	38	62	50	52	50	56	56	56	46	46	42	46
2	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
5.7	5.6	5.6	4.7	5.5	5.3	5.3	6.6	5.9	5.7	5.8	6.2	5.7	5.5	5.6	6.0	6.2	6.2	5.6	6.2	5.6	5.9
.40	.59	.29	.17	.23	.65	.86	.86	.73	.20	.19	.52	.24	.21	.62	1.1	.44	.36	.28	.36	.62	.25
.02	.02	.02	.02	.02	.02	.03	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.03	.03	.02	.03
.07	.10	.13	.10	.11	.09	.10	.17	.17	.10	.11	.08	.09	.10	.11	.19	.09	.09	.09	.18	.15	.14
1.40	1.36	2.40	3.28	2.40	1.56	2.00	4.48	2.32	2.96	3.20	1.72	2.88	3.36	2.24	3.56	1.60	1.56	3.80	4.68	2.48	3.6
1.49	1.48	2.55	3.40	1.53	1.68	2.12	4.67	2.51	3.08	3.33	1.82	2.99	3.48	2.38	3.77	1.71	1.67	3.92	4.89	2.65	3.7
.7	2.1	9.0	8.1	4.2	3.5	5.8	14.1	3.1	8.3	4.0	3.5	3.6	2.9	2.7	2.9	1.5	1.5	2.5	1.5	2.8	3.7
100+	70	28	42	36	48	37	33	81	37	83	52	83	100+	88	100+	100+	100+	100+	100+	95	100

389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	4
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	4
30	12	12	18	30	30	12	30	18	30	30	18	12	30	18	24	18	12	30	30	30	3
76	30.5	30.5	45.7	76	76	30.5	76	45.7	76	76	45.7	30.5	76	45.7	61	45.7	30.5	76	76	76	7
22	6	12	6	6	6	12	30	10	14	12	6	6	10	8	6	8	6	6	6	6	6
38	36	40	36	40	40	38	24	38	36	18	32	44	40	36	40	36	36	44	40	26	24
40	58	48	58	54	54	50	46	52	50	70	62	50	50	56	54	56	58	50	54	68	70
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	7
5.4	6.1	5.2	6.6	6.3	6.2	6.2	5.6	5.7	5.5	6.0	5.3	6.3	6.0	6.0	6.2	6.4	5.2	4.8	5.7	5.4	5.
0.28	0.86	0.92	1.1	0.62	0.72	0.65	0.65	0.66	0.54	0.72	0.56	1.3	0.48	0.53	0.51	1.1	0.78	0.78	0.51	0.78	0.
.04	.03	.03	.03	.02	.02	.03	.04	.04	.03	.03	.02	.02	.02	.03	.02	.02	.02	.02	.02	.02	.0
.17	.14	.11	.24	.12	.17	.15	.17	.16	.11	.13	.07	.12	.14	.15	.09	.11	.07	.10	.07	.09	.0
3.80	3.88	3.20	4.52	2.44	3.20	3.60	4.28	2.60	2.80	3.28	0.96	2.96	1.76	1.68	1.92	2.80	1.00	1.60	1.92	1.92	0.
4.01	4.05	3.34	4.79	2.58	3.39	3.18	4.48	2.80	2.94	3.44	1.05	3.10	1.92	1.86	2.03	2.93	1.09	1.72	2.01	2.03	1.
2.1	1.9	2.3	2.4	1.4	1.4	1.5	2.1	1.6	1.5	1.9	0.8	1.2	1.0	0.8	1.0	1.5	0.9	1.2	0.3	0.2	0.
100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	10

ld Quadrat No.:	362	363	364	365	366	367	368	369	370	380	381	382	383	384	385	386	387	388
n. Comptn. No.:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
er Depth (in.):	12	24	18	30	24	18	30	6	12	12	30	30	30	12	6	18	18	18
er Depth (cm.):	30.5	61	45.7	76	61	45.7	76	15.2	30.5	30.5	76	76	76	30.5	15.2	45.7	45.7	45.7
r (L.T. 0.002mm)%:	10	10	10	10	30	26	14	10	4	18	30	10	38	6	8	10	6	8
(0.002 - 0.05mm)%:	28	34	40	34	24	24	24	24	24	24	24	30	24	38	42	36	34	38
l (0.05 - 2.0mm) %:	62	66	50	56	46	50	62	66	72	58	46	60	38	56	50	54	60	54
ne (G.T. 2.00mm) %:	1	0	0	2	0	3	0	0	0	0	0	2	0	0	5	0	10	0
(H_2O):	5.8	5.3	5.7	5.6	5.6	6.5	5.8	5.6	5.6	5.5	5.5	5.8	5.6	5.7	5.8	5.4	5.4	5.6
anic Carbon %:	1.3	1.4	1.0	0.62	0.29	0.28	0.74	0.72	0.58	0.63	0.90	0.28	1.1	0.92	0.63	0.54	0.54	0.78
(meq/100 g):	.04	.03	.03	.03	.02	.02	.02	.03	.03	.02	.03	.03	.02	.02	.02	.02	.02	.02
meq/100 g):	.21	.13	.13	.16	.07	.08	.05	.07	.09	.07	.10	.10	.12	.10	.09	.12	.10	.12
Mg (meq/100 g):	2.08	1.72	4.04	1.72	2.64	2.52	1.80	0.96	1.04	0.96	1.48	2.96	1.72	1.60	0.88	0.96	1.12	3.36
al meq/100 g soil:	2.33	1.88	4.20	1.91	2.73	2.62	1.87	1.06	1.16	1.05	1.61	3.09	1.86	1.72	0.99	1.10	1.24	3.50
.C. (meq/100 g):	2.2	2.2	5.0	3.0	4.3	3.6	3.6	2.3	2.0	5.8	6.6	2.4	4.3	2.7	2.4	1.7	1.6	1.7
Saturation %:	100+	85	84	64	63	73	52	46	58	18	24	100+	43	64	41	65	78	100+

MA 9: Physico -chemical Analytic Data of Augered Soil Samples

188	189	190	191	192	193
83	84	85	86	87	88
12	12	12	3	3	12
30.5	30.5	30.5	7.6	7.6	30.5
6	6	8	6	4	24
36	34	30	14	16	24
58	60	62	80	80	52
0	0	0	0	0	0
5.6	5.7	5.5	5.3	6.0	5.0
.60	.33	.40	.36	.60	.40
.60	.33	.40	.36	.60	.40
.02	.02	.02	.02	.02	.02
.09	.10	.08	.15	.09	.10
1.24	1.12	1.60	1.60	1.72	1.80
1.85	1.24	1.70	1.77	1.83	1.92
.9	.5	.5	.3	.7	1.5
100+	100+	100+	100+	100+	100+

161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182
56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
3	12	12	12	12	12	3	3	12	18	18	3	12	12	12	18	18	12	18	12	12	12
7.6	30.5	30.5	30.5	30.5	30.5	7.6	7.6	30.5	45.7	45.7	7.6	30.5	30.5	30.5	45.7	45.7	30.5	45.7	30.5	30.5	30.5
22	10	6	4	6	6	4	4	8	6	6	8	8	8	6	36	52	4	6	16	18	8
30	28	38	26	34	24	22	20	36	40	28	32	34	42	48	24	18	10	22	36	22	34
48	62	56	70	60	70	74	76	58	54	66	60	60	50	46	40	30	86	72	48	60	58
0	0	0	0	0	3	15	13	4	0	0	20	0	0	0	0	0	0	0	0	16	0
6.1	5.7	6.1	6.4	6.8	6.5	6.4	6.4	6.5	6.5	6.2	6.8	6.7	6.2	6.4	5.0	6.0	6.0	6.0	6.0	6.1	5.8
2.1	.55	.33	.34	.64	.66	.49	.59	.48	1.1	.45	1.3	.90	.71	.88	2.4	.53	.39	.38	.56	.43	1.2
.03	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.04	.02	.02	.02	.03	.02	.02
.16	.15	.12	.14	.23	.16	.08	.09	.19	.16	.16	.13	.24	.12	.21	.24	.13	.17	.11	.10	.10	.07
2.80	3.20	1.68	3.16	1.96	1.88	0.80	1.20	2.48	2.48	1.96	3.84	2.64	2.64	2.80	3.40	1.20	2.56	2.04	4.24	2.96	2.8
2.99	3.37	1.82	3.32	2.21	2.06	0.90	1.31	2.69	2.66	2.14	3.99	2.90	2.78	3.03	3.68	1.35	2.75	2.18	4.37	3.08	2.8
10.6	1.8	5.8	1.9	2.9	4.3	4.6	6.7	2.6	2.6	4.6	7.4	10.0	7.4	6.5	11.0	2.2	7.3	2.2	6.0	3.6	3.6
28.	100+	31	100+	76	48	20	20	100+	100+	47	54	29	36	47	33	61	38	99	73	88	96

	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164
	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
	3	3	3	3	3	3	3	3	3	3	3	3	3	18	12	6	3	12	12	12
	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	45.7	30.5	15.3	7.6	30.5	30.5	30.5
	6	8	6	10	26	22	14	10	14	10	*	24	24	22	28	20	22	10	6	4
	34	20	22	28	18	20	20	32	34	40	*	36	38	36	34	36	30	28	38	26
	60	72	70	63	56	58	66	58	52	50	*	40	38	42	38	44	48	62	56	70
	0	0	0	0	5	20	0	0	5	1	*	0	0	0	0	0	0	0	0	0
	6.2	6.4	6.5	6.4	6.0	5.8	6.1	6.2	6.3	6.5	*	6.3	6.4	6.3	5.9	5.9	6.1	5.7	6.1	6.4
	2.6	.68	.48	.44	.25	.48	.51	1.3	.62	.43	*	1.4	1.1	1.3	1.2	2.0	2.1	.55	.33	.34
	.04	.02	.02	.02	.02	.03	.03	.03	.03	.03	*	.04	.04	.05	.04	.04	.03	.02	.02	.02
	.19	.12	.10	.11	.17	.19	.16	.27	.12	.09	*	.21	.21	.20	0.18	0.13	.16	.15	.12	.14
	7.28	3.08	2.40	2.28	3.80	2.24	3.92	4.84	4.16	4.08	*	8.68	7.92	6.48	6.60	4.96	2.80	3.20	1.68	3.16
	7.51	3.22	2.52	4.81	3.99	2.37	4.11	5.14	4.31	4.20	*	8.93	8.17	6.73	6.82	5.13	2.99	3.37	1.82	3.32
	8.5	2.1	1.3	5.5	7.9	5.9	6.9	4.5	6.9	6.5	*	11.6	11.3	9.7	11.5	7.3	10.6	1.8	5.8	1.9
	88	100+	100+	87	51	40	60	100+	62	65	*	77.	72.	69.	59.	70	28.	100+	31	100+

126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143		145	146	147
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38		40	41	42
3	3	3	3	3	3	12	3	3	3	3	3	3	3	3	3	3	3		3	3	3
7.6	7.6	7.6	7.6	7.6	7.6	30.5	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6		7.6	7.6	7.6
4	4	4	4	4	14	4	6	4	22	6	6	4	4	12	8	8	30		6	8	6
16	26	36	34	34	36	24	26	20	28	24	26	24	24	18	26	24	20		34	20	22
80	70	60	62	58	50	72	68	76	50	70	68	72	74	70	66	70	50		60	72	70
6	5	3	0	0	16	70	30	5	7	45	52	50	2	2	0	2	0		0	0	0
5.9	6.2	6.1	6.1	6.0	5.9	6.0	5.8	5.7	5.2	6.0	5.9	6.3	5.8	5.7	5.9	5.7	5.5		6.2	6.4	
.47	.58	.68	.59	.39	.59	.96	.68	.53	.39	.90	.98	.60	.33	.35	.59	.45	.31		2.6	.68	
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02		.04	.02	
.04	.09	.17	.07	.08	.08	.07	.07	.08	.12	.12	.11	.10	.07	.08	.10	.11	.16		.19	.12	
0.48	2.24	1.64	1.36	1.04	1.24	1.08	0.76	1.28	1.92	1.28	1.60	1.04	0.96	1.16	1.84	1.16	2.84		7.28	3.08	
0.54	2.35	1.83	1.45	1.14	1.34	1.17	0.85	1.38	2.06	1.42	1.73	1.16	1.05	1.26	1.96	1.29	3.02		7.51	3.22	
5.4	6.7	7.4	5.3	6.4	4.0	7.7	6.5	4.9	7.4	7.7	5.7	7.0	5.9	5.0	6.4	5.4	6.1		8.5	2.1	
10	35	25	27	18	34	15	13	28	28	18	30	17	18	25	31	24	50		88	100+	

Field Quadrat No.:	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122
Vegn. Comptn. No.:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Auger Depth (in.):	18	3	12	3	3	3	3	3	3	3	3	3	3	3	3	12	12
Auger Depth (cm.):	45.7	7.6	30.5	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	30.5	30.5
Clay (L.T. 0.002mm) %:	4	18	4	4	8	10	4	10	24	4	6	8	4	4	4	4	4
Silt (0.002 - 0.05mm) %:	28	20	16	18	32	24	34	34	24	36	34	34	34	34	36	38	26
Sand (0.05 - 2.0mm) %:	68	62	80	78	60	66	62	56	52	60	60	58	62	62	60	58	70
Stone (G.T. 2.0mm) %:	0	20	22	0	0	13	12	2	10	0	0	0	0	12	1	0	0
pH (H_2O):	6.9	6.4	6.0	6.2	6.0	6.1	6.1	6.4	6.1	6.1	6.1	5.8	5.6	6.0	6.0	5.8	6.0
Organic Carbon %:	.39	.29	.59	.52	.48	.55	.55	.54	.27	.59	.60	.51	.60	.60	.47	.34	1.3
Na (meq/100 g):	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
K (meq/100 g):	.10	.14	.11	.12	.10	.13	.20	.18	.20	.11	.10	.09	.08	.11	.10	.11	.24
Ca @ Mg (meq/100 g):	1.20	2.44	0.88	1.92	1.64	3.40	5.96	2.48	2.28	1.80	1.92	1.12	0.84	2.08	2.28	1.24	4.28
Total meq/100 g soil:	1.32	2.60	1.01	2.06	1.76	3.55	6.19	2.60	2.50	1.93	2.04	1.23	0.94	2.21	1.40	1.37	4.54
C.E.C. (meq/100 g):	1.7	2.8	1.4	1.7	2.5	1.8	4.8	2.8	1.7	2.3	1.7	1.4	1.3	1.7	1.3	2.5	2.8
Base Saturation %:	78	93	72	100+	70	100+	100+	96	100+	84	100+	88	72	100+	100	55	100

GUGA 10: Physico -chemical Analytic Data of Augered Soil Samples

39	640	641	664	665	666	667	668	669	70	71	72	73	74	75	76	77	78	79
0	41	42	65	66	67	68	69											
0	30	30	30	30	30	30	24	30	30	30	12	30	30	18	30	6	30	30
6	76	76	76	76	76	76	61	76	76	76	30.5	76	76	45.7	76	15.2	76	76
12	16	10	6	10	6	10	24	10	18	6	26	10	20	20	10	10	6	30
18	24	20	18	34	32	32	26	40	34	24	28	28	20	20	20	20	27	26
70	59	70	76	56	72	58	50	50	48	70	46	62	60	60	70	70	68	44
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
4.6	4.4	4.8	6.0	5.9	5.4	6.0	5.4	5.3	5.6	6.3	6.5	6.4	4.8	4.9	5.5	5.3	5.2	5.8
.52	.61	.49	0.31	1.1	0.56	0.41	0.08	0.33	0.52	0.16	0.07	0.47	0.33	0.51	0.59	0.33	0.45	0.24
.03	.03	.03	0.05	0.06	0.05	0.05	0.06	0.04	0.04	0.02	0.03	0.05	0.03	0.03	0.02	0.02	0.03	0.03
.07	.08	.09	0.14	0.20	0.14	0.12	0.22	0.11	0.13	0.10	0.14	0.22	0.13	0.06	0.05	0.06	0.18	0.18
1.52	1.56	1.72	2.22	3.68	1.80	2.48	2.52	1.60	2.48	1.60	2.28	4.72	0.52	0.40	1.00	1.00	2.08	2.88
1.62	1.67	1.83	2.41	3.94	1.99	2.65	2.80	1.75	2.65	1.72	2.45	4.99	0.68	0.49	1.07	1.08	2.29	3.09
0.8	2.1	0.8	0.6	1.8	0.7	0.7	1.6	1.0	2.0	0.6	2.3	1.0	1.2	1.3	1.0	0.6	0.7	2.5
100+	80	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	57	38	100+	100+	100+	100+

	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
	6	12	18	24	18	30	30	24	12	12	30	18	18	30	30	24	30	18	18	6	24
2	15.2	30.5	45.7	61	45.7	76	76	61	30.5	30.5	76	45.7	45.7	76	76	61	76	45.7	45.7	15.2	61
	14	12	14	16	10	24	14	8	10	16	8	10	14	18	8	10	10	14	12	4	4
	46	32	22	18	28	26	32	26	34	36	16	40	52	28	30	14	24	30	32	22	22
	40	56	64	66	62	50	54	66	56	48	76	50	34	54	58	76	66	56	56	74	74
	0	0	0	1	2	22	0	0	0	0	0	6	0	0	0	0	0	91	0	0	34
.0	6.1	5.2	5.3	5.7	5.4	5.8	5.0	5.0	5.8	6.2	5.7	6.0	5.0	5.1	4.2	4.4	3.8	4.0	3.4	4.1	4.6
20	.50	.45	.01	.06	.29	.30	.42	.55	.40	.55	.05	.70	.68	.22	.50	.09	.53	.48	.48	.47	.48
	.03	.04	.02	.03	.03	.02	.03	.02	.02	.03	.04	.02	,04	.15	.03	.04	.04	.04	.03	.03	.02	.03
	.11	.12	.07	.13	.15	.08	.08	.07	.10	.11	.12	.12	.13	.17	.17	.10	.12	.07	.16	.12	.06	.10
	2.20	3.00	1.16	2.24	2.96	1.08	1.04	1.40	0.96	2.48	3.20	1.68	3.24	1.92	1.56	2.00	1.48	1.36	1.44	1.44	1.20	1.56
	2.34	3.16	1.25	2.40	3.14	1.18	1.15	1.49	1.08	2.62	3.36	1.82	3.41	2.24	1.76	2.14	1.64	1.47	1.63	1.59	1.28	1.69
	1.1	1.4	1.0	1.1	1.4	0.7	1.1	1.2	0.9	1.3	1.7	0.7	1.3	1.4	1.3	1.4	0.4	0.8	0.9	0.7	0.7	0.6
	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+

Field Quadrat No.:	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	61
Vegn. Comptn. No.:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Auger Depth (in.):	24	12	12	6	6	30	6	24	12	24	24	30	18	12	30	24	18
Auger Depth (cm.):	61	30.5	30.5	15.2	15.2	76	15.2	61	30.5	61	61	76	45.7	30.5	76	61	45
Clay (L.T. 0.002mm) %:	14	18	34	10	8	14	24	6	6	12	10	4	30	8	12	10	18
Silt (0.002 - 0.05mm) %:	16	24	12	44	36	32	20	36	34	34	20	30	24	30	28	16	24
Sand (0.05 - 2.0mm) %:	70	58	54	46	56	54	56	58	60	54	70	66	46	62	60	74	68
Stone (G.T. 2.00mm) %:	0	0	58	0	0	0	6	0	13	0	1.	2	0	0	0	0	0
pH (H_2O):	5.8	6.2	6.3	5.0	5.5	5.5	6.4	5.8	5.9	6.3	6.0	5.1	5.1	5.6	6.0	5.4	6.
Organic Carbon %:	.05	.16	.20	.05	.29	.30	.12	.19	.04	.48	.16	.41	.16	.24	.50	.32	.0
Na (meq/100 g):	.04	.05	.13	.07	.04	.07	.12	.03	.10	.03	.04	.02	.13	.03	.05	.04	.0
K (meq/100 g):	.14	.17	.38	.10	.11	.13	.28	.09	.13	.11	.12	.07	.21	.09	.12	.11	.1
Ca @ Mg (meq/ 100 g):	2.84	4.36	10.7	2.76	2.32	3.44	8.00	1.64	1.60	2.28	2.96	0.88	3.44	2.20	3.08	2.00	3.
Total meq/100 g soil:	3.02	4.58	11.21	2.93	2.47	3.64	8.40	1.76	1.83	2.42	3.12	0.97	3.75	2.32	3.25	2.15	3.
C.E.C. (meq/100 g):	1.1	1.7	4.5	1.6	.8	1.4	2.7	.8	.7	1.2	1.6	.8	2.2	1.1	1.1	.8	1.
Base Saturation %:	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	100+	10

GUGA 11: Physico - chemical Analytic Data of Augered Soil Samples

8	140	14	12	11	5/6	6	9	10	8	4	2	1
8	39	40	41	42	43	44	45	46	47	48	49	50
8	39	40	41	42	43	44	45	46	47	48	49	50
1	153	169	167	13	186	156	160	166	192	55	174	127
5	389	429	424	33	472	396	406	422	488	140	442	323
0	18	34	16	24	22	18	20	34	16	32	18	20
2	20	30	40	40	58	36	30	36	32	48	42	44
8	62	36	42	36	20	46	50	30	52	20	40	36
0	27	4	0	10	0	46	30	35	0	0	30	5
5.9	6.0	6.0	5.8	6.1	6.0	6.5	5.9	6.2	6.1	5.9	6.0	7.4
1.32	2.68	1.32	1.76	1.60	1.40	1.24	.61	1.40	.68	1.14	1.62	2.40
.05	.04	.04	.02	.03	.08	.06	.02	.05	.05	.03	.08	.08
.09	.15	.18	.25	.23	.11	.10	.27	.12	.17	.16	.16	1.0
2.48	2.20	2.32	2.24	2.12	3.72	2.64	1.48	6.00	0.96	1.72	2.48	6.96
2.62	2.39	2.54	2.53	2.38	3.91	2.80	1.77	6.17	1.18	1.91	2.72	8.04
2.13	11.86	8.96	10.13	6.63	9.83	10.13	11.23	17.63	8.23	10.50	10.26	14.0
22	20	28	25	36	40	28	16	35	14	18	27	57

	16	15	7	6	5	4	3	2/3	2/3	11B	11A	7B	7A	6D	6C	6B	6A	18	17	14B	14C
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
	154	155	129	144	151	162	159	174	175	153	162	180	166	78	92	176	182	155	167	61	153
	391	394	328	366	384	411	404	442	445	389	411	457	422	198	234	447	472	394	424	155	389
	20	24	24	16	18	24	22	14	10	28	28	18	28	20	22	42	36	30	12	30	18
	32	46	26	44	36	36	50	36	52	26	30	44	36	22	30	18	16	22	34	32	20
	48	30	50	40	46	40	28	50	38	46	42	38	36	58	48	40	50	48	54	38	62
	9	5	57	25	0	0	0	3	3	0	0	0	2	60	34	56	45	0	0	0	27
	7.7	6.5	2.84	6.4	6.5	6.6	6.4	6.8	6.3	6.2	6.2	6.4	6.3	6.5	6.3	6.2	6.2	5.8	6.0	5.9	6.0
0	.67	2.48	6.4	1.10	.73	1.40	1.18	2.8	.56	7.20	2.32	1.40	.73	1.48	1.42	1.04	2.96	8.80	1.56	1.32	2.6
19	.11	.07	.08	.08	.03	.08	.07	.07	.07	.06	.28	.39	.24	.27	.22	.04	.05	.08	.04	.05	.0
20	.21	.17	.19	.13	.19	.26	.25	.24	.23	.06	.06	.03	.03	.05	.06	.14	.28	.26	.17	.09	.1
40	0.12	3.12	4.64	3.24	1.84	3.16	2.72	2.44	1.92	6.64	5.28	3.60	2.60	4.64	5.24	2.56	3.88	2.92	2.24	2.48	2.2
79	0.44	3.36	4.91	3.45	2.06	3.50	3.04	2.75	2.21	6.98	5.62	4.02	2.87	4.96	5.52	2.76	4.21	3.26	2.45	2.62	2.3
20	8.40	14.36	16.33	8.43	8.33	11.23	8.53	8.26	7.50	69.83	45.93	8.83	7.90	12.20	12.96	9.60	15.00	31.97	9.23	12.13	11.8
1		23	30	41	25	31	36	33	29	10	12	46	36	41	43	29	28	10	27	22	20

	A/7	A/6	A/6	A/5	A/4	A-3	A-2	A-1	9-10	9	7	A-10	A-9	A-8	5/6	17A	17
Field Quadrat No.:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Vegn. Comptn. No.:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Pit Depth (in.):	105	180	90	98	98	30	78	120	187	168	168	98	40	186	186	132	186
Pit Depth (cm.):	267	457	229	249	249	76	198	305	475	427	427	249	102	472	472	335	472
Clay (L.T. 0.002mm)%:	16	22	24	18	22	10	20	18	12	12	14	18	38	32	16	26	24
Silt (0.002 - 0.05mm)%:	40	48	54	44	28	44	46	52	46	42	46	48	36	50	56	24	24
Sand (0.05 - 2.0 mm)%:	44	30	22	38	50	46	34	30	42	46	40	34	26	18	28	50	52
Stone (G.T. 2.00mm) %:	4	0	0	45	50	20	0	0	40	6	0	0	5	22	0	0	0
pH (H_2O):	6.2	6.2	5.9	5.8	6.3	6.1	5.6	6.2	5.9	6.1	6.0	5.8	5.2	5.7	6.1	5.7	6.0
Organic Carbon %:	.54	1.26	1.40	1.04	.29	1.00	1.00	1.28	1.32	1.48	.72	.70	.18	.67	1.44	9.44	10.88
Na (meq/100 g):	.02	.02	.02	.02	.02	.02	.03	.03	.02	.02	.03	.03	.08	.03	.04	.10	.10
K (meq/100 g):	.23	.24	.13	.10	.09	.07	.07	.19	.12	.11	.26	.09	.19	.09	.11	.37	.44
Ca @ Mg (meq/100 g):	1.84	3.64	1.80	1.00	1.96	1.64	.32	2.08	1.56	2.20	2.00	2.00	0.32	1.60	2.88	4.28	4.52
Total meq/100 g soil:	2.09	3.90	1.95	1.12	2.07	1.73	0.42	2.30	1.70	2.33	2.29	2.12	0.59	1.72	3.03	4.75	5.06
C.E.C. (meq/100 g):	6.03	8.36	9.61	6.09	6.85	5.88	5.48	7.70	7.67	9.00	6.52	8.60	14.93	9.73	8.00	43.46	44.76
Base Saturation %:	35	47	20	18	30	29	8	30	22	26	35	25	4	18	38	11	11

KUYELLO 12: Physico-chemical Analytic Data of Pit Soil Samples

Floral identifications were in accordance with the "Floral of West Tropical Africa", volumes I, II and III, by Hutchinson & Dalzieli, second editions revised by Keay (1954, 1958), Hepper (1963, 1968, 1972). Supplementary Floras however include "A Key to Nigerian grasses" (Clayton 1960), "The Flora of Nigeria, supplement to grasses" (Stanfield 1970), "A field key to the Commoner general of Nigeria Grasses" (Blair Rains 1968) and "Savanna trees of Nigeria, a field key" (Hopkins and Stanfield, 1966). Nomenclatures of exotic tree species in the zone were in accordance with the records preserved in the Divisional Forestry Office, Zaria, Nigeria. The arrangements in the appendix follows the phylogenetic sequence of families in the Flora of West Tropical Africa, Vols. I-III.

ANNONACEAE

Annona senegalensis Pers.

RANUNCULACEAE

Clematis hirsuta Guill. & Perr.

MENISPERMACEAE

Cissampelos mucronata A. Rich.

CAPPARIDACEAE

Maerua angolensis DC.

POLYGALACEAE

Polygala petitiana A. Rich.
Securidaca longepedunculata Fres.

DROSERACEAE

Drosera indica Linn.

MOLLUGINACEAE

Glinus lotoides Linn.

POLYGONACEAE

Psorospermum corymbiferum Hochr.

AMARANTHACEAE

Achyranthes aspera Linn.
Alternanthera nodiflora R. Br.
Amaranthus spinosus Linn.
Pandiaka heudelotii (Mosq.) Hook. f.

OXALIDACEAE

Biophytum petersianum Klotzch.

ONAGRACEAE

Jussiaea suffruticosa Linn.

THYMELAEACEAE

Lasiosiphon kraussianus (Meisn.) Burtt. Davy.

:OCHLOSPERMACEAE

:ochlospermum tinctorium A. Rich.

:UCURBITACEAE

Melothria maderaspatana (Linn.) Cogn.

OCHNACEAE

Ochna afzelii R. Br. ex Oliv.

DIPTEROCARPACEAE

Monotes kerstingii Gilg.

MYRTACEAE

Eucalyptus camaldulensis Dehn.
Eucalyptus citriodora Hook.
Eucalyptus grandis Hill ex Maiden
Eucalyptus tereticornis Sm.
Syzygium guineense (Willd.) DC.

MELASTOMATACEAE

Dissotis rotundifolia (Sm.) Triana

COMBRETACEAE

Anogeissus leiocarpus (DC.) Guill & Perr.
Combretum ghasalense Engl. & Diels.
Combretum glutinosum Perr ex DC.
Combretum molle R. Br. G. Don.
Combretum sericeum G. Don.
Guiera senegalensis J.F. Gmel.
Terminalia avicennioides Guill. & Perr.
Terminalia glaucescens Planch ex Benth.
Terminalia laxiflora Engl.

HYPERICACEA

Psorospermum corymbiferum Hochr.

TILIACEAE

Corchorus tridens Linn.
Grewia mollis Juss.
Triumfetta dubia De Willd.
Triumfetta pentandra A. Rich.

STERCULIACEAE

Melochia corchorifolia Linn.
Waltheria indica Linn.

BOMBACACEAE

Ceiba pentandra (Linn.) Gaertn.

MALVACEAE

Cienfuegosia digitata Cav.
Hibisasu asper Hook. f.
Sida acuta Burm.
Sida linifolia Juss. ex Cav.
Sida ovata Forsk.
Sida rhombifolis Linn.
Sida urens Linn.
Urena lobata Linn.
Wissadula amplissima (Linn.) R.E.Fries

ZYGOPHYLLACEAE

Balanites aegyptiaca (Linn.) Del.

EUPHORBIACEAE

Alchornia cordifolia (Schum. & Thonn.) Mull
Antidesma venosum Tul.
Bridelia ferruginea Benth.
Chrozophora senegalensis (Lam.) A.Juss. ex Spreng.
Croton macrostacylus Hochst. ex Del.
Croton zambesicus Mull. Arq.
Euphorbia convolvuloides Hochst. ex Benth
Euphorbia heterophylla Linn.
Euphorbia hirta Linn.
Euphorbia polycnemoides Hochst. ex Boiss.
Hymenocardia acida Tul.
Phyllanthus discoideus (Baill) Muell. Arq.
Phyllanthus nigericus Brenan.
Securinega virosa (Roxb. ex Willd.) Baill
Uapaca togoensis Pax.

ROSACEAE

Parinari curatelifolia Planch ex Benth.

CAESALPINACEAE

Burkea africana Hook
Cassia absus Linn
Cassia mimosoides Linn
Cassia nigricans Vahl.
Cassia rotundifolia Pers.
Cassia sieberiana DC.
Cassia singueana Del.
Cassia tora Linn.

Detarium macrocarpum Harms.
Isoberlinia doka Craib & Stapf.
Isoberlinia tomentosa (Harms.) Craib & Stapf.
Piliostigma thonningii (Schum.) Milne-Redhead.
Piliostigma reticulatum (DC.) Hochst.
Tamarindus indica Linn.

MIMOSACEAE

Acacia albida Del.
Acacia ataxacantha DC.
Acacia sieberiana DC.
Albizia chevalieri Harms.
Albizia zygia DC.
Dichrostachys glomerata (Forsk) Choiv.
Entada africana Guill & Perr.
Mimosa pilgra Linn.
Parkia clappertoniana Keay
Prosopis africana (Guill. & Perr.) Taub.

PAPILIONACEAE

Abrus precatorius Linn.
Adenodolichos paniculatus (Hau.) Hutch & Dalz.
Aeschynomene indica Linn.
Afrormosia laxiflora (Boeck.) J. Raynal.
Alysicarpus glumaceus (Vahl.) DC.
Crotalaria calycina Schrank.
Crotalaria confusa Hepper
Crotalaria glauca Willd.
Crotalaria lachnosema Stapf.
Crotalaria naragutensis Hutch
Crotalaria retusa Linn
Crotalaria senegalensis (Pers.) Bacle ex DC.
Desmodium barbatum (Linn.) Benth.
Desmodium salicifolium (Poir) DC.
Desmodium hirtum Guill & Perr.
Desmodium velutinum (Willd.) DC.
Eriosema griseum Bak.
Eriosema psoraleoides (Lam.) G.Don
Eriosema pulcherrimum Taub.
Erythrina senegalensis DC
Indigofera arrecta Hochst ex A.Rich
Indigofera bracteolata DC
Indigofera capitata Kotschy
Indigofera linearis Guill & Perr.
Indigofera charlieriana Schinz.
Indigofera microcarpa Desv.
Indigofera dendroides Jacq.
Indigofera hirsuta Linn.
Indigofera macrocalyx Guill & Perr.
Indigofera nummulariifolia (Linn.) Livera ex Alston.
Indigofera pulchra Willd.
Indigofera secundiflora Poir
Ostryoderris stuhlmannii (Taub.) Dunn ex Harms.
Milletia thonningii (Schum. & Thonn. Bak.
Pterocarpus erinaceus Poir
Pseudarthria hookeri Wight & Arn.
Sesbania sesban (Linn.) Merrill.
Sphenostylis schweinfurthii Harm.
Stylosanthes mucronata Willd.
Tephrosia bracteolata Willd. & Perr.
Tephrosia linearis (willd.) Pers.
Tephrosia pedicellata Bak.
Tephrosia purpuria (Linn.) Pers.
Vigna racemosa (G. Don) Hutch & Dalz.
Zornia glochidiata Reichb. ex DC.

ULMACEAE

Celtis integrifolia Lam.
Trema guineensis (Schum. & Thonn.) Ficalho

MORACEAE

Ficus exasperata Vahl.
Ficus gnaphalocarpa (Miq.) Steud. ex A.Rich
Ficus ingens (Miq.) Miq.
Ficus ovata Vahl.
Ficus platyphylla Del.
Ficus polita Vahl.
Ficus umbellata Vahl.

CELASTRACEAE

Maytenus senegalensis (Lam.) Excell.

OPILIACEAE

Opilia celtidifolia (Guill. & Perr) Endl. ex Walp.

RHAMNACEAE

Ziziphus mauritiana Lam.
Ziziphus mucronata Willd.

AMPELIDACEAE

Cissus caesia Afzel.
Cissus crotalarioides Planch.
Cissus cornifolia (Bak.) Planch.
Cissus populnea Guill & Perr.
Cissus refescens Guill. & Perr.
Cissus quadrangularis Linn.

BURSERACEAE

Boswellia dalzielii Hutch
Commiphora africana (A.Rich) Engl.
Commiphora kerstingii Engl.

MELIACEAE

Khaya senegalensis (Desv.) A.Juss
Pseudocedrela kotschyi (Schweinf.) Harms.
Trichilia ametica Vahl. = T. roka (Forsk.) Chiov.

SAPINDACEAE

Allophylus africanus P. Beauv.
Allophylus spicatus (Poir) Radlk.
Paulinia pinnata Linn.

ANNACARDIACEAE

Heeria insignis (Del.) O. Ktze.
Heeria pulcherrima (Schweinf. f.) O. Ktze. Rev. Gem.
Lannea acida A. Rich
Lannea barteri (Oliv.) Engl.
Lannea kerstingii Engl. & K.Krause
Lannea schimperi (Hochst. ex A.Rich) Engl.
Mangifera indica Linn.

CONNARACEAE

Byroscarpus coccineus Schum. & Thonn.

ARALIACEAE

Cussonia barteri Seeman

UMBELLIFEREA

Centella asiatica (Linn.) Urb.

EBENACEAE

Diospyros abyssinica (Hien.)F.White
Diospyros mespliformis Hochst. ex A.DC

SAPOTACEAE

Butyrospermum paradoxum (Gaertn.f.) Hepper

LOGANIACEAE

Spigelia anthelmia Linn.
Strychnos innocua Del.
Strychnos spinosa Lam.

OLEACEAE

Jasminum dichotomum Vahl.

APOCYNACEAE

Carissa edulis Vahl.
Chrysophyllum albidum G. Don.
Landolphia sp.
Rauvolfia caffra Sond.
Saba florida (Benth.) Bullock
Strophanthus preussii Engl. & Pax.
Strophanthus hispidus DC.

RUBIACEAE

Adina macrocephala (Del.) Hiern.
Borreria octodon Hepper
Borreria radiata DC
Borreria verticillata (Linn.) G.F.W. Mey.
Canthium horizontale (Schum & Thonn.) Hiern.
Canthium venosum (Oliv.) Hiern.
Crossopteryx febrifuga (Afzel. ex G.Don.) Benth.
Fadogia agrestis Schweinf. ex Hiern.
Fadogia erythrophloea (K. Schum. & Krause) Hutch & Dalz.
Feretia apodanthera Del.
Gardenia aqualla Stapf & Hutch.
Gardenia erubescens Staphf. & Hutch.
Gardenia ternifolia Schum. & Thonn.
Kohautia grandiflora DC.
Mitracarpus scaber Zucc.
Mitragyna inermis (Willd.) O. Ktze.
Morelia senegalensis A. Rich ex DC.
Nauclea latifolia Sm.
Oldenlandia herbacea (Linn.) Roxb.
Pavetta glaucescens Hiern
Polysphaeria arbuscula K. Schum.
Psychotria psychotrioides (DC) Roberty.

COMPOSITAE

Acanthospermum hispidum DC
Ageratum conyzoides Linn
Aspilia africana (Pers.)C.D. Adams
Bidens pilosa Linn.
Blumea aurita (Linn.f.) DC.
Blumea perrottetiana DC
Chrysanthellum americanum (Linn.) Vatke
Dicoma sessiliflora Harv.
Echnops longifolius A. Rich
Eclipta prostrata (Linn.) Linn.
Ethulia conyzoides Linn. f.
Guizotia scabra (Vis.) Chiov.
Gutenbergia nigritana (Benth.) Oliv. & Hiern.
Gynura miniata Welw
Helichrysum odoratissimum (Linn.) Less.
Kleinia cliffordiana (Hutch.) D. Adams
Lactuca taraxacifolia (Willd.) Schum. ex Hornemann
Pulicaria crispa (Forsk.) Oliv.
Senecio abyssinicus Sch. Bip. ex A.Rich.
Sphaeranthus senegalensis DC
Synedrella nodiflora Gaertn.
Tridax procumbens Linn.
Vernonia ambigua Kotschy & Peyr.
Vernonia glaberrima Welw. ex Hoffin.
Vernonia nigritiana Oliv. & Hiern.
Vernonia oocephala Bak.
Vernonia pauciflora (Willd.) Less.
Vernonia perrottetii Sch. Bip.
Vicoa leptoclada (Webb.) Dandy.

BORAGINACEAE

Coldenia procumbens Linn.
Heliotropium indicum Linn.
Heliotropium strigosum Willd.
Heliotropium pterocarpum (DC. & A. DC.) Hochst. & Steud ex Bunge
Heliotropium supium Linn.

SOLANACEAE

Physalis angulata Linn.
Schwenckia americana Linn.
Solanum nodiflorum Jacq.
Solanum torvum Sw.

CONVOLVULACEAE

Evolvulus alsinoides (Linn.) Linn
Ipomoea argentaurata Hallier f.
Ipomoea aquatica Forsk.
Ipomoea asarifolia (Desr.) Roem & Schult.
Ipomoea eriocarpa R. Br.
Ipomoea vagans Bak.
Jacquemontia tamnifolia (Linn.) Griseb.
Merremia tridentata (Linn.) Hallier. f.

SCROPHULARIACEAE

Bacopa floribunda (R. Br.) Wettst.
Buchnera hispida Buch. - Ham. ex G. Don.
Dopatrium longidens Skan.
Scoparia dulcis Linn.
Striga asiatica (Linn) O. Ktze.
Striga hermontheca (Del.) Benth.
Striga senegalensis (= S. senegalensis) Benth.

BIGNONIACEAE

Stereospermum kunthianum Cham.

ACANTHACEAE

Blepharis linariifolia Pers.
Dyschoriste pedicellata C.B. Cl.
Dyschoriste perrottetii (Nees.) O. Ktze.
Hygrophila auriculata (= H.spinosa) (Schum.) Heine.
Hypoestes venticillaris (Linn.f) Soland ex Roem & Schult.
Justicia insularis T. Anders
Lepidagathis collina (Engl.) Milne-Redhead
Monechma ciliatum (Jacq.) Milne-Redhead
Nelsonia canescens (Lam.) Spreng.
Peristrophe bicalyculata (Retz.) Nees.

VERBENACEAE

Clerodendron capitatum (Willd.) Schum. & Thonn.
Lantana rhodesiensis Moldenke
Lippia chevalieri Moldenke
Stachyarpheta angustifolia (Mill.) Vahl.
Vitex doniana Sweet
Vitex simplicifolia Oliv.

LABIATEA

Englerastrum gracillinum Th. C.E.Fries
Hyptis specigera Lam.
Hyptis suaveolens Poit.
Leucas martinicensis (Jacq.) Ait.f.
Platostema africanum P. Beauv.
Solenostemon mannii (Hook f.) Bak.

COMMELINACEAE

Aneilema lanceolatum Benth.
Commelina benghalensis Linn.
Commelina forskalaei Vahl.
Cyanotis lanata Benth.
Murdania simplex (Vahl.) Brenan

MUSACEAE

Ensete gilletii (De Willd.) E.E. Cheesman

ZINGIBERACEAE

Costus spectabilis (Fenzl.) K. Schum.
Kaempferia aethiopica (Schweinf.) Solms-Laub.

LILIACEAE

Aloe barteri Bak.
Asparagus africana Linn.
Gloriosa superba Linn.
Urginea altissima (Linn.f.) Bak.

ARACEAE

Culcasia saxatilis A. Chev.
Stylochiton lancifolius Kotschy & Peyr.

IRIDACEAE

Gladiolus gregarius Welw. ex Bak.

DIOSCOREACEAE

Dioscorea bulbifera Linn.
Dioscorea dumentorum (Kunth.) Pax.
Dioscorea preusii Pax.

HYPOXIDACEAE

Curculigo pilosa (Schum. & Thonn.) Engl.
Hypoxis angustifolia Lam.

TACCECEAE

Tacca leontopetaloides (Linn.) O.Ktze. (T. involucrata) Schum & Thonn.

ORCHIDACEAE

Eulophia quartiniana A. Rich.

CYPERECEAE

Afrotrilepis pilosa (Boeck.) J. Raynal.
Bulbostylis abortiva (Steud.) C.B. Cl.
Cyperus amabilis Vahl.
Cyperus digitatus Roxb.
Cyperus dilatatus Schum. & Thonn.
Cyperus esculentus Linn.
Cyperus ledermannii (Kuk.) Hooper) (C. obtusiflorus Vahl.)
Cyperus ledermannii (Kuk.) Hooper.
Cyperus pustulatus Vahl.
Cyperus rotundus Linn.
Fimbristylis hispidula (Vahl.) Kunth.
Fimbristylis ovata (Burm. f.) Kern.
Fimbristylis pilosa Vahl.
Fuirena umbellata Rottb.
Kyllinga squamulata Thonn. ex Vahl.
Lipocarpha sphacelata (Vahl.) Kunth.
Mariscus altermifolius Vahl. (= M. umbellatus Vahl.)
Mariscus squarossus (Linn.) C.B. Cl.
Pycreus macrostachyos (Lam.) J. Raynal.
Scirpus jacobi C.B.C. Fischer
Scleria foliosa Hochst. ex A. Rich.

GRAMINEAE

Andropogon ascinodes C.B. Cl.
Andropogon fastigiata Sw.
Andropogon gayanus Kunth.
Andropogon pseudapricus Stapf.
Aristida adscensionis Linn.
Aristida funiculata Trin.
Aristida kerstingii Pilger.
Bambusa vulgaris Schrad. ex Wendel.
Beckeropsis uniseta (Nees.) K. Schum.
Brachiaria brizantha (Hochst ex A. Rich Stapf.

rachiaria jubata (Fig. & De Not.) Stapf.
rachiaria lata (Schumach.) C.E.Hubbard
rachiaria stigmatisata (Meg.) Stapf.
rachiaria xantholeuca (Hack. ex Schinz) Stapf.
hloris pilosa Schumach
tenium newtonii Hack
ymbopogon giganteus Chiov.
ynodon dactylon (Linn.) Pers.
actyloctenium aegyptium (Linn.) P.Beauv.
igitaria ciliaris (Rotz.) Koel.
igitaria gayana (Kunth.) Stapf ex A.Chev.
igitaria humblei Robyns
igitaria lecardii (Pilger) Stapf.
igitaria longiflora (Retz.) Pers.
chinochloa colona (Linn.) Linn.
chinochloa pyramidalis (Lam.)
leusine indica (Linn.) Gaertn.
lionurus hirtifolius Hack.
lionurus pobeguinii Stapf.
ragrostis atrovirens (Desf.) Trin & Steud.
ragrostis ciliaria (Linn.) R. Br.
ragrostis pilosa (Linn.) P. Beauv.
ragrostis tremula (Hochst ex Steud.
Eragrostis turgida (Schumach.) De Willd.
Hackelochloa granularis (Linn.) O.Ktnz.
Heteropogon contortus (Linn.) P.Beauv. ex Roem & Schult.
Hyperrhenia cyanescens (Stapf.) Stapf.
Hyperrhenia involucrata Stapf.
Hyperrhenia rufa (Nees) Stapf.
Hyperthelia dissoluta (Nees ex Steud) W.D. Clayton
Imperata cylindrica (Linn.) P.Beauv.
Leersia hexandra Sw.
Loudetia phragmitoides (Peter) C. E. Hubbard
Loudetia simplex (Nees) C.E.Hubbard
Loudetia togoensis (Pilger) C.E.Hubbard
Microchloa indica (Linn.f.) P. Beauv.
Monocymbium ceresiiforme (Nees) Stapf.
Oryza barthii A. Chev.
Oryza sativa Linn.
Oryza longistaminata A.Chev.& Roehr.
Oxytenanthera abyssinica (A.Rich) Munro
Panicum baumanii K. Schum.
Panicum flaviicola Steud
Panicum maximum. Jacq.
Panicum pansum Randl.
Panicum repens Linn.
Panicum subalbidum Kunth.
Paspalum orbiculare Forst
Pennisetum pedicellatum Trin.
Rhytachne triaristata (Steud.) Stapf.
Rottboellia exaltata Linn. f.
Sacciolepis africana C.E.Hubbard & Snowden.
Schizachyrium brevifolium Nees ex Buse
Schizachyrium exile (Hochst.) Pilger.
Schizachyrium platyphyllum (Franch.) Stapf.
Schizachyrium sanguineum (Retz.) Alston
Setaria anceps Stapf. ex Massey
Setaria palide-fusca (Schumach.) Stapf. & C. B.Hubbard.
Sporobolus festivus Hochst. ex A.Rich.
Sporobolus pyramidalis P. Beauv.
Thelepogon elegans Roth. ex Roem & Schult.
Trachypogon spicatus (Linn.f.) O. Ktze.
Urelytrum muricatum C.E. Hubbard.
Vetiveria nigritana (Benth.) Stapf.

BIBLIOGRAPHY

Abdullahi, A. et al (1978). A Report of the National Committee on Arid Zone Afforestation, prepared for the Federal Military Government of Nigeria.

Abolarin, G.A. (1978). Pers. comm. Soil Survey Laboratory, Inst. for Agric. Res., Samaru, Nigeria.

Aleksandrova, V.D. (1973). "Russian approaches to classification of vegetation", pp. 493-527, in Handbook of Vegetation Science, Part 5: Ordination and Classification of Communities, ed. R.H. Whittaker. The Hague.

Alford, M. E. Hailstone, J. Hailstone, P. Tuley (1972). "The measurement and mapping of land-resource data by point sampling on aerial photographs" reprint from Environmental remote sensing: applications and achievements. ed. E.C. Barrett and L.F. Curtis, Univ. of Bristol.

Anderson, D.J. (1965). "Classification and ordination in vegetation science: controversy over a non-exist problem?", J. Ecol. 55, 521-526.

Andrew, I.A. (1972). "The application of multi-variate statistical techniques to the analysis of variation within and between fast growing tropical tree species", M.Sc. Thesis, University of Oxford.

Andrew, I.A. (1975). "Program Cluster, Revised Cluster Analysis: User's Specification", Computer Manuals, Oxford University Computing Laboratory

Araoz, J., G. Sarmiento, and G. Monastro (1971). "An essay in the use of association and dissociation measures in phytosociological classification." J. Ecol. 59, No. 1. 39-50.

Austin, M.P. (1968). "An ordination study of a chalk grassland community." J. Ecol. 56. 739-57.

Austin, M. P. (1971). "Models and analysis of descriptive vegetation data." in Mathematical Models in Ecology, ed. J.N.R. Jeffers, 12th Symp. of the Bri. Ecol. Soc. Blackwell Sc: Pub.

Austin, M.P., and P. Greig-Smith (1968). "The application of quantitative methods to vegetation survey." II: Some methodological problems of data from rain forest. J. Ecol. 56, 827-844.

Avery, B.W. (1966). "A classification of British soils". Transactions of the 6th International Congress of Soil Science, 5, 279-285.

Barkham, J.P. and J. M. Norris (1970). "Multivariate procedures in an investigation of vegetation and soil relations of two beech woodlands, Cotswold Hills, England. Ecology 51, 630-9.

Barttlet, H.H. (1956). "Fire, primitive agriculture and grazing in the tropics" in W.L. Thomas, Man's role in changing the surface of the earth, pp. 692-720.

Bawden, M.G. (1972). "Integrated survey of Land Resources in Central Nigeria" in Savanna, Vol. 1, No. 1, 108-110. pub. Ahmadu Bello University Press, Zaria.

Beals, E.W. (1973). "Ordination: mathematical elegance and ecological naivete." J. Ecol. 61, 23-35.

Beard, J.S. (1953). "The savanna vegetation of northern tropical America." Ecol. Monogr. 23, 149-215.

Beckett, P.H.T. (1968). "Method and scale of land resources surveys in relation to precision and cost" in G.A. Stewart, ed. Land Evaluation C.S.I.R.O. Symposium, pp. 53-63.

Bews, J.W. (1929). The World's grasses. London. in J.S. Beard (1953) "The savanna vegetation of northern tropical America"; Ecol. Monogr. 23, 149-215.

Bird, E.C.F. (1957). "The use of the soil catena concept in the study of the ecology of the Wormley Woods, Hertfordshire." J. Ecol., 45. 465-469.

Black, C.A. (1965). Methods of Soil Analysis, American Society of Agronomy Inc. Madison, Wisconsin.

Blair-Rains, A. (1968). "A field key to the commoner genera of Nigerian Grasses." Samaru Miscellaneous Paper No. 7.

Boughey, A.S. (1956). "The physiognomic delimitation of West African Vegetation Types", in Committee for Technical Co-operation in Africa, C.S.A., specialist meeting on phytogeography, Yagambi. Publication No. 53, 148-165.

Bot, J. (1977). "Kuyello Farm Settlement Scheme" in Centre for Social and Economic Research 'Project Document Kuyello'. Ahmadu Bello Univ., Zaria.

Brand, B. and H. Brammer (1956). "Provisional grassland associations of the interior and coastal savannah zones of the Gold Coast." Gold Coast Dept., of Soil and Land-use Survey. Technical report No. 21. Kumasi.

Braun, L. (1935). "The undifferentiated deciduous forest climax and the association-segregate." Ecology 16, 514-519.

Braun-Blanquent, J. (1932). Plant Sociology: The study of Plant Communities. McGraw-Hill, New York.

Bray, R.J. and J. T. Curtis (1957). "An ordination of the upland forest communities of southern Wisconsin." Ecol. Monog. 27, 325-349.

Buringh, P. (1954). "The analysis and interpretation of aerial photographs in soil survey and land classification." Netherlands Journal of Agric. Science 2, 16-26.

Caillie, R. (1830). Travels through Central Africa to Timbuctoo (1830) in C. Lloyd (1973) The Search for the Niger. Collins, St James's Place, London.

Cassie, R.M. and A.D. Michael (1968). "Fauna and sediments of an intertidal mudflat." J. exp. mar. Biol. Ecol. 2, 1-23.

Cassie, R.M. (1969) "Multivariate analysis in ecology", N.Z. Ecol. Soc. Proc. 16, 53-7.

Cattell, R.B. (1952). Factor analysis, Harper & Bros. New York.

Cattell, R. B. (1965). "Factor analysis: An introduction to essentialsI. The purpose and underlying models." Biometrics 21 (1), 190-215. The Biometric Society.

Chevalier, A. (1900). "Les zones et les provinces Botanique de L'A.O.F., Comptes Rendus de l'Acad. Scien. 130 in R.W.J. Keay (1949). Govt. Printer, Lagos.

Christian, C.S. and G.A. Stewart (1953). General report on the survey of Katherine, Darwin Region. C.S.I.R.O., Australian Land Resources Series No. 1.

Clapperton, H. (1829). Journal of a Second Expedition into the Interior of Africa (1829) in E.W. Bovill (1968) The Niger Explored. Hakluyt Society, London.

Clark, C. (1977). Population, Growth, and Land use, publ. Macmillan Press Ltd. London and Basingstoke.

Clarke, G.R. (1954). "Soils of the Oxford Region." Brit. Ass. Oxford Meeting, Oxford.

Clayton, W.D. (1957). "A preliminary survey of soil and vegetation in northern Nigeria." Min. of Agric., Samaru, Northern Nigeria.

Clayton, W.D. (1960). A key to Nigerian Grasses, Samaru Res. Bulletin No. 1. Regional Res. Station, Samaru, Zaria, Northern Nigeria.

Clayton, W.D. (1963) "The vegetation of Katsina province, Nigeria." J. Ecol. 51, 345-51.

Clayton, W.D. (undated departmental report). "Some Aspects of Vegetation Survey in Nigeria." Soil Survey Section, Soil Science Dept., Inst. Agric. Res., Samaru.

Clayton, W.D. and W.A. Hope (1958). "Report on the reconnaissance soil and detailed vegetation survey of an area near Wushishi, Niger Province, Northern Nigeria." Soil Surv. Bull. Samaru, 6.

Clements, F. E. (1905). Research methods in Ecology. Univ. Publ. Co., Lincoln, Nebr.

Cocheme, J. and P. Franquin (1967). "A study of the agroclimatology of the semi-arid area south of the Sahara in West Africa." FAO, UNESCO, WMD Interagency Project on Agriclimatology, Rome, 325.

Crawford, R.M.M. and D. Wishart (1966). "A multivariate analysis of the development of dune slack vegetation in relation to coastal accretion at Tentsmuir, Fife." J. Ecol. 54, 729-43.

Culwick, A.T. (1963). Britannia Waives the Rules, publ. Nasionale Boekhandel, Capetown.

Curry-Lindahl, K. (1974). Conservation for Survival - An Ecological Strategy. London, Victor Gollancz Ltd.

Curtis, J.T. (1955b). A prairie continuum in Wisconsin. Ecology 36, 558-566.

Curtis, J.T. (1959). The Vegetation of Wisconsin: an ordination of Plant Communities. Madison, Wisconsin.

Dagnelie, P. (1978). "Factor analysis" in R.H. Whittaker, ed. Ordination of Plant Communities, pp. 215-238. Publ. The Hague, The Netherlands.

Daubenmire, R. (1966). Vegetation: identification of typal communities, Science 151, 291-298.

Daubenmire R. (1968). Plant Communities: A textbook of Plant Synecology, Harper and Row, New York, and London.

Daubenmire, R, (1968). "Ecology of fire in grasslands", Adv. Ecol. Res. 5, 209-266.

Davies, O. (1968). "The origins of agriculture in West Africa", Current Anthropology 9, 479-480.

Dawkins, H.C. (1970). "Techniques for long-term diagnosis and prediction in forest communities" in E. Duffey and A.S. Watt, eds. The Scientific Management of Animal and Plant Communities for Conservation. The 11th Symposium of the British Ecological Society. Blackwell Sc. Pub., Oxford, London and Edinburgh.

De Leeuw, P.N. (1965)."The role of savanna in nomadic pastoralism: Some observations from Western Bornu, Nigeria." In Netherlands Journal of Agric. Sci. 13, 178-189.

De Leeuw, P.N. (1975). "Species preferences of the domestic ruminants grazing Nigerian Savanna" in Wildlife Management in savanna woodland, pp. 207-224. Proc. Int. Symp. Wildlife Management, Ibadan.

De Leeuw, P.N., and P. Tuley (1972). "The vegetation", pp. 121-55, in The Land Resources of North East Nigeria, Vol. 1. The Environment, Land Resources Study, No. 9. Land Resources Division, London.

De Leeuw, P.N., A. Leslie and P. Tuley (1972). The Land Resources of North East Nigeria, Vol. 4. Present and Potential Land Use. Land Resources Study No. 9. Land Resources Division, Tolworth Tower, Surrey.

Del Moral, R. and C. H. Muller (1970). "The allelopathic effects of Eucalyptus camaldulensis Amer. Midl. Natur. 83, pp. 254-282 in E. L. Rice (1974) Allelopathy.

Dobbs, C. G. (1969), "Concerning the Control and the Defence of Environment Pollution." Reprint from Journ. of the Soil Ass. Walnut Tree Manor, Haughley, Stowmarket, Suffolk.

Drzymalski, E.R. (1974). Methods of Soil Analysis. Soil Survey Laboratory, Inst. Agric. Res., Samaru.

Everitt, B.S. (1979). "Unresolved problems in Cluster Analysis", Biometrics 35, pp. 169-181.

Emerson, R.A. (in J. Griffith-Jones (1977)). The virtuous weed, publ. Blond & Briggs Ltd., London and Tiptree.

Frey, T. and H. van Groenewoud (1972). "A cluster analysis of the D² matrix of white spruce stands in Saskatchewan based on the maximum-minimum principle." J. Ecol. Vol. 62, pp. 873-886.

Forestry-Lagos (1962 196 . ores ration of Nigeria National Development Pla 19 . pu Federal Ministry of Economic Development, Lagos, 3-30

Forestry-Lagos (1 . 'F estry t programme", publ. Federal Ministry of Economic Development, Lagos.

Gauch, H.G. Jr., and T.R. Wentworth (1976). Canonical correlation analysis as an ordination technique. Vegetatio 33, 17-22.

Gittins, R. (1969). "The application of ordination techniques." In Benchmark Papers in Systematic and Evolutionary Biology, Vol. 2. Halsted Press, Penn.

Gleason, H.A. (1926). "The individualistic concept of the plant association.". Bull. Torrey Bot. Club, 53, 7-26.

Goldsmith, F.B. and C.M. Harrison (1976). "Description and analysis of vegetation." in S.B. Chapman, ed. Methods in Plant Ecology, pp. 85-155. Blackwell Sci. publ.

Goodall, D.W. (1952). "Quantitative aspects of plant distribution.". Biol. Rev. 27, 194-245.

Goodall, D.W. (1954). "Vegetational classification and vegetation continua." Angew-Pflanz. Zoziol. 1, 168-82.

Goodall, D.W. (1963). "The continuum and the individualistic association." Vegetatio II, 297-316.

Goodall, D.W. (1965). "The nature of the mixed community." Proc. Ecol. Soc. Australia 1, 84-96.

Goodall, D.W. (1978). Sample Similarity and Species Correlation in Ordination of Plant Communities, ed. R.H. Whittaker, pp. 99-149. The Hague, Netherlands.

Goodland, R.J.A. (1969). "An ecological study of the Cerrado vegetation of South-Central Brazil Thesis, McGill University, Montreal in J. Ecol.

Goodland, R.J.A. (1970a). "Plants of the Cerrado vegetation of Brazil." Phytologia, 20, 57-78.

Goodland, R.J.A. (1970b). The Savanna Controversy . Ed. publ. McGill University, Montreal.

Goodland, R.J.A. (1971). "A physiognomic analysis of the 'Cerrado' Vegetation of Central Brazil." J. Ecol. Vol. 59, 411-419.

Greig-Smith, P. (1964). Quantitative plant ecology, 2nd ed. Butterworths & Co., London.

Greig-Smith, P., M.P. Austin, and T.C. Whitmore (1967). "The application of quantitative methods to vegetation survey." I. Association analysis and principal component ordination of rain forest. J. Ecol. 55, 483-503.

Greig-Smith, P. (1971). "Analysis of vegetation data: the user viewpoint." in G.P. Patil, E.C. Pielou, ed. Statistical Ecology, and W.G. Waters Vol. 3, pp. 149-166. Penn. State Univ.

Greig-Smith, P. (1979). pers. comm.

Grigg, D.B. (1974). The agricultural systems of the world: An evolutionary approach. Cambridge Geographical Studies, Cambridge Univ. Press.

Grisebach, A. (1872). Die Vegetation der Erde nach ihrer klimatischen Anordnung, Wilhelm Engelmann, Leipzig, Vols I and II.

Gulliver, P.H. (1975). "Nomadic Movements: Causes and Implications" in Theodore Monod, ed. Pastoralism in Tropical Africa, Oxford Univ. Press, London, Ibadan.

Haggar, R.J. (1968). "Grazing behaviour of Fulani cattle at Shika, Nigeria." Tropical Agric. Tina, 45, 179-185.

Hall, A.V. (1970). "A computer-based method of showing continua and communities in ecology". J. Ecol. 58, No. 3, 591-602.

Harper, J.L. (1971). "Grazing, fertilizers and pesticides in the management of grasslands." in E. Duffey and A.S. Watt, ed. The Scientific Management of Animal and Plant Communities for Conservation, pp. 15-31, 11th Symposium of British Ecological Society. Blackwell Scientific Publications, Oxford.

Haw, R.C. (1959). The Conservation of Natural Resources, Faber & Faber Ltd. 24 Russell Square, London.

Hepper, F.N. (1963, 1968, 1972). "Floral of West Tropical Africa." See Hutchinson and Dalziel (1927 & 1936).

Higgins, G.M. (1964). "Soils of some rice growing areas in Northern Nigeria." Reprint from African Soils Vol. IX, No. 2, pp. 247-287.

Hill, M.O. (1973). "Reciprocal averaging: an eigenvector method of ordination." J. Ecol. 61, 237-249.

Hill, P. (1971). "Grass forage, food for fauna or fuel for fire or both?" Proc. 11th Annu. Tall Timbers Fire Ecol. Conf. pp. 337-375.

Hope, W.A. (1976). "Ikara Farm Centre." Soil Survey Report. Inst. Agric. Res. Samaru (unpublished).

Hopen, C.E. (1958). The Pastoral Fulbe Family in Gwandu. International African Institute, Oxford University Press.

Hopkins, B. (1957). "Pattern in the Plant Community", J. Ecol. 45, 451-463.

Hopkins, B. (1963). "The role of fire in promoting the sprouting of some savanna species", J. West African Sci. Ass. 7, 154-162.

Hopkins, B. (1965). "Observations on savanna burning in the Olokemeji Forest Reserve, Nigeria." J. Appl. Ecol. 2, 367-381.

Hopkins, B. (1970). "Vegetation of the Olokemeji Forest Reserve, Nigeria VI and VII. The plants on the savanna site with special reference to their seasonal growth." J. Ecol. 58, 765-825.

Hopkins, B. (1974). Forest and Savanna: An introduction to tropical terrestrial ecology with special reference to West Africa. 2nd ed. Heinemann, Ibadan and London.

Hopkins, B. and D.P. Stanfield (1966). "A field key to the savanna trees of Nigeria." Ibadan University Press.

Hore, P.N. (1970). "Weather and Climate" in Zaria and its Region. Occasional Paper 4, Dept. of Geog., Ahmadu Bello Univ. ed. M.J. Mortimore.

Horowitz, M.M. (1975). "Herdsman and Busbandman in Nigera: Values and Strategies." in Theodore Monod. ed. Pastoralism in Africa.

Hotelling, H. (1933). Analysis of a complex of statistical variables into principal components in Benchmark papers in systematic and evolutionary biology, Vol. 2, 31-55, ed. E.H. Bryant and W.R. Atchley, Halsted Press.

Howard, W.J. (1964). "A description of some of the surveys carried out by the savanna investigation unit." Proceedings of the First Nigeria Forestry Conference, Kaduna, Northern Nigeria.

Hugot, H.J. (1968). "The origins of agriculture in Africa: The Sahara." Current Anthropology 9, 47-60.

Hutchinson, J. and J.M. Dalziel (1927 & 1936). "Flora of West Tropical Africa", second editions revised by Keay (1954, 1958) and Hepper (1963, 1968, 1972). Crown Agents for Overseas Govts. and Admin. Millbank, London.

Ivimey-Cook, R.B. and M.C.F. Proctor (1966). "The application of association-analysis to phytosociology." J. Ecol. 54, 179-92.

Jackson, G. (1970) "Vegetation around the city and nearby villages of Zaria" in Zaria and its region. Ahmadu Bello Univ. Dept. of Geog. Occasional Paper 4, ed. M.J. Mortimore, 61-71.

Jaeger, F. (1945). "Zur Gliendergun und Benennung des tropischen grass-landgurtels" in Natural Savannas as a Transition to the Arid Zone pp. 238-265, Ecology of Tropical and Sub-tropical vegetation by H. Walter (1971) English translation Oliver & Boyd, Edinburgh.

Jardine, N. and R. Sibson (1968). "The construction of hierarchic and non-hierarchic classifications." Computer Journal II, 17-184.

Jardine, N. and R. Sibson (1971). "Numerical Taxonomy", Wiley, London, p. 275.

Keay, R.W.J. (1949a). An Outline of Nigerian Vegetation. Govt. Printer, Lagos.

Keay, R.W.J. (1949b). "An example of Sudan Zone Vegetation". J. Ecol. 37, 305-324.

Keay, R.W.J. (1953). An Outline of Nigerian Vegetation. Second Edition, Govt. Printer, Lagos.

Keay, R.W.J. (1954 & 1958). Flora of West Africa. See Hutchinson and Dalziel 1954 and 1956).

Keay, R.W.J. (1959). An Outline of Nigerian Vegetation. Third Edition, Govt. Printer, Lagos.

Kemp, R.H. (1969). "Trials of exotic tree species in the Savanna region of Nigeria". Research Paper No. 4. Savanna For. Res. Station, Samaru, Zaria. Fed. Republic of Nigeria, Min. Agric. & Nat. Res.

Kempton, R.A. (1979). "The Structure of Species Abundance and Measurement of Diversity". Biometrics 35, 307-321, March 1979.

Kershaw, K.A. (1968a). "A survey of the vegetation in Zaria province, N. Nigeria". Vegetatio 30, 244-68.

Kershaw, K.A. (1968b). "Classification and ordination of Nigerian Guinea Savanr Vegetation". J. Ecol. 56, 467-482.

Kershaw, K.A. (1973). Quantitative and Dynamic Plant Ecology, Second Edition, Edward Arnold Publishers, London.

King, J. (1962). "The Festuca-Agrostis grassland complex in south-east Scotland". J. Ecol. 50,321-355.

Kirk-Green, A.H.M. (1962). Barth's travels in Nigeria.

Klinkenberg, K. and G.M. Higgins (1970). "An outline of Northern Nigerian soils". Samaru Res. Bulletin 107. Inst. Agric. Res., Samaru.

Koppen-Geiger (1936). "Handbuch der Klimatogie" in C.P. Wilsie, ed. Crop adaptation and distribution, Iowa State University.

Kowal, J.M. and K.B. Adeoye (1973). "An assessment of aridity and the severity of the 1972 drought in northern Nigeria and neighbouring countries". Savanna Vol. 2 No. 2. December 1973. publ. Ahmadu Bellow University, Zaria, Nigeria.

Kowal, J.M. and A.H. Kassam (1978). Agricultural ecology of Savanna: A study of West Africa, Clarendon Press, Oxford.

Krajina, V.J. (1961). "Ecosystem classification of forests: Summary". in Recent Advances in Botany II, 1599-1603. Univ. Toronto Press, Toronto.

Lambert, J.M. (1971). "Theoretical models for large-scale vegetation survey" in J.N.R. Jeffers, ed. Mathematical Models in Ecology, [illegible] of the British Ecol. Soc. Blackwell Sci. Pubs. pp.87-109.

Lawson, G.W., J. Jenik and K.O. Armstrong-Mensah (1968). "A study of a vegetation catena in Guinea savanna at Mole Game Reserve (Ghana)". J. Ecol. 56, 505-757.

Lely, H.V. (1925). The useful trees of Northern Nigeria . London.

Lloyd, C. (1973). The Search for the Niger. Collins, St James's Place, London.

Lloyd, P.S. (1971). "Effects of fire on the chemical status of herbaceous communities of the Derbyshire Dales". J. Ecol. 59, 261-273.

Macmillan, H.F. (1943). Tropical Planting and Gardening with special reference to Ceylon . publ. Macmillan & Company Ltd., London, Bombay, Calcutta, Madras, Melbourne. 5th edition, 1943.

Madgwick, H.A.J. and P.A. Desrochers (1972). "Association-analysis and the classification of forest vegetation of the Jefferson National Forest". J. Ecol. 60, No. 2, 285-92.

Major, J. (1961). "On two trends in phytocoenology". Vegetatio 10, 372-385. (Translation of Ponyatovskaya, V.M.)

Major, J. (1969). "Historical Development of the Ecosystem Concept" in G.M. Van Dyne, ed. The Ecosystem Concept in Natural Resource Management, pp. 9-22. Academic Press, New York and London.

McDonald, R.P. (1970). "The theoretical foundations of principal factor analysis, canonical factor analysis, and alpha factor analysis." British J. Math. Psychol., 23 1, 1-21. The British Psychological Society.

McIntosh, R.P. (1958). "Plant Communities". Science Vol. 128, No. 3316, 115-120.

McIntosh, R.P. (1967). "The continuum concept of vegetation". Bot. Rev. 33, 130-187.

McIntosh, R.P. (1973). "Matrix and plexus techniques' in R.H. Whittaker, ed. Handbook of vegetation science. Ordination and Classification of Communities 5, pp. 157-191.

Meek, C.K. (1925). The Northern Tribes of Nigeria, Vols. I and II. An Ethnographical Account of Northern Provinces of Nigeria, publ. Frank Cass and Co. Ltd. (1971 New Impression.)

Metz, L.J. and R.A. Klawitter (1961). "Some effects of prescribed burning on coastal plain forest soil". U.S. Forest Serv., South-east Forest Exp. Sta. Paper 133, 10.

Meyers, J.G. (1936). "Savannah and forest vegetation of the interior Guiana plateau". J. Ecol. 24, 162-184.

Miller, R. (1954). Travels of Mungo Park.

Milne, G. (1935). "Some suggested units for classification and mapping, particularly for East African soils". Soil Res. 4, 183-98

Milne, G. (1947). "A soil reconnaissance journey through parts of Tanganyika Territory, 1935-36." J. Ecol. 35, 192-265.

Mohammed, I.G. (1978). "Forest Plantations, Kaduna State." Report from the Divisional Forest Officer, Zaria, to the Ministry of Animal and Forest Resources, Kaduna State. (Unpublished.)

Moore, W. G. (1974). "The Penguin Dictionary of Geography." 5th edition, Penguin Reference Books Ltd.

Moreau, R. E. (1933). "Pleistocene climatic changes and the distribution of life in East Africa." J. Ecol. 21, 415-435.

Morgan, W.B. (1969). "Peasant agriculture in tropical Africa." in M.F. Thomas and G.W. Wittington, Environment and land use in Africa, 241-72.

Morison, C.G.T., A.C. Hoyle, J.F. Hope-Simpson (1948). "Tropical forest soil-vegetation catenas and mosaics." J. Ecol. 36, 1-84.

Morris, B. (1970). The epiphytic orchids of Malawi, publ. Society of Malawi.

Morrison, D.F. (1967). Multivariate Statistical Methods. New York, McGraw-Hill.

Moss, R.P. (1968). "The soil resources of Tropical Africa" in M.F. Thomas, ed. Geomorphology and Land classification in tropical Africa.

Moss, R.P. (1969). "The ecological background to land use studies in tropical Africa, with special reference to the West," in M.F. Thomas and G.W. Whittington, ed. Environment and land use in Africa, pp. 193-238.

Moss R.P. (1969). "An ecological approach to the study of soils and land use in the forest zone of Nigeria" in Environment and Land use in Africa, pp. 385-407.

Mueller-Dombois, D. and H. Ellenberg (1974). Aims and methods of vegetation ecology. John Willey & Sons, New York.

Muller, C.H. (1966). "The role of chemical inhibition (allelopathy) in vegetational composition." Bull. Torrey Bot. Club 93, 332-351.

Murdock, G.P. (1960). "Staple subsistence crops of Africa." Geographical Review 50, 523-540.

Nie, N.H., C.H. Hull, J.G. Jenkins, K. Steinbrenner and D.H. Bent (1975). Statistical Packages for the Social Sciences (SPSS), 2nd edition. McGraw-Hill Book Co.

Nielsen, M.S. (1965). Introduction to the flowering plants of West Africa, University of London.

Nigeria Year Book (1968, 1973). "A 'Daily Times' Magazine Division Publication". Times Press Ltd., Apapa.

Niven, C.R. (1950). A short history of Nigeria, publ. Longmans, Green & Co., London.

Norman, D.M. (1968). "Why practise intercropping?" in Samaru Agric. Newsletter Vol. 10, No. 16, December 1968, publ. Inst. Agric. Res. Samaru.

Noy-Meir, I. (1973). "Data transformation in ecological ordination I. Some advantages of non-centering." J. Ecol. 61, 329-341.

Noy-Meir, I. and M.P. Austin (1970). "Principal component ordination and simulated vegetation data." Ecol. 51, 551-2.

Noy-Meir, I. and R.H. Whittaker (1978). "Recent developments in continuous multivariate techniques" in Ordination of Plant Communities, pp. 337-8.

Nye, P.H. and D.J. Greenland (1960). The Soil Under Shifting Cultivation, Technical Communication No. 51, publ. Commonwealth Agricultural Bureaux 1960.

Ojo, G.O.A. (1973). "The introduction of exotics with particular reference to Eucalyptus in Nigeria." Federal Dept. of Forest Research Ibadan, Research Paper. Savanna Series No. 24.

Okali, D.U.U. (1971). "Tissue water relations of some woody species of the Accra Plains, Ghana." J. Ecol. Vol. 59, 89-101.

Ologe, K.O. (1971). "Gully development in Zaria Area, N. Nigeria, with particular reference to the Kubanni Basin." Ph.D. thesis submitted to the University of Liverpool.

Orloci, L. (1966). "Geometric models in ecology I. The theory and application of some ordination methods." J. Ecol. 54, 193-215.

Orloci, L. (1968). "A model for the analysis of structure in taxonomic collections." Can. Journ. Bot. 46, 1093-1097.

Osanoto, G.O. (1972). "Plant distribution associated with the soil catena in the Guga Forest Reserve with special reference to the ironstone layers." B.Sc. project. Ahmadu Bello University, Zaria.

Osanoto, G.O. (1975). "A study of some comparative approaches to vegetation-environment analysis in the Aber Valley, North Wales." M.Sc., dissertation, University of Wales.

Owen, D.F. (1976). Ecosystems and how they work in What is Ecology? 109-136. 2nd impression, publ. Oxford University Press.

Pakarinen, P. and R. Ruuhijarvi (1978). "Ordination of Northern Finnish peatland vegetation with factor analysis and reciprocal averaging." Ann. Bot. Fennici 15, 147-157.

Phillips, E.A. (1959). Methods of vegetation study, publ. Holt, Rinehart & Wiston Inc. 383 Madison Ave., New York, NY 10017.

Phillips, J. (1959). Agriculture and ecology in Africa. Faber & Faber, London.

Poore, M.E.D. (1962). "The method of successive approximations in descriptive ecology." Adv. Ecol. Res. 1, 35-68. Academic Press, Inc., London.

Poore, M.E.D. (1964). "Integration in the plant community." J. Ecol. 52, 213-226.

Pritchard, N.M. and A.J.B. Anderson (1971). "Observations on the use of cluster analysis in botany with an ecological example." J. Ecol. 59, No. 3, 727-747.

Proctor, M.C.F. (1966). "The descriptive approach to vegetation studies" in J.M. Lambert, ed. The Teaching of Ecology. British Ecol. Soc. Symposium No. 7, 113-123.

Pullan, R.A. (1961). "A report on the reconnaissance soil survey of Birnin Kebbi (Sokoto) area". Samaru Soil Survey Bulletin 17.

Pullan, R.A. and P.J. de Leeuw (1969). "The Soils of Kirawa Area, North East State, Nigeria." Soil Survey Bulletin No. 42. Inst. Agric. Res., Samaru. Ahmadu Bello University, Zaria, Nigeria.

Purseglove, J.W. (1976). Tropical crops. Monocotyledons and Dicotyledons. Vols. I and II. Publ. Longman Group Ltd., London, 2nd impression.

Putwain, P.D. and J.L. Harper (1970). "Studies in the dynamics of plant populations II. The influence of associated species on populations of Rumex acetosa and R. acetosella L. in grassland." J. Ecol. 58, 1970.

Ramsay, D.McC (1963). "A preliminary working classification of soils for Northern Nigeria." Soil Survey Report 7, Inst. Agric. Res., Samaru.

Ramsay, D. McC. (1968). "Land use in Nigeria" in Samaru Agric. Newsletter Vol. 10, No. 4, August 1968, publ. Inst. Agric. Res., Samaru.

Ramsay, D.M. and G.M. Higgins (1966). "Methods and uses of soil survey in Northern Nigeria". Samaru Agric. Newsletter Vol. 8, No. 6, Inst. Agric. Res., Ahmadu Bello University, Zaria.

Ramsay, D.McC and P.N. de Leeuw (1964). "An analysis of Nigerian Savanna I. The Survey Area and the Vegetation Developed over Bima Sandstone." J. Ecol. 52, 233-254.

Ramsay, D.McC. and P.N. de Leeuw (1965). "An analysis of Nigerian savanna IV. Ordination of vegetation developed in different parent materials." J. Ecol. 53, 661-677.

Ramsay, J.M. and R. Rose Innes (1963). "Some quantitative observations on the effects of fire on the Guinea savanna vegetation of Northern Ghana over a period of eleven years." African Soils 8, 41-85.

Rao, C.R. (1955). "Estimation and tests of significance in factor analysis." Psychometrika, 20, 93-111.

Rao, C.R. (1960). "Multivariate analysis: An indispensable aid in applied research." Sankhya 22, 317-338.

Rao, C.R. (1961). "Some observations on multivariate statistical methods in anthropological research." Bull. Int. Stat. Inst. 38, 99-109.

Rao, C.R. (1964). "The use and interpretation of principal component analysis in applied research." Sankhya: The Indian Journ. of Stat. Series A 26, 329-358.

Rice, E.L. (1974). Allelopathy: Physiological Ecology, A series of Monographs, Texts and Treatises. Publ. Academic Press, New York, San Francisco, London.

Richards, P.W. (1970). The Life of the Jungle. Our Living World of Nature Series. McGraw-Hill, New York.

Richards, P.W. (1973). "The tropical rain forest". Reprint from Scientific American. December 1973. Vol. 229, No. 6.

Rolf, F.J. (1971). "Perspectives on the application of multivariate statistics to taxonomy" Taxon 20(1), 85-90, in E.H. Bryant and W.R. Atchley, ed. Benchmark Papers in Systematic and evolutionary Biology, Vol. 2, pp. 5-10. Halsted Press.

Rose-Innes, R. (1971). "Fire in West African vegetation." Proc. 11th Annu. Tall Timbers Fire Ecol. Conf. pp. 147-173.

Salisbury, E.J. (1959). "Causal Plant Ecology." in W.B. Turrill, ed. Vistals in Botany I: International Series of Monographs on Pure and Applied Biology. Pergamon Press, London, New York, Paris, Los Angeles, pp. 124-144.

Schimper, A.F.W. (1903). Plant geography on a physiological basis. Oxford.

Schimper, A.F.W. and F.C. von Faber (1935). Pflanzengeographie auf physiologicher Grundlage. 3rd ed. Fisher, Jena. in "Approaches to classifying vegetation" R.H. Whittaker, pp. 3-31. ed. Classification of Plant Communities (1978) publ. The Hague, The Netherlands.

Smith, E.F., V.A. Young, K.L. Anderson, W.S. Ruliffson, and S.N. Rogers (1960). "The digestibility of forage on burned and non-burned bluestem pasture as determined with grazing animals." J. Anim. Sci. 19. 388-391.

Smith M.G. (1955). "The economy of Hausa Communities of Zaria." A report to the Colonial Social Science Research Council. Colonial Research Studies No. 16, publ. Her Majesty's Stationery Office.

Stanfield, D.P. (1966). "The flora of Nigeria GRASSES illustrations." Ibadan University Press.

US.D.A. (1951). Soil survey manual. Agricultural Handbook No. 18. United States Department of Agric. Soil Survey Staff.

Tansley, A.G. (1935). "The use and abuse of vegetational concepts and terms." Ecol. 16, 285-307.

Theron, J.J. (1951). "The influence of plants on the mineralization of nitrogen and the maintenance of organic matter in soil." J. Atric. Sci. 41, 289-296 in E.L. Rice (1974) Allelopathy.

Tomlinson, P.R. (1965). "Soils of northern Nigeria". Samaru Miscellaneous Paper No. 11, Inst. Agric. Res., Samaru.

Troll, C. (1935). "Gedanken und Bermerkungen zur okologischen pflanzen-geographie." Geogr. Zsch. 41, 380-8 in H. Walter (1971), Edinburgh.

Turner, B. (1977). "The geomorphology and land use of the fadamas of central northern Nigeria." (Thesis submitted to the University of London for the degree of D.Phil. Dept. of Geography.) Soil Survey Bulletin 46. Inst. Agric. Res., Samaru.

Valette, J. (1977). "Land evaluation of the soils on Nupe Sandstone in the Mokwa-Kainji-Kontagora area, N.W. Nigeria." Samaru Agric. Newsletter Vol. 19, No. 1, 27-34.

Valette, J. and G.O. Osanoto (1977). "Soil and vegetation survey of Kuyello Area, Kaduna State." Soil Survey Bulletin Draft. Inst. Agric. Res., Samaru.

Vavilov, N.I. (1950). "The origin, variation, immunity and breeding of cultivated plants." Chronica Botanica 3, 1-366.

Vogl, R.J. (1974). "Effects of Fire on Grasslands" in Fire and Ecosystems ed. T.T. Kozlowski and C.E. Ahlgren, pp. 139-194. Academic Press In.,

Wallace, W. (1896). Notes on a journey through the Sokoto empire and Borgu in 1894 in Geographical Journal 8, 212-213.

Walter, H. (1971). Ecology of tropical and subtropical vegetation. Oliver & Boyd, Edinburgh.

Walter, H. (1973). Vegetation of the earth in relation to climate and eco-physiological conditions. Springer-verlag, New York, Heidelberg, Berlin.

Walter, M.W. (1968). "Length of the rainy season in Nigeria." Samaru Res. Bulletin No. 103.

Warming, J.E.B. (1892). Lagoa Santa. K. danske Vidensk. Selsk. Skr. 6 (3), 155-488 in R. Goodland (1971). J. Ecol. 59, 411-419.

Warming, E. and P. Graebner (1918). Lerhrbuch der okologischen Pflanzengeographie. Berlin in J.S. Beard (1953) "The Savanna Vegetation of Northern Tropical America." Ecol. Monogr. 23, 149-215.

Watt, A.S. (1934). "The vegetation of the Chiltern Hills with special reference to the beechwoods and their seral relationships, Pt. I." J. Ecol. 22, 230-70.

Watt, A.S. (1947). "Contributions to the ecology of bracken (Pteridium aquitinum) IV. The structure of the community." New Phytol. 46, 97-121.

Watt, A.S. (1970). "Factors controlling the floristic composition of some plant communities in Breckland" in E. Duffey and A.S. Watt, eds. Scientific Management of Animal and Plant Communities for Conservation, pp. 137-166.

Weaver, J.E. and F.E. Clements (1938). Plant Ecology. McGraw-Hill, New York.

Webb, D.A. (1954). "Is classification of plant communities either possible or desirable?" Bot. Tidsskr. 51, 362-70.

Webster, R., and P.T.H. Beckett (1964). "A study of the agronomic value of soils interpreted from air photographs." Transactions of The 8th Int. Congr. of Soil Sci. 5, 795-803.

Webster, R. and P.T.H. Beckett (1970). "Terrain classification and evaluation using air photography: review of recent work at Oxford." Photometry, 26, 51-73.

Westhoff, V. (1970). "The dynamic structure of plant communities in relation to the objectives of conservation," in E. Duffey and A.S. Watt, ed. The Scientific Management of Animal and Plant Communities for Conservation. 11th Symposium of the British Ecological Society, pp. 3-14.

Westhoff, V. and E. van der Maarel (1973). "The Braun-Blanquent approach" in R.H. Whittaker, ed. Ordination and Classification of Communities, Handbook of Vegetation Science, Vol. 5, 617-726. Tuxen, Junk, The Hague.

Whittaker, R.H. (1953). "A consideration of climax theory: the climax as a population pattern." Ecol. Monogr. 23, 41-78.

Whittaker, R.H. (1956). "Vegetation of the Great Smoky Mountains." Ecol. Monogr. 26, 1-80.

Whittaker, R.H. (1962). "Classification of natural Communities.".Bot. Rev. 28, pp. 1-239.

Whittaker, R.H. (1967). "Gradient analysis of vegetation." Biol. Rev. 42, 207-264.

Whittaker, R.H. (1973). Ordination and Classification of Communities - Introduction Handbook of vegetation science Part 5, The Hague.

Whittaker, R.H. (1975). Communities and Ecosystems. Second edition. publ. Macmillan Publications Co., Inc. New York. Collier Macmillan Publishers, London.

Whittaker, R.H. (1978). Ordination of Plant Communities (ed.) W. Junk bv publ. The Hague, Boston.

Whittaker, R.H. and H.G. Gauch Jr. (1978). "Evaluation of ordination techniques" in Ordination of Plant Communities, pp. 277-336.

Whitten, D.G.A. and J.V.R. Brooks (1978). The Penguin dictionary of Geology. Hazell Watson & Viney Ltd., Aylesbury, Bucks.

Whyte, R.O. (1951). The rape of the earth: a world survey of soil erosion, co-ed. G.V. Jacks. Faber & Faber Ltd., London.

Wickens, G.E. (1976). "Speculations on long distance dispersal and the flora of Jebel Marra, Sudan Republic." Kew Bulletin Vol. 31, 105-50.

Williams, W.T. and J.M. Lambert (1959). "Multivariate methods in plant ecology 1. Association-analysis in plant communities." J. Ecol. 47, 83-101.

Williams, W.T. and J.M. Lambert (1960). "Multivariate methods in plant ecology: II. The use of an electronic digital computer for association analysis." J. Ecol. 48, 689-710.

Williams, W.T., G.N. Lance, M.B. Dale, and H.T. Clifford (1971). "Controversy concerning the criteria for taxonometric strategies." Computer Journal 14, 162-5.

Willis, A.J. (1973). "Quantitative methods of vegetation analysis," in Introduction to Plant Ecology. A completely revised edition of the late Sir Arthur Tansley's book. London. George. Allen & Unwin Ltd., pp. 112-127.

Woodell, S.R.J. (1978). Field discussions during supervisory visit to Nigeria.

Woodell, S.R.J. (1980). Personal Communications based on supervisory comments on initial drafts of this thesis.

Errata

1. Other bibliographies

Coombs, C.H. (1953). "Theory and methods of social measurement" in L. Festinger and D. Katz (ed.) Research Methods in the Behavioral Science, pp. 471-535. New York, Holt, Rinehart and Wiston.

Osae, T.A. and S.N. Nwabara (1968). A short history of West Africa. Book One. A.D.1000 to 1800. University of London.Press Ltd.

Oosting, H.J. (1956). The study of plant communities: An introduction to plant ecology, 2nd ed. San Francisco and London.

Pielou, E.C. (1975). Ecological Diversity. John Wiley & Sons Inc., New York.

Stevens, S.S. (1946). "On the theory of scales of measurement." Science, 103: 677-680.

Willian, R.G.M. (1940). "Notes on the vegetation of Northern Nyasaland". Empire Forestry Journ. 19: 48-71.

2. 'cerado' or 'cerrado' should be spelt Cerrado.