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A phytosociological classification of the Rustenburg Nature Reserve

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ABSTRACT

The vegetation of the Rustenburg Nature Reserve, situated on the Magaliesberg in Acocks's (1953) Sour Bushveld Veld Type of South Africa, is classified by the Braun-Blanquet Method. Five major vegetation types, including main subtypes, basic community types, variations and sub-variations are described floristically, physiognomically and in terms of habitat features. The vegetation is mapped at community type and variation level, at a scale of 1 : 30 000.

INTRODUCTION

The Rustenburg Nature Reserve is situated in Acocks's (1953) Sour Bushveld, which is listed by Edwards (1972a) as one of 52 of the South African Veld Types extremely lacking in conservation. The Sour Busveld covers 18 306 km², occurring in mountainous areas in the Transvaal. The Rustenburg Nature Reserve, which covers 2 896 ha, i.e. 0,2 per cent of the Veld Type, falls under the Nature Conservation Division of the Transvaal Provincial Administration and is the only area in this Veld Type that is managed specifically and reasonably permanently for conservation (Edwards, 1972a).

The Reserve is situated between 25° 41′ S and 25° 45′ S and between 27° 9′ E and 27° 13′ E, on the Magaliesberg, 2,5 km southwest of the outskirts of Rustenburg. The area comprises the farm Rietvallei 824 and a portion of previous town land. Rietvallei originally belonged to President Paul Kruger of the Zuid-Afrikaanse Republiek, who used the area as summer grazing for his horses. Later the farm belonged to the Rustenburg Town Council from whom it was obtained by the Transvaal Provincial Administration.

A botanical survey of the Reserve was carried out by Mr N. H. G. Jacobsen who supplied the botanical information for completion of an IBP (International Biological Programme) check sheet (Von Richter & Jacobsen, 1970/1) and compiled a check list of 554 plant species occurring in the Reserve (Jacobsen, 1971). Several of the plant communities mentioned in the IBP check sheet are confirmed as vegetation types in the classification presented here. The plant communities listed by Jacobsen were based on general reconnaissance observation whilst the communities described here were abstracted hierarchically by comparing complete floristic lists from sampling points spread over the Reserve. Inevitably, therefore, the communities mentioned in the IBP check sheet comprise vegetation types at different levels of the present hierarchical classification as well as combinations of communities which are here not regarded as together forming distinct vegetation types. The check sheet also lists communities that, although distinct in prominent species, are not so in total floristic composition. These differences emphasize some advantages of formalized semi-detailed surveys and the need raised by Edwards (1972a) to standardize and co-ordinate the recognition and identification of plant communities for a reference framework of South African vegetation.

Other surveys in the Sour Bushveld include those by: (i) Collett (1956) who gives a general description of a small nature reserve on the Magaliesberg; (ii) Van Wyk (1959) who described, at a broad level, the vegetation of the Pilansberg, part of the Magaliesberg and some hills in between these two mountains; and by (iii) Van Vuuren (1961) and Van Vuuren & Van der Schijff (1970). In the latter survey, communities were identified on the basis of total woody species composition. Woody species proved to be strongly differentiating between plant communities, also in the present study, and as Van Vuuren (1961) also lists grasses and forbs occurring in the communities recognized, his results can be integrated with classifications based on total floristic composition. Communities that are strongly related to those identified in the Rustenburg Nature Reserve have been described from the Central Variation of the Bankenveld by Coetzee (1972, 1974a) and from the Sourish Mixed Bushveld by Du Plessis (1973) and Theron (1973). These affinities stress the need for a uniform classification system that can be expanded by a process of integration and revision to include all Veld types.

The classification presented here is based on the the Braun-Blanquet method of vegetation survey, discussed in detail by Westhoff & Van der Maarel (1973) and Werger (1974a). This procedure is recommended by the Botanical Research Institute for making primary inventories of plant communities. It is methodologically suited to defining plant communities on the basis of considerations such as those discussed by Edwards (1972b), Werger (1973a & b, 1974b), Coetzee & Werger (1973, 1974a) and Coetzee (1974b). The method has been developed over a long period of extensive and increasingly successful applications in Europe, outlined in historical perspective by Werger (1973c), and is specifically designed to facilitate the integration of results from different workers in different areas into a comprehensive hierarchical reference framework in a manner explained by Werger (1974a). Presentation of results in table form has been standardized and the wealth of information essential for rational use of natural resources, readily apparent in such tables, is discussed by Werger (1974b).

PHYSIOGRAPHY AND PHYSIOGNOMY

The part of the Magaliesberg on which the Reserve is situated comprises recrystallized quartzite with interbedded hornfels and diabase intrusions (Fig. 1). The quartzite and hornfels are sedimentary rocks of the Transvaal System (Magaliesberg Stage of the

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Pretoria Series) and the intrusive diabase is of the Bushveld Igneous Complex. The Reserve lies on the summit, eastern slopes and foothills of the mountain (Figs. 2 and 3).

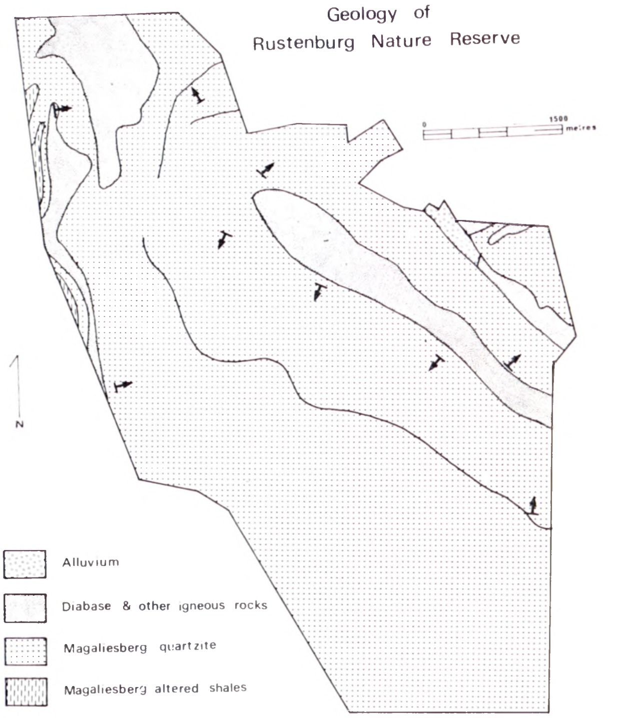

FIG. 1.—Geological map of the Rustenburg Nature Reserve (from the Dept. of Mines, 1960).

FIG. 2.—Topography of the Rustenburg Nature Reserve (from Trigonometrical Survey Office, 1969).

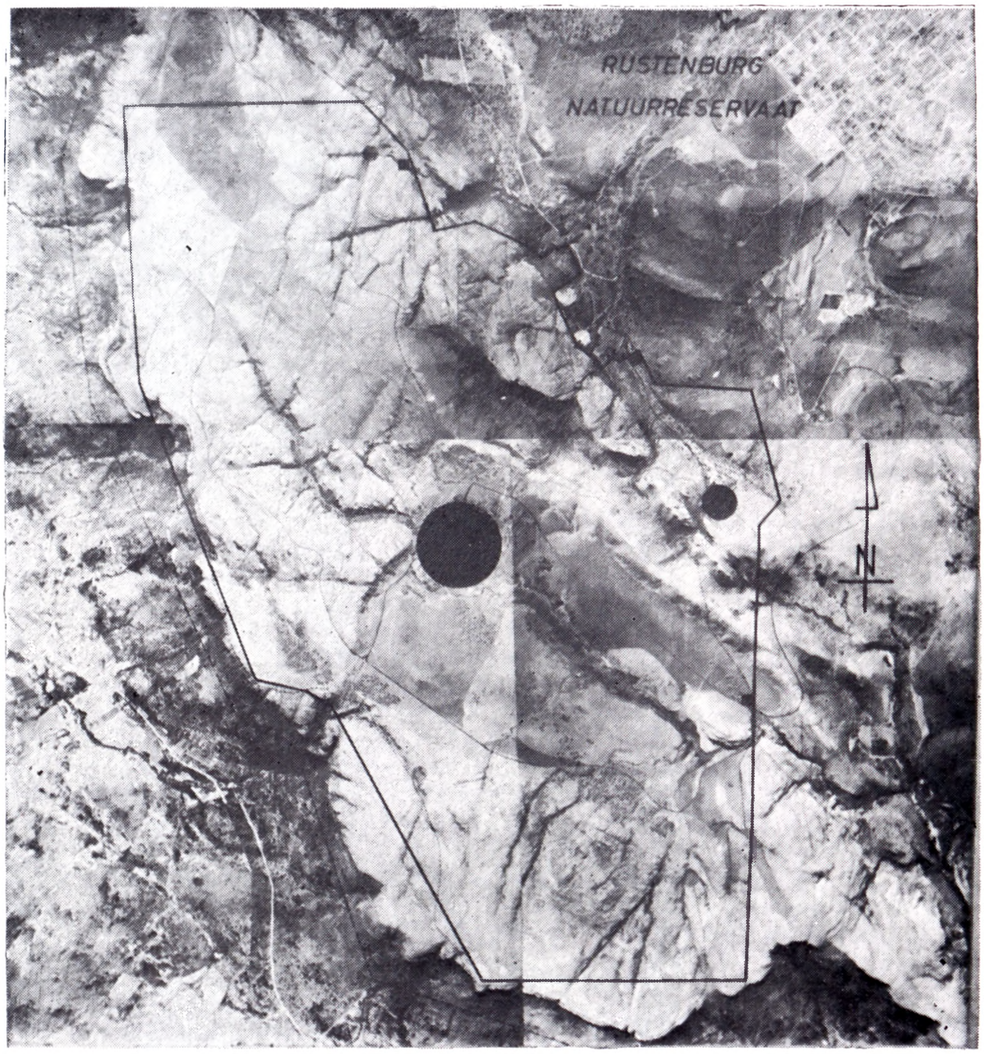

FIG. 3.—Air photo showing the boundaries of the Rustenburg Nature Reserve and proposed camping sites (black discs). The broken line shows proposed new boundaries.

It is intended to enlarge the Reserve to include part of the western slopes, which have been included in the classification but not in the vegetation map (Fig. 8).

Altitudes in the Reserve vary from 1 230 m in the lowest part, on the eastern side of the mountain, to 1 660 m on the summit.

The western slopes of the Magaliesberg (Fig. 11) are steep and underlain by diabase alternating with hornfels, which weather faster than the quartzite summit. The soils on the western slopes are litholitic, mainly dark reddish-brown, with sandy clay-loam texture. Evergreen *Protea caffra*-dominated woodlands are found on steep, flat or convex slopes with no water accumulation, whereas deciduous woodlands in which *Acacia caffra* is dominant, co-dominant or subdominant are found on concave slopes or on convex slopes below cliffs, where water accumulation is considerable. *Acacia caffra* is strongly dominant in cool mesophytic areas such as concave south-facing slopes. On warmer west-southwest-facing convex slopes directly beneath cliffs, *Acacia caffra* is also dominant but with *Combretum molle, Combretum zeyheri, Dombeya rotundifolia* and *Vangueria infausta* as subdominants. *Combretum molle* and *Pouzolzia hypoleuca* are dominant and *Acacia caffra* subdominant on a very hot west-northwest-facing convex slope beneath tall cliffs. Patches of semi-deciduous forest occur in kloofs of the western slopes.

Most of the Reserve is situated on a 2–3,5 km wide summit plateau of quartzite, extending over 8 km in a north-south direction. The plateau contains two geomorphologically distinct regions (Fig. 4). The northern region is a predominantly flat to convex area of exposed quartzite, 1 500–1 650 m in altitude. At the highest part, the northern plateau region divides the whole plateau into a northern and southern catchment area. A considerable amount of free perennial water originates in each of the catchment areas, forming streams down the eastern side of the mountain. The northern plateau region is mainly a mosaic of lithosol and very shallow-litholitic soils. The soils are gravelly, dark reddish-brown to black, sandy to sandy-loam, with much decomposed organic material. Areas of extensive sheet outcrop carry a seasonal grassland vegetation with scattered stands of widely spaced *Lopholaena coriifolia* shrubs and a number of characteristic xerophytic grasses and succulents. Semi-deciduous *Landolphia capensis-Bequaertiodendron magalismontanum* Shrubland grows amongst bouldery rocky outcrops. Two small islands of diabase, overlain by deep non-stoney soils that carry evergreen *Protea caffra*-dominated woodlands, evergreen *Protea gaguedi*-dominated shrubland and seasonal grassland, occur on the far northern part of the plateau. Some of these deeper soils have dark reddish brown orthic A-horizons and dusky-red, dark reddish brown, reddish brown or dark red B-horizons, while others have dark brown, orthic A-horizons and yellowish red to red B-horizons. The B-horizons have sandy-loam to sandy clay- loam and clay-loam textures.

The southern plateau region is a basin with a flat marshy area in the bottom, vegetated mainly by dense *Phragmites mauritianus*-dominated seasonal reedswamp. The marsh is at 1 425–1 440 m altitude. Deep soils overlie the quartzite on the gentle slopes rising from the marsh to the steeper brim where the quartzite is exposed. The brim emerges at 1 440 m altitude in the south and at 1 500 m altitude in the north, east and west. The deeper soils of the plateau basin are well differentiated over most of the area, becoming gradually more litholitic towards the brim. Deciduous *Acacia caffra*-dominated woodland, with evergreen *Protea caffra* trees as sub-dominants, occupy the far northern corner of the basin where the soil has a dark reddish brown to dusky red clay-loam orthic A-horizon and a dark reddish brown to dark red clay-loam B-horizon. Other well differentiated soils of the plateau basin have dark reddish brown orthic A-horizons varying from sandy-loam to sandy clay-loam, and dark red to dark reddish brown, mostly sandy clay-loam B-horizons. Most of the area carries seasonal grassland with isolated stands of deciduous *Burkea africana*-dominated and evergreen *Protea caffra*-dominated woodlands and a stand of evergreen *Protea gaguedi*-dominated shrubland. The litholitic soils towards the edges are dark reddish brown, with texture ranging from sand to clay-loam, and carry grassland. The vegetation of the rocky quartzite brim of the plateau basin is mainly seasonal grassland and semi-deciduous *Landolphia capensis-Bequaertiodendron magalismontanum* Shrubland as in the northern plateau area. *Faurea saligna* trees fringe narrow drainage lines down the rocky sides of the basin.

A northwest to southeast series of valleys, underlain by diabase, separate the larger part of the summit plateau from another quartzite summit area to the east, which extends as a ridge from the northern plateau region to the southeast (Fig. 5). The summits of the western slopes of the series of valleys are between 1 570 m and 1 650 m altitude, the summits of the eastern slopes between 1 450 m and 1 530 m

FIG. 4.—View from the north over flat to convex plateau area, with exposed quartzite in the foregnurdo and the plateau basin in the background.

FIG. 5.—Valleys separating quartzite ridge on the right from plateau region, the edge of which can be seen on the left.

and the valley bottoms between 1 380 m and 1 440 m. The valleys are drained along four lines that cut through the eastern side. Small patches of semi-deciduous forest occur where drainage lines run through the kloofs. The four catchment areas are separated by three transverse saddle-like watersheds. Soils of this series of valleys are mainly deep-litholitic and dark reddish brown with sandy clay-loam texture. An interrupted seasonal grassland zone is found on the upper slopes of the western sides of the valleys, which are exposed to the north and east (Fig. 6). Evergreen *Protea caffra* woodlands grow at the upper end of the series of valleys in the north, on the concavo-convex watersheds and on concavo-convex and convex surfaces of valley sides. Deciduous *Acacia caffra*-dominated woodlands occur in the lower parts of the valleys and concavo-concave surfaces of the valley sides. Soils of these *Acacia caffra*-dominated woodlands are markedly less stony than those of the grasslands and *Protea caffra*-dominated woodlands.

A lithosol-litholitic complex of sheetlike to broken quartzite with semi-deciduous *Landolphia capensis-Bequaertiodendron magalismontanum* Shrubland predominates on the steep upper northeast-facing slopes of the eastern part of the mountain (Fig. 7). The soils are gravelly, black sand to sandy-loam with much decomposed organic material. Broad-leaved deciduous woodlands with *Burkea africana, Ochna pulchra, Combretum zeyheri* and *Faurea saligna* as prominent trees, occur on the less rocky lower slopes and foothills of the northeastern side of the Magaliesberg. Soils here are gravelly, stony, brown to dark brown

FIG. 6.—Upper end of northernmost of series of valleys, with **Rhynchosia monophylla—Tristachya biseriata** Grassland on the upper slopes of the western sides of the valleys, which are higher than the eastern sides.

FIG. 7.—Steep, rocky, north-east-facing slopes with the **Croton gratissimus—Landolphia capensis** Variation of **Landolphia capensis — Bequaertiodendron magalismontanum** Shrubland, viewed from the lowland in the east of the Reserve.

sand, sandy-loam and sandy clay-loam, and dark reddish brown, predominantly sandy clay-loam and clay-loam.

A low flat area of tertiary to recent alluvium protrudes into the foothills in the east of the Reserve at an altitude of 1 250–1 320 m. The deep soil is differentiated into a dark reddish brown to dusky red sandy clay-loam orthic A-horizon, and a dark reddish brown to dusky red, clay-loam to sandy clay-loam B-horizon. The B-horizon is gravelly in some areas. Deciduous *Acacia caffra*-dominated woodland, mostly with *Combretum zeyheri* and *Dombeya rotundifolia* as sub-dominants, is found in this part of the Reserve.

CLIMATE

The following climatic data were recorded over a period of 42 years at the Rustenburg-511/458 weather station, 10 km northeast of the Reserve, and over a period of five years at Little Quendon-511/432, 3 km east of the Reserve (Weather Bureau, 1954). Average monthly maximum temperatures are between 34 °C and 36 °C during the hottest months of October to February and between 24,8 °C and 25,2 °C during the coldest months of June and July. Mean monthly minimum temperatures are highest (11,9 °C–13,1 °C) during December to February and lowest (−2 °C–0 °C) during June to August. Ground frost may be expected to occur on the average at least once per month from May to September at these weather stations, employing a Stevenson-screen temperature of 3 °C as criterion for light ground frost (Schulze, 1965). Light ground frost or near ground frost conditions may be expected to occur daily at these stations in June and July when mean daily minimum temperatures are between 1,8 °C and 3,4 °C.

The Rustenburg weather station is, however, at 1 119 m altitude and Little Quendon at 1 200 m altitude, whereas at the Rustenburg Nature Reserve the altitude varies from 1 230 m–1 660 m. Van Vuuren (1961), who recorded temperatures at various altitudes on the northern and southern side of another part of the Magaliesberg over a one year period, found that average weekly maximum temperatures were 1,82 °C higher at the northern foot of the mountain than at the northern summit. Average weekly minimum temperatures recorded by him were lower at the foot than at the summit. Due to differences in radiation, discussed by Coetzee (1974), temperatures are generally higher on north-facing slopes than on south-facing slopes, as found by Van Vuuren (1961). Such temperature effects may be modified by dense vegetation cover, under which Van Vuuren (1961) recorded on the average less extreme values. Cold air from the summits accumulates in the bottom of the series of valleys between the plateau and eastern summit ridge and concentrates in kloofs draining these valleys. This was experienced at a camping site at the bottom of one such kloof where cold gravity winds, strong enough to be clearly felt, flowed down the kloof during clear calm autumn nights. Similarly, cold air from the summit pleateau will flow down slopes and drainage lines and cold air south of the plateau divide will accumulate in the bottom of the plateau basin and escape through an opening in the southeastern brim of the basin.

Winds are mainly light to moderate and blow mostly from the northern sector in summer and winter, except for short periods during thunderstorms or weather changes when they have a southerly component (Weather Bureau, 1960; Van Vuuren, 1961; Schulze, 1965). The Rustenburg Nature Reserve falls between the 700 mm and 800 mm per year rainfall isohyets according to a 1:250 000 rainfall map of the Department of Water Affairs (1966). These figures are confirmed by records of 32–54 years at Rustenburg-511/400 4,5 km northeast, Donkerhoek-511/310, 1,8 km north-northeast, Baviaanskranz-511/404, 3,5 km east and Buffelshoek-511/285, 1 km southwest of the Reserve (Weather Bureau, 1965). The rainfall is reliable, being at least 85% of the normal rainfall during 75–85% of all years, and falls mainly during the summer months of October to March when 85–90% of the normal annual rainfall is received (Weather Bureau, 1957). The rainfall is almost exclusively due to thunderstorms and instability showers (Schulze, 1965).

MANAGEMENT

The Nature Conservation Division of the Transvaal Provincial Administration, whose policy is to conserve natural areas, to introduce endemic fauna and at the same time to provide recreational facilities, have been allowing limited organized excursions into the Reserve. A camping site has been provided on the edge of the *Acacia caffra* woodland at the lower end of a kloof on the eastern side of the mountain, and mountain huts are being built in a number of sites on the summit. Plans are in hand to extend facilities, and an office complex and camping site is to be built in the *Acacia caffra* woodland in the northern part of the plateau basin. The house and store of the Superintendent and the living quarters of his staff are already situated in this woodland. Apart from the camping sites, huts, living quarters and a few concealed sand quarries, excavated to maintain roads, the Reserve is unscarred by human impact.

The Reserve is fenced with a game fence and is lightly stocked with a large variety of game species, utilizing different habitats. There are no signs of overgrazing and trampling. The following account of larger game species occurring in the Reserve is based on observations by the Superintendent, Mr J. de Klerk. The figures given in brackets are his up to date census figures (pers. comm.). Species found mainly in the grasslands of the mountain plateau are springbuck (38), red hartbeest (33), blesbuck (32), Burchell's zebra (23), black wildebeest (17), oribi (2) and steenbuck (1). Sable antelope (21) are found mainly in the woodlands of the plateau region, kudu (10) are observed chiefly in the woodlands of the series of valleys between the two summit areas, and mountain reedbuck (73+) occur widespread on the mountain slopes. Waterbuck (12) concentrate in the densely wooded areas near water, i.e. in kloof forest on the eastern side of the far northern plateau, in *Acacia caffra* woodland near the marshy part of the plateau basin and in nearby thickets. Impala (114) and reedbuck (8) are usually observed in the woodlands of the flats and foothills on the eastern side of the mountain and in woodlands on the plateau. Impala are also frequently observed in grasslands near woodlands. Klipspringer (16) are found in rocky habitats all over the Reserve and Natal duiker (16) are widespread. Rock rabbits are among the conspicuous small mammals and live in large numbers in rock crevices of cliffs. Predators known to occur in the Reserve are leopard, brown hyaena, black-backed jackal and caracal.

A burning programme for the Reserve has been introduced recently by the Nature Conservation Division. This entails periodic rotational burning of certain areas after the first spring rains to remove accumulated litter when this is judged to be in excess. Areas thus burned are the grasslands, shrublands and woodlands of the plateau basin, excluding the marsh, and the grasslands and *Protea gaguedi*-dominated shrubland on the deep soils overlying the diabase in the far northern part of the plateau. Except for accidental fires which have occurred from time to time the rest of the Reserve is not burnt and is protected by fire breaks.

METHODS OF SURVEY AND CLASSIFICATION

The Braun-Blanquet method of sampling and synthesis followed here is reviewed and described by Werger (1974a). Some optional sampling procedures, which fall within the flexibility allowed by the method, were introduced. The Braun-Blanquet method specifies that the total sample should show as adequately as possible the total variety in the study area. To achieve this, sampling sites were stratified using 1:360 000 air photos. After having become acquainted with variation in the field, variation in vegetation structure, dominant tree species and habitat was mapped on the air photos. Twenty-one stratification classes were obtained. The maximum sampling intensity was approximately one site per 6,5 ha for 14 smaller classes, each of which covered 64,8 ha or less. This means that a proportionately larger number of sampling units for smaller classes were considered necessary only where the total number of samples in the class did not exceed ten. These smaller classes, which covered 496 ha (17% of the Reserve) required 74 sampling units (39% of the sample taken in the Reserve). The remaining seven classes covering 2 400 ha received 116 sampling units. The minimum number of sampling units per larger class was ten, so that the sampling intensity for the larger classes was approximately one sampling unit per 23,8 ha in four of these classes and between one per 6,5 ha and one per 23,8 ha in the remaining three. The final vegetation map (Fig. 10), based on floristic tables, virtually corresponds to the initial stratification map on the air photos. This is due firstly to the prominance of habitat features related to plant communities in mountainous terrain, where strong topographic differences are of major importance (cf. Van Vuuren, 1961; Theron, 1973; Du Plessis, 1973; Coetzee, 1974a); and secondly to the strong differentiating

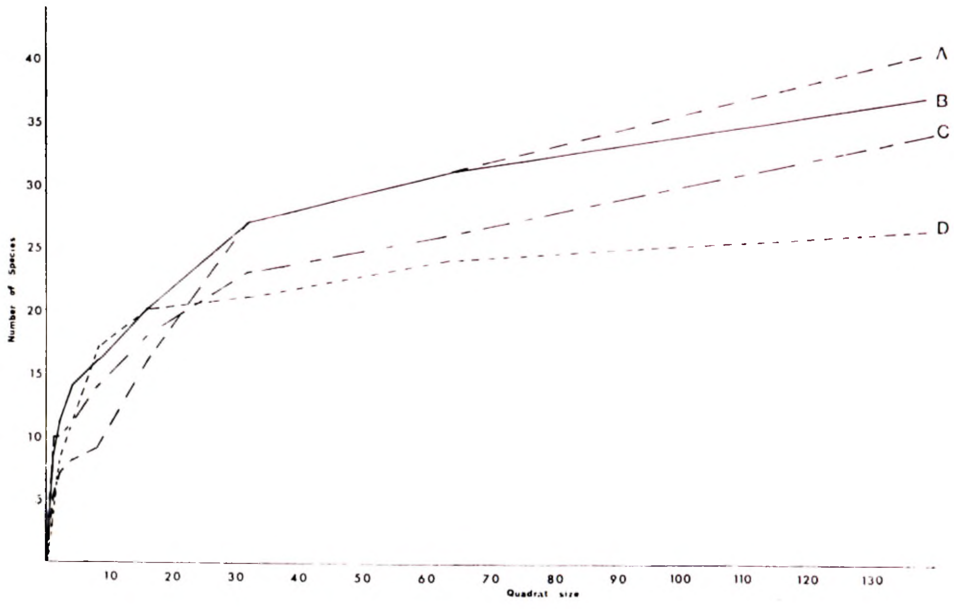

FIG. 8.—Species-area curves for: (A) **Tristachya biseriata—Combretum zeyheri** Variation of **Burkea africana — Ochna pulchra** Woodland (Sect.3.1.1.1b); (B) **Asparagus krebsianus—Landolphia capensis** Variation of **Landolphia capensis — Beguaertiodendron magalismontanum** Shrubland (Sect. 3.2.1b); (C) Grassland Variation of **Digitaria brazzae — Tristachya rehmannii** Woodlands, Shrublands and Grasslands (Sect. 3.1.2c); (D) **Thesium transvaalense — Eragrostis nindensis** Variation of **Cyperus rupestris —Eragrostis nindensis** Grassland (Sect. 3.2.2 b).

character of prominent woody species. Without the formal floristic analysis, however, it is impossible to determine the hierarchical level of the reconnaissance classes and floristic and ecological relationships between them.

A set of nested quadrats was placed in four of the stratification classes, chosen for their dissimilarity and wide occurrence in the Reserve, to obtain some idea of the relationship between quadrat size and number of species (Fig. 8). Three of the four resultant species area curves (Fig. 8: A, B, C) show a marked levelling off in number of species when exceeding 32 m² (8×4m) and the fourth showed a similar levelling off after 16 m² (4×4 m). A quadrat size of 50 m² (5×10 m) was therefore considered efficient for reducing qualitative floristic variance between samples of very similar vegetation types. However, because of the coarse structure of some of the vegetation types, a quadrat size of 100 m² (10×10 m) was chosen to obtain representative cover values for species. No new floristic scale of pattern was encountered at this quadrat size.

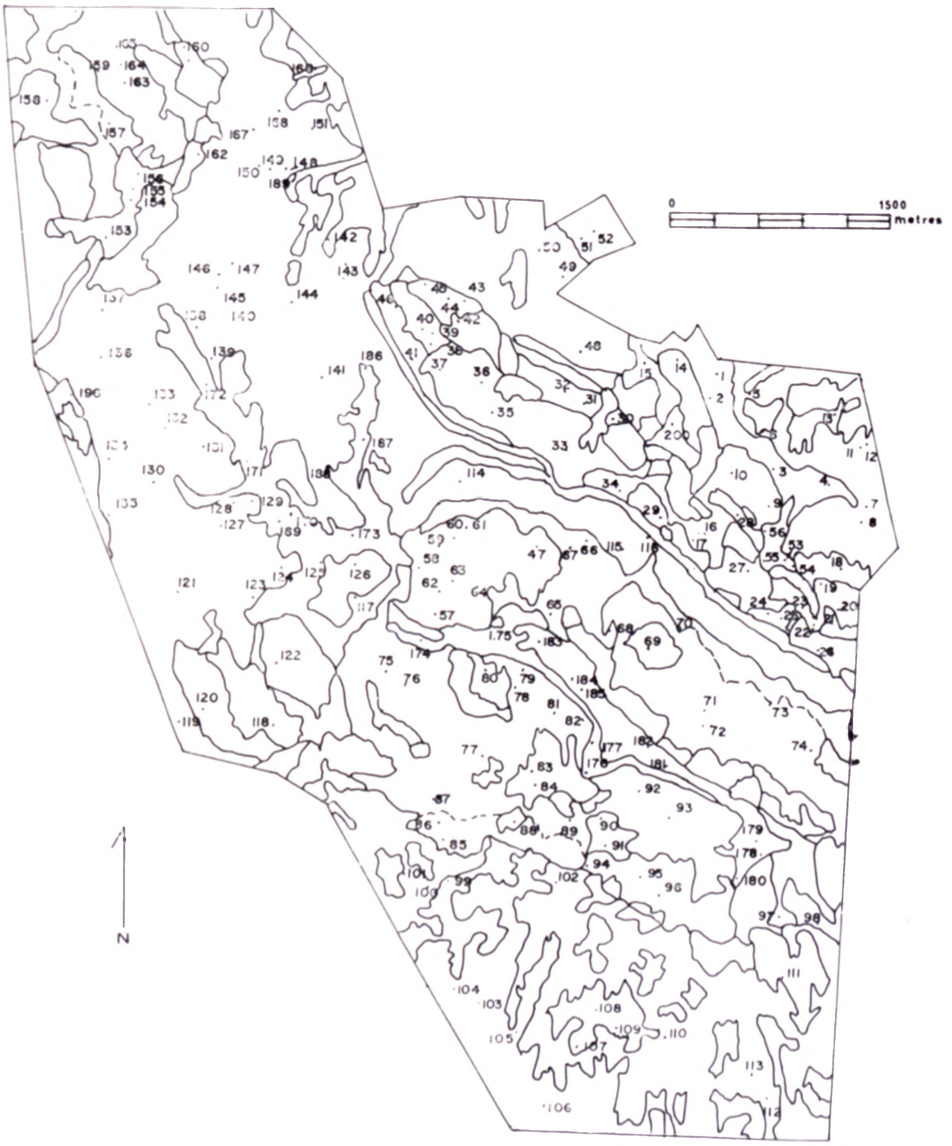

FIG. 9.—Distribution of samples in the Rustenburg Nature Reserve with boundaries of mapping units (cf. Fig. 10).

Sampling sites were placed randomly in the stratification units on the air photos to obtain a representative distribution, but these points served only to indicate the approximate position of the quadrats which were then placed in the field in a visually homogeneous stand, representative of the stratification unit (Fig. 9). A quadrat size and shape of 10×10 m was adhered to throughout the survey even though such rigidity is not prescribed and is in some instances regarded as undesirable in the Braun-Blanquet method. Quadrats were nevertheless sufficiently homogeneous and representative to make any change in size and shape unnecessary, although in grasslands quadrats were usually unnecessarily large.

Tables 2–6 show the ordered sampling data. More data from a wider area is essential before community types can be ranked and before character species can be distinguished. A capital "D" before the name of a species in Tables 2–6 means that such a species differentiates a particular community type from all other community types in the Reserve, whereas "d" means that the species is differentiating for more than one community type which do not form an exclusive type at a higher level in the hierarchy. The other units involved are shown in parentheses after the "d". Communities have been tentatively named, primarily by constant differentiating species which are, wherever possible, also conspicuous. The names remain, however, merely symbols; the floristic-sociological unit (phytocoenon) to which a particular stand of vegetation belongs must be determined on the basis of total species composition (Westhoff & Den Held, 1969).

PHYTOCOENA

Each of the mapping units in Fig. 10 belongs to one of the eight physiognomic types already mentioned (Table 1). Physiognomic types that correspond with distinct phytocoena are forests, *Acacia caffra*-dominated woodlands, broad-leaved deciduous woodlands, *Protea gaguedi*-dominated shrublands, *Bequaertiodendron*-dominated shrublands and reed-swamps. The grassland and *Protea caffra*-dominated phytocoena cut across physiognomic boundaries at higher levels of the hierarchy.

As indicated in Table 1, the phytocoena of the Rustenburg Nature Reserve have been hierarchically grouped into five main vegetation types.

1. Hypoestes verticillaris—Mimusops zeyheri *Forests* (Table 2)

TABLE 2.—Hypoestes verticillaris—Mimusops zeyheri Forests

	Community number	1.1		1.2.1			1.2.2		
	Relevé number	166	139	196	15	55	56	53	54
	Number of species	18	16	17	38	22	16	21	24
	Slope (°)	6		23	6	24	37	24	24
	Aspect	E	E	SW	NE	NNE	ENE	NW	N
	Soil texture (S= sand, sandy; C= clay; L= loam)	S	SL	SCL	SCL	SCL	SL	SL	SCL
	Soil colour (Bl= black; dRB= dark reddish brown)	Bl	Bl	Bl	dRB	Bl	Bl	Bl	dRB
	Outcrop (%)	o	o	o	o	o	o	o	o
	Boulders	o	a	r	o	a	a	a	a
	Large stones (o=absent; r= rare; f= frequent; a= abundant)	o	r	r	o	f	a	a	a
	Medium stones	o	r	o	o	f	a	f	a
	Small stones & gravel	f	r	o	o	f	a	a	a
	Differentiating species of Ilex mitis-Pittosporum viridiflorum Forest (1.1)								
D	Pittosporum viridiflorum	4	2						
D	Halleria lucida	3	1						
D	Cyperus albostriatus	3	+		+				
D	Rothmannia capensis	2	+						
D	Ilex mitis	2	+	+					
d(3.2.1.)	Bequaertiodendron magalismontanum	+	5					+	
D	Blechnum attenuatum	+	1						
D	Secamone alpini	+	1		+				
D	Myrsine africana	+	+			+			
d(3.2.1b1)	Haemanthus magnificus	+	+						
	Differentiating species of Diospyros whyteana - Celtis africana Forest (1.2.1.)								
D	Diospyros whyteana		+	3	2	2			
D	Maytenus undata			+	1	2			
D	Solanum rubetorum			+	+	+		+	
D	Celtis africana		+	5	4				+
d(2.2b;2.3)	Rhus pyroides				3	2			+
D	Combretum erythrophyllum			2		2			
D	Acacia ataxacantha		+		+	+			
D	Acocanthera oppositifolia			+	+				
	Differentiating species of Ficus pretoriae - Urera tenax Forest (1.2.2.)								
D	Urera tenax						2	+	+
D	Cyphostemma cirrhosum subsp. cirrhosum					+	+	+	+
D	Hermannia floribunda					+	+	+	+
D	Enteropogon macrostachyus							2	3
D	Ficus pretoriae							+	+
D	Droguetia woodii					+		2	+
d(3.2.1a)	Croton gratissimus subsp. gratissimus						1	1	
D	Commelina benghalensis					+		+	+
D	Setaria verticillata							+	+
D	Tagetes minuta					+		+	+
	Differentiating species of Acalypha glabrata - Dombeya rotundifolia Forests (1.2.)								
D	Rhoicissus tridentata			+	+	+	+	+	+
d(2)	Dombeya rotundifolia				+	2	+	5	4
d(2)	Rhus leptodictya				+	1	3	2	1
D	Acalypha glabrata			3		2	2	+	
	Differentiating species of Hypoestes verticillaris - Mimusops zeyheri Forests (1.)								
D	Achyranthes sicula	+		+	+	+	+	+	
D	Hypoestes verticillaris	+		+	3		+	+	+
d(3.2.1)	Fagara capensis	+	+	+	+				+
D	Mimusops zeyheri		+		+	3	3		
	Infrequent species								
	Combretum molle				+		+		+
	Grewia occidentalis				+	1			1
	Helinus integrifolius				+	+		+	
	Pappea capensis			+			+	+	

Species of single or double occurence: Euclea crispa (relevé 196: (+); 56:+), Oplismenus hirtellus (189:(+); 196:+), Panicum maximum (15:+; 54:+), Pavetta assimilis var. pubescens (15:+; 56:+), Solanum giganteum (166:+; 196:+), Solanum nodiflorum (55:+; 54:+), Acacia karroo (15:+), Brachylaena rotundata (166:+), Bridelia mollis (15:+), Buddleia salviifolia (166:+), Cussonia spicata (55:+), Diospyros lycioides subsp. guerkei (15:+), Duranta repens (15:+), Ehrharta erecta (15:1), Erigeron floribundus (15:+), Euclea natalensis (15:+), Glycine javanica (15:+), Grewia monticola (54:+), Heteromorpha arborescens (15:+), Hibiscus calyphyllus (15:+), Littonia modesta (15:+), Mariscus indecomus (53:+), Myrica pilulifera (166:1), Nuxia congesta (56:+), Osyris lanceolata (15:+), Phyllogeiton zeyheri (15:+) Pteridium aquilinum (166:+), Sida dregei (15:+), Teucrium capense (54:+), Vangueria infausta (15:+), Vepris undulata (196:+), Withania somnifera (54:+), Ziziphus mucronata (15:+).

TABLE 1. - Relationship between the phytosociological hierarchy and physiognomic classes

PHYTOSOCIOLOGICALLY DEFINED VEGETATION TYPES		PHYSIOGNOMIC CLASS
Hierarchical arrangement of mapping units	Mapping units	
1	Hypoestes verticillaris-Mimusops zeyheri Forests (shown in Table 2)	FORESTS
2 Eustachys mutica-Acacia caffra Woodlands (shown in Table 3)		
2.1 Combretum zeyheri - Acacia caffra Woodland	(a) Not mapped (Kalanchoe paniculata - Acacia caffra Variation)	ACACIA CAFFRA - DOMINATED WOODLANDS
	(b) Digitaria smutsii - Acacia caffra Variation	
2.2 Brachiaria serrata - Acacia caffra Woodland	(a) Blumea alata - Acacia caffra Variation	
	(b) Protea caffra - Acacia caffra Variation	
2.3	Setaria lindenbergiana - Acacia caffra Woodland	
3 Loudetia simplex - Aristida aequiglumis Woodlands, Shrublands and Grasslands		
3.1 Eragrostis racemosa - Diplachne biflora Woodlands, Shrublands and Grasslands (shown in Table 4)		
3.1.1 Sphenostylis angustifolius - Tristachya biseriata Woodlands and Grasslands		
3.1.1.1 Burkea africana - Ochna pulchra Woodland	(a) Tristachya biseriata - Combretum zeyheri Variation	BROAD LEAVED DECIDUOUS WOODLANDS
	(b) Silene burchellii - Burkea africana Variation	
3.1.1.2	Rhynchosia monophylla - Tristachya biseriata Grassland	GRASSLANDS
3.1.1.3 Tristachya biseriata - Protea caffra Woodland	(a) Alloteropsis semialata - Protea caffra Variation	PROTEA CAFFRA - DOMINATED WOODLANDS
	(b) Cryptolepis oblongifolia - Protea caffra Variation	
3.1.2 Digitaria brazzae - Tristachya rehmannii Woodlands, Shrublands and Grasslands	(a) Elephantorrhiza elephantina - Protea caffra Woodland Variation	
	(b) Monocymbium ceresiiforme - Protea gaguedi Shrubland Variation	PROTEA GAGUEDI - DOMINATED SHRUBLANDS
	(c) Grassland Variation	GRASSLANDS
3.2 Coleochloa setifera - Selaginella dregei Shrubland and Grassland		
3.2.1	Landolphia capensis - Bequaertiodendron magalismontanum Shrubland (shown in Table 5)	BEQUAERTIODENDRON - DOMINATED SHRUBLANDS
3.2.2	Cyperus rupestris - Eragrostis nindensis Grassland (shown in Table 5)	GRASSLANDS
4	Aristida junciformis - Arundinella nepalensis Grassland (shown in Table 6)	
5	Pteridium aquilinum - Phragmites mauritianus Reedswamp (shown in Table 6)	REEDSWAMPS

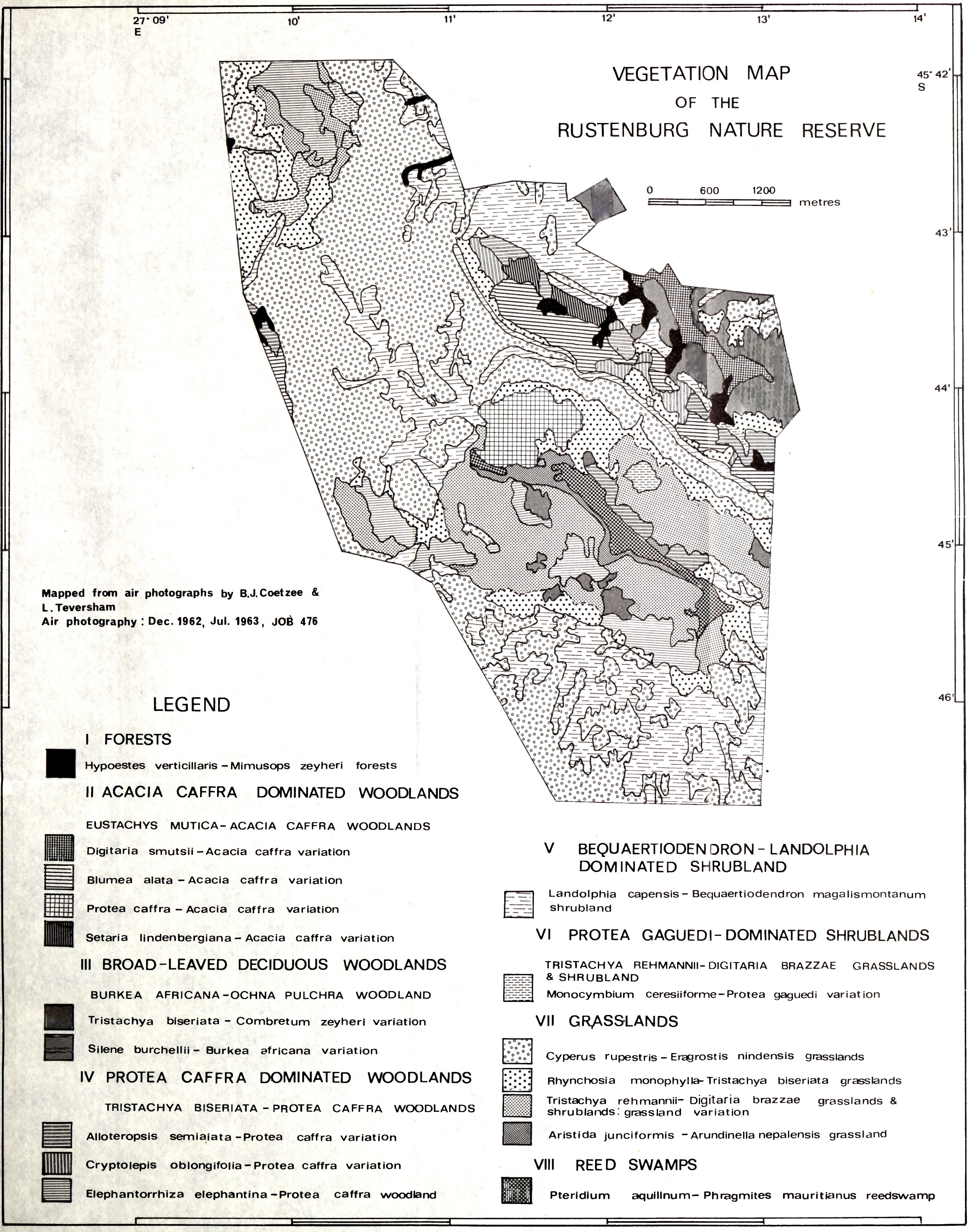

Fig. 10.—Vegetation map of the Rustenburg Nature Reserve.

Forests are of small extent in the Reserve and have a result been poorly sampled, particularly since the relevés cover three distinct forest types, each represented by only two or three relevés. One of these forest types, the *Ilex mitis—Pittosporum viridiflorum* Forest, has few species in common with the other two forest types but is nevertheless more closely related to them than to any other syntaxon in the Reserve. The three forest types are therefore regarded as belonging to an exclusive phytocoenon, differentiated by a number of species as shown in Table 2. Of these, *Hypoestes verticillaris* and *Achyranthes sicula* are the most constant in all three forest types.

All three forest types grow in kloofs, which can be either very hot and dry, or relatively warm and permanently moist, or cool and less moist. The marked floristic and structural affinities of these forests, however, suggest that the kloof habitats should be very similar. Woody species of the upper stratum, being largely restricted to a particular forest type, seem to respond most to the habitat differences between the kloofs. Virtually only species of the lower strata are responsible for the floristic affinities, suggesting that the distinctive habitat similarities are those that affect mostly these lower strata species. The most obvious of such similarities are those resulting from the dense upper canopy layer, such as poor light penetration, less radiation heat received and lost by the surface, less drying out of the soil and air, and a mat of organic material. It appears, however, that some uniform habitat conditions, independent of vegetation structure and associated with kloofs, must primarily exist to determine the tall, dense canopy cover of all these forest types. This habitat feature may be a concentration of drainage water deep enough below the surface to supply the extensive and relatively deep root systems required to support tall forest trees. The primary habitat similarities between the different kloofs thus appear to cause certain structural similarities in the vegetation, which then create the necessary habitat conditions for floristic similarities.

1.1 Ilex mitis—Pittosporum viridiflorum *Forest*

This forest type is strongly differentiated by its dominant woody species, *Ilex mitis, Pittosporum viridiflorum, Rothmannia capensis, Halleria lucida* and *Bequaertiodendron magalismontanum.* The latter species also differentiates the *Landolphia capensis—Bequaertiodendron magalismontanum* Shrubland (Sect. 3.2) where the species occurs as a shrub. In this forest it grows into a 13 m tall tree. This forest is found in narrow east-facing kloofs with perennial streams or free underground water near the surface. The dominant tree stratum has a dense uneven canopy covering 90 to almost 100%, and is between 5 m and 13 m tall. Shrubs and small trees, up to 5 m tall, cover less than 1% in the denser forest, but can cover 20% in the more open forest represented by Relevé No. 166. Similarly, the forb layer covers 2% in the denser tree stand sampled and 30% in the more open tree stand. *Blechum attenuatum* is the dominant forb under the denser tree canopy and *Cyperus albostriatus* is dominant under the more open tree canopy. The woody liane *Secamone alpini,* which is also a differentiating species, appears in both relevés of this forest type. The tree fern *Cyathea dregei,* which was not recorded in the relevés, also occurs in such forests in the Reserve.

The *Ilex mitis—Pittosporum viridiflorum* Forest, although apparently much poorer in species, has many characteristic species in common with the *Mimusops - Chrysophyllum - Apodytes dimidiata* Variation and the *Mimusops-Chrysophyllum-Strychnos usambarensis* Variation of the *Mimusops-Chrysophyllum* Community described by Van Vuuren (1961). The habitats are also very similar. These variations occupy the most mesic habitats of sheltered parts of the kloof on the northern side of the mountain.

1.2 Acalypha glabrata—Dombeya rotundifolia *Forests*

These two forest types also grow in sheltered but drier kloofs where there is no surface water or free ground water near the surface.

(a) Diospyros whyteana—Celtis africana *Forest*

An example of this forest type is shown in Fig. 11. Virtually all differentiating species are dominant or sub-dominant woody species (Table 2).

FIG. 11.—Western slopes of the Magaliesberg with **Diospyros whyteana—Celtis africana** Forest in southwest-facing kloof, and **Landolphia capensis — Bequaertiodendron magalismontanum** Shrubland in the foreground.

This forest is found in relatively cool kloofs of various aspects where there is no perennial free water. Strongly differentiating species such as *Celtis africana, Combretum erythrophyllum* and *Diospyros whyteana* have also been observed to grow in riverine forest in the Bankenveld where it is also cool but moister. Van Vuuren (1961) observed that the vegetation in a closely related community on the southern side of the Magaliesberg is less tropical than on the northern side and it is clear from one of his diagrams (Fig. 8: Van Vuuren, 1961) that average minimum temperatures in the community on the southern side are lower during winter months than on the northern side of the mountain where vegetation similar to *Ilex mitis—Pittosporum viridiflorum* Forest is found. Further more, two of the predominantly north-facing relevés of the forest type described here (Relevés No. 15 and 55) are situated in kloofs into which a considerable amount of cold air drains during winter from catchment areas in the higher valleys. Low winter temperatures rather than moisture deficiency appear therefore to be important habitat features distinguishing *Diospyros whyteana—Celtis africana* Forest habitats from those of *Ilex mitis—Pittosporum viridiflorum* Forest.

The upper stratum covers 70-90% and is 5-12 m tall, with *Celtis africana, Combretum erythrophyllum* and *Mimusops zeyheri* as dominants. A smaller tree and tall shrub stratum, 2-5 m tall, covers 10-70% and a layer of shrubs and young trees, 0,5-2 m tall, covers 5-25%. A low stratum consisting of varying proportions of grasses, forbs and small woody plants covers 1-60%.

The *Acalypha glabrata* community described by Van Vuuren (1961) and characteristic of the relatively dry kloof on the southern side of the mountain, is closely related to the forest type described here. These two vegetation types have many distinctive habitat features and many, though not all distinctive species in common.

(b) Ficus pretoriae—Urera tenax *Forest*

Relevés of this forest are on steep to very steep north, northwest and east-northeast-facing talus slopes. These slopes are hot an dry, probably with much less cold air accumulation than in *Diospyros whyteana—Celtis africana* Forest.

The dominant tree and tall shrub stratum is 2-5 m tall, covering 85% or more. Dominant species in this stratum are *Mimusops zeyheri, Urara tenax, Rhus leptodictya, Croton gratissimus, Dombeya rotundifolia* and *Lannea discolor. Ficus pretoriae*, another dominant, is an emergent tree, up to 10 m tall and covering 5%. A shrub stratum, dominated by *Acalypha glabrata* in some places and by *Grewia monticola* in others, is 0,5-2 m tall, with cover varying from 0,25-25%. The lowest stratum in some places covers only 1% but in others up to 75%, with *Enteropogon macrostachyus, Droguetia woodii* and an unidentified species of the Malvaceae as dominants.

This forest type has weak affinities with the *Croton—Combretum* Variation of the *Croton* Community, described by Van Vuuren (1961) as an ecotone between sheltered mesophytic kloof forest and arid shrubby vegetation. The variation described by Van Vuuren has a few habitat features and distinctive species in common with the forest type described here, but seems to grow in a more mesophytic habitat and to contain more mesophytic species.

2. Eustachys mutica — Acacia caffra *Woodlands* (Table 3)

Table 3 shows a distinct phytocoenon comprising a number of closely related woodland types dominated by *Acacia caffra.* These woodlands occur on flat level surfaces with clay-loam soils and on slopes that are probably nutritionally enriched and in some places relatively mesic, due to water accumulation. The latter is inferred from the geomorphology and topographic position of these slopes, and the high pH and conductivity of the soils relative to surrounding areas suggest a higher nutritional status (Table 2, 3 and 4). The *Acacia caffra* Savannas on diabase and in sheltered valleys, described by Coetzee (1974a), belong to the same syntaxon as the woodlands described here. The *Eustachys mutica—Acacia caffra* Woodlands are divided into three main syntaxa, which form a series from hot and xeric to cool and mesic shown by their arrangement in Table 3. Some of the differentiating species of *Eustachys mutica—Acacia caffra* Woodlands do not occur in the extreme xeric *Kalanchoe paniculata—Acacia caffra* Variation whereas others are absent from the extreme mesic *Setaria lindenbergiana—Acacia caffra* Woodland.

Brachiaria serrata—Acacia caffra Woodland occupies the centre position in the series. This woodland has a number of differentiating species in common with the moderately xeric *Digitaria smutsii—Acacia caffra* Variation of the *Combretum zeyheri—Acacia caffra* Woodland on the hot xeric end of the series. The *Protea caffra—Acacia caffra* Variation, which is the more mesic part of the central unit, shares a number of differentiating species with the *Setaria lindenbergiana—Acacia caffra* Woodland on the cool mesic end of the series. Some of these latter differentiating species are also shared with communities in the *Eragrostis racemosa-Diplachne biflora* syntaxon (Tables 3 and 4). The mesophytic part of this series is therefore partly differentiated from the more xerophytic part by floristic affinities with vegetation found on soils that are probably more leached.

2.1 Combretum zeyheri—Acacia caffra *Woodland*

This woodland is the more xeric of the *Eustachys mutica—Acacia caffra* woodlands and has two variations.

(a) Kalanchoe paniculata—Acacia caffra *Variation*

This Variation occurs below cliffs on steep, convex, northwest to west-facing slopes on the western side of the Magaliesberg, outside the present boundaries of the Reserve (Fig. 11). The soils are litholitic, very stoney (all sizes) and gravelly. Relevé 14 is atypical of this variation in species composition and habitat (Table 3). The relevé lacks virtually all differentiating species of *Eustachys mutica—Acacia caffra* Woodlands, but does not fit better elsewhere.

The tallest trees (5-8 m) cover 1% or less. These include *Dombeya rotundifolia* and *Rhus leptodictya* on west-facing slopes and *Pappea capensis* and *Combretum zeyheri* on northwest-facing slopes. The dominant tree stratum is between 2 m and 5 m tall and covers 30-50%. *Acacia caffra* is the dominant tree on west-facing slopes and *Combretum molle* is the dominant tree on northwest-facing slopes. Cover of the shrub and small tree stratum, which is 0,5-2 m tall, is 1-2% on west-facing slopes, but can be 20% on north-facing slopes where *Pouzolzia hypoleuca* is the dominant in this stratum. Grasses and forbs cover 40-50%.

(b) Digitaria smutsii—Acacia caffra *Variation*

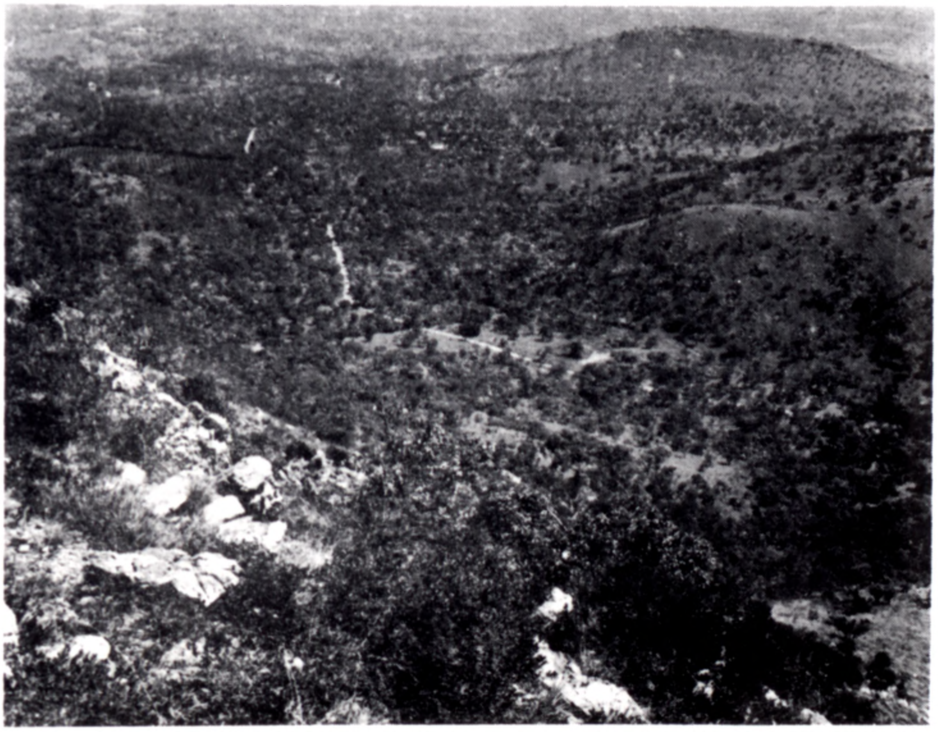

FIG. 12.—View from the Magaliesberg to the flats between the north-eastern foothills of the mountain, with the **Digitaria smutsii—Acacia caffra** Variation of **Combretum zeyheri—Acacia caffra** Woodland.

This Variation occurs on the well differentiated alluvial soils of the flats between the northeastern foothills of the Magaliesberg (Fig. 12).

Emergent trees, 5–8 m tall, in some places cover less than 1% but in other places 5–10%. A 2–5 m tall tree stratum is always present, covering 15–35%. *Acacia caffra* is usually the dominant tree with *Dombeya rotundifolia*, *Combretum zeyheri* and *Ziziphus mucronata* as sub-dominant trees. Shrubs and young trees, notably *Lippia javanica*, *Psidia punctata*, *Acacia caffra*, *A. karroo*, *Dombeya rotundifolia* and *Ziziphus mucronata*, form a 0,5–2 m tall stratum covering 1–5%. Grasses and forbs cover 75–90% (Fig. 13). *Eragrostis acraea* is a dominant grass in places, but did not occur in quadrats. This Variation has affinities with *Acacia karroo—Setaria perennis* Tree Savanna, described by Theron (1973), which grows at the foot of slopes and in valley bottoms on stabilized alluvial soils.

FIG. 13.—The **Digitaria smutsii—Acacia caffra** Variation of **Combretum zeyheri — Acacia caffra** Woodland.

h2.2 Braciaria serrata—Acacia caffra *Woodland*

This phytocoenon which forms the central part of the hot xeric to cool mesic series also has two variations.

(a) Blumea alata—Acacia caffra *Variation*

This variation occurs on litholitic soils of the lower north-northeast to east-facing slopes of the series of valleys between the two summit areas of the Reserve (Fig. 18). Two of the differentiating species of this Variation also differentiate the *Cryptolepis oblongifolia—Protea caffra* Variation, which is the xeric variation of *Tristachya biseriata—Protea caffra*

Woodland and grows mostly on higher east-northeast-facing slopes of the same series of valleys. *Acacia karroo* is prominent, having distinctively high cover values in the *Blumea alata—Acacia caffra* Variation, and *Rhynchelytrum setifolium* seems to be significantly constant.

The tallest tree stratum of 5–10 m can be absent, cover 5–35% or, where the second stratum covers very little, 65%. A second tree stratum, 2–5 m high usually covers 20–25%, but can also cover only 2%. *Acacia caffra* is mostly the dominant tree, with either *A. karroo* or *Lannea discolor* co-dominant in places, but *Acacia karroo* can be dominant with *A. caffra* sub-dominant. A young tree stratum, 0,5–2 m tall, of *Acacia caffra* and *Lannea discolor* covers 10% in Quadrat No. 26 where the total cover is only 50%, and a tall tree stratum is absent, probably owing to the particularly steep (27°) slope. A young tree and shrub stratum, 0,5–2 m tall and including *Acacia caffra, Dombeya rotundifolia* and *Artemisia afra*, covers 2% in Quadrat No. 27, where tall trees cover 65% and smaller trees cover only 2%. The grass and forb stratum in the latter two quadrats covers 50–65% whereas in the other quadrats of this variation this lower stratum covers 75–85%.

(b) Protea caffra—Acacia caffra *Variation*

This variation is restricted to the flats and gentle slopes in the northern part of the plateau basin. Most of the large number of more constant differentiating species and about half of the approximately 40 species contributing significantly to its characteristic species combination, are shared with vegetation types of the *Eragrostis racemosa—Diplachne biflora* syntaxon (Table 4). The *Protea caffra—Acacia caffra* Variation is therefore transitional between *Eustachys mutica—Acacia caffra* Woodlands and the *Eragrostis racemosa—Diplachne biflora* syntaxon (Table 4), two distinct vegetation types at a broad level of the hierarchy presented here as well as of the hierarchy described by Coetzee (1974). Both these broad vegetation types are among the most widespread in the Sour Bushveld. The homogeneous ecotonal situation occurring here could be studied more intensively to gain information on extreme states of distinctive habitat features between two extensive vegetation types.

The physiognomy of this variation is shown in Fig. 14. An upper tree stratum, 5–10 m tall, can be absent or cover up to 4% and includes *Acacia caffra, A. karroo, Protea caffra,* and *Faurea saligna.* A 2–5 m tall tree stratum, with most of the trees from 4–5 m tall and including *Acacia caffra, A. karroo* and *Protea caffra,* covers mostly 45–60%, but can cover 75% where taller trees are absent (Quadrat No. 58). *Acacia caffra* is usually the dominant tree with *Protea caffra* sub-dominant but *P. caffra* can also be co-dominant, or dominant with *Acacia caffra* sub-dominant. A young tree and shrub stratum, 0,5–2 m tall, covers 0,5 to 1% and includes *Rhus eckloniana, R. pyroides, Acacia caffra, Diospyros lycioides, Artemisia afra, Ziziphus mucronata* and *Lippa javanica.* The grass and forb layer covers 70–90%.

2.3 Setaria lindenbergiana—Acacia caffra *Woodland* (Fig. 15)

Setaria lindenbergiana, a distinctive differentiating species of this variation, also differentiates *Landolphia capensis—Bequaertiodendron magalismontanum* Shrubland (Table 5), but has distinctively high cover values in the *Setaria lindenbergiana—Acacia caffra* Variation.

The variation is found on cooler aspect slopes on the western side of the Magaliesberg and in the valleys between the two summit areas. The slopes are flat to concave, below cliffs or usually low in the topography where there is probably water accumulation. Soils are litholitic.

Five to 10 m tall trees, including *Acacia caffra, A. karroo, Cussonia paniculata* and *Faurea saligna*, are usually present, in some places covering less than 2% and in others covering 15–20%. A 2–5 m stratum covers 20–60%. *Acacia caffra* is the dominant tree. *A. karroo* can be co-dominant and *Dombeya rotundifolia* and *Cussonia paniculata* can be sub-dominant. Shrubs and young trees, 0,5–2 m tall, can be absent

FIG 14.—Physiognomy of the **Protea caffra—Acacia caffra** Variation of **Brachiaria serrata—Acacia caffra** Woodland; **Acacia caffra** (A), **Acacia karroo** (B) and **Protea caffra** (C).

TABLE 4. - Eragrostis racemosa - Diplachne biflora Woodlands, Shrublands and Grasslands

Community number	3.1.1.1(a)	3.1.1.1 (b)	3.1.1.2	3.1.1.3(a)	3.1.1.3(b)	3.1.2 (a)(i)	3.1.2(a)(ii)	3.1.2(b)	3.1.2(c)
Relevé number	5 10 51 6 9 11 7 8 52	88 31 80 90	85 97 86 66 13 29 24 89 120 87 18 67 25 46 41 162	22 194 21 20 23 191 44 43 190 45 19	39 40 16 17 38 30 34	159 163 164 165	84 83 81 118 94 95 96 65	160 153 156 155 69 154 93 161	77 76 75 79 78 71 92 74 68 82 72 70 73 157

Number of species

Slope (°)

Aspect

Soil A-horizon: texture (s=sand, sandy; c=clay; l=loam)
colour (B=brown; dB=dark brown; dRB=dark reddish brown; dR=dark red; duR=dusky red)
pH(H_2O)
resistance(Ω)

B-horizon: texture (see A-horizon for symbol meanings)
colour (R/YR=red/yellowish red; others: see A-horizon)
pH(H_2O)
resistance(Ω)

depth (m)(R=litholitic soil)

Outcrop (%)

Boulders
Large stones (o=absent; r=rare; f=frequent; a=abundant)
Medium stones
Small stones and gravel

Differentiating species of Burkea africana - Ochna pulchra Woodland (3.1.1.1)	
D	Burkea africana
d(3.2.1)	Ochna pulchra
D	Vangueria infausta
d(2)	Lannea discolor
Differentiating species of Tristachya biseriata Combretum zeyheri Variation (3.1.1.1a)	
d(21,32.1a)	Combretum zeyheri
d(3.2.1bi)	Faurea saligna
D	Dyschoriste transvaalensis
D	Loudetia flavida
D	Brachiaria brizantha
D	Leucas neuflizeana
D	Tapiphyllum parvifolium
D	Acalypha senensis
d(21,321)	Combretum molle
D	Thesium magalismontanum
Differentiating species of Rhynchosia monophylla - Tristachya biseriata Grasslands (3.1.1.2)	
D	Rhynchosia monophylla
Differentiating species of Tristachya biseriata - Protea caffra Woodland (3.1.1.3)	
d	Athrixia elata
D	Bulbostylis oritrephes
D	Indigofera burkeana
D	Graderia subintegra
D	Scleria bulbifera
D	Scilla nervosus
Differentiating species of Alloteropsis semialata - Protea caffra Variation (3.1.1.3a)	
D	Alloteropsis semialata
D	Anomatheca laxa
D	Ficinia filiformis
D	Helichrysum galpini
d(2.3)	Mohria caffrorum
Differentiating species of Cryptolepis oblongifolia- Protea caffra Variation (3.1.1.3b)	
d(2.2a)	Blumea alata
d(2.2)	Conyza aegyptica
d(2.2a)	Dicoma zeyheri
Differentiating species of Sphenostylis angustifolius - Tristachya biseriata Woodlands and Grasslands (3.1.1)	
D	Tristachya biseriata
D	Sphenostylis angustifolia
d(D:3)	Anthospermum rigidum
D	Cryptolepis oblongifolia
d(D:3)	Schizachyrium sanguineum
D	Helichrysum coriaceum
D	Pearsonia aristata
D	Rhynchosia totta
d(2.2a)	Ruellia patula
Differentiating species of Digitaria brazzae Tristachya rehmannii Woodlands, Shrublands & Grasslands (3.1.2)	
D	Digitaria brazzae
d(2.2 b)	Elephantorrhiza elephantina
D	Ipomoea ommaneyi
D	Tristachya rehmannii
d(2.2 b)	Acalypha angustata var. glabra
d(22b,23)	Aloe davyana
D	Gnaphalium undulatum
d(2.2b)	**Ledebouria marginata**
D	Crabbea hirsuta
D	Cymbopogon excavatus
D	Ophrestia oblongifolia
D	Crassula transvaalensis
d	Rhynchosia nervosa
Species common to communities 3.1.1.3 and 3.1.2a	
d(2.2b)	Protea caffra
d(2.3.21bi)	Oxalis obliquifolia
d(22b,23)	Vernonia natalensis
d(-)	Indigofera hedyantha
d(2.2)	Digitaria diagonalis
Differentiating species of subvariation 3.1.2(a)(i)	
D	Eriosema cordatum
D	Gnidia capitata
d(2.2b)	Asparagus laricinus
D	Brunsvigea natalensis
d(21b,22)	Setaria flabellata
Differentiating species of Digitaria brazzae - Protea gaguedi Shrubland Variation (3.1.2b)	
D	Protea gaguedi
D	Monocymbium ceresiiforme
D	Digitaria monodactyla
Differentiating species of Eragrostis racemosa - Diplachne biflora Woodlands, Shrublands& Grasslands (3.1)	
d(22,322b)	Becium obovatum
d(3.2.2b)	Eragrostis racemosa
D	Cassia mimosoides
d(2.2)	Kohautia amatymbica
D	Vernonia monocephala
D	Pygmaeothamnus zeyheri
D	Parinari capensis
d(3.2.2b)	Dicoma anomala subsp. anomala
d (2.2)	Panicum natalense
d(2.2)	Diplachne biflora
d(2.2)	Urelytrum squarrosum
d(2.2)	Chaetacanthus setiger
d(2.1)	Elionurus argenteus
d(2.2b)	Pentanisia angustifolia
D	Senecio erubescens
d(3.2.2b)	Thesium transvaalense
D	Thesium cytisoides
d(2)	Setaria perennis
Differentiating species of Loudetia simplex- Aristida aequiglumis communities (3 :Tables 4 & 5)	
d(2.2)	Diheteropogon amplectens
d(2.2)	Brachiaria serrata
d(2.2)	Rhynchelytrum setifolium
d(2.2)	Trachypogon spicatus
D	Bulbostylis burchellii
D	Aristida aequiglumis
D	Loudetia simplex
D(3.2.2)	Indigofera comosa
D(3.2.2)	Nidorella hottentotta
D	Andropogon schirensis var. angustifolius
D	Cyanotis speciosa
D	Tephrosia elongata
d(2.2)	Senecio venosus
D(3.2.2)	Albuca setosa
D(3.2.2)	Raphionacme burkei
General and infrequent species	
	Themeda triandra
	Erigeron floribundus
	Pellaea calomelanos
	Commelina africana
	Asparagus suaveolens
	Hypoxis rigidula
	Felicia muricata subsp. muricata
	Heteropogon contortus
	Chascanum hederaceum
	Dichapetalum cymosum
	Nolletia rarifolia
	Silene burchellii
	Commelina erecta
	Gazania krebsiana subsp. serrulata
	Lotononis orthorrhiza
	Helichrysum nudifolium
	Helichrysum setosum
	Raphionacme hirsuta
	Ledebouria sp.
	Boophane disticha
	Bequaertiodendron magalismontanum
	Cyperus obtusiflorus
	Nidorella resedifolia
	Rhus eckloniana
	Thunbergia atriplicifolia
	Vernonia oligocephala
	Vernonia sutherlandii
	Crassula nodulosa
	Eriosema burkei
	Lippia javanica
	Polygala amatymbica
	Solanum panduraeforme
	Anthericum cooperi
	Aster harveyanus
	Eragrostis capensis
	Eragrostis curvula
	Euphorbia inaequilatera
	Helichrysum kraussii
	Helichrysum kuntzei
	Lantana rugosa
	Oldenlandia herbacea
	Ledebouria revoluta
	Trichoneura grandiglumis

Species occurring in three relevés or less and not included in the above table: Aristida transvaalensis (20:+; 88:+; 96:+), Chascanum adenostachyum (15:+; 86:+; 87:+), Clematis oweniae (38:+; 44:+; 191:(+)), Conyza podocephala (159:(+); 164:+; 190:+), Eustachys mutica (10:+; 80:+, 94:+), Helichrysum adscendens (22:+; 23:+; 190:+), Hypericum aethiopicum (43:+; 44:(+); 45:+), Landolphia capensis (7:+ 19:+); 44:+), Lannea edulis (5:+; 8:+; 16:(+)), Phyllanthus incurvis (5:+; 8:+; 51:+); Piloselloides hirsuta (83:(+); 84:+; 90:+), Rhus leptodictya (11:(+); 34:(+); 38:+), Rhynchelytrum repens (75:+; 90:+; 162:(+)), Schistostephium crataegifolium (65:(+), 190:+, 194:+), Tagetes minuta (40:+; 88:+; 118:(+)), Acacia caffra (38:(+); 191:2), Aristida congesta subsp. congesta (81:+; 159:+), Aster peglerae (190:+ 191:+), Berkheya zeyheri subsp. zeyheri (16:(+); 17:+), Brachiaria nigropedata (120:+; 162:(+)), Crabbea angustifolia (8:+; 90:(+)), Cycnium adonense (94:+; 165:+), Cymbopogon validus (7:+; 9:(+)), Dianthus transvaalensis (66:+; 70:+), Dicrostachys cinerea (8:+; 51:(+)), Enneapogon pretoriensis (5:+; 10:(+)), Eragrostis nindensis (6:+; 162:+), Eulophia ovalis (65:+; 80:(+)), Euphorbia clavarioides var. truncata (97:+; 162:(+)), Hebenstreitia dentata(160:+; 162:(+)), Helichrysum lepidissimum (20:+; 22:+), Ipomoea bolusiana (16:+; 23:+), Kalanchoe thyrsiflora (7:+; 24:+), Microchloa caffra (89:+; 93:+), Ozoroa paniculosa (7:(+); 8:1), Pearsonia cajanifolia (17:+; 160:(+)), Pentarrhinum insipidum (159:+; 191:+), Pogonarthria squarrosa (76:(+); 88:+), Senecio albanensis (190:+; 191:+), Senecio [illegible] (24:(+); 88:+), Setaria lindenbergiana (7:+; 11:(+)), Sida dregei (8:(+); 51:+), Solanum nodiflorum (191:+; 194:(+)), Sonchus wilmsii (65:+; 75:+), Sporobolus stapfianus (94:+; 118:+), Striga bilabiata (68:+; 70:+), Strychnos pungens (7:+; 9:(+)), Sutera burkeana (8:+; 191:+), Talinum caffrum (51:+; 88:+), Tephrosia longipes var. lurida (79:+; 85:(+)), Tephrosia polystachya (8:+; 46:(+)), Truimfetta sonderi (5:(+); 8:1), Acalypha angustata var. angustata(159:+), Alepidea setifera (190:+), Aloe peglerae (24:+), Andropogon schinzii (43:+), Anthericum transvaalense (13:+), A. trichophlebium (80:+), Arthrosolen sericocephalus (16:+), Asclepias fruticosa (190:+), A. stellifera (77:+), Berkheya carlinopsis subsp. magalismontana (19:+), Bidens bipinnata (40:+), Buddleia saligna (194:+), Bulbine stenophylla (93:+), Cephalaria zeyherana (45:+), Chaetacanthus burchellii (67:+), Eragrostis sclerantha (162:+) E stapfii (162:+), Euphorbia schinzii (29:+), Evolvulus alsinoides (51:+), Fimbristylis ovata (84:+), Fuirena pubescens (16:+), Gerbera viridifolia (190:+), Harveya sp. (66:+), Helichrysum caespititium (82:+), H. cerastioides (70:+), H. glomerulatum (20:+), H. nudifolium var. quinquinerve (44:+), H. undatum (10:+), Helichrysum sp. (16:+), Hermannia depressa (8:+), Hyparrhenia filipendula var. pilosa (80:+), Indigofera daleoides (51:+), Ipomoea bathycolpos var. bathycolpos (8:+), Justicea anagalloides (8:+), Koeleria cristata (194:+), Kohautia virgata (88:+), Lapeirousia erythrantha var. sandersonii (86:+), Loranthus sp. (163:+), Merremia tridentata subsp. angustifolia (8:+), Oldenlandia herbacea (68:+), Pachycarpus schinzianus (95:+), Pappea capensis (5:+), Pearsonia sessilifolia (30:+), Pelargonium luridum (65:+), Peristrophe bicalyculata (5:+), Polygala hottentotta (40:+), Rhus discolor (190:1), R. lancea (191:+), Scabiosa columbaria (84:+), Selaginella dregei (19:+), Senecio microglossus (46:+), Sphedamnocarpus pruriens var. pruriens (38:+), Vernonia staehelinoides (51:+), Ximenia caffra (7:1), Ziziphus mucronata (5:+).

TABLE 5. - *Coleochloa setifera - Selaginella dregei* Shrubland and Grassland

Community number				3.2.1 (b) (i)									3.2.1. (b) (ii)								3.2.2 (a)																									3.2.2(b)																						
Relevé number	48	49	50	173	172	170	117	171	169	188	102	186	113	112	99	12	110	187	142	28	116	114	138	126	133	143	109	108	107	101	119	123	128	151	127	129	139	115	140	131	98	111	121	150	136	100	122	141	146	124	132	145	106	144	149	125	167	104	137	105	135	147	130	148	103	134	152	158
Number of species	36	34	25	36	34	34	44	33	34	28	36	28	28	32	30	30	3	21	33	30	32	14	28	25	25	31	27	27	29	24	30	30	20	22	27	26	26	34	27	26	26	34	30	25	31	27	28	34	23	29	31	33	26	28	28	29	28	32	31	33	25	26	24	30	36	35	31	33
Slope (°)	39	30	27	36	44	39	27	32	36	16	19	29	13	29	15	19	19	17	19	32	16	30	9	9	7	8	11	10	10	<1	5	4	5	6	3	5	6	18	3	5	2	4	4	5	2	5	1	6	6	5	7	4	4	4	7	7	3	6	6	6	1	8	4	9	9	3	-	1
Aspect	NE	NE	NE	SE	SW	SW	ESE	ENE	ENE	NW	ESE	ENE	NNE	ENE	NE	W	NE	SE	NNE	N	SW	S	SW	SE	ENE	NNW	NNE	NNE	NE	-	NE	ESE	E	E	SSW	NE	WSW	WSW	E	ESE	SSE	WSW	SSW	N	SE	NNE	-	SW	ENE	ESE	ESE	E	NNE	N	E	WSW	ESE	N	NNW	NNE	-	NW	SE	E	NNE	W	-	-
Soil: texture (s=sand, sandy; l=loam; c=clay)	s	s	sl	-	sl	sl	scl	sl	s	sl	sl	s	s	s	s	sl	s	sl	sl	sl	sl	sl	sl	sl	sl	sl	sl	sl	sl	sl	sl	sl	sl	sl	sl	sl	sl	sl	sl	sl	-	sl	sl	sl	sl	sl	sl	s	sl	sl	sl	sl	s	sl	sl	sl	sl	-	sl	s	sl	sl	sl	sl	sl	sl	sl	s
colour (Bl=black; dRB=dark reddish brown; dB=dark brown; vdG=very dark grey)	Bl	Bl	Bl	dRB	Bl	Bl	dRB	Bl	Bl	Bl	Bl	Bl	dB	Bl	dRB	dRB	dRB	Bl	Bl	dRB	Bl	Bl	Bl	Bl	Bl	Bl	dRB	Bl	Bl	dRB	Bl	Bl	Bl	dRB	Bl	Bl	Bl	Bl	Bl	vdG	dRB	Bl	Bl	Bl	Bl	dRB	dRB	dRB	Bl	dRB	dRB	Bl	Bl	dRB	Bl	Bl	dRB	-	Bl	dRB	dRB	dRB	dRB	dRB	dRB	dRB	dRB	dRB
pH (H_2O)	4.5	6.1	4.9	5.0	5.4	4.7	5.6	5.0	4.3	4.7	5.7	4.3	4.7	4.7	5.0	5.0	5.0	4.7	4.6	4.7	5.0	4.4	5.0	4.8	5.1	4.8	4.9	5.0	5.0	5.0	4.9	5.0	4.8	4.8	4.9	4.8	5.1	5.0	5.1	5.1	5.0	4.8	5.2	4.9	5.0	5.2	5.1	5.1	5.2	4.8	4.8	4.9	5.2	5.1	4.7	4.9	5.4	5.0	6.5	5.1	5.2	4.8	5.3	4.9	5.1	5.1	4.9	5.2
resistance (Ω)	1600	1000	6700	2100	1300	1200	1100	2100	2300	4900	1500	2400	7000	4700	2050	2000	5100	2450	3000	1700	7100	2700	2450	3900	2600	3000	3400	4000	3300	3150	2450	2500	4900	7050	3400	6300	2500	3900	2600	1900	3300	3900	6500	4700	2300	2600	5050	3500	3100	7300	2100	4100	4100	3700	4700	4700	3500	2600	800	3900	1500	5200	2400	5300	4100	2600	6200	2950
Outcrop(%) B=bouldery outcrop; b=low, irregular; s=sheet outcrop	b 95	b 95	b 95	B 80	B 90	B 95	B 90	b 90	b 90	B -	B 90	B 90	b 20	b 95	B 95	b 25	B 90	B 95	B 90	B 80	b 30	b 85	b 30	s 80	s 20	s 50	s 10	s 5	s 85	-	s 55	s 1	s 25	s 90	s 4	s 10	s 25	b 7	s 6	s 11	s 45	s 95	s 10	s 15	b 90	s 4	s 2	s 6	s 25	s 4	s 7	s 40	s 80	s 30	s 80	s 4	s 3	s 6	s 10	s 85	s 2	s 10	s 2	s 10	s 4	s 2	s 8	s 12
Boulders (o=absent; r=rare; f=frequent; a=abundant)	f	a	r	o	o	o	f	o	r	o	o	o	o	r	o	f	o	o	o	f	o	o	r	o	o	r	f	r	o	-	o	o	o	r	o	o	o	f	o	o	o	o	o	o	o	r	o	o	o	o	o	o	r	o	o	o	r	o	o	r	o	o	o	o	r	o	o	o
Large stones	f	a	r	f	r	o	f	o	r	r	o	o	o	o	o	f	o	o	r	r	r	o	r	o	o	o	f	f	r	-	r	o	o	r	r	o	r	a	o	o	o	o	r	o	o	r	o	r	o	o	o	r	f	o	o	o	o	r	r	f	o	o	o	r	r	o	r	o
Medium stones	a	a	f	f	r	o	f	o	r	r	o	o	r	r	o	a	o	o	r	a	a	o	r	f	r	f	f	a	r	-	f	o	r	a	f	o	r	a	r	r	f	r	r	r	f	r	r	a	r	r	r	r	r	r	r	r	f	r	r	a	o	r	o	a	r	r	f	r
Small stones and gravel	a	a	f	a	f	r	a	f	f	f	a	f	a	r	a	a	a	r	a	a	a	a	a	a	a	a	a	a	a	-	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Differentiating species of Landolphia capensis - Bequaertiodendron magalismontanum Shrubland (3.2.2)																																																																				
d(1.1) Bequaertiodendron magalismontanum	2		1	2	2	2	2	2	3	1	2	3	2	2	2	+	2	2	2	2	+										+																																					
D Landolphia capensis	+	+	1	+	+		+	+	1	+	+	2	+	1	1	+	3	2	+	1																						+																										
d(1) Fagara capensis	+	+	+	+	+	+	+	+	+	+	+	+	+			+		+	+	+																																																
D Tapiphyllum parvifolium	+	+				+	+	+	1	1		2	+	1	+	+	+		+	2	+																																															
D Brachylaena rotundata	+				+	+	+	+		+	+				+			3		+																																																
D Commelina erecta	+			+	+	+	+		+					+	+		+		+																																																	
d(D:2.3) Setaria lindenbergiana	+		+		+	+	+			+							+	+																																																		
d(21 & 3111a) Combretum molle	+	+	+			+					+				+					+																																																
D Indigofera malacostachys		+	+				+				+		+	+	+															+			+													+																						
D Anthospermum hispidulum	+		+	+					+			+								+	+																	+																														
D Maytenus tenuispina	+							+		+					+				+	+																											+																					
d(3.1.1.1) Ochna pulchra	+	+									+				+	1				+																																																
D Berkheya carlinopsis subsp. magalismontana				+					+				+	+						+	+																																															
Differentiating species of Croton gratissimus - Landolphia capensis Variation (3.2.1(a))																																																																				
d(1,22,21a) Croton gratissimus subsp. gratissimus	2	+	1							+																																																										
D Portulaca kermesina	+	+	+																																																																	
D Crassula argyrophylla	+	+	+																	+																																																
D Canthium huillense	+		+										+																																																								
d(2.1) Combretum zeyheri		+	1																																																																	
D Enneapogon pretoriensis	+	+																																																																		
D Evolvulus alsinoides	+	+																																																																		
D Hibiscus aethiopicus	+	+																																																																		
D Osyris lanceolata	+		+			+																																																														
Differentiating species of Asparagus krebsiana Landolphia capensis Variation (3.2.1(b))																																																																				
D Asparagus krebsianus					+	+	+				+	+			+		+	+																																																		
D Crassula sp.				+				+		+		+	+	+			+		+									+																							+																	
D Cyperus sphaerospermus				+	2	1	+				1				+		+			+																																																
D Nuxia congesta				+		1	+				+	+						+	+	+																																																
d(2.2b) Diospyros lycioides subsp. guerkei					+	+	+	+				+						+	+		+																																															
Differentiating species of Faurea saligna - Landolphia capensis Sub. variation (3.2.1.(b)(i))																																																																				
D Clutea pulchella				+	1	1	+	+	+	1		+																																																								
d(3111 a,) Faurea saligna				2	1	+	+	+	+		+																																																									
D Canthium gilfillanii				+	+	1		+		+			+																																																							
d(2.3.1.2a;3.1.1.3) Oxalis obliquifolia				+	+	+	+				+											+	+														+								+																							
D Plectranthus madagascariensis				+	+	+			+			+							+			+																+									+																					
d(1.1) Haemanthus magnificus				+	+	+	+																																																													
d(2) Piloselloides hirsuta				+	+		+			1																																																									
Differentiating species of Cyperus rupestris - Eragrostis nindensis Grassland (3.2.2)																																																																				
D Eragrostis nindensis													+						+		+	+		+	+	+	+	+	+	+	+	+		+	1	+	+	+	+	+	+	1	+	+	+	1	+	+	+	+	2	+		+	1	1	1	2	+	+	+	+	+	1	3	+	+	+
D Cyperus rupestris													+											+	+	+	+	+	+	+	+	+		+	+	+	+		+	+		+	+	+	+	+		+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+
D Lopholaena coriifolia										+			+				+				2	+	+	+	+		1	1	1	+	1	+	+	+	+	+	+		+	+	+		2	+	+	+	+			1	1	+	+			+	+	+	+	+			+		2	+		
d(D:3) Indigofera comosa											+										+		+	+	+		+	+	+			+			+	+		4		+			+	+		+	+	+	+	+	+	+		+	+	+		+	+	+	+	+	+	+	+	+	+	+
d(D:3) Nidorella hottentotta																					+		+	+								+	+			+	+	+		+		+	+		+		+	+	+	+	+				+	+	+	+	+		+		+		+	+	+	+
d(D:3) Raphionacme burkei																							+		+		+	+			+			+	+		+	+	+	+	+	+	+			+				+	+				+		+	+			+	+	+	+	+	+	+	+
D Lapeirousia erythrantha var. sandersonii																			+				+			+	+	+		+	+	+	+	+	+		+	+		+		+	+	+	+	+	+	+		+		+					+	+	+						+			
d(D:3) Albuca setosa				+																	+					+				+								+	+	+		+			+	+	+	+	+		+	+		+	+		+		+	+	+	+	+	+		+	+	
D Xerophyta viscosa		+																		+						+						+				+			+	+	+	+	+	+	+		+		+	+	+	+		+	+		+	+	+		+				+	1		+
D Frithia pulchra																					+	+	+	+	+	+			+				+		+	+	+		+		+				+							+	+	+					+		+					+		
D Khadia acutipetala																									+	+								+	+					+					+			+			+			+	+		+	+	+	+	+		+		+	+	+	+
D Eragrostis stapfii			+					+																	+		+		+			+		+	+		+	+		+			+		+		+			1	+						+		+				+			+		+
D Euphorbia schinzii																					+		+	+		+											+	+	+	+	+	+						+	+			+		+	+	+		+				+		+				
D Ledebouria revoluta																					+		+	+	+		+	+	+		+	+					+	+					+				+	+						+	+													
D Microchloa caffra														+												+					+	+			+	+			+					+						+	+	+		+							+				+		+
Differentiating species of Thesium transvaalense- Eragrostis nindensis Variation (3.2.2(b))																																																																				
d(3.1) Thesium transvaalense																					+																+	+	+						+			+	+	+		+			+	+	+	+	+	+		+	+	+		+	+	
D Anacampseros subvelutinum			+																																						+	+	+	+	+						+	+		+	+	+	+		+			+		+	+		+	+
d(3.1) Dicoma anomala subsp. anomala																																											+			+	+					+	+					+	+	+	+		+			+	+	+
d(2.2,3.1) Becium obovatum																																																					+	+	+				+		+	+	+			+		+
d(3.1) Eragrostis racemosa																+																																					+			+				+	+	+		+	+		+	+
D Helichrysum cerastioides																																								+				+						+						+	+					+	+	+	+	+	+
D Euphorbia clavarioides var. truncata																																													+				+		+			+						+	+				+	+		
Differentiating species of Coleochloa setifera - Selaginella dregei Shrubland and Grassland (3.2)																																																																			
D Selaginella dregei				+		+	+	+	+	1	+	+	2	+	+		+		+	+	+		+	+	+	1	+	+	+	1	+	+	+	+	+	+	+		+	+	1	+	+	1	+	2	+	+	+	1	1	+		+	1	+	+	+	1	+	+	+	+	+	+	+	+	
D Coleochloa setifera	+	1	3	1	+	1	+	2	1	1	+	+	2	2	+		+	+	+	+	3	2	3	2	2	1	3	3	3	2	2	2	2	1	1	2	2	2	2	2	1	+	2	1	2			+			+	+	+						+	+						+		
D Adromischus umbraticola	+		+						+			+											+	+	+	+			+	+	+	+	+				+		+		+	+			+			+				+	+	+	+	+		+	+	+	+	+		+	+	+		+
D Rhus magalismontanum					+	+				+		2	+	+	+		+			+							+	+	+	+	+	+	+	+	+	+			1		+	1			+	1		+			+	+				+		+	+							+		
D Cymbopogon validus	1	2	1	+			+	1	+	+	+	+		2	+	+	1	+	1		+				+	1			+		+	+	+		+	+			+			+									+	+							+									
D Aloe peglerae		+						+					+	+			+				+			+			+	+	+	+	+			+		+				+	+	+		+		+												+							+	+		
D Oldenlandia herbacea	+						+					+	+			+		+	+	+			+				+			+	+	+														+				+								+							+		+	
D Aristida diffusa	+	+	+										+	+								+				1	+	+	+	+												+				1												1							+			
Differentiating species of Loudetia simplex- Aristida aequiglumis communities (3:Tables 4-5)																																																																				
d(2.2) Diheteropogon amplectens	+	+	+					+	+		+			+	+	1	+		+	+	+		+	+	+	+	+	+	+	+	+		+	1		+	+	+	+	+	+	+	+	+	+	+	+	+	1	+	+	+	2	+	+	1	1	+	1	2	+	+	+	2	+	1	2	1
d(2.2) Brachiaria serrata				+	+			+						+		+					+		+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	1		+	+	1	+	1	+	1		+	+	+		+	+	+	+		+	+	+	+	+	+	+	+
d(2.2) Rhynchelytrum setifolium	+		+	+	+	+	+	+	+		+	+	+	+	+	+	+		+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+
d(2.2) Trachypogon spicatus					+			+				+	+	+	+	3	+			+	2				+	+		+	+	+		+	+	1				+	+		+	+	+	+		+	2	1	+	+	+	+	+	1	+	+	2	+		1		1			+	+	2	+
D Bulbostylis burchellii	+	+	+	+	+		+	+	+		+		+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	1	+	+	+	+	+	+	+	2	2	+	+	+	+	+	1	1	2	2	+	+	+	+	+	+	1	+	1	1	+
D Aristida aequiglumis											+				+	1			+	+	+		+	+		+	+	+	+	+	+	1		+	+	+	+	+	+	+	2	2	+	+	+	1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
D Loudetia simplex				+					+					+	+	+				2	+		+	+	+											+	+	+	+		2	+	+				+	2				+	+	+		+			+	+								+
D(3.1.1) Anthospermum rigidum								+		+	+				+	+	+			+			+	+	+	+	+		+			+				+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+		+		+	+		+	+
D Andropogon schirensis var. angustifolius	+												+	+	+	1	+		+					+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+		+	+	+	+	+		+	+	+	+	+		+	+	+	+		+			+	+	+		+	1	+
D(3.1.1) Schizachyrium sanguineum	+		+		+		+	+	+		+		+	+	+		+		+					+		+	+	+	+	1	+		+	+							1	+	+	+			+		+				+	+	1	+	+		+		+		+	+	+		+	
D Cyanotis speciosa									+							+			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+		+		+	+	+	+	+			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
D Tephrosia elongata									+			+	+	+			+									+	+	+	+			+	+					+				+				+	+					+				+						+		+		+		
d(2.2) Senecio venosus				+			+	+	+		+			+	+	+	+			+			+	+														+							+			+									+			+				+			+	
General and infrequent species																																																																				
Themeda triandra				1	+	+			+		1			1	+		+		+	1	+				+	+	+	+	+	2	+	1		1	1	+	+	1	1	+	1		1	2	1	1	1		2	+	+	2	+	1	1	+	+	2	1	1	3	3	3	2	2	1	1	2
Commelina africana	+	+		+			+				+					+			+	+	+					+		+	+	+	+			+		+		+			+			+		+			+	+		+	+		+	+	+	+		+		+		+	+	+	+	
Pellaea calomelanos	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+		+	+	+	+		+	+	+	+	+			+				+			+		+			+												+	+				+				+				
Tristachya biseriata									2					+		2				+																		1			+												2		+					2							+	1
Cleome monophylla				+		+																+				+					+												+	+					+											+				+				
Kalanchoe thyrsiflora							+		+			+																+	+									+								+												+		+					+			
Vangueria infausta									+					+		+		+			+								+																								+							+								
Senecio orbicularis				+												+								+											+		+	+												+																		
Brachiaria nigropedata																			+													+			+								+							+	1																	
Loudetia flavida	+	+											+	+		+																										+																										
Mohria caffrorum				+	+			+													+	+	+																																														
Dichapetalum cymosum									+																									+								+																									+	+
Limeum viscosum																																			+												+			+	+	+																
Thesium cytisoides																																							+									+				+				+				+								
Vernonia monocephala																							+															+							+			+											+									
Boophane disticha																																																					+					+		+					+			
Canthium suberosum					+		+				+						+																																																			
Cleome maculata		+																	+																									+																						+	
Dipcadi marlothii																							+								+	+				+																																
Ficus ingens							+	+			+								+																																																	
Lotononis laxa																+										+																																						+				+
Maytenus undata						+	+			+								+																																																		
Oropetium capense																									+								+																		+									+								
Ledebouria sp.																				+																		+																			+							+			
Sutera campanulata										+	+	+					+																																																			

Species occurring in three relevés or less and not included in the above table:

Cassia mimosoides (121:(+); 122:+; 134:(+)), Ceterach cordatum (110:(+); 170:+; 188:(+)), Chascanum adenostachyum (130:+; 132:(+); 158:(+)), Cheilanthes hirta (102:+; 110:+; 173:+), Crassula nodulosa (104:(+); 106:(+); 141:+), Cussonia paniculata (117:(+); 172:+; 187:+), Cyphostemma cirrhosum subsp. cirrhosum (117:+; 170:+; 188(+)), Gazania krebsiana subsp. serrulata (135:+; 141:+; 144:(+)), Gladiolus permeabilis var. edulis (123:(+); 138:+; 141:+), Mariscus sp. (103:+; 125:+; 130:+), Mimusops zeyheri (28:(+); 110:+; 171:(+)), Myrothamnus flabellifolius (99:+; 112:+; 113:1), Ochna holstii (171:+; 186:+; 187:2), Pappea capensis (117:(+); 172:+, 187:(+)), Parinari capensis (99:+; 106:+; 169:(+)), Rhynchelytrum repens (49:+; 134:+; 143:+), Rhynchosia nervosa (100:(+); 106:+; 158:+), Rhynchosia nitens (110:1; 117:+; 169:(+)), Sarcostemma viminale (50:(+), 117:(+); 186:+), Tephrosia rhodesica (49:+; 142:(+); 102:+), Tricalysia lanceolata (186:+; 187:+; 188:1), Vernonia sutherlandi (12:+; 110:+; 171:+), Acokanthera oppositifolia (186:+; 187:+); Apodytes dimidiata (170:(+), 173:+); Bulbine stenophylla (129:+; 136:+), Dyschoriste transvaalensis (12:+; 28:+), Helichrysum kraussii (99:+; 169:+), Hemizygia canescens (123:(+); 124:+), Indigofera oxalidea (101:+; 103:(+)), Lotononis orthorrhiza (125:(+); 136:+), Mariscus capensis (49:(+); 102:+), Ozoroa paniculosa (49:(+); 102:+), Phyllanthus parvulus (117:+; 119:+), Pollichia campestris (117:(+); 172:+), Rhoicissus tridentata (117:+; 172:+), Rhynchosia monophylla (103:(+); 111:+), Rhynchosia venulosa (102:+; 105:(+)), Silene burchellii (111:+; 121:(+)), Solanum incanum (122:(+), 142:+), Sporobolus stapfianus (106:+; 113:+), Tephrosia longipes var. lurida (49:+; 109:+), Vernonia staehelinoides (12:(+); 111:+), Zornia linearis (49:+; 119:+), Aloe davyana (110:+); Aristida junciformis (28:+), Aristida sp. (103:+), Asparagus setaceus (117:+), A. suaveolens (169:+), Barleria pretoriensis (49:+), Burkea africana (12:1), Clematis brachiata (172:+), Cotyledon orbiculata (110:+), Crassula transvaalensis (111:+), Craterostigma wilmsii (113:+), Cymbopogon plurinodis (28:+), Cyphocarpa angustifolia (49:+), Dalechampia sp. (117:+), Dicoma zeyheri (148:+), Digitaria brazzae (141:+), Dombeya rotundifolia (117:+), Eragrostis curvula (136:+), E. sclerantha (145:+), Ficus soldanella (48:+), Hebenstreitia dentata (167:+), Helichrysum athrixifolium (170:+), Hypoestes verticillaris (48:+), Indigofera filipes (127:+), I. nebrowniana (49:+), Lightfootia paniculata (116:+), Maerua caffra (187:+), Monocymbium ceresiiforme (141:+), Nemesia fruticans (173:+), Nolletia rarifolia (158:+), Pachystigma pygmaem (122:+), Panicum natalense (141:+), Pellaea viridis (102:+), Pittosporum viridiflorum (170:1), Pouzolzia hypoleuca (48:+), Rhynchosia totta (48:+), Sphenostylis angustifolius (98:+), Streptocarpus vandeleuri (173:+), Striga gesnerioides (115:+), Talinum caffrum (49:+), Tephrosia longipes (28:+), T. polystachya (117:+), Trachyandra saltii (114:+), Turbina oblongata (117:+), Urelytrum squarrosum (141:+), Wahlenbergia banksiana (173:+), Ximenia caffra (112:+).

FIG. 15.—Physiognomy of **Setaria lindenbergiana—Acacia caffra** Woodland.

or cover up to 20% and include *Artemisia afra, Rhus eckloniana, R. discolor, R. leptodictya, Lippia javanica, Acacia caffra, A. karroo, Acalypha glabrata* and *Diospyros lycioides*. Grasses and forbs cover 70–80%.

This variation has affinities with the *Acacia caffra—Setaria lindenbergiana* variation described by Van Vuuren (1961) as growing in temperate and moist habitats below cliffs with water accumulation, on the southern side of the Magaliesberg. Another related vegetation type was described by Coetzee (1974) as *Acacia caffra* Savanna on diabase, where the soil is relatively moist and presumably base-rich. This Variation also appears to have affinities with *Acacia caffra—Setaria perennis* and *Faurea saligna—Setaria perennis* Tree Savannas described by Theron (1973).

3. Loudetia simplex—Aristida aequiglumis *Woodlands, Shrublands and Grasslands* (Tables 4 and 5)

This widespread phytocoenon can be classified with some of the Sourish Mixed Bushveld of the Loskop Dam Nature Reserve (cf. Theron, 1973), the Chert Vegetation, Shale Vegetation and the vegetation with abundant large boulders, on quartzite outcrops and on massive chert outcrops, described by Coetzee (1974a) from the Jack Scott Nature Reserve in the Bankenveld and the *Chrysophyllum* community described by Van Vuuren (1961). The vegetation is differentiated by a large number of species, common to Table 4 and 5, which have a wide distribution in the cooler and higher rainfall areas of the Transvaal (cf. Coetzee & Werger, 1975). In the Rustenburg Nature Reserve the *Loudetia simplex—Aristida aequiglumis* syntaxon grows on the more leached soils with low conductivity and pH. This vegetation includes broad-leaved deciduous woodlands, *Protea caffra*-dominated evergreen woodlands, *Protea gaguedi*-dominated evergreen shrublands, *Bequaertiodendron-Landolphia*-dominated semi-deciduous shrub-land and seasonal grasslands. These form two broad types, the first occurring on deeper litholitic and better developed soils, and the second on bouldery outcrops and on a shallow litholitic and lithosol mosaic with extensive sheet outcrop.

3.1 Eragrostis racemosa—Diplachne biflora *Woodlands, Shrublands and Grasslands*

Table 4 shows the vegetation on litholitic and deeper soils, excluding the vegetation on very shallow litholitic soils found in areas of extensive sheet outcrop.

3.1.1 Sphenostylis angustifolius—Tristachya biseriata *Woodlands and Grasslands*

The vegetation associated with litholitic soils includes three major syntaxa which seem to grow on separate parts of a complex gradient associated with altitude and soil nutrients: the first, which is deciduous woodland (3.1.1.1), occurring on the foothills on the northeastern side of the mountain (with an exceptional variation growing in deep soils on the plateau); a second, which is *Protea caffra*-dominated woodland (3.1.1.3), found on slopes in the series of valleys between the two summit areas and on slopes on the western side of the mountain; and a third, which is grassland (3.1.1.2), growing on the lower pH and conductivity soils near the summit and on the plateau. The deciduous woodland variation on the plateau (3.1.1.1b) occurs in areas that appear to be nutritionally richer than the grasslands of litholitic soils as indicated by the frequency of comparatively high soil conductivity (Table 4). The pH values of the deciduous woodland variation on the plateau, however, are, like the grasslands, generally lower than those of the *Protea caffra*-dominated woodlands and the deciduous woodlands of the foothills. Relevé 42 of the deciduous woodlands on the plateau is an exception with a relatively high soil pH and supports these suggestions because it includes *Protea caffra* as well as *Oxalis obliquifolia* of the same group of differentiating species for *Protea caffra*-dominated woodlands (see also discussion in 3.1.2a).

3.1.1.1 Burkea africana—Ochna pulchra *Woodland (deciduous woodland)*

(a) Tristachya biseriata — Combretum zeyheri *Variation*

FIG. 16.—The **Tristachya biseriata—Combretum zeyheri** Variation of **Burkea africana — Ochna pulchra** Woodland on the eastern side of the mountain, in the foreground.

This variation occurs on the litholitic soils of the foothills on the northeastern side of the Magaliesberg (Fig. 16) and is differentiated from the related variation on the plateau by *Combretum zeyheri*, *Combretum molle* and other species of the same group as shown in Table 4. The two species mentioned also differentiate *Combretum zeyheri—Acacia caffra* Woodland from the other more mesic *Eustachys mutica—Acacia caffra* Woodlands, suggesting that the variation of the foothills grows in a more xeric habitat than that of the variation on the plateau. *Tapiphyllum parvifolium* also differentiates *Landolphia capensis—Bequaertiodendron magalismontanum* Shrubland, which, like the variation on the foothills and unlike the one on the plateau, occurs on litholitic soils. Relevés include various hotter and cooler aspects except the cooler southerly aspects from southeast to south-southwest.

Trees from 5–10 m tall cover less than one to 20%, usually less than 6%, and include *Combretum zeyheri*, *C. molle*, *Burkea africana*, *Faurea saligna* and *Ochna pulchra*. A 2–5 m tall tree stratum covers from less than one to 15% and includes the same species as the taller stratum as well as *Lannea discolor*, *Strychnos pungens*, *Mundulea sericea*, *Ximenia caffra* and *Ozoroa paniculata*. A 0,5–2 m tall stratum of young trees and shrubs, including all the species of the upper stratum as well as *Cryptolepis oblongifolia*, *Lannea discolor*, *Bequaertiodendron magalismontanum*, *Tapiphyllum parvifolium* and *Ozora paniculata*, usually covers 5–15% but can also cover only one per cent. Any one of the woody species in the upper two strata can be dominant and in some places a number of them are co-dominant. The grass and forb stratum covers 60–85%.

(b) Silene burchellii—Burkea africana *Variation*

This variation differs considerably in species composition, habitat and appearance from the former (Fig. 17). The position of the *Silene burchellii—*

FIG 17.—Physiognomy of the **Silene burchellii—Burkea africana** Variation of **Burkea africana—Ochna pulchra** Woodland growing on flats in the plateau basin and dominated by **Burkea africana** trees.

Burkea africana Variation in the lower parts of the plateau basin in areas of water accumulation, indicate that it is more moist than the *Tristachya biseriata-Combretum zeyheri* Variation of the same woodland type. The former is probably also cooler, as a result of its position on the top of the mountain and the accumulation of cold air in the plateau basin during winter.

Burkea africana trees, 5–8 m tall, are usually present covering 1% or less on the shallower soils and up to 25% on deeper soils. Smaller *Burkea africana* trees (2–5 m high) cover 25–55%, where taller trees are sparse or absent. A 2–5 m layer of *Protea caffra* trees covering up to 20%, occurs in quadrat No. 42 (pH = 5,9) under denser stands of the taller trees. A 0,5–2 m stratum, including *Burkea africana, Protea gaguedi, Ochna pulchra, Vangueria infausta* and *Rhus eckloniana*, usually covers 1–2% and grasses and forbs cover 65–75%.

FIG. 18.—**Tristachya biseriata — Protea caffra** Woodland in the foreground, growing in the series of valleys between the two summit areas. On the opposite slope to the right is the **Blumea alata—Acacia caffra** Variation of **Combretum zeyheri—Acacia caffra** Woodland and, in the background, an example of **Rhynchosia monophylla — Tristachya biseriata** Grassland.

3.1.1.2 Rhynchosia monophylla—Tristachya biserriata *Grasslands*

Grassland belonging to the *Sphenostylis angustifolius—Tristachya biseriata* syntaxon, occurs on non-rocky litholitic soils of the upper valley slopes between the two summit areas and of the plateau basin (Fig. 23).

3.1.1.3 Tristachya biseriata—Protea caffra *Woodland*

This woodland comprises the *Protea caffra*-dominated vegetation of litholitic soils (Fig. 18).

(a) Alloteropsis semialata—Protea caffra *Variation*

This mesic Variation occurs on 10–35° slopes with southerly aspects found in the series of valleys between the summit areas in the Reserve and on the western side of the Magaliesberg outside the Reserve. In four of the five quadrats with the lowest slope angles (10,5° to 17,5°) 75% or more of the unvegetated surfaces are covered with accumulated grass and leaf litter. This condition should be monitored since the recently introduced burning programme aims to protect these areas from fire. Most of the gentler slopes in this *Protea caffra*-dominated woodland are found in the northern upper end of the series of valleys where three of the quadrats concerned are situated (Nos. 43, 44 and 45).

Protea caffra is the only species in the tree stratum, which is 2 to 4 or 5 m tall and covers 15–25%. Young *Protea caffra* trees, 0,5–2 m tall were sometimes present. Grasses and forbs cover 70–85%.

(b) Cryptolepis oblongifolia — Protea caffra *Variation*

This is the more xeric of the two variations and occurs on 9–29° slopes in the valleys between summit areas. Aspect is mostly east-northeast but east and west-southwest aspects were also recorded.

Protea caffra trees form a 2–5 m stratum covering 15–25%, exceptionally 5%. *Cryptolepis oblongifolia* shrubs and young *Protea caffra* trees, 0,5–2 m tall, are usually present, covering one per cent or less. The grass and forb stratum covers 75–85%.

3.1.2 Digitaria brazzae — Tristachya rehmannii *Woodlands, Shrublands and Grasslands*

This vegetation occurs on the deeper, well differentiated soils of the plateau and includes *Protea caffra*-dominated woodland, *Protea gaguedi*-dominated shrubland and grassland. All these variations are found on well drained slopes and depressions of the lower areas on the plateau where water accumulation can be expected. Distinct differences between the habitats of these variations and their sub-variations are characterized by position in the landscape, geomorphology, soil texture, colour and pH.

(a) Elephantorrhiza elephantina—Protea caffra *Woodland Variation*

Soil pH in this variation is not as low as in the shrubland and grassland variations (Table 4). Higher pH values also distinguish the habitat of *Protea caffra*-dominated woodlands on litholitic soils from that of the grasslands on litholitic soils (3.1.1.). These two *Protea caffra*-dominated types have a group of differentiating species, including *P. caffra*, in common.

FIG. 19.—The **Elephantorrhiza elephantina** — **Protea caffra** Woodland Variation with 5 m tall **Protea caffra** trees.

In the strongly related vegetation of the Jack Scott Nature Reserve in the central Bankenveld, the only difference observed between the habitats of grasslands and *Protea caffra*-dominated woodlands on chert, overlying dolomite, was a marked difference in thickness chert cap (Coetzee, 1972, 1974). *Protea caffra* woodlands occur where dolomite is close to the surface and although soil pH was not measured this difference does suggest comparatively higher soil pH in the *Protea caffra* woodlands. There were no indications of climatic differences between the two adjacent areas.

(i) The first sub-variation occurs in flat, low but well drained drainage belts. One of the differentiating species, *Setaria flabellata*, is restricted to the three quadrats with sandy clay-loam and clay-loam A-horizons. B-horizons are dusky red. Two to 5 m tall *Protea caffra* trees cover 40–60% and grasses and forbs, up to 2 m tall, cover 75–85% (Fig. 19).

(ii) A second sub-variation is found at the end of long slopes just before and on the steeper decent to drainage lines, steep drops or further slopes and on slightly elevated areas from which water drains outward in all directions (Fig. 23). B-horizons are dark red to dark reddish brown. *Protea caffra* trees, 2–5 m high cover 5–30% and grasses and forbs up to 2 m tall cover 80–90%.

(b) Monocymbium ceresiiforme—Protea gaguedi *Shrubland Variation* (Fig. 20 and 23).

FIG. 20.—One metre tall **Protea gaguedi** — dominated shrubland belonging to the **Monocymbium ceresiiforme** — **Protea gaguedi** Variation of **Digitaria brazzae** — **Tristachya rehmannii** Woodlands Shrublands and Grasslands.

Protea gaguedi-dominated shrubland occurs on concave slopes with deep soils in lower parts of the plateau. The shrubs, mostly 0,3–1 m tall but up to 1,75 m, cover 10–15% and grasses and forbs cover 70–80%.

(c) *Grassland Variation*

Grasslands belonging to this vegetation occur on deep soils of flat to convex slopes of the lower plateau areas, excluding those slopes described for the *Elephantorrhiza elephantina—Protea caffra* Woodland Variation. The total cover is between 60 and 85% (Fig. 23).

3.2 Coleochloa setifera—Selaginella dregei *Shruland and Grassland*

The vegetation shown in Table 5 includes a shrubland type occurring on broken bouldery outcrops and a grassland type found in areas with extensive sheet outcrop.

3.2.1 Landophia capensis — Bequaertiodendron magalismontanum *Shrubland*

This vegetation occurs on broken outcrops with plants growing in cracks, fissures and litholitic soil-pockets. In some places trees are dominant in the upper stratum. The shrub growth-form is, however, usually very prominent and many woody species that occur widely as trees, are often shrubby in this vegetation. Trees are often also characteristically stunted.

Two main variations of this community type were found in the Reserve: (a) one on the very steep, northeast-facing slopes of the Magaliesberg; and (b) another on the summit plateau.

(a) Croton gratissimus — Landolphia capensis *Variation*

This variation occurs on 27–29° xeric north-facing slopes of the mountain (Fig. 7). The extensive quartzite outcrop is broken but low and flat.

An upper stratum of trees and tall shrubs, 2–4 m tall, including *Bequaertiodendron magalismontanum, Croton gratissimus* and *Combretum zeyheri*, covers 2–25%. Shrubs, 0,5–2 m tall cover 30% and include *Bequaertiodendron magalismontanum, Landolphia capensis* and *Tapiphyllum parvifolium*. Grasses and forbs cover 5–55%.

(b) Asparagus krebsianus—Landolphia capensis *Variation*

The variation on the cooler plateaux is further subdivided:

(i) The *Faurea saligna—Landolphia capensis* Sub-variation is found mainly on steep southerly and easterly-facing slopes along deep drainage lines. Trees and tall shrubs, 2–5 m tall, usually cover 20–30% and include *Faurea saligna, Bequaertiodendron magalismontanum, Brachylaena rotundata, Canthium suberosum, Rhus leptodictya, Nuxia congesta, Tapiphyllum parvifolium* and *Combretum molle*. A shrub stratum of 0,5–2 m tall, covers 2–16%. Grasses and forbs cover 10–15%.

(ii) The other sub-variation occurs on the more open parts and on slopes with northerly aspects (Fig. 21). Shrubs and trees vary from 0,5–5 m, but are often lower than 3 m, and cover 15–40%. Lower shrubs, grasses and forbs cover 5–20%.

3.2.2 Cyperus rupestris — Eragrostis nindensis *Grassland*

This grassland is found on the plateau in areas that are a mosaic of extensive, flat unbroken sheet outcrop and litholitic soils (Figs. 22 and 23). Cover of outcrop in quadrats varies from 1–95%, but these differences do not distinguish the two variations found:

(a) The *Coleochloa setifera—Eragrostis nindensis* Variation, differentiated by *Coleochloa setifera*, occurs mainly on black soil. *Lopholaena coriifolia* shrubs of up to 2 m are usually present, covering less than 5%. Grasses and forbs cover from 15 to 55%.

(b) The *Thesium transvaalense—Eragrostis nindensis* Variation found mainly on dark reddish brown soil, is transitional to the *Eragrostis racemosa—Diplachne biflora* unit occurring on deeper litholitic dark reddish

FIG 21.—Stand of **Landolphia capensis—Bequaertiodendron magalismontanum** Shrubland amongst outcrops of large, quartzite boulders on the plateau.

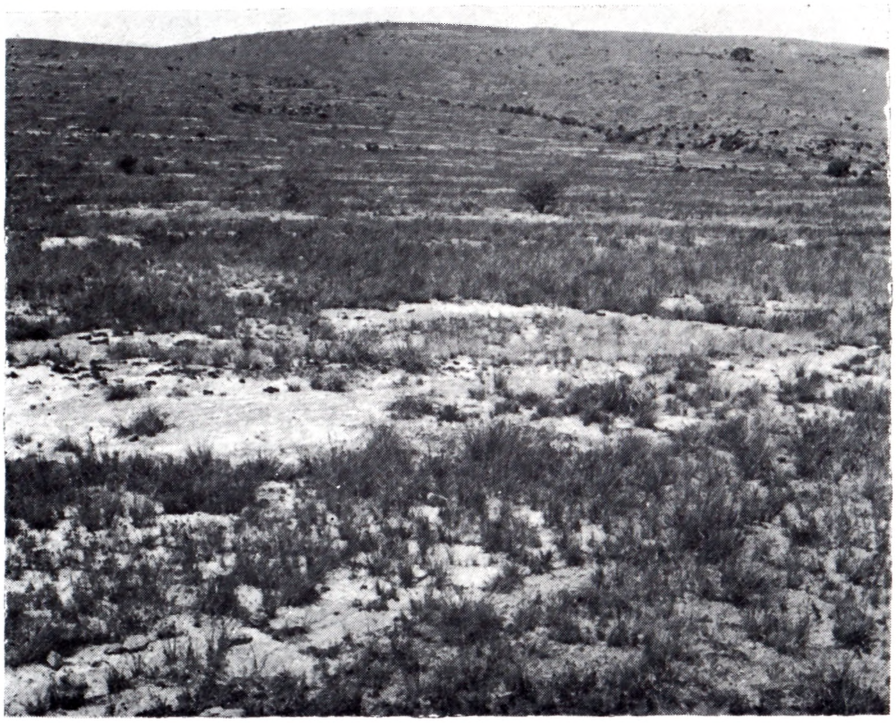

FIG. 22.—Stands of **Cyperus rupestris — Eragrostis nindensis** Grassland growing on very shallow litholitic soils and in cracks in a mosaic of bare sheet-outcrop and shallow gravelly soils.

brown soils (Table 4). Grass and forb cover in this variation is between 40 and 50% and *Themeda triandra* has characteristically constant high cover values as opposed to the former.

4. Aristida junciformis — Arundinella nepalensis *Grassland* (Table 6)

This vegetation occurs in slightly elevated areas, with relatively high water table, fringing the *Pteridium aquilinum — Phragmites mauritianus* Reedswamps (Sect. 5) and small streams, and in shallow submerged marshy areas (Fig. 23). The vegetation has a few infrequent species in common with the reedswamps but species occurring elsewhere in the Reserve are rarely encountered. As shown in Table 6, the dominant species vary with different water table depths and soil characteristics. The *Rhynchospora glauca*-dominated quadrat in the submerged area with stagnant water had a floating layer of iron bacteria.

5. Pteridium aquilinum — Phragmites mauritianus *Reedswamp* (Table 6)

The reedswamp occurs in the bottom of the plateau basin in a mass of water, humic material and roots, which reach down to below 2 m depth (Fig. 23). The *Phragmitis mauritianus* plants grow 4–5 m above the surface of the water and cover 30–90%.

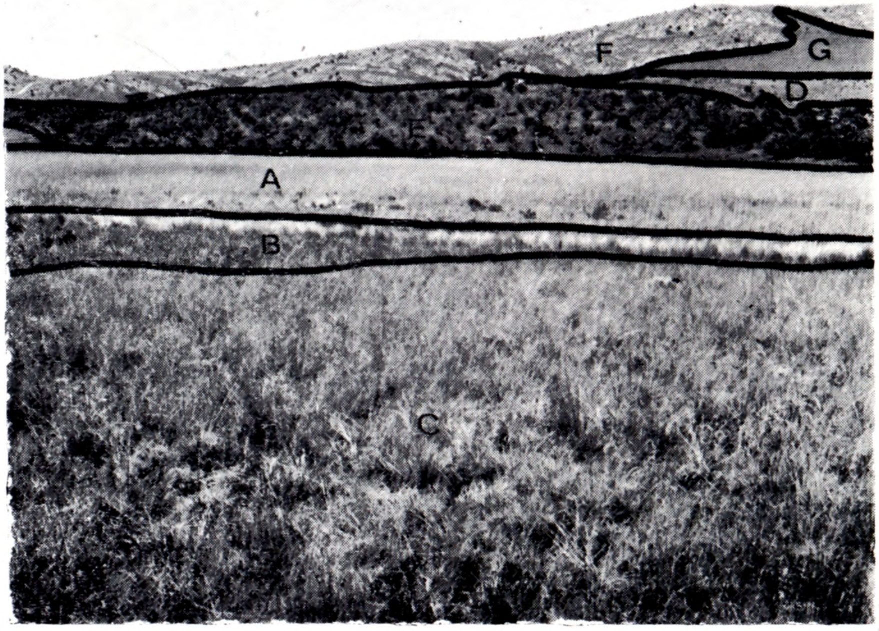

FIG. 23.—Part of the plateau basin with stands of: **Pteridium aquilinum — Phragmites mauritianus** Reedswamp (A); **Aristida junciformis — Arundinella nepalensis** Grassland (B), which fringes the reedswamp; the Grassland Variation (C), the **Monocymbium ceresiiforme — Protea gaguedi** Shrubland variation (D) and the **Elephantorrhiza elephantina — Protea caffra** Woodland Variation (E) of **Digitaria brazzae — Tristachya rehmannii** Woodlands, Grasslands and Shrublands; **Cyperus rupestris — Eragrostis nindensis** Grassland (F); and **Rhynchosia monophylla — Tristachya biseriata** Grassland (G).

TABLE 6. Aristida junciformis—Arundinella nepalensis Grassland and Pteridium aquilinum—Phragmites mauritianus Reedswamp

Community number	4						5						
Relevé number	177	174	179	180	178	168	182	181	185	183	184	175	176
Number of species	14	21	10	19	14	8	8	5	5	5	3	14	16
Topsoil: texture (s = sand; sandy; c= clay; l = loam; o = organic)	sl	sol	s	s	s	o	o	o	o	o	o	cl	s
colour (Bl=black; B/db=Brown/dark brown; dRB = dark reddish brown)	Bl	Bl	Bl	B/dB	dRB	Bl	Bl	Bl	Bl	Bl	Bl	Bl	Bl
pH(H_2O)	5,3	5,8	4,8	6,7	6,4	5,1	-	-	-	-	-	5,6	5,5
resistance(Ω)	1600	1500	1500	4300	3250	1250	-	-	-	-	-	1700	-
Soil depth(m)	>1	>1	>1	>1	>1	0,5	>1	>1	>1	>1	>1	>1	>1
Water table (cm)(f=free running surface water; s=stagnant surface water)	70	50	50	f	f	s	f	f	f	f	f	120	120
Differentiating species of Aristida junciformis - Arundinella nepalensis Grassland (4)													
D Arundinella nepalensis	1	+	+	+	+	1							
D Pycnostachys reticulata	+		1	+	+	+							
D Helichrysum setosum	+	+	+	+	+								
D Nidorella auriculata	1	2	+	+	+							+	
D Aristida junciformis	4	5	1			2							1
D Helichrysum stenopterum		2			+	+							
D Andropogon huillensis	+	+											
D Fimbristylis ferruginea	+	+											
D Berkheya speciosa subsp. lanceolata	+	+	+									+	
D Imperata cylindrica			5	+									
D Miscanthidium teretifolium				4	4		2	2					
D Conyza ulmifolia				+	+								
D Rhynchospora glauca						5							
D Stiburus alopecuroides	+		+			1							
Differentiating species of Pteridium aquilinum - Phragmites mauritianus Reedswamp (5)													
D Phragmites mauritianus							3	3	5	5	5		
D Pteridium aquilinum				+			4	2	5	4	5	4	
D Cyperaceae (unidentified species)							3	4	2	+	3		
D Gunnera perpensa					+		+	+	+	+			
Infrequent species													
Pelargonium luridum												+	+
Oxalis obliquifolia				+								+	+
Thunbergia atriplicifolia		+										+	+
Erigeron sp.	+									+		+	1
Scirpus burkei													4
Eragrostis sp.	+												2
Commelina sp.	+			+	+								+
Polygonum pulchrum				1	+				+				+
Vernonia hirsuta	+			+								1	
Buddleia salviifolia		+		+	+								
Helichrysum mundii			+	+			+						

Species of single or double occurence:

Artemisia afra (174:+; 175:+), Clematis oweniae (174:+; 175:+), Hypericum lalandii (168:+; 177:+), Leersia hexandra (182:+; 185:+), Polygonum strigosum (181:+; 182:+), Adenostemma caffrum (178:+), Albuca setosa (176:+), Aloe davyana (174:+), Anthoxanthum sp. (180 +), Asclepias fruticosa (180:+), Chironia palustris subsp. palustris (174:+), Crassocephalum picridifolium (178:+), Cyperus sphaerospermus (176:+), Epilobium tetragonum (179:+), Eriosema salignum (175:+), Euphorbia striata (176:+), Gnidia microcephala (174:+), Haplocarpa scaposa (174:+), Helichrysum kuntsei (174:+), Heteropogon contortus (176:+), Hibiscus aethiopicus (175:+), Hyparrhenia dregeana (174:1), Hypericum aethiopicum subsp. sonderi (176:+), Indigofera sp. (175:+) Ledebouria sp. (174:+), Nemesia fruticans (176:+), Paspalum orbiculare (180:+), Pellaea viridis (174:+), Scirpus fluitans (180:+), Senecio erubescens (174:+), S. isatideus (175:+), S. serratuloides (180:+), Senecio sp. (168:+), Setaria perennis (176:+), Thelypteris confluens (178:+).

6. *Relevés No.* 175 *and* 176 (Table 6)

Relevés No. 175, dominated by *Pteridium aquilinum*. and 176, dominated by *Scirpus burkei*, are included in Table 6 because they have a few species, mostly infrequent, in common with *Aristida junciformis—Arundinella nepalensis* Grassland and *Pteridium aquilinum—Phragmites mauritianus* Reedswamp, but are otherwise very poor in species.

Both relevés are from the predominantly grassland fringe around the reedswamp.

ACKNOWLEDGEMENTS

This project was launched by the Botanical Research Institute preparatory to more extensive surveys of the Transvaal Bushveld. Permission to study the Reserve was granted by the Nature Conservation Division of the Transvaal Provincial Administration, who also provided accommodation and other facilities, particularly through the kind co-operation of Messrs Delmyn Pretorius and J. de Klerk, the conservation officers on the Reserve. Miss L. Teversham did most of the technical work, and Mr S. Makena assisted me in the field. The soil samples were analysed for pH and resistance by the Soil and Irrigation Research Institute. Plant identifications were done by the herbarium staff of the Botanical Research Institute. Dr J. W. Morris handled the computer work of accurately printing Tables 2–6 in the desired form before publication and Mr O. J. H. Bosch made useful suggestions during a field inspection of the soils. All these contributions are gratefully acknowledged.

UITTREKSEL

Die plantegroei van die Rustenburg-natuurreservaat op die Magaliesberg in Acocks (1953) *se Suurbosveld Veldtipe word met behulp van die Braun-Blanquet-metode geklassifiseer. Die floristiese samestelling, fisionomie en habitatkenmerke van vyf hoof plantegroeitipes, insluitende hoof subtipes, basiese gemeenskapstipes, variasies en subvariasies in die Reservaat, word beskryf. Die plantegroei is op die vlak van gemeenskapstipes en variasies teen 'n skaal van* 1: 30 000 *gekarteer.*

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Book Reviews

TREES OF SOUTHERN AFRICA by EVE PALMER & NORAH PITMAN. *Cape Town: A. A. Balkema. 3 vol.* 1972–1973. *Pp.* 2235. *Price* R25 *per volume.*

This work, in three volumes, is a successor to the authors' Trees of South Africa (1961), which attained such wide popularity in South Africa. While the earlier book dealt with only 176 tree species, this deals with all the just over 1000 species in Southern Africa – also, it covers a wider area taking in South West Africa, Botswana, Lesotho and Swaziland as well. The book is lavishly illustrated by nearly 2000 black and white photographs, numerous colour plates and 900 line drawings by artists Norah Pitman and Rhona Collett. In the preparation of the book Eve Palmer, who was responsible for the text and her husband, Geoffrey Jenkins, well-known novelist, who contributed the colour photographs, travelled over 160,000 kilometres collecting specimens and seeing the trees growing in their natural habitats. The text was written in co-operation with the Botanical Research Institute, Pretoria. This book undoubtedly represents the most comprehensive and detailed work ever produced on the trees of Southern Africa.

The 298-page introduction covers such topics as prehistory, trees, men and history, distribution, trees and animals, trees and magic, poison trees, trees and food and what men make of trees. This serves as a fascinating background to the pages that follow.

The tree descriptions comprise the following: – a brief synonymy, common names in English, Afrikaans and Bantu, a non-technical botanical description, notes on the distribution, ecology, ethnobotany, medicinal and economic uses, and derivation of the scientific name. Each description is accompanied by illustrations of the habit, bark, leaves, flowers and fruit of the tree.

The illustrations vary considerably in quality. Some keys to species are provided. These keys have been conceived by the first author, taken from existing keys or adapted from existing keys.

A few criticisms can be levelled at the book. Although a reference bibiography, chronologically arranged, is given (pp. 292–296) there is no tie-up in the text to these references. It may be argued, of course, that for a book intended chiefly for the layman, the insertion of source references would interrupt the continuity and smooth flow of the text. One wonders, too, why with a page width of 19 cm, 6 cm should be devoted to a left-hand margin. This seems extravagant, though perhaps appealing from a lay-out point of view. On p. 1541 it is stated that *Kiggelaria africana* was first collected in the Cape in the mid-18th century. In actual fact it was probably collected in the second half of the 17th century, because it was referred to in the works of Sterbeeck (1682), Hermann (1687) and Plukenet (1692). *Scolopia thorncroftii* is treated as a distinct species, whereas it is clearly a synonym of *S. zeyheri* (see Sleumer, 1972). On p. 213 Eve Palmer jumped the gun in using the name *Ozoroa concolor* (Presl ex Sond.) De Wint.; this combination, at the time of going to press of this review, has not been published. The inevitable gremlin has crept in: the plate facing p. 289 of *Moringa ovalifolia* bears the caption "The most valued trunk in Southern Africa – that of the black stinkwood, *Ocotea bullata*". Typographical errors are few.

This book is fluently written and readable and is recommended to all those interested in the trees of Southern Africa. The price, however, will probably put this book beyond the reach of all but libraries.

D. J. B. KILLICK

FERNS OF THE WITWATERSRAND by F. D. HANCOCK & A. LUCAS. *Johannesburg: Witwatersrand University Press.* 1973. *Pp.* xv + 94. *Price* R7,00.

When preparing this work, the authors obviously gave special attention to the needs of the undergraduate student. In the introductory chapter life cycles and the general ecology of ferns in the study area are discussed. This is followed by an enumeration of the principal features of the four divisions of Pteridophyta and a short discussion of their evolution.

An identification key with line illustrations showing diagnostic characters enables the reader to identify the 32 species which have been recorded on the Witwatersrand. The more serious student will be disappointed that neither generic nor family diagnoses are provided. Each page of text consists of a brief description and a section on derivation of the scientific name, vernacular names, habitat, diagnostic features, distribution outside the Witwatersrand and uses by Man. The line drawings by Barbara Pike and Patsy-Lynne Edkins are generally of excellent quality, illustrating the habit or part of the frond, the sporangium and the spores. Unfortunately no scale is provided. This can be very misleading, for example in the case of *Selaginella mittenii* the habit sketch is larger than life and the plant looks like *S. kraussiana*. The four water-colour plates show much less detail than the line drawings, and merely add to the cost of the book.

The authors are congratulated on this work, but it is suggested that they bring out a cheaper, soft-covered edition which should increase the popularity of the book. The printing is of excellent quality, the paper is good, and the cloth binding attractive and durable.

P. VORSTER

GRUNDFRAGEN UND METHODEN IN DER PFLANZENSOZIOLOGIE. Ed. E. van der Maarel & R. Tüxen. *The Hague: W. Junk.* 1972. *Ber. 14th Int. Symp. Int. Verein. Vegetationskunde, Rinteln,* 1970. *Pp.* [illegible] 533, *figures, tables. Price* R25.

This is certainly one of the most interesting and important volumes in the well-known series of proceedings of the annual international symposia of the International Association for Plant Geography and Ecology organized by Tüxen. As always, the discussions following the papers are as significant as the papers themselves, and they clearly reflect the cordial, but sometimes blunt atmosphere which is so typical of Tüxen's symposia. At this symposium, the possibilities of integrating the methods, concepts and results of the mathematically orientated and the "traditional" ecologists were explored. The good and often long discussions following the papers frequently show the marked contrast in thinking and approach between these two groups of ecologists. The "traditionalists" often make much effort to be understanding and open to the ideas of the mathematical ecologists, and both sides repeatedly express the need for synthesis between these two approaches. The possibilities and power of mathematical techniques in ecology are thoroughly discussed, as well as the meaning of the results they produce in terms of the interpretations of the traditional ecologists. In this respect the discussions in this volume may, in the long term, prove to be of historical interest in illustrating the present period of attempts by ecologists to unify their efforts in promoting the ecological understanding of vegetation and so to further the science of ecology.

The number and quality of the contributions in the present volume are too many to allow a complete review and only a few topics can be mentioned here. Most papers and large parts of the discussions are in German, although some are in English or French. However, virtually all papers have English summaries.

The first half of the book merits its title and deals with phytosociological methods in general, whereas the second half discusses some more specific topics. The book opens with a paper by Westhoff discussing the place of vegetation science in the biological sciences. Westhoff reviews briefly the Anglo-American and some continental European opinions regarding vegetation science. He discusses the various scientific branches which are part of vegetation science, building on the well-known work of Schmithüsen, and concludes that vegetation science fully deserves a place as a distinct branch of the biological sciences. In the discussion following this paper the place of ecosystem research is debated.

Moore discusses computer-based methods for the analysis of phytosociological data in historical perspective, with emphasis on their application in compiling Zürich-Montpellier phytosociological tables. Unfortunately Moore wrongly considers that phytosociologists of the Zürich-Montpellier School first "intuitively grasp" the plant communities in the field, checking them later in their tables. Although this may frequently have occurred it is certainly not the correct approach of the School as such. Homogeneous stands of vegetation are recognized in the field and each stand is sampled as an example of a plant community yet to be recognized. This is done independently of any preconceived ideas as to the nature and affinities of communities. The communities are only compiled and delimited in a table as abstractions of many similar stand samples. Moore describes the Zürich-Montpellier procedure of table making as divisive. The comparison of relevés with one another on their species contents and the arrangement of the most similar ones together is, however, an agglomerative procedure.

A most interesting paper is given by Whittaker on convergences of ordination and classification. After pointing out the differences in "scientific cultures" between the Anglo-American and continental European plant ecology, he argues that therefore no "simple fusion in agreement" between the two is to be expected. He suggests, however, three possible convergences, namely, in theory of vegetation structure, in of quantitative classification techniques, and in the application gradient analysis as an adjunct to classification. He emphasizes the possibilities of using this third procedure as an aid to clarify and communicate vegetational relationships in a Zürich-Montpellier classification. Whittaker regards complete convergence between the two approaches as not even desirable for the advance of ecological theory and understanding of vegetation.

The possibilities of more objective phytosociological methods are considered by Doing, while several authors, e.g. Orloci, Ivimey-Cook, Fresco, Van Emden, Romane, discuss quantitative analysis strategies, such as association-analysis and various types of information and factor analyses. Romane presents an account of an application of factor analysis of correspondences, a technique which allows a direct estimation of the relationships between species occurrences and habitat factors.

Daget, Godron and Guillerm present their technique of ecological profiles, being frequency distributions of species against various classes of habitat factors. From these profiles and a calculation of the indicator value of each species for various ecological factors, ecological groups of species can be compiled which indicate distinctive environmental conditions. It is unfortunate that there is apparently some editorial mistake in this paper, which makes it difficult for the reader to follow.

Tüxen's "Critical observations on the interpretation of phytosociological tables" is also a useful paper, in which he compares the differences in eleven relevés made of the same quadrat on the same day by eleven phytosociologists, who were each allowed only fifteen minutes. Tüxen demonstrates how careful one must be in sampling vegetation and in deliminting types, and how difficult it is to interpret data collected by others in vegetation unknown to the interpreter. He also warns against the false idea of exactitude, which is sometimes given by some analytical techniques. The discussion following this paper is long and good, touching on themes such as sampling and the necessity for mutual understanding between the person who carries out the field work and the mathematically orientated office ecologist. The exposition by Pignatti, on how he would detect that there was something wrong with such data, if they were presented to him, is unconvincing.

Van der Maarel presents his preliminary findings in an application of principal component ordination of plant communities on the basis of their plant genus, family and order relationships.

Further articles deal with homotoneity and new computer programmes for the processing of phytosociological data (Stockinger & Holzner; Spatz). In a paper by Wagner the procedure of omitting unrepresentative stands from a phytosociological table is discussed.

The second half of the volume deals with more specific topics. There are several papers on phenology and its interpretation in a community context, of which in particular the ones by Dierschke and by Hartmann are followed by stimulating discussions. Then follow a number of papers on the phytosociological classification of forest communities, saline communities and bog communities, as well as on specific aspects of some weed communities, waterplant communities and Icelandic grasslands. Altogether this second half of the volume is as varied as the first, it is not reviewed here in detail, because it is mainly, although not entirely, of local interest.

It is fortunate that the present volume has been published relatively soon after the symposium, since this increases its value considerably. This publication, with its 38 papers and long and important discussions should not be absent from any library specializing in plant ecology. An invaluable book, indeed, and for a reasonable price.

M. J. A. Werger

Die Vegetation von Afrika by R. Knapp. *Stuttgart: Gustav Fischer Verlag.* 1973. *Pp.* xliv+626, 823 *figures*, 825 *tables & species lists. Price ca.* R60.

This book, whose full title reads "The vegetation of Africa with references to environment, development, economy, agriculture and forestry geography", is published as part III in the series "Vegetationsmonographien der einzelnen Grossräume" under the general editorship of H. Walter, and includes a short introduction and a detailed list of contents in English. It attempts to give an ecologically relevant account of African vegetation based on nearly twenty years of literature studies by the author and ten years of study trips to all parts of Africa. The book consists of eight chapters: first, a general one dealing with climate, phytogeography, anthropogenic influences, fire and methods used in the book, followed by seven chapters consecutively describing the tropical rain forest zone, the savanna and dry deciduous woody vegetation zone, the montane vegetation, the afro-alpine vegetation, the vegetation of the deserts and subdeserts, the vegetation of the evergreen sclerophyllous zones and adjacent winter rainfall regions, and the vegetation of the Macaronesian areas (Cape Verde and Canary Islands and Madeira). The description of the vegetation of the islands in the Indian Ocean (Madagascar, Mascarenes, Seychelles and Socotra) is included in appropriate sections of the various chapters. The descriptions and interpretations offered in the book are to a very large extent based on data collected by Knapp, and although more than 1 500 literature references are listed at the end of the book only a few of them have been used and intergrated in the descriptions. Consequently, a picture of the vegetation of Africa is presented, that is far more subjective than was necessary. This is particularly apparent in the sections dealing with the more complex vegetation types. It is also apparent in, for example, the section on phytogeography, where, without any discussion of literature, the Usambara-Zululand Domain as part of the Guineo-Congolian Region, and the Afro-alpine Region in southern Africa, are not recognized. All the high mountain vegetation in southern Africa is considered to be montane, but this montane zone also includes, according to Knapp, virtually the entire grassland area of the Highveld and the Bankenveld. Thus it gets a rather wide interpretation.

The description of each zone starts with notes on its distribution and possible subdivisions, its specific ecological features such as climate, soils, human and other influences, its economic uses and possibilities, etc., and then proceeds to a description of its plant communities. Each description is followed by a list of species indicating which are dominant and which are characteristic according to Knapp. This presentation of species lists has, however, two serious disadvantages:

(1) The lists of species, indicating which are characteristic (absolute character species according to Knapp, p.vii and p.32), suggest that the "plant communities" described are comparable to associations or other syntaxa as recognized by Zürich-Montpellier methods, which they are not at all. Knapp's "plant communities" are rather formations or subformations.

(2) The species lists suggest a far higher degree of accuracy than actually given. This is obvious when reading sections on vegetation types with which one is familiar.

Although there are still many minor points in the book which are not strictly true, or with which one might disagree, it is, apart from the previous objections, an admirable piece of work: a single author succeeding in giving so many useful facts on such a large and diverse area! The literature list is probably the largest one existing on African vegetation, and it is just a pity that it does not include a number of the more important publications of the last four or five years, particularly those from South Africa and Angola. The book has a good index and is well and extremely richly illustrated with many maps, profiles, diagrams and photographs. Its price is therefore not excessively high and, although it will be prohibitive for many a scientist's private library, institutes concerned with the vegetation of Africa, or with vegetation formations and their geographical and ecological characteristics, should have it in their libraries.

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Handbook of Vegetation Science. Chief ed. R. Tüxen. Ordination and Classification of Communities. Ed. R. H. Whittaker. *The Hague: W. Junk. Vol.* 5. 1973. *Pp.* x+738, 91 *figures*, 40 *tables. Price* R40.

Handbook of Vegetation Science. Chief ed. R. Tüxen. Vegetation Dynamics. Ed. R. Knapp. The Hague: W. Junk. Vol. 8. 1974. Pp. x+366, 37 figures, 8 tables. Price R20.

With the publication of these first volumes of the Handbook of Vegetation Science, a landmark in vegetation science has been reached. The Handbook, of which R. Tüxen is editor in chief, is planned to provide in 18 volumes an up-to-date and comprehensive summary of concepts, methods and knowledge acquired in vegetation science. The Handbook is a most ambitiously planned project that attempts to integrate into one composite picture the various approaches to the study of vegetation based on the many philosophies concerning the nature of vegetation, the insights gained from all the different theoretical and applied branches of this science, as well as the historical lines towards the stage of development where this science stands today.

Volume 5, under the editorship of R. H. Whittaker, is the first volume to appear in print, and it certainly comes close to its planned goal of reviewing and integrating all major concept and methods applied in the analysis of vegetation and the synthesis of these data. In twenty chapters the book deals with a wide range of ordination and classification approaches without much overlap among the chapters. Each chapter has a summary in English and German and a bibliography of cited works. From these bibliographies it seems that the chapters, except the last one, have been completed before or in 1971. In the introduction, Whittaker, who is not only a competent editor of the book but also author or co-author of eight of its chapters, distinguishes between community classification (syntaxonomy) versus phytosociology, and between ordination versus gradient analysis. He states that the book is an account of procedures, rather than of approaches to understanding of which those procedures are part; of ordination and classification, rather than of gradient analysis and phytosociology. He also emphasizes again that the two major approaches, ordination and classification, are complementary.

The section on direct gradient analysis consists of four chapters. In the first two chapters Whittaker discusses the techniques and results of direct gradient analysis. Attention is paid to sampling and the various ways of analysing vegetation relationships from the samples. He formulates again his conclusions about the spatial structure of vegetation, as he has explained already in previous publications, particularly in Gesellschaftsmorphologie (Ber. Int. Symp. Rinteln 1966. The Hague: Junk, 1970). In Chapter 4 Whittaker and Woodwell deal with retrogression and the way to measure this. In the final chapter of this part of direct gradient analysis, Sobolev and Utekhin give an instructive account on Russian approaches to community systematization, particularly of Ramensky's ideas and procedures. They clearly point out the differences and similarities with American concepts and procedures.

The second section on indirect gradient analysis, consisting of six chapters, starts with a contribution by Goodall on measures of similarity and correlation in their own right, irrespective of the particular ordination and classification techniques to which they may be put. Goodall's contribution is a clearly written, useful discussion giving guidelines for the choice of the indices to be used. In the next chapter McIntosh discusses and illustrates various matrix and plexus techniques, most of which are graphical representations of data and results. Cottam, Goff and Whittaker discuss the Wisconsin (Bray and Curtis) comparative ordination technique, pointing out its three important advantages over other ordination techniques: (i) it is a most versatile and least vulnerable technique; (ii) it is equally effective for direct and indirect ordination, and (iii) it has great value in research as a framework for investigating and understanding vegetational relationships. In Chapter 9 Dagnelie discusses factor analysis and its application in vegetation studies. Dagnelie writes in French, which is rather unfortunate: he has published an account of this technique in French before, and for a wider understanding of the technique it would have been better if this chapter had been written in English. In the next chapter, however, Orloci, discussing and comparing a large number of ordination procedures, again briefly describes factor analysis. He points out its disadvantages and says that these "may be the reasons why factor analysis, despite its effective use by Dagnelie, has not aroused wider interest among phytosociologists" (p. 280). Orloci concludes that Kruskal's method of multidimensional scaling has a good potential in phytosociological ordinations and advises its further use. The final chapter in this part on indirect gradient analysis is an evaluation of ordination techniques by Whittaker and Gauch. It gives, as the authors say, "a classification of ordination techniques and an ordination of some of these by relative usefulness", as concluded from tests with simulated oenocline data. The various techniques need to be evaluated in terms of freedom from distortion of sample positions, ranges of sample variation that can be handled, clarity of data treatment and results, computational expenses, and general effectiveness for research. The authors' conclusion, which has also been published in Ecology 53 (1972), is that the method of Bray and Curtis is the best and that principal component analysis is the worst of the compared methods. Principal component analysis is most useful for narrow ranges of community variations. (Compare also Beals, 1973, J. Ecol. 61).

The third section of the book, consisting of nine chapters and 400 pages, deals with classification. An introductory chapter by Whittaker gives a perspective that facilitates the understanding of the following chapters (compare Whittaker, 1962, *Bot. Rev.* 23). Whittaker also explains why a classification of vegetation is an artificial classification. Beard discusses the physiognomic approach. His discussion, particularly that on floristic and physiognomic units, tends to be somewhat dogmatic, and apparently Beard favours to confuse the issue as far as the concept "association" is concerned. Then follow chapters by Whittaker on dominance types, especially as used by Clements and by Frey of the Finnish School and forest site-types as used in particular by Cajander. Barkman contributes a comprehensive and critical review of synusial approaches to classification, giving clear examples. From this it becomes apparent that virtually all synusial work is done in the northern temperate and boreal regions, mostly on cryptogamous epiphytic and on aquatic vegetation. Very few data have been collected on the rich vascular epiphytic vegetation of the tropics. There are also review chapters on Russian approaches to classification of vegetation by Aleksandrova, on Scandinavian (mainly Uppsala) and Baltic approaches by Trass and Malmer, and on numerical classification by Goodall. Goodall evaluates the various numerical classificatory approaches and points out how ordination and numerical classification can be efficiently combined. The final and longest chapter in the book by Westhoff and Van der Maarel, discusses in detail the concepts and techniques of the Braun-Blanqet approach. It also reviews briefly the extensive use of this approach in various parts of the world. Several references to literature mentioned in this section are not listed in the 19 pages of references at the end of the chapter, however, and should be traced in Excerpta Botanica Sect. B, Sociologica. An outline of the use of numerical techniques as complementary to the Braun-Blanquet approach in order to save effort and facilitate and improve interpretation of the results, is added. This chapter is the most comprehensive account of the Braun-Blanquet approach existing in English, and is obviously up-to-date.

It may be concluded that the editor (and the authors) have succeeded in giving in one volume a comprehensive and integrated picture of the philosophies and methods of modern vegetation science, and it is to be expected that this will facilitate the further development of the science, because it makes so much information that was formerly difficult to get at, readily available to a wide group of scientists.

Volume 8, edited by R. Knapp, gives a less integrated picture of the main points of knowledge available on vegetation dynamics and the methods used to acquire this knowledge than Whittaker succeeded in integrating the contributions to his book. The contributions to Volume 8 deal with a wide range of topics and although all are somehow concerned with the theme of the book, those contributions that deal with fairly closely related topics overlap one another more strongly than the chapters of Volume 5. Nevertheless, Volume 8 is a most useful source of information on vegetation dynamics, with at the end of the book 64 pages of literature references on the subject. The book is subdivided into 7 sections, together consisting of 27 short chapters by 17 authors. Knapp himself has written five chapters. Apart from five chapters in German by Tüxen, Reinhold and Aichinger, with English summaries, none of the other chapters, which are all in English, have summaries. Apparently Major contributed one manuscript which was cut by the editor and published as five different chapters in various sections of the book.

Major's contribution on kinds of change in vegetation and chronofunctions, and Rabotnov's discussion on differences between fluctuations and successions, form the first section of the book. Rabotnov considers fluctuations to be characterized by (i) differently orientated changes in phytocoenoses from year to year, (ii) reversibility of the changes, and (iii) absence of invasion of new species.

The second section is devoted to methods of syndynamic analysis. Tüxen discusses the value of macrofossils, pollen, spores and subfossil soil profiles for drawing conclusions on the history of vegetation types. Knapp outlines the value of studies of newly invaded land areas, of relics of historical records on maps, photographs and other documentations, of permanent quadrats and of plant migrations for drawing conclusions on the syndynamics of vegetation types. Also, in this section, Aleksandrova and Karamysheva point out some specific factors causing vegetation changes in the Eurasian tundras, steppes and semideserts. In the tundra severe grazing by reindeer can cause problems, and Aleksandrova reports that it can take 20 to 50 years before the lichen cover is regenerated after complete destruction. Very interesting are the short chapters by Stearns on the use of documents of the American General Land Office that has collected records since 1785, and by Reinhold on the value of historical forestry records in Central Europe and France for syndynamic studies in formerly forested areas. The section concludes with a chapter by Knapp briefly discussing cyclic (regeneration) succession and its relations to linear succession and to fluctuations, as well as the value of ecosystem research, simulation and modelling in the study of vegetation dynamics. Knapp says that only natural events of catastrophic dimensions, or actions of man, should cause destruction of stable communities (*Schluss- und Dauergesellschaften*). To this one should also add the action of indigenous large herbivores, however.

The third section consits of two chapters, both by Knapp, summarizing some of the main points of knowledge about genetic and cytological conditions of plant populations and the impact of mutual influences between plants, such as competition, repression, allelopathy and promoting effects, as causes for vegetation changes.

The fourth section deals with classification of successions. Dansereau advocates the importance of Huguet del Vilar's scheme of physiological regimes; Whittaker discusses the climax concept and points out that mainly because he favours the concept of the population structure of vegetation, he prefers a climax pattern hypothesis; Major deals with duration in successional series; Aleksandrova and Knapp explain many technical terms from, respectively, Russian and Western Hemisphere literature dealing with vegetation dynamics; and, finally, Aichinger illustrates briefly his concept of vegetation development type.

The next section on productivity and chemical changes in succession stages, contains a brief introduction by Lieth to the developing literature on this subject (with a printing error in a subtitle, p. 185), three papers by Major with many data on biomass, nitrogen and ash elements accumulation and pH changes in successions, and a chapter by Beard discussing vegetational changes on ageing landforms in the tropics and subtropics. Beard considers such vegetational changes to be mostly retrogressive: erosion (peneplanation) of afforested land leads to changes in the soil (desiccation) and this brings about changes in the vegetation, mostly towards savannas or grasslands. Beard also adds another two climax terms to the already enormous climax vocabulary.

Then follows a section with interesting examples of fluctuations, in which Korchagin and Karpov, Coupland and Bykov, write on fluctuations in the coniferous Taiga, North-American grasslands and Turanian semideserts. In the North-American grasslands the effects of overgrazing are accentuated by severe drought. Overgrazing of mixed (mid and short) grasslands leads, according to Coupland, to short grasslands and in the drier areas to encroachment of desert shrubs, as found also in hot marginal grassland areas of South Africa.

The final section in the book contains two papers by Tüxen on synchronology of Central European vegetation. Tüxen reviews the possibilities and results of palaeosociological studies of fossils of the Carboniferous, the Tertiary and the Quarternary. He also reviews the existing palaeosociological literature on the various Central European syntaxa.

This book edited by Knapp contains a wealth of data and ideas on vegetation dynamics. It is indeed a pity that Tüxen has used the same foreword in both volumes, thereby crediting Whittaker in volume 8 with the editorial work done by Knapp. Interested vegetation scientists and libraries will undoubtedly want to purchase these volumes of the Handbook of Vegetation Science. The volumes are certainly not expensive by to-day's standards.

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