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An account of the plant communities of Tussen die Riviere Game Farm, Orange Free State

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ABSTRACT

As part of the IBP survey of conservation sites, the vegetation of Tussen die Riviere Game Farm, Orange Free State, was surveyed and analysed according to the Braun-Blanquet phytosociological method. A classification of the plant communities occurring there is given. A way by which a hierarchical classification of plant communities in South Africa could be constructed, is suggested. Each plant community is physiognomically classified according to Fosberg's (1967) system. Two disadvantages of this system are discussed briefly.

INTRODUCTION

The continental phytosociological method described by Ellenberg (1956) and Braun-Blanquet (1964) has proved effective for the analysis of a wide variety of vegetation types in different parts of the world. For various reasons this method was not used in southern Africa until recently, when it was also shown to be a quick and useful method for analysing the floristically rich South African and South West African vegetation (Van Zinderen Bakker, 1971; Volk & Leippert, 1971; Werger *et al.*, 1972).

Using this technique, Tussen die Riviere Game Farm was surveyed on a semi-detailed scale, as part of the survey of conservation areas for the International Biological Programme. This could be a first step towards a comprehensive classification of South African plant communities. If such surveys were undertaken in all conservation areas within South Africa, this would result in classifications of the plant communities at points distributed over a variety of South African Veld Types (Acocks, 1953). Classifications of plant communities in areas that are floristically not too different from one another, would provide insight into the variation of these communities. By comparing and combining vegetation classifications of such floristically related areas, an integrated, consistent and generally applicable classification could be worked out. Each of these would represent key areas from where interpolation and survey of the intermediate areas can be undertaken. In such a way a comprehensive hierarchical classification of plant communities could rapidly be developed.

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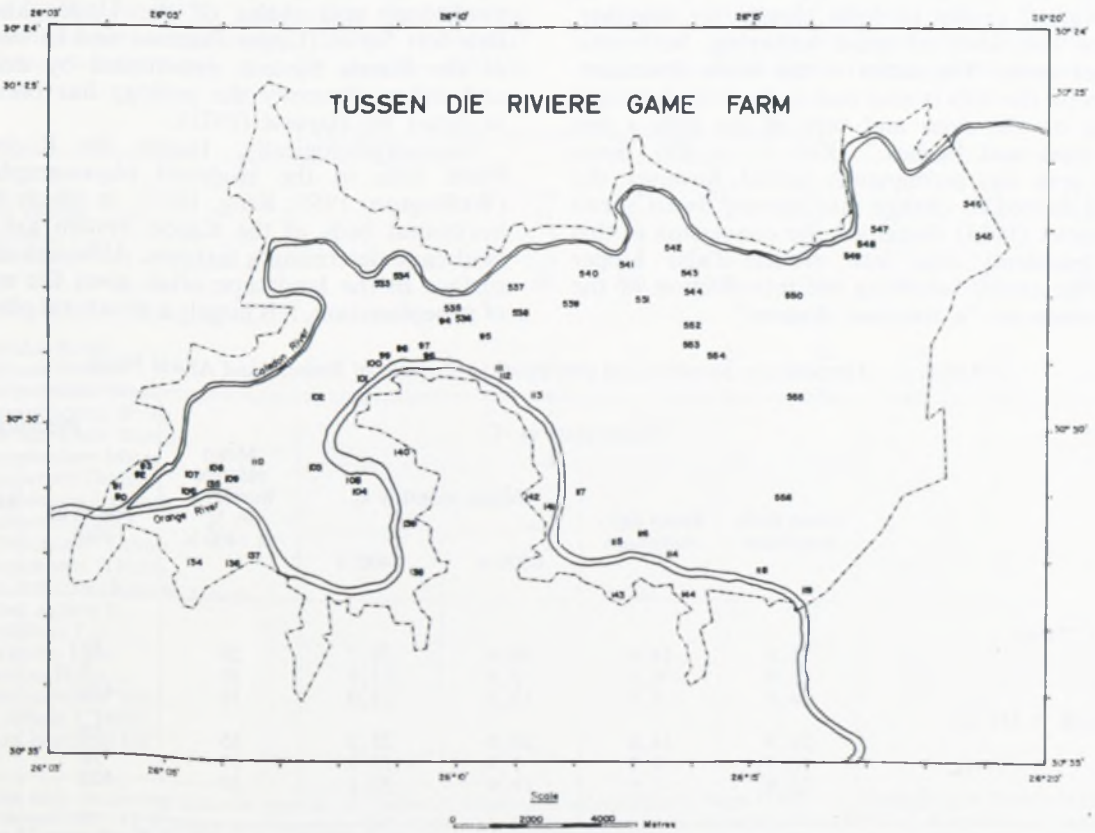

FIG. 1.—Map of Tussen die Riviere Game Farm, showing the position of the relevés.

THE STUDY AREA

Tussen die Riviere Game Farm is situated in the southern Orange Free State at about 30° 30′ S and 26° 15′ E, on the peninsula at the confluence of the Orange and Caledon Rivers (FIG. 1.).

The Game Farm was created in 1967, when the area was withdrawn from farming in anticipation of the inundation along the Caledon and Orange Rivers by the filling of the Hendrik Verwoerd Dam Lake.

Tussen die Riviere Game Farm is approximately 22 000 ha in extent, falling entirely in the False Upper Karoo Veld Type (Acocks, 1953). Because of its situation near the eastern border of this Veld Type, a number of species from the wetter eastern parts of the country occur on protected sites. According to Acocks (1953), the plains scarcely differ from those of the Central Upper Karoo, whereas the hills, that are not severely overgrazed, are essentially grassy. The principal shrub on these False Upper Karoo hills, *Rhus erosa*, does not occur in the Central Upper Karoo.

Since the withdrawal of the area covered by the Game Farm from sheep and cattle farming, there has been a marked recovery of the veld from its former poor condition, which was typical of the overgrazed and poorly managed veld of the whole region.

More than a century ago, when the European settlers still crossed the Orange River from the south only temporarily, Andrew Smith travelled through the area north of the Orange River and reported the good condition of the veld there. Travelling in the vicinity of the present-day Bethulie, he wrote in his diary (Kirby, 1939): ".... on flats, but especially on the hills an abundance of dry grass" (Vol. 1, p. 81) and "The flats have scarcely a bush upon them, and the grass grows in tufts closely set together. There are two sorts of grass occurring, both sour and sweet grass. The latter is the most abundant. The grass on the hills is also said to be sour. Amongst the rocks on the sides and tops of the hills a few stunted trees and bushes." (Vol. 1., p. 89). Soon after the area was permanently settled, however, the grassland started to change into karroid dwarf shrub veld. Acocks (1953) described the conversion of this former grassland area into eroded False Upper Karoo vegetation, following the introduction of the merino sheep as "a national disaster".

According to the Köppen system, the climate of this area can be defined as BSkw': arid (steppe) climate, cold and dry, with a mean annual temperature lower than 18°C, although the mean annual temperature of the hottest month exceeds 18° C. The winter is dry, and the rainy season is from November to April with a maximum in March (Schulze, 1947; Weather Bureau, 1954). During summer the climate of the region is under the influence of moist equatorial and maritime tropical air from which the precipitation falls largely in thunderstorms, so that much of it is lost to agriculture because of the rapid runoff. In winter anticyclonic systems over the Orange Free State bring fine, dry weather, with almost cloudless skies and light winds (Kendrew, 1961). Since humidity and temperature are of main importance to plant life, the bioclimatic map of UNESCO-FAO (1963) is based on ombrothermic diagrams (where precipitation in mm and temperature in °C on twice the precipitation scale are plotted against month of the year) and the xerothermic index (hot weather drought index). This map classifies the climate of the Tussen die Riviere Game Farm area as intermediate temperate tropical, which means that the dry season coincides with the period of shortest daylight, the mean temperature of the coldest month is between 0° and 10° C, and the xerothermic index is between 100 and 150. The Weather Bureau (1954) published the statistics shown in Table 1 for the weather stations at Bethulie and Aliwal North, between which Tussen die Riviere is located. A climate diagram for Bethulie is given by Walter & Lieth (1960).

The mean number of days with frost at Aliwal North is 65,4 (Weather Bureau, 1954).

General information on the geology of the area from Du Toit (1954) and Truter & Rossouw (1955) shows that the entire area consists of sandstones, mudstones and shales of the Upper and Middle Beaufort Series (Upper Permian and Lower Triassic) of the Karoo System, interrupted by dolerite sills and dykes. Recently the geology has been mapped in detail by Harmse (1971).

Geomorphologically, Tussen die Riviere Game Farm falls in the Highveld physiographic region (Wellington, 1955; King, 1967), in which the almost horizontal beds of the Karoo System are the main landscape-determining features. Although the tabular surface in the landscape often gives the appearance of peneplanation, it is largely a structural phenomenon

TABLE 1.—Temperature, humidity and precipitation stasistics of Bethulie and Aliwal North

	Temperature in °C				Mean relative humidity in % at 1400 h	Precipitation	
	Mean daily maximum	Mean daily minimum	Mean monthly at			Mean in mm	Mean number of days ≥0,2 mm
			0800 h	1400 h			
Bethulie (1 274 m)							
Jan.	31,2	14,6	20,9	29,7	28	61	8,0
July	16,9	—0,1	2,4	15,9	35	9	1,9
Year	24,6	7,9	12,7	23,0	35	441	62,2
Aliwal North (1 332 m)							
Jan.	29,9	14,0	20,0	28,2	35	75	9,2
July	16,5	—1,5	1,3	15,9	37	10	2,2
Year	23,8	7,1	11,9	22,1	37	522	67,3

At Bethulie temperature and precipitation observations were taken over a period of 20 years, at Aliwal North over 18 years. Humidity observations were taken at Bethulie over 13 years, at Aliwal North over 7 years.

(Wellington, 1955). The relief in the landscape is caused by dolerite dykes and sills, the latter often capping the mesas and koppies. The slopes of softer sandstone and mudstone underlying the dolerite are usually steep.

Apart from the abundant lithosols in Tussen die Riviere Game Farm, and some alluvium along the rivers, the prevailing soil type is solonetzic (Van der Merwe, 1962; Loxton, 1962; D'Hoore, 1963). These solonetzic soils possess a fairly dense and structureless, 0,15 to 0,25 m thick A horizon of grey loam, that breaks up into clods, lumps and finer material on slight pressure. The pH of this horizon is slightly acid. Separated from the A horizon by an abrupt transition is the B horizon of dark blackish-brown clay, which on drying, forms columns and is rather impervious to water. Downwards the colour of this layer gradually changes to a lighter brown. The pH of this B horizon is alkaline. Soils from the dolerite are colluvial. The A horizon consists of reddish-brown structureless sandy loam and the B horizon of compact, dark, reddish-brown columnar structured clay (Van der Merwe, 1962).

METHODS

During 1970 and 1971, 64 sample plots were layed out in the area (Fig. 1) and phytosociological tables compiled according to the procedures described by Braun-Blanquet (1964), Ellenberg (1956) and Knapp (1971). Value 2 of the cover-abundance scale was slightly modified following Barkman *et al.* (1964), so that 2m means "very abundant, but covering less than 5% of the plot area", 2a "cover 5–12% independent of number of individuals", and 2b "cover 13–25% independent of number of individuals". Plot size was determined according to the method described by Werger (1972), and fixed at the following sizes: for riverine communities, 25 m²; for dwarf shrub Karoo veld, 50 m²; and for shrubby hillside vegetation, 100 m². Only permanently recognizable species were recorded, thus omitting most annuals and geophytes. Two doubtful species, *Cotyledon decussata* and *C. orbiculata* were not separately distinguished, but treated as one complex taxon. Site factors such as aspect, slope angle, soil depth and pH of top soil were measured, and geological, geomorphological and other environmental features noted. The communities distinguished were classified into physiognomic formations according to Fosberg's (1967) system, which is recommended for IBP surveys.

THE PLANT COMMUNITIES

The vegetation of Tussen die Riviere Game Farm can be divided into three major groups of communities:

(1) The riverine communities;
(2) The communities of the flats and gently sloping terrain; and
(3) The communities of the steep slopes.

(1) *Riverine communities* (Table 2).

The woody riverine vegetation on the levees of fine alluvial sand with a pH between 6,5 and 7,5 mainly belongs to one community: the *Acacia karroo-Celtis africana* Community (Fig. 3). It is usually three-layered consisting of a tree layer from 6 to 10 m with an average cover of 75%; an open 2 to 4 m tall shrub layer with an average cover of 40–50%; and a field layer up to about 0,60 m, consisting of grasses, herbs and small shrubs, with a greatly varied cover depending on the amount of grazing.

Physiognomically, this community falls in Fosberg's (1967) class 1A2 (5), deciduous thorn forest formation.

Differential species in the tree layer are *Acacia karroo* and *Celtis africana;* in the shrub layer *Rhus pyroides*, *Diospyros lycioides* subsp. *lycioides*, *Lycium hirsutum*, *Clematis brachiata* and *Melianthus comosus;* and in the field layer *Atriplex semibaccata*, *Asparagus*

TABLE 2.—Acacia karroo-Celtis africana *Community*

Relevé no.	114	101	105	141	135	118	112	106
Number of species	11	13	14	12	16	18	16	16
Soil depth (m)	>2	>2	>2	>2	>2	>2	>2	>2
pH (top soil)	7,0	7,0	6,5	7,0	7,5	7,5	6,5	7,0
Total cover (%)	98	100	100	98	100	100	95	100
Rhus pyroides Burch.	3	5	2a	2a	2b	2b	3	+
Celtis africana Burm.f.	+	+	1	4	3	2a	4	4
Diospyros lycioides Desf.	1		5	2a	1	4	+	2a
Atriplex semibaccata R. Br.	1	2a	+	+	+	+	+	
Asparagus suavolens Burch.		1	+	+	+	+	2b	3
Lycium arenicolum Miers	4	1	2a		1	+	1	+
Lycium hirsutum Dunal	1	1	+		+	1	1	+
Bromus willdenowii Kunth.	1	+	+	+		+	+	+
Chenopodium murale L.	+	+		+	+	+	+	
Clematis brachiata Thunb.		+	1	+	+	+	+	
Melica decumbens Thunb.			1	4	3	2a	1	1
Asparagus setaceus (Kunth) Jessop	1	2a			+	+		1
Achyranthes aspera L.				1	+	+	+	1
Rubia cordifolia L.			1	+	+	1		+
Aster muricatus Less.		+				+	+	+
Acacia karroo Hyne					2b	4	2a	4
Melianthus comosus Vahl			1		1	+		
Cineraria lobata L'Herit.					+			1
Sisymbrium burchelli DC	+							1

Species only occurring once in relevés of Table 2: Eragrostis lehmanniana Nees (114: +), Enneapogon brachystachyus (Jaub. et Spach) Stapf (101: 1), Conyza podocephala DC. (101: +), Eragrostis curvula (Schrad.) Nees (105: r), Chrysocoma tenuifolia Berg. (105: r), Pentarrhinum insipidum E. Mey. (141: +), Phytolacca heptandra Retz. (118: +), Olea africana Mill. (112: r), Pentzia globosa Less. (112: r), Silene capensis Otth. (106: +).

suaveolens, *A. setaceus*, *Bromus willdenowii*, *Chenopodium murale*, *Melica decumbens*, *Achyranthes aspera* and *Rubia cordifolia*. This *Acacia karroo-Celtis africana* Community is typical for the levees of this section of the Orange River. A few kilometres upstream *Acacia karroo* disappears completely, whereas some 50 km downstream *Celtis africana* does not occur any more in the riverine vegetation. Detailed documentation will be given in a forthcoming paper.

Relevés 114 and 101 (Table 2) differ slightly from others in that *Rhus pyroides*, *Atriplex semibaccata*, *Lycium arenicolum* and *Asparagus setaceus* have higher cover-abundance values, whereas *Melica decumbens*, *Achyranthes aspera*, *Rubia cordifolia* and *Acacia karroo* do not occur in these two plots. This is because the relevés 114 and 101 were taken in narrow strips of riverine vegetation, where most of the *Acacia karroo-Celtis africana* Community was previously cleared for cultivation leaving only a narrow, rather disturbed strip on the bank of the Orange River. Relevés 114 and 101 can thus be regarded as the rudimentary fragments of the community.

On the outer edge of the levee one sometimes finds communities that are completely dominated by *Lycium arenicolum* or by *Salsola rabieana*, accompanied by pioneer species like *Eragrostis lehmanniana*, *Chrysocoma tenuifolia*, *Aster muricatus*, *Asparagus suaveolens*, *Walafrida saxatilis*, *Tragus koelerioides*, seedlings of *Acacia karroo*, etc. Usually the areas where these communities occur show traces of former cultivation. The *Lycium*-dominated community falls into formation 1B2 (4), deciduous thorn scrub; and the *Salsola*-dominated community into formation 1B1 (8c), Grey microphyllous evergreen scrub (Fosberg, 1967). These communities have not been sampled on Tussen die Riviere Game Farm.

Where the levee drops away into the river channel one often finds a community mixture of the *Acacia karroo-Celtis africana* Community with *Salix capensis*, *Nicotiana glauca*, *Agrostis lachnantha* and even *Salix babylonica*. On dry sand banks in the river channel a temporary weed community occurs, with *Agrostis lachnantha*, *Lactuca serriola*, *Erigeron floribundus*, *Argemone subfusiformis*, *Polygonum lapathifolium*, *Xanthium spinosum*, *Chenopodium ambrosioides*, etc. No relevés were made in these unstable communities.

(2) *Communities of the flats and gently sloping terrain* (Table 3)

All these communities are usually two-layered. The grass and dwarf shrub layer from 0,15 to 0,60 m high is the most important, with a cover up to 50%, but usually less. A very open layer of creeping and rosette plants, up to 0,05 m high, with a cover less than 5%, is common.

The communities of the flats are floristically poorer than those of the sloping terrain. Physiognomically these communities are classified under Fosberg's (1967) formation 2C1 (3), evergreen narrow sclerophyll dwarf steppe scrub. The *Eragrostis lehmanniana-Chrysocoma tenuifolia* Community shows a tendency towards 2F1 (2), evergreen narrow sclerophyll dwarf shrub steppe savanna formation.

2 (a) Eragrostis lehmanniana-Chrysocoma tenuifolia *Community*

This community differs from all the others in that it is unstable, occurring on flat to slightly sloping old lands with rather deep soils (0,50 m to 1 m). The top soil is usually a sandy loam with a pH between 5,5 and 7,0. The community has no differential species, but is typified by the high cover-abundance values reached here by *Eragrostis lehmanniana* and *Chrysocoma tenuifolia*. *Pentzia globosa* sometimes also plays an important role. Due to the importance of *Eragrostis lehmanniana*, this community has a higher cover, about 60%, than other communities on the flats. The community is floristically very poor in that virtually only the earliest Karoo pioneer species occur: apart from the above mentioned ones, *Tragus koelerioides*, *Walafrida saxatilis*, *Aristida congesta*, *Indigofera alternans*, *Gnidia polycephala* and *Pterothrix spinescens*. Eventually this community will possibly develop into one of the others, probably into the *Chrysocoma tenuifolia-Lessertia pauciflora* Community.

2 (b) Chrysocoma tenuifolia-Lessertia pauciflora *Community*

This is one of the most common communities in Tussen die Riviere Game Farm and neighbouring Karoo. It is found on the flats with soils over 1 m deep. The top soil is a fine and middle grained sandy loam, that has a slightly acid pH from 5,5 to 7,0. Sometimes one finds a few coarse gravel stones in the top soil. Ant heaps occur frequently in this community (Fig. 2).

FIG. 2.—**Chrysocoma tenuifolia-Lessertia pauciflora** Community. Note the frequent ant heaps and the dominance of **Chrysocoma tenuifolia**. In the right hand background a slope with mainly **Rhus erosa-Stachys burchelliana** Community.

Relevé no.	103	110	113	534	117	537	551	142	134	143	540	542	555	546	95	137	140	104	96	100	549	553	90	139	116	533	109
Number of species	6	9	15	15	11	11	13	20	16	12	15	16	19	18	19	15	18	13	16	11	36	28	30	23	18	29	28
Aspect	NE		E	E	NE	N			N	NE	N				NW	N	NW	SE	SE	SE	S	SE	S	S	SE	E	SE
Slope (°)	3		1	4	4	4			1	2	1				5	4	2	4	6	5	6	5	5	3	5	10	5
Geology (s = sand- & mudstone, d = dolerite)	d	s		s		s	s	s	s	s	s	s	s	s	s	s	s	s	s	s+d	s	s	s+d	s	s	s	s+d
Soil depth (m)	0,5	>1	>1	0,7	>2	>1	0,3	>1	>1	0,7	>1	>1	>1	>1	<,1	<,1	0,1	0,3	<,1	0,3	<,2	<,2	<,1	<,3	<,1	<,3	<,1
pH (top soil)	7,0	6,0	5,5	6,5	7,0	6,5	6,0	6,0	6,5	5,5	6,5	7,0	6,0	6,0	5,5	6,5	7,5	6,0	5,5	5,5	6,5	6,0	5,5	6,0	5,5	7,0	6,0
Total cover (%)	55	70	75	65	45	30	40	55	45	20	15	35	60	40	55	55	35	40	65	40	15	40	50	60	55	30	40
Differential species of the Chrysocoma tenuifolia-Lessertia pauciflora *Community*																											
Osteospermum scariosum DC.							+	r	r		+	1	+				+					1		+			
Lessertia pauciflora Harv.							+	+		r	r	+										+					
Cyperus usitatus Burch.			1					+	+																		
Aptosimum depressum Burch.						+			+									+							+		
Salsola glabrescens Burtt Davy									+		+	+															
Nestlera conferta DC									+		+																
Species common to Chrysocoma tenuifolia-Nenax microphylla *and* Chrysocoma tenuifolia-Polygala leptophylla *Communities*																											
Nenax microphylla (Sond.) Salter								+								+	+	2a	2a	r	1	+	+	1	+	1	+
Aristida diffusa Trin.	+														1	+	+	r	2b		1	+	1			2a	+
Hibiscus marlothianus K. Schum.			+	r	+												1	1	+		+			+		+	+
Trichodiadema pomeridianum L. Bol.			+										+		r		+				+	+		+			
Dianthus basuticus Burtt Davy																		+			+		+				
Euphorbia clavarioides Boiss.															+	+						+					
Differential species of the Chrysocoma tenuifolia-Polygala leptophylla *Community*																											
Convolvulus boedeckerianus Peter.		+	+																		+	+		+			r
Polygala leptophylla Burch.					+																	+					r
Schizoglossum capense (Schltr.) Huber			r		+																		+	+			
Helichrysum niveum (L.) Less.																					+	1	+				
Osteospermum leptolobum (Harv.) T. Norl.																		+							1	1	
Thesium spartioides A. W. Hill				+																	+			+	r		
Nananthus sp.																					+		1				
Eragrostis denudata Hack. ex Schinz																						+				+	
Species of the slopes																											
Gazania krebsiana Less.				+																	+	+	+	+	+	+	+
Lotononis laxa Eckl. & Zeyh.															+				1		+	+	+	+	+		+
Heteropogon contortus Beauv.																+					+		+			+	
Cymbopogon plurinodus (Stapf) Stapf													+								+					+	r
Rhus ciliata Licht.																					1		+			+	
Lightfootia albens Spreng. ex A. DC.																					1		+				r
Sutera halimifolia (Benth.) Kuntze																					+		+		+		
Species common to Chrysocoma tenuifolia-Lessertia pauciflora *Community and the communities of the slopes*																											
Limeum aethiopicum Burm.									+	r		+		+		+						+	r	+	+	+	+
Eragrostis curvula (Schrad.) Nees							+			+			+	+							+	+	r	+	+		
Lycium salinicolum Verdoorn				+					+	+	1	+	1	1									r			+	
Themeda triandra Forsk.				+				2a					2a								+			2b			1
Helichrysum dregeanum Sond & Harv.								+						+	1							+	2a	+			
Melolobium microphyllum Eckl. & Zeyh.					+			+													+	+					
Common Karoo species																											
Chrysocoma tenuifolia Berg.		3	2a	2a	2b	2a	2a	2b	2b	2a	2a	2b	1	2a	2b	2a	1	3	2b	2a	1	2b	2a	2b	3	2b	3
Pentzia globosa Less.		+	2a	2b	1	1	2b	2a	2a	+	+	+	2a	2b	2a	2a	2a	+	2a	2a		2a	1	1	2b	+	1
Eragrostis lehmanniana Nees	3	3	3	3	2b	2b	+	2a	2a		1	1	+	+	+		1	2a	+	2b	+	1		1	r	+	1
Tragus koelerioides Aschers.			+	1		1	1		1	+	1	1	1	+	1	1	+	1	1	1	+	1	1	+	1	1	1
Walafrida saxatilis Rolfe		+	+	1	+	+	+	1	+	+	+	1	+	1	+	+	+		+	r	+	+	+	1	+	+	+	+
Aristida congesta Roem. & Schult.	1	+	+		+	+	+	+	+	+	+	1	1		1	+		+	+			+			+	+	+
Eragrostis obtusa Munro							1	+	+	1		2a	2b	1	1	+						1		+	1	+	+
Indigofera alternans DC.			+	+		+	+	+			+		+		+				+	+		+		+		+	1
Gnidia polycephala (C.A. Mey.) Gilg				+	1	+			+		r	+			+	+		r	+	+						2a	+
Pterothrix spinescens DC.		+			+	+		+										+	+	+	+		+			+	+
Other accompanying species																											
Hermannia coccocarpa O. Ktze.			+					+			+	+			r		+					+			+	+	+
Sutera atropurpurea (Benth.) Hiern									1								+				1					+	2a
Solanum supinum Dun.			r											+	+									+			+
Aster muricatus Less.				+			+						+	+													
Sporobolus fimbriatus Nees							+						+	+								+	+				
Oropetium capense Stapf										+					+	+									+		
Geigeria filifolia Mah.f.				+									+				1										1
Mariscus capensis Schrad.	+	1	2m																+								
Enneapogon scoparius Stapf											+						1									+	+
Eriocephalus spinescens Burch.																	2a						r		+		
Asparagus suaveolens Burch.															+						+		r			+	
Hibiscus pusillus Thunb.								r									r						+				
Cynodon hirsutus Stent								+		+				+													
Polygala uncinata E. Mey.																	r			r	+						
Hermannia linearifolia Harv.																	+		+								+
Tragus berteronianus Schult.							+							1								+					

Infrequent species in relevés of Table 2:

Anacampseros lanigera Burch. (553: +), Argyrolobium lanceolatum Eckl. & Zeyh. (549: +), Aristida curvata (Nees) Trin. & Rupr. (553: +), Atriplex semibaccata R. Br. (546: r), Blepharis villosa (Nees) C.B. Cl. (533: +. 534: r), Brachiaria serrata (Thunb.) Stapf (549: +), Caralluma lutea N.E. Br. (549: +), Chascanum pinnatifidum (L.f.) E. Mey. (90: +), Crassula setulosa Harv. (555: r), Crassula transvaalensis (Kuntze) K. Shum. (90: +), Dicoma macrocephala DC. (533: +), Digitaria eriantha Steud. (549: +, 555: +), Diospyros austro-africana De Wint. (90: +), Diospyros lycioides Desf. (553: +), Enneapogon brachystachyus (Jaub. & Spach) Stapf (542: +), Fingerhuthia africana Lehm. (139: +), Gnidia capitata L.f. (459: +), Helichrysum ericaefolium Less. (142: +), Helichrysum lucilioides Less. (137: +), Helichrysum zeyheri Less. (137: +), Hermannia cuneifolia Jacq. var. glabrescens (Harv.) Verdoorn (109: +, 549: +), Hermannia pulverata Andr. (546: +), Ifloga caespitosa C.A. Sm. (142: +), Kohautia amatymbica Eckl. & Zeyh. (96: +, 103: 1), Lightfootia denticulata (Burch.) Sond. (103: +, 110: +), Lycium pilifolium C.H. Wright (542: 2a), Nestlera humilis Less. (546: 1), Olea africana Mill. (90: r), Pelargonium fumarioides L'Herit. (537: +), Pentzia lanata Hutch. (134: +), Polygala ephedroides Burch. (549: +), Rhus crosa Thunb. (549: 1), Ruschia sp. (549: +), Sporobolus discoporus Nees (95: +), Sutera albiflora Verdoorn (90: +),

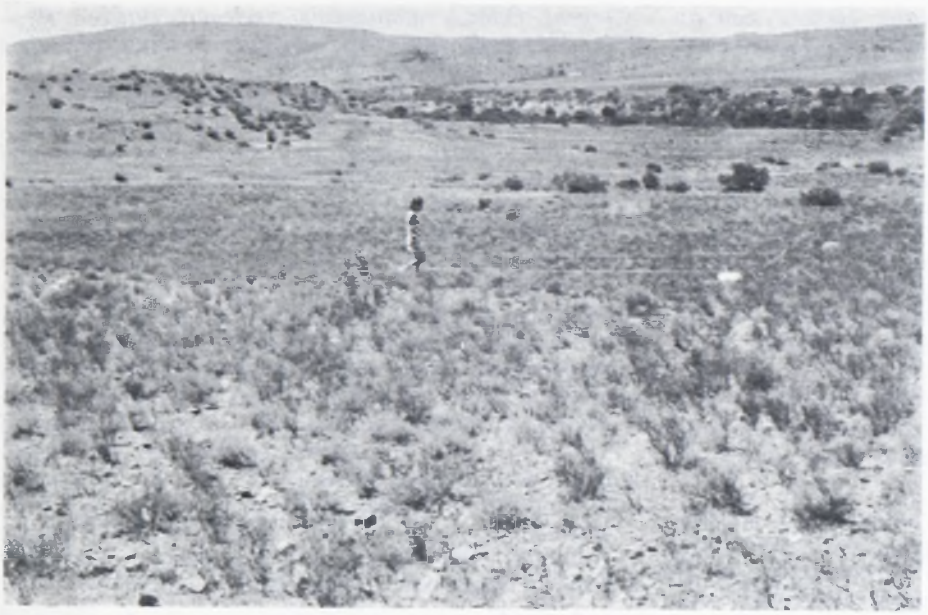

FIG. 3.—Showing sampling of **Chrysocoma tenuifolia-Polygala leptophylla** Community in foreground. On the slope in the centre left **Rhus erosa-Stachys burchelliana** Community and in the centre right **Acacia karroo-Celtis africana** Riverine Community.

The community has a number of good differential species, which are not, however, abundant: *Osteospermum scariosum*, *Lessertia pauciflora*, *Cyperus usitatus*, *Aptosimum depressum*, *Salsola glabrescens* and *Nestlera conferta*. Apart from the common Karoo species, this community has also a number of species in common with the communities of the gently sloping terrain, although they are less constant and abundant here: *Limeum aethiopicum*, *Eragrostis curvula*, *Lycium salinicolum*, *Themeda triandra*, *Helichrysum dregeanum* and *Melolobium microphyllum*.

Relevés 537 and 546 represent heavily overgrazed stands in this community.

2 (c) Chrysocoma tenuifolia-Nenax microphylla *Community*

This community is found on the nearly flat terrain and slopes up to 6° with shallow soils of 0,02 to 0,30 m, or with lithosols and outcrops of mudstone and fine and medium-grained sandstone of the Beaufort series. The pH of the soil is usually from 5,5 to 6,5, except in relevé 140, where the pH was 7,5 and the soil gave a light positive calcrete reaction.

Although no absolute differential species has been found, this community possesses a characteristic species combination: species shared with the *Chrysocoma tenuifolia-Polygala leptophylla* Community, *Nenax microphylla*, *Aristida diffusa*, *Hibiscus marlothianus*, *Trichodiadema pomeridianum*, *Dianthus basuticus* subsp. *basuticus* and *Euphorbia clavarioides*, occur together with the common Karoo species. Both *Pentzia globosa* and *Chrysocoma tenuifolia* are usually abundant in this community. Although *Aristida diffusa* is typical it does not reach such high cover-abundance values in this community as in the communities of the steep slopes (Table 4).

2 (d) Chrysocoma tenuifolia-Polygala leptophylla *Community*

This community occurs on gentle slopes of 5° to 10° of mudstone and fine to medium-grained sandstone of the Beaufort series. Outcrops occur regularly. Sometimes there is a slight dolerite influence. The soil is a shallow lithosol, 0,02 to 0,30 m thick and slightly acid with pH 5,5 to 7,0 (Fig. 3). The aspect is generally south to east. Differential species appear to be *Convolvulus boedeckerianus*, *Polygala*

FIG. 4.—South-east facing dolerite slope with **Olea africana-Maytenus heterophylla** Community, that is also rich in **Rhus undulata** var. **burchellii**, **Euclea crispa** and **Tarchonanthus camphoratus**.

leptophylla, *Schizoglossum capense*, *Helichrysum niveum*, *Osteospermum leptobolum*, *Thesium spartioides*, *Nananthus* sp. and *Eragrostis denudata*. Further, this community has species in common with the *Chrysocoma tenuifolia-Nenax microphylla* and the *Chrysocoma tenuifolia-Lessertia pauciflora* Community (see 2(b), 2(c) and Table 3). This community also has species in common with the communities of the steeper slopes and stonier areas, such as *Gazania krebsiana*, *Lotononis laxa*, *Heteropogon contortus*, *Cymbopogon plurinodis*, *Rhus ciliata*, *Lightfootia albens* and *Sutera halimifolia*. The dominant species in this community is usually *Chrysocoma tenuifolia*.

3. *The communities of the steep slopes* (Table 4)

Floristically and structurally the richest communities in Tussen die Riviere Game Farm occur on broken veld.

The vegetation of all these communities consists of three or four layers: a very sparse layer of creeping and rosette plants up to 0,05 m high and usually covering less than 5%, although sometimes considerably higher; a grass, dwarf shrub and small shrub layer up to about 0,80 m, covering usually between 35% and 50%, but with exceptions of 15% and 70%; a tall shrub layer, with an occasional low tree, between 1 to 4 m high, of which the cover changes between 10% and 30% in the *Rhus erosa-Stachys burchelliana* Community and the *Rhus erosa-Rhynchelytrum repens* group of communities and between 25% and 55% in the *Olea africana-Maytenus heterophylla* group of communities. Sometimes there is also an open tree layer, up to 6 m in height and with a cover of about 10% to 30%, except in relevé 556, where it covers 70%. Without further refinement of Fosberg's (1967) system, it is somewhat difficult to classify these communities physiognomically. The *Rhus erosa-Rhynchelytrum repens* group of communities and the *Rhus erosa-Stachys burchelliana* Community fit best under category 2B1 (2): evergreen broad sclerophyll steppe shrub, whereas the *Olea africana-Maytenus heterophylla* group of communities fits best under formation 1B1 (4a): Mesophyllous evergreen broad sclerophyll scrub, with transitions to formation 2B1 (2).

All these communities of the steep slopes have a great number of species in common of which the most important are *Asparagus suaveolens*, *Aristida diffusa*, *Diospyros lycioides* subsp. *lycioides*, *Rhus erosa*, *Rhus undulata* var. *burchellii*, *Eustachys paspaloides*, *Sporobolus fimbriatus*, *Olea africana*, *Diospyros austro-africana*, *Enneapogon scoparius*, *Sutera albiflora* and *Euclea coriacea*. These communities have also a number of species in common with the *Chrysocoma tenuifolia- Polygala leptophylla* Community of the gentle slopes [see 2 (d)] and with the *Chrysocoma tenuifolia-Lessertia pauciflora* Community [see 2 (b)]. Although the common Karoo species are always present in these communities of the steep slopes, their cover-abundance values usually do not reach such high values as in the communities of the flats and gently sloping terrain.

3 (a) Rhus erosa—Rhynchelytrum repens *Communities*

This is a group of three communities which floristically differ only slightly from one another. The three communities of this group are characterized by the following differential species: *Rhynchelytrum repens*, *Pellaea calomelanos*, *Asclepias fruticosa*, *Phyllanthus maderaspatensis*, *Aristida curvata*, *Haworthia tesselata* and *Hyparrhenia hirta*.

One of these communities, represented by relevés 547, 545, 144 and 136, is relatively poor in species, in that it lacks largely the above-listed differential species, and also *Olea africana*, *Euclea coriacea* and *Themeda triandra*. It occurs on steep sandstone and mudstone slopes of 12° to 27° with a northern to eastern aspect. The soil is always very shallow with a pH between 6,0 and 7,0 and there are many rocky outcrops. A second community in this group is rich in species and is characterized by the occurrence of *Hyparrhenia hirta* and the importance of *Rhus undulata* var. *burchellii*. This community also occurs on steep sandstone and mudstone slopes of 13° to 30° with a northern aspect. The soil, which has a pH varying between 5,5 and 7,0 is between 0,10 and 0,70 m deep, which means that it is not so shallow here as in the first community of this group. Although rocky outcrops occur, they do not play such an important role in this community.

A third community of this group is characterized by the absence of *Hyparrhenia hirta*, and the slightly higher cover-abundance values reached here by *Euclea crispa* and *Enneapogon scoparius*. It occurs on steep (23° to 31°) dolerite slopes, also with a northern to north-western aspect.

Relevé 544 was situated on the nearly level summit of a dolerite koppie, near the northern edge. Soil only occurs in fissures and is slightly acid with a pH from 5,5 to 7,0. These last two communities have a few species in common with the group of *Olea africana-Maytenus heterophylla* Communities: *Cheilanthes eckloniana*, *Lantana rugosa* and *Euclea crispa*. Relevé 548 is different from the others in that is has *Argyrolobium variopile* and *Rhus lancea* with high cover-abundance values. Relevé 541 is extraordinarily rich in species.

3 (b) Rhus erosa—Stachys burchelliana *Community*

In this community *Rhus erosa* plays an important role, although *Olea africana*, *Tarchonanthus camphoratus*, *Rhus undulata* var. *burchellii*, *Rhus ciliata* and *Diospyros austro-africana* also can be important in the shrub layer (Fig. 3). The community is characterized by a number of differential species, of which *Cheilanthes hirta*, *Stachys burchelliana* and *Chamarea capensis* are the most constant. The community has the following species in common with the group of *Olea africana-Maytenus heterophylla* Communities: *Tarchonanthus camphoratus*, *Senecio hieracioides*, *Celtis africana*, *Selago albida*, *Asparagus laricinus*, *Cotyledon decussata-orbiculata* complex, *Elyonurus argenteus* and *Pavonia patens*.

The community occurs on steep dolerite slopes of 9° to 27° with a south-western aspect. The only exceptions form relevé 92, which lies on a sandstone slope of 6° and relevé 102 which has an eastern aspect. The soil virtually occurs only in fissures and is always very shallow with a pH from 5,5 to 6,0. Relevé 108 differs from the others in that is has *Acacia karroo* with a high cover-abundance value.

3 (c) Olea africana-Maytenus heterophylla *Communities*

On steep and protected south-facing sites in Tussen die Riviere Game Farm a group of communities occurs in which the tall shrub and tree component

TABLE 4.—Communities of the steep slopes.

Relevé no.	547	545	144	136	539	543	554	552	538	548	535	541	544	92	99	91	93	94	102	108	97	98	107	115	550	119	138	556	538	191
Number of species	29	22	16	27	49	32	44	48	33	32	28	61	39	32	32	47	33	41	45	48	35	32	38	38	47	33	32	44	53	41
Aspect	N	NE	NE	E	N	N	NE	NW	N	NW	NW	NW	—	S	S	SE	S	S	E	SW	SW	SW	S	SE	SE	SW	SW	S	SW	SW
Slope (°)	20	27	12	15	30	25	30	13	27	31	24	23	—	6	9	19	7	12	26	19	15	27	25	24	33	24	31	32	35	31
Geology (=ssand- & mudstone, d=dolerite)	s+d	s	s	s	s	s	s	s	d	d	d	d	d	s	d	s+d	s+d	d	d	d	d	d	d	d	d	d	d	d	s	s
Soil depth (m)	0,5	0,5	0,5	0,5	0,4	0,6	0,1	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
pH (top soil)	7,0	7,0	6,5	6,0	6,5	7,0	6,5	5,5	—	5,5	7,0	7,0	6,0	5,5	6,0	6,0	5,5	5,5	5,5	5,5	5,5	6,0	5,5	6,0	6,5	—	6,5	—	7,0	5,5
Total cover (%)	40	40	35	40	25	12	30	35	35	20	40	40	60	35	70	70	80	80	70	90	80	75	75	80	70	90	85	80	75	70
Differential species of the Rhus erosa-Rhynchelytrum repens *group of communities*																														
Rhynchelytrum repens (Willd.) C.E. Hubb.		+			+	+	+	+	+	+	+	+	+																	
Pellaea calomelanos (Swartz) Link					+				+	+	+	+					+										+			
Asclepias fruticosa L.	+				+	+	+		+			+							+											
Phyllanthus maderaspatensis L.			+		+	+	+					+																		
Aristida curvata (Nees) Trin. & Rupr.					+		+	+	+				+																	
Haworthia tesselata Haw.						+	+			+		1																		+
Hyparrhenia hirta (L.) Stapf					2a	+	3	+																						
Differential species of the Rhus erosa-Stachys burchelliana *Community*																														
Cheilanthes hirta Swart														+	+	1		+	1	+	+	+	+					1	+	
Stachys burchelliana Launert				1													+		1	1		1	1				2a			
Chamarea capensis (Thunb.) Eckl. & Zeyh.															+	+	+	+					+							
Maytenus polyacantha (Sond.) Marais																	1			+			+	+						
Polygala ephedroides Burch.														+	+	+														
Lasiosiphon burchellii Meisn.														1		1														
Differential species of the Olea africana-Maytenus heterophylla *group of communities*																														
Melica decumbens Thunb.													+							1					+	+	+		+
Crassula harveyi Schonl.																									+	1	1		+	1
Mohria caffrorum (L.) Desv.																									+	+	+		+	
Hibiscus aethiopicus L.																								+				+	+	+
Crassula filamentosa Schonl.																										+		+		+
Maytenus heterophylla (Eckl. & Zeyh.) N. Robson																										2a	+	2a		
Crassula setulosa Harv.																										+		+		
Grewia occidentalis L.																										2b				
Gerbera piloselloides (L.) Cass.								+																+				+	1	
Berkheya radula (Harv.) De Wild.																												+		
Eragrostis chloromelas Steud.							+																					+		
Helictotrichon longifolium (Nees) Schwieck.																												+		
Haemanthus hirsutus Bak.																												+		
Carex spicato-paniculata C.B. Cl.																														
Gerbera viridifolia (DC.) Sch. Bip.																													1	
Linum thunbergii Eckl. & Zeyh.																													+	
Asparagus denudatus (Kunth) Bak.																												1		
Cussonia paniculata Eckl. & Zeyh.																												+		
Koeleria cristata (L.) Pers.																												+		
Species common to Rhus erosa-Stachys burchelliana *and* Olea africana-Maytenus heterophylla *Communities*																														
Tarchonanthus camphoratus L.													1			+	1	1	2b		1		2b	2a	1		2a	1		
Senecio hieracioides DC.															+			r		+		+	+	+	+			+	1	
Celtis africana Burm.f.								1								+				+	+	2a			+			1	+	r
Selago albida Choisy												+				+			1				+	1	1		+			1
Asparagus laricinus Burch.													+						+	+			+	+	1				+	
Cotyledon decussata-orbiculata												+		r		+			1						+					1
Elyonurus argenteus Nees																	1	1						+			+		1	
Pavonia burchellii (A. DC.) R.A. Dyer																						1					r			
Species common to Rhus erosa-Rhynchelytrum repens *and* Olea africana-Maytenus heterophylla *Communities*																														
Cheilanthes eckloniana (Kunze) Mett.					+		+	+	1	+	+	+												+	1	1	+		+	+
Lantana rugosa Thunb.					+		+		+			+																+	+	
Euclea crispa (Thunb.) Guerke						+				+		2b	1														2a	1			
Species common to the communities of the steep slopes																														
Asparagus suaveolens Burch.	+			1	+		+	+	+	+	+	+	+	+	+	+	r	+	1	1	1	2b	1	2a	+	2a	+	1	1	+
Aristida diffusa Trin.	2b	1	2a	+	2a	2a	1	1	2b	1	2b	2a	2a	2a	2a	2a	2a	2b		2a	+	+	2a	1	2a			2a	2a	2a
Diospyros lycioides Desf.	+	+		1	+		+	1	1	+		1	+	+	1		1	1	+	2a	+	1	1	1	+	+	+	+	2a	2a
Rhus erosa Thunb.		1		1	2a		1	1	2b		1	+	1	+	2a	+	2b	2a	1	2b	1	+	1	2b	1		1	2b	2a	2a
Rhus undulata Jacq.		2b		+	2b		2a	2a	+	+		+	2a			+		+	1	1	2b	2a	1	2a	2a	2b	+	2a	1	+
Eustachys paspaloides (Vahl) Lanza & Mattei			+	+	+	+	+		+	+	+	1	+		+	+	+	+	1	+				+	1	+	1		+	+
Sporobolus fimbriatus Nees	+	2a		+	+		+	+		+		+	+			+			+	1	1	1	+	1	+	3	+	+		
Olea africana Mill.					1			1	+	2a		r	+	r		1		+		1	2b	3	1	4	+	3	3	4	2b	2a
Diospyros austro-africana De Wint.	+		+	+	+			+		+		+		+		+		1	2a	2b			2a	+	1			1	+	+
Enneapogon scoparius Stapf	+	+			+	1	+	1	1	+	2a	+	2a					2a	+			+	+		2b	1		+		
Sutera albiflora Verdoorn	+				+	+	+	+	2a	+	+	+	+		+	+		+		r				1						
Euclea coriacea A. DC.					+			+		+						+		+	1	+	r	+	1	1			1	+	+	r
Hermannia cuneifolia Jacq.		+		r		+	+				+	+				1			+	+			1					+	+	1
Argyrolobium lanceolatum Eckl. & Zeyh.					+	+	+					+				+		+	+	+				+	+		+	+	+	+
Solanum supinum Dun.		+			+	+	+	+				+			r	+		r	r	+	+	+								
Chascanum pinnatifidum (L.f.) E. Mey.	+				+	+	+	+	+		+	+				+			+					r						
Digitaria eriantha Steud.				+							+	+		+						+			1			+	+	+	+	1
Aster muricatus Less.												+							1			+	+	1	1	+	+	+	+	+
Hibiscus pusillus Thunb.	+					+	+			+		+			+				r	+		1	+		+		1			+

Anthospermum rigidum Eckl. & Zeyh.																														
Aloe broomii Schonl.					+	+	+	+					+		+				1		+				+					+
Pollichia campestris Soland.				+	+		+	+		+		r							+		+				+			+		
Pelargonium aridum R.A. Dyer							+						+			r						r	+	r	+					
Brachiaria serrata (Thunb.) Stapf					+			+				+						1		+			+					+	+	
Adromischus rupicola C.A. Sm.						+		+				+							+	+			+		+					+
Pegolettia retrofracta (Thunb.) Kies							+					+					+			+							r			r
Species of the slopes																														
Rhus ciliata Licht.	2a		2a	2a	1	1	+	+		+	2b	2a	2a	2a	2a	2b	1	+	2a	2a	1	1			+		+			
Cymbopogon plurinodis (Stapf) Stapf			+			+	+		+	+	+	1	+			+		1	+	1		r	1	2a	+	+	1	+	+	1
Heteropogon contortus (L.) Beauv.			1		+	+	+	+	+	+	1	1	+	1	+	+	+	1	2a	+				1	+	+				1
Lightfootia albens Spreng ex A. DC.	+				+			+		+	+			1		1	1	1		r			r		+				+	+
Sutera halimifolia (Benth.) Kuntze	+				+		+	+			+	+	+	+		+	+	+		+	+				+					
Lotononis laxa Eckl. & Zeyh.	+							+				+		+	1	+	1	+		+										+
Gazania krebsiana Less.												+				+	+	+											+	1
Species common to Chrysocoma tenuifolia-Lessertia pauciflora *Community and communities of the slopes*																														
Eragrostis curvula (Schrad.) Nees		+	+	+	+		+	+		+		+	+	+	2b	+	+	1	+	2a	+	1	2b	+	+	r	1	1	1	2a
Themeda triandra Forsk.					+	+	+	+	+	1	+	+		+	1	+	1	+	1	1			1	2a	2a	+	2b	2a	+	+
Lycium salinicolum Verdoorn		+	+	+	+		+	+					+							1	+	+	+		+				+	+
Helichrysum dregeanum Sond. & Harv.						r	+				+	+						+	+	+	+		1		+	+	+		+	1
Limeum aethiopicum Burm.	+		+			+						+	+		r	+			r		r									
Melolobium microphyllum Eckl. & Zeyh.								+	+		+						2a													+
Common Karoo species																														
Chrysocoma tenuifolia Berg.	2a	1	1	2a	1	+	1	2b	+	+	2a	2a	2a	1	2b	1	2a	2a	2a	1	1	1	1	+	+	+	+	+	2a	+
Tragus koelerioides Aschers.	1	1	+	+	+		+	1	+	+	+	1	1	1	1	1	1	1	+	1	+	+	+	+	+	+		+	+	+
Wallafrida saxatilis Rolfe	1			1				+	+			r	+	r	+	+	+	+	+	+	1		1	+	+	+	+	+	+	+
Pentzia globosa Less.	+			+	r	r	+	2a					1	+	2a	2a	+	1	1	+	2a	1	+	r				r	+	+
Aristida congesta Roem. & Schult.	+	+	1	1	+	+	+	+	+	+	+	+	1	+	1	+		+	+	+				+						
Eragrostis lehmanniana Nees	1	+	+		+		+	1	1	+	+	+	1		+	1					+	+		+	+	+			+	
Indigofera alternans DC.	+				+	+	+	1			+	+	+		+			r	+		+									
Eragrostis obtusa Munro	+	+						+					+		r						+		+					r		+
Gnidia polycephala (C.A. Mey.) Gilg			+		1		+				+		+			+	+	+		+										
Pterothrix spinescens DC.	+													+	+	+	+	+												
Other accompanying species																														
Viscum rotundifolium L.f.				+	+			+								1		1			+	+		+		+				
Hermannia coccocarpa O. Ktze.															+	+			+	+	+		+							+
Sutera atropurpurea (Benth.) Hiern		1		1										+			1						1	+						
Mariscus capensis Schrad.					+						+		+	+		+		+	+											
Nenax microphylla (Sond.) Salter	+					+								+	+			+											+	
Dianthus basuticus Burtt Davy								+				+		1			+												+	
Melianthus comosus Vahl															1					1				r				+		r
Hibiscus marlothianus K. Schum.												+	+	+		+			+											
Blepharis integrifolia (L.f.) E. Mey.					+							+							+	r										
Cynodon hirsutus Stent		+		+																	2a									
Hermannia linearifolia Harv.				+	+											+														
Tragus berteronianus Schult.		+					+																		+					
Dicoma macrocephala DC.		+		+							+																			
Talinum caffrum (Thunb.) Eckl. & Zeyh.																			+		+					+				
Withania somnifera Dun.							+		+													+								

Infrequent species in relevés of Table 4:

Acacia karroo Hayne (108: 2b), Achyranthes aspera L. (98: +, 552: +), Achyranthes sicula (L.) All. (136: 1), Aloe grandidentata Salm. Dyck. (102: 1, 541: +), Aloinopsis sp. (541: +), Argyrolobium variopile N.E. Br. (548: 2b), Asparagus setaceus (Kunth) Jessop (97: +), Asparagus striatus (L.f.) Thunb. (107: +), Aster filifolius Went. (107: +), Atriplex semibaccata R. Br. (108: r), Bulbostylis humilis Kunth (538: +), Cenchrus ciliaris L. (545: 2a), Ceterach cordatum (Thunb.) Desv. (115: 1), Chloris virgata Swartz (544: +), Cineraria lobata L'Herit (550: +), Clematis brachiata Thunb. (111: r, 136: r), Commelina africana L. (97: +, 119: +), Crassula lycopodioides Lam. (541: +), Crassula nodulosa Schonl. (541: +), Dimorphotheca cuneata Less. (111: +), Eragrostis denudata Hack. ex Schinz (538: +, 544: +), Eriocephalus pubescens DC. (91: +), Eriocephalus spinescens (539: +), Euryops empetrifolius DC. (541: +), Geigeria filifolia Mah.f. (92: +, 547: +), Helichrysum cerastioides DC. (544: +), Helichrysum ericaefolium Less. (93: +), Helichrysum zeyheri Less. (543: 1, 552: +), Hermannia candidissima Spreng. (545: 1), Hermannia depressa N.E. Br. (552: +), Indigofera bifrons E. Mey. (543: +), Ipomoea crassipes (Hook.) C.A. Sm. (550: +), Kalanchoe thyrsiflora Harv. (538: +, 550: +), Lycium hirsutum Dunal (97: r), Monsonia angustifolia E. Mey. (538: +, 547: +), Nananthus sp. (91: +), Oropetium capense Stapf (552: +), Panicum stapfianum Fourq. (536: +), Pellaea quadripinnata (Forsk.) Prantl (539: +), Pentzia sphaerocephala (92: +), Peucedanum cf. connatum E. Mey. (536: +), Phyllanthus burchellii Muell. Arg. (538: +), Phymaspermum aciculare Benth. & Hook.f. (138: +, 541: +), Phymaspermum parvifolium (DC.) Benth. & Hook.f. (91: +), Polygala (Werger, 1084), (543: +), Polygala leptophylla Burch. (543: +, 547: +), Polygala uncinata E. Mey. (102: +, 536: +), Rhigozum obovatum Burch. (543: +), Rhus lancea L.f. (548: 2a), Rhus pyroides Burch. (98: +), Rhynchosia confusa Burtt Davy (541: 1), Rubia cordifolia L. (536: r), Sarcostemma viminale (L.) R. Br. (541: +), Setaria flabellata Stapf (99: +, 536: +), Silene capensis Otth. (108: +), Stipagrostis zeyheri (Nees) De Wint. ssp. sericans (Hack. apud Schinz) De Wint. (538: 1), Sutherlandia humilis Phill. & Dyer (541: +), Trichodiadema pomeridianum L. Bol. (111: r, 536: +), Trichoneura grandiglumis (Nees) Stapf & C.E. Hubb. (535: +), Zinnia multiflora L. (539: +).

plays an important role. They are characterized by the following differential species: *Melica decumbens*, *Crassula harveyi*, *Mohria caffrorum*, *Hibiscus aethiopicus* var. *ovatus*, *Crassula filamentosa*, *Maytenus heterophylla*, *Crassula setulosa* and *Grewia occidentalis*.

Olea africana is the most important species in this group of communities. As has been mentioned before, they have species in common with the *Rhus erosa-Stachys burchelliana* Community and with two of the *Rhus erosa-Rhynchelytrum repens* group of communities.

On steep dolerite slopes of between 24° and 33°, protected by nearby ridges, a community occurs in which apart from *Olea africana*, *Rhus undulata* var. *burchellii*, *Euclea crispa*, *Tarchonanthus camphoratus* and *Themeda triandra* can be important (Fig. 4). Relevés 115, 119, 138 and 550 are examples of this community.

Relevés 556, 536 and 111 are each examples of different communities, belonging to this group of communities.

Relevé 556 represents the vegetation in a dolerite kloof, near the ridge of a mountain. There is very little soil, and species like *Cussonia paniculata* and *Koeleria cristata* occur here.

Relevé 536 represents the vegetation in a well protected sandstone kloof. Here, also, soil occurs only in fissures. Species like *Carex spicato-paniculata* and *Gerbera viridifolia* are typical.

Both the communities, of which relevés 556 and 536 are examples, occur frequently and more typically further upstream in the Orange River Valley.

Relevé 111 represents the vegetation on a very steep (31°) south-west facing sandstone slope. It is floristically not so rich as the two above-mentioned communities, and is a more open vegetation, in which grasses like *Aristida diffusa*, *Digitaria eriantha*, *Cymbopogon plurinodis*, *Heteropogon contortus* and *Eragrostis curvula* play an important part.

DISCUSSION

As has been pointed out several times (Tüxen, 1970; Werger *et al.*, 1972), more relevés from a wider area are necessary for granting fixed status in a hierarchy to communities recognized in a study such as this. It can then also be determined with certainty whether weedy species like *Asclepias fruticosa* and *Aristida curvata* are indeed differential species of the *Rhus erosa-Rhynchelytrum repens* group of communities, as they appear to be from the present data. Only with more relevés available can it also be decided whether relevés like 541, which are rather rich in species, are fully representative examples for the communities into which they have been incorporated or whether they are merely exceptions.

It is an immportant advantage of the Braun-Blanquet phytosociological method that without much extra effort an unrestricted amount of new relevé data can be compared with and incorporated into the existing classification and that gradually an hierarchical classification of the plant communities of the South African veld can be compiled. The method is also of utmost use for planners, pasture and veld management scientists and many others (Tüxen, 1968–69) as, from the tables, grazing potential and stage of deterioration for each vegetation spot (relevé), as well as for each community, can immediately be read, because it shows cover-abundance values and total species composition for each relevé and variation thereof within a community. Thus, as Tüxen (1970) has pointed out, a phytosociological table, because of its synthetic character, but without loosing detailed information, contains more information than the sum of information contained in all single relevés.

The application of only a physiognomic system for classification of the vegetation is of limited use, since these systems are always highly artificial. Thus, vegetation types which are floristically very different may be classified in the same formation and vice versa. In the present study we see that floristically similar communities end up in different formation classes, for example the *Eragrostis lehmanniana-Chrysocoma tenuifolia* Community and the Chrysocoma *tenuifolia-Lessertia pauciflora* Community.

The Fosberg (1967) system provides a reasonably suitable physiognomic classification for these Karoo communities, especially if some refinements could be effected. However, the definitions of concepts are very rigid. The names of the formations are intended to have the double function of label and diagnosis. These two features of the Fosberg (1967) system lead to rather peculiar word combinations in formation names, that offend slightly, because they would be contradictory in more common language usage. A less strictly defined system, and one where names have not so much the function of diagnosis but more that of labelling, like the Ellenberg & Mueller-Dombois (1967) system, would overcome this problem. For many workers this latter system has the disadvantage, however, of using as criteria characters that are not strictly vegetational.

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SAMEVATTING

As deel van IBP-opname van beskermde gebiede is die plantegroei van die Tussen die Riviere-wildplaas, O.V.S., geanaliseer volgens die Braun-Blanquet plantsosiologiese metode. 'n Klassifikasie van die ter plaatse voorkomende plantgemeenskappe word gegee. 'n Manier word voorgestel waarop 'n hierargiese klassifikasie van die plantgemeenskappe in Suid-Afrika opgestel kan word. Elke plantgemeenskap is volgens Fosberg (1967) se sisteem van plantformasies geklassifiseer. Twee nadele van hierdie sisteem word kortliks bespreek.

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