Time

1982 quarterly (Jun, Aug, Nov, Jan)

1983/84 seasonal surveys (May, Sep, Jan, May)

8751 8751

Veld dynamics and utilisation of vegetation by herbivores on the Ganias Flats, Skeleton Coast Park, SWA/Namibia

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ABSTRACT

Veld surveys and game counts were conducted quarterly during 1982 and seasonally during 1983/84 on a typical pro-Namib plain on the eastern boundary of the Skeleton Coast Park. A strong correlation between veld condition and rainfall was evident. The perennial vegetation of the river washes remained greener than the annual grasses on the gravel plains. Most game migrated eastwards during the rainy season in response to improved inland pastures, brought about by the east-west rainfall gradient of the Namib Desert. Game returned to the study site during the drier months, utilising chiefly the vegetation of the river washes. Very low game numbers were recorded and herbivores utilised only a small fraction of the available and apparentely suitable forage.

INTRODUCTION

The aim of this study was to establish the relationship between fluctuations in veld conditions and the seasonal movements of large herbivores on a typical pro-Namib plain along the eastern boundary of the Skeleton Coast Park.

The climate of the Namib Desert is characterised by low average temperatures, high humidity and the presence of fog with an increase in temperature and a decrease in humidity eastwards from the coast (Seely 1978a). Rain is regarded as the single most important factor in desert and semi-desert ecosystems (Seely & Stuart 1976; Viljoen 1980), and a direct correlation between rainfall and vegetation cover has been observed in both the central Namib (Seely 1978b; Nel *et al.* 1985) and in Kaokoland (Viljoen 1980).

After good rains fell in the northern Namib Desert and western Kaokoland during March–April 1982, the vegetation cover on the pro-Namib plains changed dramatically, providing an ideal habitat for herbivores, birds and insects. Previous ground-based game counts and aerial surveys indicate that game densities on these plains show noticeable seasonable and annual fluctuations (Viljoen 1980, 1982a, 1982b; Skeleton Coast Park unpublished data). At present the boundaries of the Skeleton Coast Park are unfenced and no pastoral or game management is practised in this area.

SITE DESCRIPTION

The study site, situated on the Ganias Flats, was 55 km long and 5 km wide. This area lies between the Hoanib and Hoarusib Rivers and is bisected by the eastern boundary of the Skeleton Coast Park (Figure 1). To the west of the Ganias Flats lie the sand dunes of the northern Namib Desert and to the east, plains extend until the mountainous regions of the Kaokoland escarpment. The study site falls within the western part of the pro-Namib and is characterised by sparsely vegetated plains and numerous river washes. Although rain may be absent for several years, the area receives an average rainfall of 30–100 mm per annum (Viljoen 1980). The Aridosols of the plains are described as being mostly unconsolidated and comprised chiefly of stone, gravel and fine sand while the Entisols of the river washes, where a measure of soil differentiation occurs, have a higher degree of organic material (Viljoen 1980).

METHODS

Two habitat types, namely gravel plains and river washes, were recognised. These habitats were surveyed

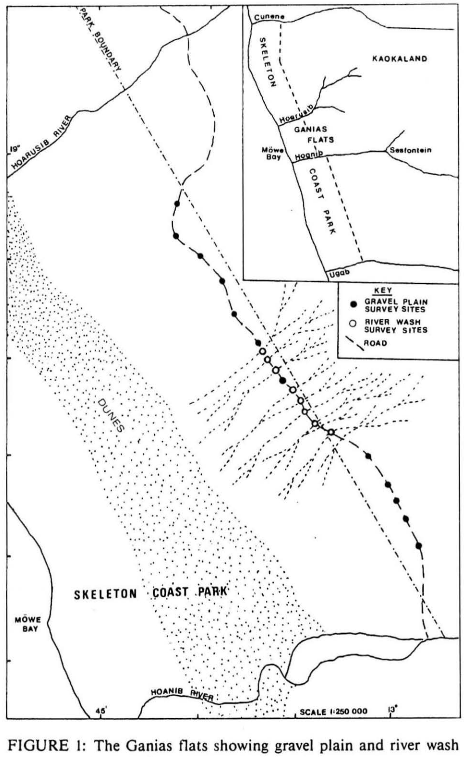

FIGURE 1: The Ganias flats showing gravel plain and river wash survey sites.

separately using the step point method, a modification of the wheelpoint method described by Tidmarsh and Havenga (1955).

Twelve sites on the gravel plains, approximately 3 km apart, and eight river washes, were surveyed on a quarterly basis during 1982, and on a seasonal basis during 1983 and 1984. Three seasons were recognised as follows: a wet season (January–April), a cool dry season (May–August) and a hot dry season (September–December).

At each site, a metal rod (diameter 5 mm) was plunged vertically into the ground every 2 m. For each plunge the following information was recorded during the 1982 surveys:

1. the plant species nearest to the rod, and
2. in the case of a strike, whether or not it was a basal hit.

During the seasonal surveys of 1983–84 the following information was recorded for each plunge:

1. the plant species nearest to the rod,
2. in the case of a strike whether it was a crown or basal hit,
3. the estimated precentage green material of that plant, and
4. the estimated percentage utilisation of that plant by mammalian herbivores and insects.

A total of 2 448 points for the gravel plains and 2 128 points for the river washes were recorded during each survey.

Seasonal ground-based game counts were conducted along the main route through the study area and attempts were made to record direct utilisation of plants by herbivores. As rain gauges erected on the Ganias flats were repeatedly knocked over and destroyed by hyaenas, rainfall data were obtained from the weather stations at Möwe Bay and Sesfontein. (Figure 1).

The following formulae were used to obtain the values mentioned in the Tables and Figures.

a. The Index of Greenness (I_G) for species x $= I \times A$
where I = percentage green material of species x $\div$ 100
A = the relative abundance of species x.

b. The Index of utilisation of species x (I_U) $= U \times A$
where U = percentage utilisation of species x $\div$ 100
A = relative abundance of species x.

c. The Palatability Factor (B) of species x $= \frac{E \times U}{S}$
where U = percentage of utilisation of species x $\div$ 100
S = the total number of species x scored
E = the number of species x showing signs of herebivore utilisation.

d. The Attractance Value (AV) of species x = B × I.

RESULTS

Rainfall data from Möwe Bay and Sesfontein and the indices of greenness for both habitat types on the Ganias Flats are presented in Figure 2, together with game count data gathered from the study area between June 1982 and May 1984. The seasonal fluctuations in the percentage crown and percentage basal cover on the Ganias Flats during the duration of the study are depicted in Figure 3 and the indices of herbivore utilisation for the river washes and gravel plains are illustrated in Figure 4. The relative abundance and percentage basal cover of the most common plant species encountered are given in Table 1 and 2. The index of greenness, index of utilisation by mammalian herbivores and the palatability factors of plants utilised between January 1983 and May 1984 are given in Tables 3 and 4. The Attractance values of all plants utilized are summarised in Table 5. The index of utilisation of plants showing damage by insects are summarised in Table 6 and a species breakdown of game count figures is given in Table 7.

DISCUSSION

Rainfall

The difference in rainfall received at Möwe Bay and at Sesfontein during the period 1982–1984 (Figure 2),

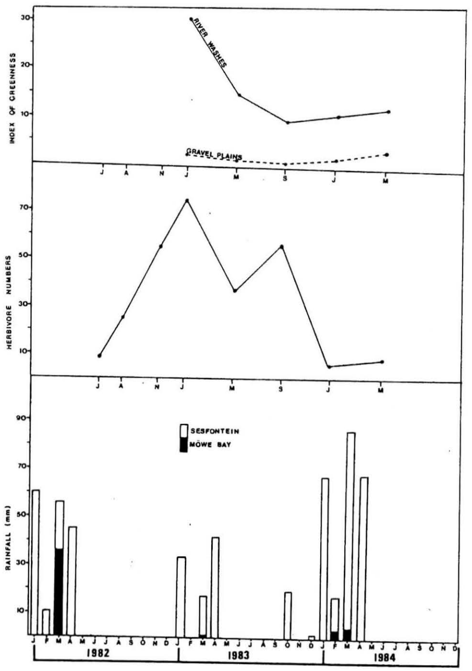

FIGURE 2: Rainfall data, fluctuating herbivore numbers and the index of greenness of vegetation on the Ganias flats.

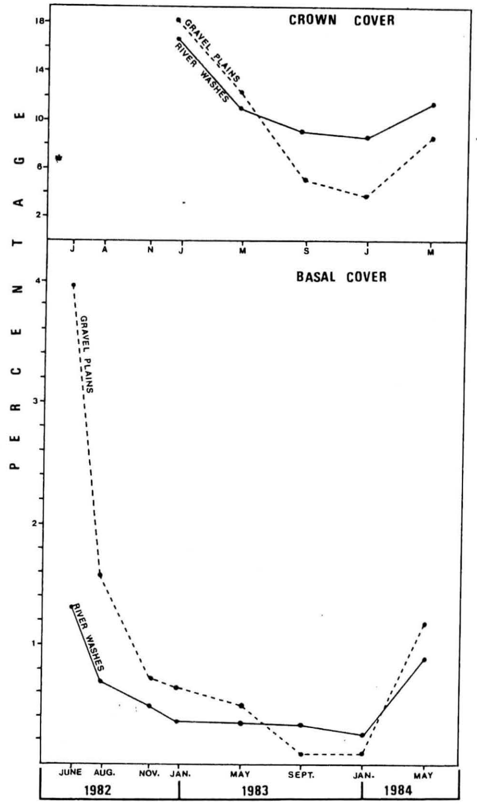

FIGURE 3: Fluctuations in the vegetation cover on the Ganias flats between 1982 and 1984.

clearly illustrates the east-west rainfall gradient which is typical of the Namib Desert. Rainfall during this period was highly sporadic (Figure 2). In 1982 the study site and surrounding areas received the first heavy showers in years (pers. obs.). Although Sesfontein received 73,5 mm of rain during the following year, almost no rain fell at the coast and all indications suggest that <1 mm fell on the Ganias Flats. In 1984 more substantial rains fell over the entire area with Sesfontein receiving 220,7 mm while 9 mm fell at the coast. It is therefore assumed that a minimum of 10 mm fell on the Ganias Flats during this period.

Species composition and abundance

On the Ganias Flats, the river washes support a far greater species diversity and a highter proportion of perrenial plants than the gravel plains which are comprised mostly of ephemeral and annual grasses (Tables 1 & 2). Most species remained present during the dry period of 1983, although significant changes in individual species abundance were recorded between 1982 and 1984 (Tables 1 and 2). On the gravel plains, *S. uniplumis* var. *intermedia* and *S. hochstetterana* remained dominant and co-dominant throughout the study period, while *S. hochstetterana* and *G. spinosa* remained the two most common river wash species (Tables 1 & 2).

Crown and basal cover

The vegetation cover on the Ganias Flats varies seasonally and annually in response to environmental factors such as rainfall fluctuations and drought. The light showers which fell during March 1983 were not sufficient to bring about any change in the gradual decline in vegetation cover, which improved only after the more substantial 1984 rains (Figure 3). Using basal cover as a veld condition indicator it was evident that during the course of this study the gravel plains, with their higher proportions of annual grass species, reacted more drastically to environmental factors than did the river washes (Figure 3). During the dry months of 1983 the basal cover on the gravel plains was low to virtually non-existent in places. However, the river washes with their higher perennial component, maintained a relatively high, albeit fluctuating, vegetation cover throughout all seasons. A similar situation was noted on the central Namib plains during times of drought (Nel *et al.* 1985).

On the Ganias Flats annuals such as *S. uniplumis* var.

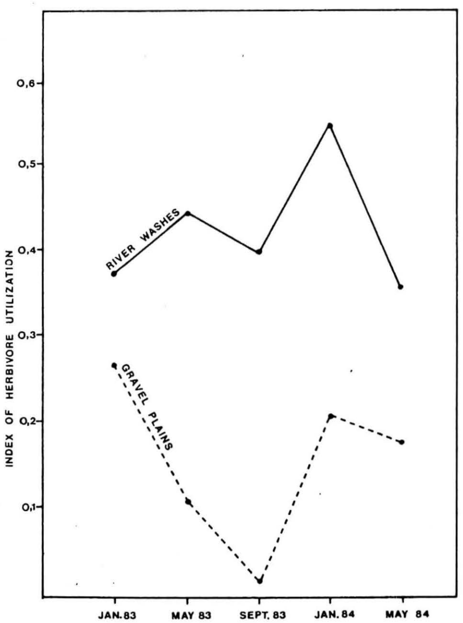

FIGURE 4: The indices of vegetation utilisation by herbivores on the gravel plains and river washes of the Ganias flats between 1983 and 1984.

...species encountered on the gravel plains of the Ganias Flats.

	JUNE 1982		AUG. 1982		NOV. 1982		JAN. 1983		MAY 1983		SEPT. 1983		JAN. 1984		MAY 1984	
	A	B_c	A	B_c	A	B_c	A	B_c	A	B_c	A	B_c	A	B_c	A	B_c
Stipagrostis hochstetterana	14,30	0,51	19,57	0,45	15,77	0,12	11,19	0,16	20,79	0,12	19,44	0,04	17,03	0,12	20,95	0,29
S. uniplumis var. *intermedia*	45,60	1,76	46,36	0,49	49,31	0,25	42,97		42,65	0,08	41,70		47,63		53,63	0,65
S. subacaulis	12,00	0,74	11,93	0,20	12,87	0,25	17,77	0,16	14,09	0,12	14,80	0,04	15,24	0,04	2,98	0,08
Trianthema triquetra	12,90	0,32	12,58	0,25	12,25	0,04	18,38	0,08	13,15	0,04	14,70		10,74		12,76	
Lotononis platycarpos	5,70	0,46	1,80	–	1,88		3,10	0,04	2,21		3,60		2,45		0,45	
Zygophyllum simplex	4,13	0,13	2,78	0,08	2,82		2,12	0,08	1,47		0,53		0,37		0,78	
Sesuvium sesuvioides	1,90	0,13	2,29	0,08	2,33	0,04	2,53		3,55		3,30		2,94		4,25	
Kohautia lasiocarpa	1,20		1,31		0,82		0,45		0,29		0,04		–		0,12	
Tephrosia dregeana	0,60		0.37		0,29		0,33		0,49		0,60		0,25		0,41	
Heliotropium oliveranum	0,09		0,04		0,08		0,12		0,08		0,04		0,20		0,12	
Euphorbia phylloclada	0,09		0,12		0,33		0,12		0,16		0,40		–		–	
Helichrysum gariepinum	–		0,25		0,33		0,61		0,57		0,40		0,86		0,61	
Geigeria spinosa	0,05		0,20		0,29	0,04	0,12		0,16		0,66		0,65		0,45	
Indigophera spp.	0,23		–		0,12		0,08		–		–		–		–	
Cleome foliosa	–		–		–		0,04		0,20		–		0,45		1,02	
Osteospermum microcarpum	–		–		–		–		–		0,12		–		0,49	
Adenolobus pechuelli	–		–		0,12		–		0,08		0,12		0,65		0,41	
Petalidium angustitibum	0,05		–		0,29		–		0,04		0,16		0,53		0,41	

TABLE 2: The relative abundance (A) and the percentage basal cover (Bc) of the most common species encountered in the river washes of the Ganias Flats.

	JUNE 1982		AUG. 1982		NOV. 1982		JAN. 1983		MAY 1983		SEPT. 1983		JAN. 1984		MAY 1984	
	A	B_c	A	B_c	A	B_c	A	B_c	A	B_c	A	B_c	A	B_c	A	B_c
Stipagrostis hochstetterana	12,47	0,10	36,1	0,23	20,39	0,09	19,55	0,05	25,05	0,28	23,92	0,09	24,01		31,02	0,14
S. uniplumis var. *intermedia*	35,29	0,39	8,27	0,14	22,18	0,09	16,02		7,89		5,92		7,00		3,10	
S. namaquensis	–		–		–		0,19		1,13		0,47		0,80		2,30	
Astenatherum spp.	–		1,88		2,4	0,05	0,89		1,55	0,05	0,70		0,89		1,03	
Petalidium spp.	–		2,3		1,27	0,05	1,92		2,16		1,69	0,05	1,03		2,68	0,05
P. angustitibum	0,24		2,16		0,8		0,47		2,40		2,07	0,05	2,02		3,24	0,05
Geigeria spinosa	13,29	0,19	10,67	0,14	14,14	0,05	16,45	0,05	12,95		18,52	0,05	19,92	0,18	15,65	0,23
Tephrosia dregeana	2,94		6,3		7,05	0,05	9,49		6,11	0,05	5,73		4,61		3,76	0,05
Merremia spp.	2,6	0,14	1,08	0,05	2,02	0,05	2,26	0,05	2,54		3,05		2,82		3,57	
Cleome foliosa	–		0,05		0,61		–		–		0,23		1,27		2,44	
Osteospermum mocrocarpum	3,76		5,6		4,62		6,06	0,05	9,92		10,62	0,05	8,65		7,71	
Helichrysum gariepinum	1,03		4,09		5,55		6,11	0,05	7,66	0,05	6,34		7,42		4,79	
Kohautia lasiocarpa	15,12	0,14	7,19		6,02	0,05	4,23		3,81		3,90		0,99		2,02	
Heliotropium oliveranum	0,29		0,8		0,23		0,23		0,09		0,09		0,09		–	
Zygphyllum stapfii	2,36	0,10	3,52	0,09	4,23		4,51	0,05	5,36		5,92	0,05	6,91	0,09	6,53	0,19
Z. simplex	2,31	0,10	0,28		0,66		0,14		0,05		–		–		–	
Sesuvium sesuvioides	1,25		1,27		1,32		1,23	0,05	1,03		1,13		0,89		2,02	
Lebeckia spp.	1,73		3,43		3,24		6,60		10,25		7,71		8,08		6,63	0,05
Lotononis platycarpos	1,25	0,05	0,19		–		0,52		0,19		0,14		0,23		–	
Salsola spp.	0,19		0,19		0,09		0,33		0,19		0,09		0,38		0,47	
Trianthema triquetra	1,25		0,75		0,56		0,23		0,19		0,09		0,85		0,14	
Tricholeana monachne	–		–		–		0,23		0,23		0,38		0,09		–	
Hermsteadtia spp.	–		0,61		0,52		0,14		0,28		0,47		–		0,19	
Euphorbia phylloclada	0,72		0,52		0,52		0,70		0,33		0,33		0,23		0,09	
E. damarana	–		0,32		0,05		–		0,23		0,14		0,23		0,23	
Tephrosia oxygona	–		–		–		0,09		0,09		0,05		0,23		0,09	

TABLE 3: The index of greenness (I_G), index of utilization (I_U), and the palatability factors (B) of utilised plants on the gravel plains of the Ganias Flats.

	JAN. 1983			MAY 1983			SEPT. 1983			JAN. 1984			MAY 1984		
	I_G	I_U	B	I_G	I_U	B	I_G	I_U	B	I_G	I_U	B	I_G	I_U	B
Sitpagrostis hochstetterana	0,8191	0,1925	$5,6 \times 10^{-4}$	0,1601	0,0894	$5,1 \times 10^{-5}$	0,0486	0,0214	$2,3 \times 10^{-6}$	0,4668	0,1238	$1,2 \times 10^{-5}$	1,7368	–	–
S. uniplumis var. *intermedia*	0,0283	0,0748	$4,9 \times 10^{-6}$	0,0043	–	–	–	–	–	–	–	–	2,5474	–	–
S. subacaulis	0,0320	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Trianthema triquetra	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lotononis platycarpos	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Zygophyllum simplex	1,1783	–	–	0,4921	–	–	0,0428	–	–	0,1398	–	–	0,0720	–	–
Sesuvium sesuvioides	0,1429	–	–	0,0185	–	–	–	–	–	–	–	–	–	–	–
Kohautia lasiocarpa	–	–	–	–	–	–	–	–	–	–	–	–	0,0280	–	–
Tephrosia dregeana	0,1939	–	–	0,0204	–	–	0,0214	–	–	–	–	–	0,0123	–	–
Heliotropium oliveranum	–	–	–	–	–	–	–	–	–	–	–	–	0,0720	–	–
Euphorbia phylloclada	0,0080	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Helichrysum gariepinum	–	–	–	–	–	–	–	–	–	–	–	–	0,0320	–	–
Geigeria spinosa	–	–	–	0,0040	–	–	–	–	–	–	–	–	–	–	–
Indigophera spp.	0,0400	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cleome foliosa	0,0400	–	–	0,0640	0,0280	$5,6 \times 10^{-2}$	–	–	–	0,1800	0,0736	$5,9 \times 10^{-2}$	0,4202	0,1795	$7,0 \times 10^{-2}$
Osteospermum microcarpum	–	–	–	–	–	–	–	–	–	–	–	–	0,0571	–	–
Adenolobus pechuelli	–	–	–	0,0040	–	–	0,0100	–	–	0,0650	0,0244	$2,3 \times 10^{-3}$	0,0615	–	–
Petalidium angustitibum	–	–	–	0,0240	–	–	0,0640	–	–	0,1957	–	–	0,0246	–	–

TABLE 4: The index of greenness (I_G), index of utilization (I_U), and the palatability factors (B) of utilised plants in the river washes of the Ganias Flats.

	JAN. 1983			MAY 1983			SEPT. 1983			JAN. 1984			MAY 1984		
	I_G	I_U	B	I_G	I_U	B	I_G	I_U	B	I_G	I_U	B	I_G	I_U	B
Sitpagrostis hochstetterana	3,2355	0,0743	$5,5 \times 10^{-5}$	0,6087	0,1227	$3,7 \times 10^{-5}$	0,0933	0,0383	$9,4 \times 10^{-6}$	0,2641	0,0024	$1,9 \times 10^{-7}$	0,2729	0,0062	$3,0 \times 10^{-5}$
S. uniplumis var. *intermedia*	0,4966	–	–	–	–	–	–	–	–	–	–	–	0,0093	–	–
S. namaquensis	0,0855	–	–	0,2351	–	–	0,0611	0,0141	$3,0 \times 10^{-3}$	–	–	–	0,4831	–	–
Astenatherum spp.	0,3466	–	–	0,0705	–	–	0,0420	0,1260	$4,8 \times 10^{-2}$	–	–	–	0,1591	–	–
Petalidium spp.	1,3496	–	–	0,7983	–	–	–	–	–	0,0093	–	–	0,0469	–	–
P. angustitibum	0,3760	–	–	1,4729	–	–	1,2660	–	–	1,0476	–	–	1,3430	–	–
Geigeria sponosa	6,8004	–	–	0,9509	–	–	0,7223	–	–	0,7509	–	–	0,1127	–	–
Tephrosia dregeana	2,3933	0,0522	$5,4 \times 10^{-5}$	0,3287	–	–	0,3266	–	–	0,0796	–	–	0,0094	–	–
Merremia spp.	1,2905	–	–	1,3054	–	–	1,0275	–	–	1,3418	0,0564	$1,0 \times 10^{-3}$	1,8778	–	–
Cleome foliosa	0,6768	0,1786	$8,6 \times 10^{-2}$	0,8782	0,3146	$1,4 \times 10^{-1}$	0,1150	0,0230	$2,0 \times 10^{-2}$	0,6444	0,4652	$2,6 \times 10^{-1}$	1m1956	0,3416	$5,6 \times 10^{-2}$
Osteospermum microcarpum	2,5276	–	–	0,9563	–	–	0,5639	0,2071	$1,1 \times 10^{-3}$	0,3034	–	–	0,0332	–	–
Helichrysum gariepinum	0,2322	–	–	–	–	–	0,1395	–	–	0,0890	–	–	0,0422	–	–
Kohautia lasiocarpa	0,6087	0,0423	$2,2 \times 10^{-4}$	0,1318	–	–	0,0468	–	–	0,0236	–	–	0,8219	–	–
Heliotropium oliveranum	0,0644	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Zygphyllum stapfii	3,0079	–	–	4,3019	–	–	3,4389	–	–	3,6478	–	–	3,4739	0,0091	$2,0 \times 10^{-4}$
Z. simplex	0,1200	–	–	0,0300	–	–	–	–	–	–	–	–	–	–	–
Sesuvium sesuvioides	0,1561	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lebeckia spp.	4,8371	–	–	3,9800	–	–	3,5774	–	–	5,1672	–	–	3,3099	–	–
Lotononis platycarpos	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Salsola spp.	0,2217	–	–	0,1330	–	–	0,0270	–	–	0,2423	–	–	0,1974	–	–
Trianthema triquetra	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tricholeana monachne	0,0376	–	–	0,0920	–	–	–	–	–	–	–	–	–	–	–
Hermsteadtia spp.	0,0735	–	–	0,1073	–	–	0,0564	0,0188	$4,0 \times 10^{-3}$	–	–	–	0,1203	–	–
Euphorbia phylloclada	0,2707	–	–	–	–	–	0,1082	–	–	0,0736	–	–	0,0383	–	–
E. damarana	–	–	–	0,0552	–	–	0,0323	–	–	–	–	–	0,1794	–	–
Tephrosia oxygona	0,0630	0,0816	$2,0 \times 10^{-1}$	–	–	–	–	–	–	–	–	–	0,0405	–	–

TABLE 5: The attractance values of utilized plants on both gravel plains (GP) and river washes (RW) on the Ganias Flats.

	JAN. 1983		MAY 1983		SEPT. 1983		JAN. 1984		MAY 1984	
	GP	RW	GP	RW	GP	RW	GP	RW	GP	RW
Stipagrostis hochstetterana	$4,6\times10^{-4}$	$1,8\times10^{-4}$	$8,0\times10^{-6}$	$2,3\times10^{-5}$	$1,0\times10^{-7}$	8×10^{-7}	$5,7\times10^{-6}$	$5,0\times10^{-7}$	–	8×10^{-7}
S. uniplumis var. *intermedia*	$1,0\times10^{-7}$	–	–	–	–	–	–	–	–	–
S. namaquensis	–	–	–	–	–	$1,8\times10^{-4}$	–	–	–	–
Kohautia lasiocarpa	–	$1,4\times10^{-4}$	–	–	–	–	–	–	–	–
Tephrosia dregeana	–	$1,6\times10^{-4}$	–	–	–	–	–	–	–	–
T. oxygona	–	$1,3\times10^{-2}$	–	–	–	–	–	–	–	–
Cleome foliosa	–	$5,8\times10^{-2}$	$3,6\times10^{-3}$	$1,2\times10^{-1}$	–	$2,3\times10^{-3}$	$1,1\times10^{-2}$	$1,6\times10^{-1}$	$3,0\times10^{-2}$	$6,8\times10^{-2}$
Astenatherum spp.	–	–	–	–	–	$2,0\times10^{-3}$	–	–	–	–
Osteospermum microcarpum	–	–	–	–	–	$6,3\times10^{-4}$	–	–	–	–
Hermsteadtia spp.	–	–	–	–	–	$2,3\times10^{-4}$	–	–	–	–
Adenolobus pechuelli	–	–	–	–	–	–	$1,5\times10^{-4}$	–	–	–
Merremia spp.	–	–	–	–	–	–	–	$1,3\times10^{-3}$	–	–
Zygophyllum stapfii	–	–	–	–	–	–	–	–	–	7×10^{-4}

TABLE 6: The index of utilization of plants displaying defoliation by insects on both the gravel plains (GP) and the river washes (RW) of the Ganias Flats.

	JAN. 1983		MAY 1983		SEPT. 1983		JAN. 1984		MAY 1984	
	GP	RW	GP	RW	GP	RW	GP	RW	GP	RW
Stipagrostis hochstetterana	0,05	0,05	0,3	0,18	0,36	0,08	1,05	–	0,40	0,07
S. uniplumis var. *intermedia*	0,009	–	0,03	–	–	–	–	–	–	–
s. namaquensis	–	–	–	–	–	–	–	–	–	0,06
Zygophyllum simplex	0,053	–	0,02	–	–	–	–	–	–	–
Lebeckia spp.	–	–	–	0,17	–	–	–	–	–	0,10
Astenatherum spp.	–	–	–	0,03	–	–	–	–	–	–

TABLE 7: Seasonal variations in game numbers on the Ganias Flats between June 1982 and May 1984.

Date	Springbok	Gemsbok	Ostrich	Total
1982				
June	1	8	1	10
August	1	19	5	25
November	49	0	4	53
1983				
January	65	10	0	75
May	7	0	30	37
September	1	3	51	55
1984				
January	1	2	4	7
May	2	7	0	9

intermedia, S. subacaulis, T. triquetra and *L. platycarpos* appear particularly vulnerable to drought, showing noticeable basal cover decline (Tables 1 & 2). Hardier perennial species such as *S. hochstetterana* were more resilient, displaying more gradual changes to environmental factors. Perennial xerophytic species, such as *Z. stapfii* are the most drought resistent plants in this area, maintaining their basal cover and succulent foilage even throughout the driest periods.

The percentage green material

During this study, the vegetation in the river washes remained consistently greener than that on the surrounding gravel plains (Figure 2). This is attributable to the higher perennial component in the river wash habitat where several species maintained a relatively high index of greenness even during the driest months (Table 4). The overall index of greenness did not improve after the light 1983 rains (Figure 2) although in the river washes *Merremia* spp. and *C. foliosa* showed a slight increase in percentage green material.

Even though no precipitation occurred, both habitats became noticeably greener after September 1983 (Figure 2) when several species displayed an increase in their percentage green material (Tables 3 & 4). This green flush was probably a response by the perennials to the rising summer temperatures.

The 1984 showers, estimated to have been at least 10 mm on the Ganias Flats, brought about a slight recovery of veld conditions (Figure 2). This recovery was most noticeable on the gravel plains where grass species, *viz. S. uniplumis* var. *intermedia* and *S. subacaulis,* showed an increase in percentage green material from zero to 5% and 13% respectively. In addition, several other species became greener (Table 3).

Game numbers, migration and veld utilisation

Viljoen (1980) found that the northern pro-Namib areas were only well utilised by large herbivores during the rainy season, with the majority of game species moving east during the drier months. Similar observations were made in the Namib Park in the central Namib Desert where Nel *et al.* (1985) report that the seasonal migration of game was west to east and back. the westward movement occurred with the onset of rain and the extended eastward migration was made impossible by fences. This situation has resulted in local game overpopulations and overgrazing in areas of the Namib Park (Nel *et al.* 1985).

An inverse trend occurs in the northwestern pro-Namib areas where game numbers on the Ganias Flats are at their lowest directly after the rains, and increase when the area is at its driest (Figure 2). Similarly, there was an increase in the relative herbivore utilisation of the vegetation on both the gravel plains and river washes during the dry summer months preceding the 1984 rains (Figure 4). This occured even though both crown and basal cover and the index of greenness were at their lowest (Figures 2 & 3). The drop in herbivore numbers observed during May 1983 and January 1984 and the subsequent decrease in herbivore utilisation of vegetation on the Ganias Flats could be as a result of the east-west rainfall gradient typical of the Namib Desert. It appears that most game migrated from west to east immediately after earlier rains which had fallen in the interior promised better pastures inland. This migration took place even though good rains had fallen on the western pro-Namib plains. The return migration from east to west is probably stimulated by desiccation, due to higher temperatures and hot winds, of inland pastures. Thus, it is during the drought periods that the western pro-Namib areas, particularly the river wash habitats, serve as an important food reservoir for large herbivores.

In the pro-Namib a north-south migration, encompassing a movement of game from the plains into the episodic riverine areas, has also been observed. Gemsbok *Oryx gazella* in particular are seen in greater numbers in the Hoanib River during the early summer months where they are believed to feed extensively off *Acacia albida* pods and to seek shelter during the hot, dry season.

During the course of this study the vegetation in the river washes showed consistently higher herbivore utilisation than did the surrounding gravel plains (Figure 4). The results depicted in Tables 3 and 4 show that *S. hochstetterana* and *C. foliosa* were the only two species consistently utilised by herbivores while hardy perennials such as *S. namaquensis, A. pechuelli, Astenatherum* spp., *O. microcarpum* and *Merremia* spp. provided valuable forage during the drier periods of 1983. *C. foliosa* was the most palatable species encountered and, although relatively scarce on both the gravel plains and in the river, washes, showed consistently high attractance values (Table 5.).

Springbok *Antidorcas marsupialis* were regularly seen in the river washes feeding off *C. foliosa, T. oxygona, T. dregeana, Merremia* spp. and *Z. stapfii.* Gemsbok were not seen feeding, but their preference for the gravel plains as apposed to the river washes suggests a diet comprising mostly of grass. In particular, *S. hochstetterana* regularly showed characteristic signs of gemsbok utilisation as described by Van Zyl (1965). Although utilisation of vegetation by ostrich *Struthio camelus* was difficult to detect and quantify, these birds were often seen feeding on *Z. simplex* and the flowers of *O. microcarpum* in the river washes. Utilisation of vegetation by rodents, which is believed to be substantial in other areas (Curtis & Perrin 1979), was not quantified during this study although Cape hares *Lepus capensis* were often encountered in the river washes. Signs of vegetation utilisation by this species as described by Smithers (1983), were noted amongst the larger perennial grasses such as *Astenatherum* spp. and *S. namaquensis,* particularly where roots or new growth had been exposed. Smaller rodents were infrequently observed but signs of their presence were evident in the river washes where plants such as *Geigeria spinosa* appreared to have been utilised.

Game numbers in Kaokoland and the Skeleton Coast Park have decreased dramatically since the early 1970's due to competition with domestic stock, severe droughts and poaching (Viljoen 1980; 1982 a; 1982 b). Table 7 shows the low density of game counted in the study area between 1982 and 1984 and Tables 3 and 4 show that minimal utilisation of the veld oncurred during the period. Thus, it appears that preferred forage species were selected by herbivores while the more abundant species where largely ignored. Of some of the key pasture species viz. *S. uniplumis* var. *intermedia, S. subacaulis* and *G. spinosa,* only *S. uniplumis* var. *intermedia* displayed signs of game utilisation (Table 3). During the dry months although still abundant, the nutritional value of this species declined considerably and showed no signs of further utilisation.

Termites and wind play an important role in vegetation defoliation (Nel *et al.* 1985). All but obvious insect utilisation was difficult to detect and quantify. *S. hochstetterana* was the only species that showed noticeable signs of insect defoliation on a regular basis (Table 6). The grasses on the gravel plains showed a higher degree of insect utilisation than did the river wash plant species and overall utilisation appears to have been at its highest during the hot, dry season ending in January 1984.

CONCLUSION

Between 1982 and 1984 rainfall occurred sporadically over the northern pro-Namib and the vegetation cover on the Ganias Flats declined significantly in the absence of annual showers. In particular the gravel plains, with their high proportion of annual grasses became largely devoid of vegetation during the dry months.

An increase in game numbers and subsequent veld utilisation occured on the Ganias Flats during periods of drought when the river washes, which were characteristically greener and more substantially vegetated than the surrounding gravel plains, supplied herbivores with valuable forage. In view of the low game numbers encountered and accounts of substantial game herds occurring in the past, it appears that the northwestern pro-Namib plains are understocked at present and only a small fraction of the suitable forage is utilised.

Provided seasonal game movements between the

Skeleton Coast Park and the interior remain unrestricted, the northwestern pro-Namib areas should continue to act as an important food reservoir for the game of this region, particularly during times of drought. Thus, any attempts to erect a game-proof fence along the eastern boundary of the Skeleton Coast Park should be avoided in the interests of the long term ecological future of this region.

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Branching patterns in *Aloe dichotoma* – is *A. ramosissima* a separate species?

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ABSTRACT

The proposal that *Aloe ramosissima* be reduced to varietal rank under *A. dichotoma,* based on a low incidence of *ramosissima*-type branching pattern (less than 100 mm above ground level) in most *A. dichotoma* populations, is invalid, as the *ramosissima*-type branching pattern has a different cause in the two taxa. Branching patterns in *A. dichotoma* populations show a majority of first branchings at between 1.5 m and 2.5 m above ground. Branching below 1 m in *A. dichotoma* populations is caused by ungulate destruction of the apical meristem, whereas in *A. ramosissima* branching below 1 m is initiated by spontaneous meristematic division.

INTRODUCTION

Aloe dichotoma Masson is one of three species in the section *Dracoaloe* Berger of the genus *Aloe.* The Dracoaloe are characterized by dichotomous branching and cylindric-ventricose, fleshy, yellow flowers about 33 mm long (Reynolds 1982). The three species (*A. dichotoma, A. ramosissima* Pillans and *A. pillansii* L. Guthrie) are differentiated by their height and degree of branching, leaf size, and orientation of inflorescences. All three species are confined to dry, rocky areas: *Aloe dichotoma* is the most widespread, occurring in the northwestern Cape Province, South Africa, and southern South West Africa/Namibia (its southern distributional range), and isolated populations at Brandberg (Jankowitz 1977; Reynolds 1982). Both *A. ramosissima* and *A. pillansii* are confined to a few populations in the northern Richtersveld and near Rosh Pinah in the Luderitz magisterial district of South West Africa/Namibia.

Aloe dichotoma grows to 9 m tall, with a trunk of about 1 m diameter, and has pronounced dichotomous branching above this height. The leaves are 250–350 mm long and 50 mm broad at the base. The inflorescence is a branched panicle, up to 300 mm long, and usually branched into three (occ. 4 or 5) racemes. *Aloe ramosissima* differs in being shorter, up to 3 m tall, and in branching at a height of less than 600 mm. It also has smaller leaves, 150–200 mm long and about 22 mm broad at base, thinner branches and smaller rosettes of leaves at the branch tips. However, it is indistinguishable from *A. dichotoma* on inflorescence and floral characters (Reynolds 1982), and on microscopic leaf characters (Glen & Hardy 1987).

Recently, Glen & Hardy (1987) proposed that *Aloe ramosissima* be reduced to varietal rank under *A. dichotoma* Mason as *A. dichotoma* Mill. Although based on microscopic and macroscopic data, their major argument is that the branching from near ground level, the major diagnostic feature of *A. ramosissima,* occurs at low levels in all populations of *A. dichotoma* (H.F. Glen pers. comm.).

The aims of this study were to investigate the levels of branching in *A. dichotoma* in its southern distributional range and to determine whether the pattern of branching differed among populations and between *A. dichotoma* and *A. ramosissima.*

METHODS

Eleven populations of *A. dichotoma* Masson were sampled in southern South West Africa/Namibia and the northwestern Cape (Figure 1) during July 1987. Sampling was undertaken on a minimum of 100 live

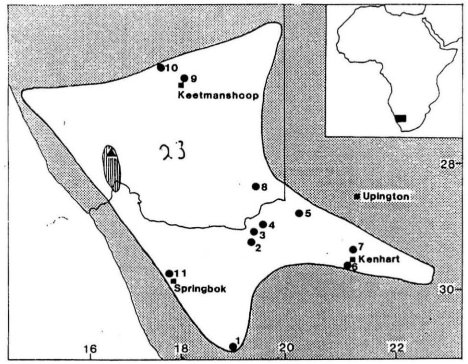

FIGURE 1: Location of populations of *Aloe dichotoma* (●) and *A. ramosissima* (▲) investigated in this study. Locality names are given in Table 1. The unshaded area denotes the southern distributional range of *A. dichotoma* based on herbarium records and Jankowitz (1977). Similary, the hatched area denotes the distributional range of *A. ramosissima.*