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The efficient use of small plots in a fynbos phytosociological study in the northern Cederberg: a quick way to collect plant-environmental data

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Keywords: Cederberg, phytosociological survey, small plot sizes

ABSTRACT

A phytosociological survey of selected plant communities in the northern Cederberg was made using small (4–16 m^2) plot sizes. A satisfactory phytosociological table was obtained, and plant-environmental relationships were inferred from it. The use of small plot sizes enabled ecological information about plant communities to be quickly, easily and efficiently obtained. This method could be of considerable use for establishing and monitoring vegetation patterns.

UITTREKSEL

'n Fitososiologiese opname van geselekteerde plantgemeenskappe in die noordelike Cederberg is gemaak, en klein (4–16 m^2) perseelgroottes is gebruik. 'n Bevredigende fitososiologiese tabel is verkry, en plant-omgewingsverhoudings is daaruit afgelei. Die gebruik van klein perseelgroottes het daartoe gelei dat ekologiese inligting oor plantgemeenskappe vinnig, maklik en doeltreffend verkry kon word. Hierdie metode sou heel nuttig vir die bepaling en monitering van plantegroeipatrone gebruik kon word.

INTRODUCTION

The Zürich-Montpellier, or Braun-Blanquet, approach has been widely used to survey and classify vegetation (Werger 1974). The aim of such studies is to describe the communities of the chosen area and to correlate them with environmental factors. In South Africa these vegetation studies have been carried out at scales ranging from regional, comprising several thousands of hectares (Boucher 1978; Cowling 1984; Taylor 1984), to smaller areas of a few hundred hectares and less (Werger *et al.* 1972; Cowling *et al.* 1976; Campbell & Moll 1977; McKenzie *et al.* 1977; Glyphis *et al.* 1978; Laidler *et al.* 1978; Campbell *et al.* 1980; Van Wilgen & Kruger 1985). In these studies plot size has ranged from 4 to 200 m^2: choice of plot size has largely depended on floristic richness and structure of the communities sampled, and usually ignores the small-scale pattern. Relatively small plots (e.g. 25 m^2) have been suggested as suitable for reflecting less habitat heterogeneity than larger plot sizes, in turn leading to the unmasking of subtle variations within the observed communities (Van Wilgen & Kruger 1985).

Large plots possibly covering heterogeneous habitats and hence reflecting transitional communities, are time-consuming for data collection. Small plots obviate both these problems. The aim of this study was to perform a phytosociological survey in the northern Cederberg using plots of small size (4–16 m^2) in order to see if a satisfactory Braun-Blanquet table could be obtained, and if plant-environmental patterns could be inferred.

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STUDY AREA

The area surveyed was in the Pakhuis Pass area of the northern Cederberg at altitudes ranging from 600 to 1 000 m. The communities sampled lay between 18° 59′ E to 19° 04′ E, and 32° 08′ S to 32° 11′ S, covering an area of approximately 300 hectares. The vegetation is described as Mesic Mountain Fynbos (Moll *et al.* 1984). The geology of the area is quartzitic sandstone of the Peninsula Formation of the Table Mountain Group. The area falls within the 60% winter rainfall region. The annual rainfall is 480 mm of which 72% falls between April and August (winter). Mean monthly maximum temperatures range from 20°C (winter) to 30°C (summer). Mean minimum temperatures drop to 5°C in midwinter.

METHODS

The area was surveyed using aerial photographs in order to broadly identify communities. Braun-Blanquet techniques as described by Werger (1974) were used. Since plant relationships with the environment, and with other plants, will be related to both the scale of environmental variation and to plant size, relevé size was chosen in relation to vegetation structure (height) as follows: 2 × 2 m (<1 m in height); 2 × 4 m (1–2 m in height); and 4 × 4 m (>2 m in height). The following data were collected in January 1986: floristic lists and cover abundance for each of five to six relevés per community (22 plots in total); species not in the relevé, but occurring in the surrounding area in a 1–2 m border round the plot recorded as (+). Environmental data, as set out in Table 1, were recorded for each relevé. The computer program TWINSPAN (two-way indicator species analysis, Hill 1979) was applied to the raw data, producing a tabular matrix approximating Braun-Blanquet table work. The matrix was further sorted by hand.

TABLE 1.—Phytosociological table of northern Cederberg communities

Height of tallest stratum (m)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	6	6	3	4	4
Plot size (m^2)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	16	16	16	16	16
Rock cover (superscripts are BB cover values)	n	n	n	n	n	n	b^1 I^2	II^3	II^3 III^3	II^2 III^2	II^3	b^1 I^2	b^2	b^3	b^2	I^4 II^2	b^1	III^2	II^1	n	II^1	b^2
Aspect	-	-	NW	NW	-	-	E	NE	NW	E	E	E	-	-	N	NE	-	SE	SE	S	SW	NW
Soil depth	3	2	3	3	3	2	01	01	1	0	01	01	01	01	1	1	01	2	2	2	2	2
Soil moisture	d	d	d	d	d	d	d	d	d	d	d	d	df	df	df	df	df	dr	dr	dr	dr	dr
Slope	0	0	0	1	0	0	1	3	2	3	3	1	0	0	0	0	0	0	0	0	1	1
Altitude (m)	970	1000	900	900	900	1000	910	980	900	1050	910	910	890	880	880	830	830	900	900	600	920	920
Number of species	22	18	16	15	14	8	6	18	15	13	18	13	9	8	10	14	8	22	14	17	11	12
Relevé	1	5	4	2	3	6	17	13	14	12	15	16	10	11	7	8	9	18	19	22	20	21
Community 1																						
Thamnochortus platypteris	3	2	1	3	2	2																
Willdenowia arescens	1	1	1	1	2	(+)		+														
Ischyrolepis monanthos	2	2	3	2	2																	
Macrostylis decipiens	2	(+)	2			(+)		+	1													
Metalasia agathosmoides	2	1	1	(+)											+							
Aristea sp.	+	+	1	1																		
Thesium sp. (H.T.10759)	2	1	(+)								(+)											
Rafnia diffusa	2	+	+																			
Ficinia dunensis	1	1		(+)																		
Ischyrolepis sp. (cf. *curviramis*)		1			2																	
Pentaschistis viscidula			1		1																	
Muraltia sp. (H.T.11380)	1		1																			
Ficinia bulbosa	1	1																				
Grisebachia ciliaris	2	+																				
Phaenocoma sp.			1	(+)																		
Campanulaceae (H.T.10861)	1	+																				
Helichrysum sp.				+	+																	
Thymelaeaceae			(+)		1																	
Tetraria nigrovaginata	(+)					(+)																
Mesembryanthemum sp.		+	+																			
Pelargonium sp.	+	+																				
Thesium nudicaule	(+)	(+)																				
Ursinia sp.	1		(+)																			
Elytropappus sp. (H.T.909/4)	+																					
Subcommunity 2b																						
Cannomois parviflora						2	2	1	2	+	1	1										
Anthospermum aethiopicum							+	+	1	+	+	+	+			(+)		(+)				
Tetraria ustulata								1	1	1	(+)	2										
Ficinia deusta	1					(+)		+	1	+	+											
Metalasia densa			1					3	+		1											
Cymbopogon marginatus			2					(+)		2												
Chasmanthe sp.								+							+							
Tetraria cuspidata							4			1												
Clutia alaternoides										+	+											
Elytropappus sp.								+		+												
Hypodiscus neesii								1			1	3										
Pentaschistis curvifolia								1	1													
Struthiola ciliata							+	+				+										
Selago sp.									+		+	+										
Campanulaceae									+		+	+										
Subcommunity 2a																						
Ischyrolepis gaudichaudiana													2	3		1	3	(+)				
Merxmuellera arundinacea													(+)	1								
Community 2																						
Ischyrolepis sieberi								2	2	3	3		1	1	3							
Stoebe plumosa										3	1	2		2	2		2					
Ficinia nigrescens									1	(+)	+	(+)	+	+	+	1	(+)					
Cliffortia ruscifolia				1		2					+	1	1	3	1	+	2	(+)				
Lobostemon glaucophyllus								(+)						(+)		(+)						
Subcommunity 3b																						
Indigofera frutescens																					+	(+)
Pentaschistis sp.																		(+)			+	+
Lidbeckia quinqueloba																					(+)	(+)
Rhus rimosa																					(+)	(+)

BB cover values: (+) = not in quadrat, but occurring in surrounding area in a 1 to 2 m border round plot; + = <1% of quadrat area; 1 = 1–5%; 2 = 5–25%; 3 = 25–50%; 4 = 50–75%; 5 = 75–100%.

Rock cover (superscripts are BB cover values): n = none; b = bedrock; III = rock size (ht), >0.5 m; II = 0.25–0.5 m; I = 0.05–0.25 m.

Soil depth: 0 = skeletal, <0.05 m; 1 = shallow, 0.05–0.15 m; 01 = mixed skeletal and shallow; 2 = medium, 0.15–1.00 m; 3 = deep, >1.0 m.

Soil moisture: d = dry, well drained; df = dry, flat, hard surface; dr = dry, well drained with runoff.

Slope: 0 = level, 0–3°; 1 = gentle, 4–8°; 2 = moderate, 9–16°; 3 = steep, 17–26°.

TABLE 1.—Phytosociological table of northern Cederberg communities (continued)

Height of tallest stratum (m)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	6	6	3	4	4
Plot size (m^2)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	16	16	16	16	16
Rock cover (superscripts are BB cover values)	n	n	n	n	n	n	b^1 I^2	II^3	II^3 III^3	II^2 III^2	II^3	b^1 I^2	b^2	b^3	b^2	I^4 II^2	b^1	III^2	II^1	n	II^1	b^2
Aspect	-	-	NW	NW	-	-	E	NE	NW	E	E	E	-	-	N	NE	-	SE	SE	S	SW	NW
Soil depth	3	2	3	3	3	2	01	01	1	0	01	01	01	01	1	1	01	2	2	2	2	2
Soil moisture	d	d	d	d	d	d	d	d	d	d	d	d	df	df	df	df	df	dr	dr	dr	dr	dr
Slope	0	0	0	1	0	0	1	3	2	3	3	1	0	0	0	0	0	0	0	0	1	1
Altitude (m)	970	1000	900	900	900	1000	910	980	900	1050	910	910	890	880	880	830	830	900	900	600	920	920
Number of species	22	18	16	15	14	8	6	18	15	13	18	13	9	8	10	14	8	22	14	17	11	12
Relevé	1	5	4	2	3	6	17	13	14	12	15	16	10	11	7	8	9	18	19	22	20	21
Subcommunity 3a																						
Myrsine africana																		1	+	2		
Chironia baccifera																		+	+	+		+
Diospyros glabra																		+	(+)		+	
Phylica oleifolia																+	(+)	(+)		2		
Euclea acutifolia																		+		(+)		
Viscum sp.																		(+)		+		
Rhus undulata																		+	1			
Community 3																						
Olea europaea subsp. *africana*																		5	2	3		2
Maytenus oleoides																		1	(+)	(+)	2	(+)
Heeria argentea																		4	2		3	2
Euclea natalensis																			1	(+)	(+)	4
Ficinia acuminata																		1				+
Protasparagus scandens																				+		+
Protea nitida																		(+)			(+)	
Widespread species																						
Eriocephalus africanus			(+)													2				(+)		
Ehrharta ramosa	+				2		+			+	+		1	1	2	1	+	+			+	+

BB cover values: (+) = not in quadrat, but occurring in surrounding area in a 1 to 2 m border round plot; + = <1% of quadrat area; 1 = 1–5%; 2 = 5–25%; 3 = 25–50%; 4 = 50–75%; 5 = 75–100%.

Rock cover (superscripts are BB cover values): n = none; b = bedrock; III = rock size (ht), >0.5 m; II = 0.25–0.5 m; I = 0.05–0.25 m.

Soil depth: 0 = skeletal, <0.05 m; 1 = shallow, 0.05–0.15 m; 01 = mixed skeletal and shallow; 2 = medium, 0.15–1.00 m; 3 = deep, >1.0 m.

Soil moisture: d = dry, well drained; df = dry, flat, hard surface; dr = dry, well drained with runoff.

Slope: 0 = level, 0–3°; 1 = gentle, 4–8°; 2 = moderate, 9–16°; 3 = steep, 17–26°.

Species not included in the above and found in one relevé only (species name is followed by relevé number, cover abundance value): *Agathosma* sp. 13, +; *A. pubigera/esterhuyseniae* 6, 1; *Arctotis laevis* 1, (+); *A.* sp. 2, 2; *Aspalathus spinosissima* 8, 1; *A. tridentata/quinquefolia* 2, (+); *Aristea singularis* 20, +; *Babiana* sp. 8, 1; *Cassine peragua* 19, (+); *Chrysocoma tenuifolia* 22, (+); *Crassula atropurpurea* 9, +; *Cullumia bisulca* 8, 2; *Dilatris ixioides* 17, (+); *Diosma acmaeophylla* 9, (+); *Diospyros austro-africana* 19, 1; *Dodonaea viscosa* 22, +; *Erica* cf. *articularis* 7, +; *Eriocephalus* sp. 5, 1; *Euclea linearis* 22, 1; *E. undulata* 22, +; *Ficinia cedarbergensis* 15, (+); *F. compar* 5, 1; *Gnidia* sp. 3, 1; *Helichrysum rutilans* 3, +; *Hypodiscus argenteus* 15, 1; *Kiggelaria africana* 19, (+); *Knowltonia capensis* 22, +; *Leucadendron concavum* 1, +; *Lobelia* sp. 14, +; *Macrostylis squarrosa* 7, 2; *Manulea* sp. 3, (+); *Maytenus heterophylla* 22, 1; *Muraltia* sp. 16, +; *Othonna amplexifolia* 22, (+); *Passerina glomerata* 8, 1; *Pelargonium* cf. *crithmoides* 8, +; *P. scabrum* 12, 1; *Pharnaceum* sp. 2, +; *Podocarpus elongatus* 19, 2; *Prismatocarpus* sp. 1, +; *Protasparagus* sp. 18, +; *Protea acaulos* 2, (+); *Restio* sp. (H.T. 00714) 6, 3; *Rhus dissecta* 22, (+); *R. scytophylla* 19, +; *R. tomentosa* 18, 1; *Scabiosa* sp. 3, 1; *Secamone alpinii* 18, (+); *Selago* sp. 13, +; *Serruria aitonii* 2, (+); *Stoebe* sp. 4, +.

RESULTS AND DISCUSSION

There are three major floristic communities (Table 1).

1. *Thamnochortus platypteris–Willdenowia arescens* Community

This community is an open herbland occurring in relevés 1 to 6, and differential species are *Thamnochortus platypteris* and *Willdenowia arescens*. This graminoid guild is further represented by high cover of *Ischyrolepis monanthos* in all relevés except number 6 (which in general has few species); as well as *Ficinia dunensis* in three relevés; and *Ischyrolepis* cf. *curviramis*, *Pentaschistis viscidula*, *Tetraria nigrovaginata* and *Ficinia bulbosa* in two relevés each. *Macrostylis decipiens* and *Rafnia diffusa* are low sprawling bushes (± 300 mm high), together forming an understorey to the restioid stratum in three relevés. *Metalasia agathosmoides* occurs in four relevés, and there is an occasional low presence of further asteraceous species, *Phaenocoma* sp., *Helichrysum* sp., *Elytropappus* sp. and *Ursinia* sp., in some of the relevés.

This community occurs on flat, sandy plains that are fully exposed to sun and wind. The soil is well drained

and deep (>1 m in four relevés, and 0.15–1.00 m in two relevés), and consists of a coarse-textured pale grey sand. There is no rock cover. These factors, together with the hot, dry summers and low annual rainfall create generally very dry conditions.

The widespread and generally high cover of Restionaceae species substantiates the hypothesis that these shallow-rooted species are suited to survive in areas exposed to severe summer drought due to their ability to respond to summer moisture flushes with very rapid photosynthesis (Van der Heyden & Lewis 1989). The presence of both graminoids and Asteraceae concurs with Campbell's (1986) finding that these taxa predominate at the dry end of fynbos gradients. The occasional presence of deeper-rooted proteoids (*Leucadendron concavum*, *Protea acaulos* and *Serruria aitonii*), each occurring in only one relevé, indicates the infrequent availability of sufficient water at deeper levels.

2. *Ischyrolepis sieberi–Ficinia nigrescens* Community

This mid-dense graminoid shrubland has *Ischyrolepis sieberi* and *Ficinia nigrescens* as differential species. There is also a high cover of the shrubs *Stoebe plumosa* and *Cliffortia ruscifolia*, in many of the relevés. This community is spread over two different landscape forms: relevés 7 to 11 occur on level areas with much exposed bedrock, and relevés 12 to 17 occur on well-drained rocky slopes (gentle to steep). Both environments have soils varying in depth from skeletal to shallow, and consisting of dark brown, mixed fine and coarse sand particles. Soil of the bedrock environment type was dry and well drained when examined in mid-summer, but during winter rains the underlying bedrock could cause water accumulation. Soils on the rocky slopes would be well drained during the rainy season.

Subcommunity 2a

This subcommunity of five relevés (7–11) on level bedrock has *Ischyrolepis gaudichaudiana* as sole differential species. *Merxmuellera arundinacea* occurs in two relevés.

Subcommunity 2b

This subcommunity occurs in the six relevés (12–17) of the rocky slopes environment, and has *Cannomois parviflora* and *Anthospermum aethiopicum* as differential species. Other graminoid species such as *Tetraria ustulata*, *T. cuspidata* and *Ficinia deusta* commonly occur as do the shrubby components *Metalasia muricata* and *Struthiola ciliata*. Within sight of each relevé was a mature *Protea nitida* and/or *P. laurifolia* forming a sparse woodland overstorey. The aspect of these slopes is mostly east with the one northwest-facing relevé (No. 14) being near to a seepage area. This, together with the high rock cover, would make it a less dry and less wind-exposed environment than the bedrock one, and could account for the absence of most of this subcommunity's species in the level bedrock environment (relevés 7–11). Furthermore, the rockiness in combination with slope-related drainage patterns would result in a variety of moisture-related microhabitats. This could also be the cause of the greater numbers of species found on the rocky slopes than on the level bedrock. Greater species richness on rocky slopes than on level areas in arid areas has been attributed to these factors (Barbour & Diaz 1973; Olsvig-Whittaker *et al.* 1983).

3. *Olea europaea* subsp. *africana–Maytenus oleoides* Community

The differential species of this closed woodland are *Olea europaea* subsp. *africana* and *Maytenus oleoides*. These, as well as *Heeria argentea* and *Euclea natalensis*, are common to most of the relevés of subcommunities 3a and 3b. This community occurs adjacent to large boulders (4 m and higher) which provide shelter from wind, sun and fire, as well as extra moisture due to shade and water runoff. Soils are of medium depth and the slope level to gentle. This has allowed the development of a closed woodland of trees and shrubs. *Cassine peragua*, a forest tree (in one relevé, No. 19), and *Protasparagus scandens*, common in forest undergrowth, indicate the tendency of succession to low forest. Substantial forest development in this community is undoubtedly limited by the low rainfall of the area, and the fact that the prevalence of fire on the adjacent plains severely limits the forest area.

Subcommunity 3a

The differential species are *Myrsine africana* and *Chironia baccifera* in this subcommunity which occurs in three relevés. These, together with *Diospyros glabra* and *Euclea acutifolia* form an understorey to the closed woodland canopy. The ground layer is poorly developed and consists of sparsely occurring *Chironia baccifera*. These species are mostly excluded from the drier subcommunity 3b.

Subcommunity 3b

Indigofera frutescens and *Pentaschistis* sp. are differential species. This subcommunity represents a drier gradient of Community 3 since the relevés in which it occurs (20 and 21) have more sunny aspects (SW and NW) than the other relevés which face S or SE. This could account for the absence of most of these species in the former subcommunity, and *vice versa*. These two subcommunities appear to reflect moisture-related microhabitat differences within the woodland community.

CONCLUSIONS

A satisfactory phytosociological table was produced using small plot sizes. We obtained a neat phytosociological table, with well-defined communities. This in itself indicates the existence of small-scale pattern in fynbos. The survey was quickly (five days field work) and easily achieved. The efficiency of this method would allow comparatively easy monitoring and quick establishment of plant-environmental relationships.

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