DINTERIA NO. 23:102-115 - WINDHOEK, NAMIBIA - OCTOBER 1992

Loss of genetic diversity due to veld degradation - a case study in the northern Kalahari, Grootfontein district

B.J. Strohbach*

Introduction

In the fields of phyto-sociology and vegetation dynamics, biodiversity is often only an attribute of the ecosystem, which has an influence on the choice of data processing methods. The following types of biodiversity are distinguished:

Alpha-diversity is the within-habitat diversity or species richness.

Beta-diversity is the degree of compositional change over a coenocline (or a gradient).

Gamma-diversity represents the over-all species diversity in the area, irrelevant of different habitats. (Gauch, 1982; Whitaker, 1973).

Beta- and Gamma-diversity are of relevance in a theoretical sense - available computer programmes are often restricted by a maximum amount of species or pseudo-species and samples. The effectiveness of ordination methods is often limited by the beta-diversity - a PCA gets utterly confusing due to the arch-effect if the beta-diversity is more than 2 Half Changes (Gauch, 1982).

However, diversity does become important for the quality of forage: It is a well-established fact that the forage value of overgrazed veld is far less than that of well-managed veld. Nutritional deficiency symptoms are also not unknown of, as such veld often becomes dominated by a few single species.

For this case study, alpha-diversity was taken as the amount of species recorded on a sample site.

* National Botanical Research Institute, P/Bag 13184, Windhoek, Namibia

Study area

The study area is situated in the north-eastern part of the Grootfontein district, and forms part of the Northern Kalahari as described by Giess (1971).

Geology

The geology is comprised of wind-blown sands, forming linear dunes from east to west. In the interdunal flats (streets) soil formation has started, with Huttons (MacVicar *et al.*, 1986) being the most common soil type. Occasionally a vlei is formed, the soils being high in clay content. In such cases, seasonal waterlogging is apparant. Large areas are underlaid by calcrete, which occurs at various depths.

Climate

The climate is typical summer rainfall, with the average annual rainfall of 440 mm.

Vegetation

The dunes are covered with deciduous forest, dominated by *Terminalia sericea, Burkea africana* and *Combretum* spp. The vegetation of the interdunal streets consists of *Acacia* spp. dominated savanna, varying from an open savanna to dense thorn shrubs.

Methods

a. Fieldwork

The study has been conducted in the savannas of the interdunal streets, excluding all vlei's and all outcroppings of calcrete.

Sampling has been done on various stages of overgrazing, especially sampling on known grazing gradients. These known grazing gradients are established within the camp systems: from a point in the far corner of a camp where the grazing intensity is minimal, right up to the trough where the concentration of animals is the highest. This obviously is not only a grazing gradient - factors like trampling, nutrient enrichment of the soil due to cattle faeces, and seed dispersal through cattle faeces (mainly seeds from pods) is also intensified near the trough. It must be stressed at this point that it is known that grazing intensity changes over such a gradient, but that the actual grazing intensity is impossible to establish.

At each sample site a 0,1 ha quadrat was put out and all woody plants within the quadrat were counted. At the same time, the species composition of the grass layer was established by means of the wheel-point apparatus (Tidmarsh & Havenga, 1955). A sample of the soil (A and B horizon respectively) was also taken.

b. Data analysis

The data was ordinated by DECORANA (Hill, 1979), and the ordination diagram of Axis 1 and Axis 2 was drawn (Figure 1). On this diagram the position of the plots in known grazing gradients was marked (Figure 2). By this method it was established that the grazing is depicted by ordination Axis 1.

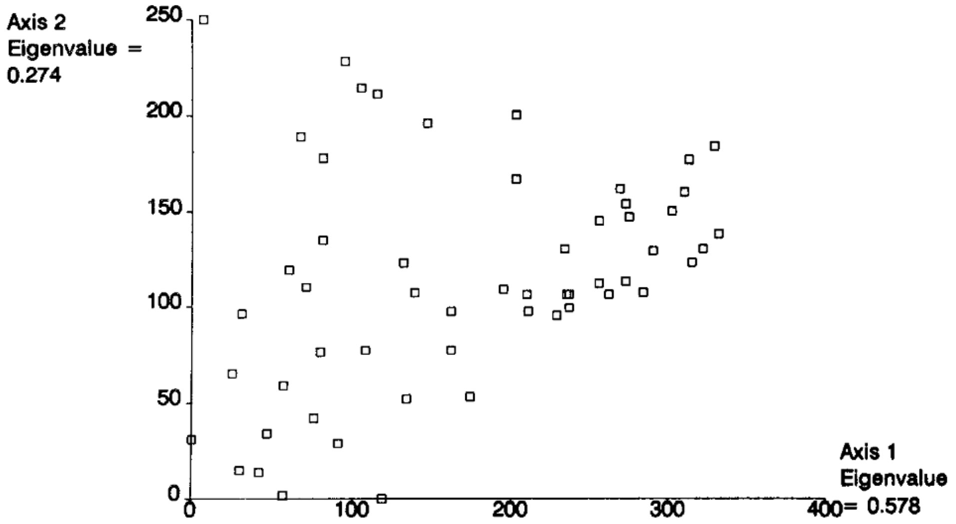


Figure 1: DCA Ordination diagram of the sample relevés, axis 1 against axis 2.

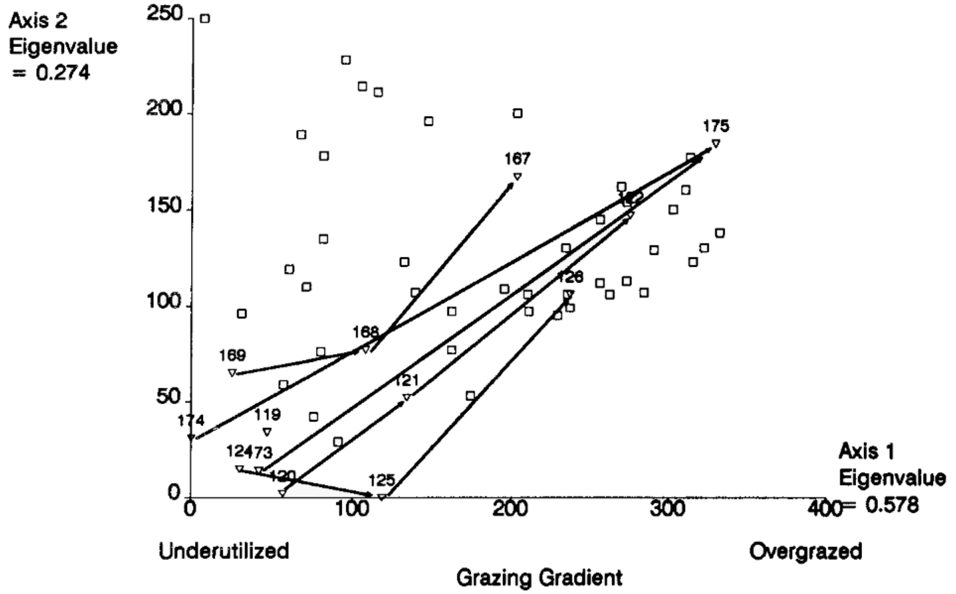


Figure 2: DCA Ordination diagram of the sample relevés, with the known grazing gradients shown.

The density of the trees was put out against Axis 1, and a polinomal regression curve fitted through the points, using NWA STATPAK (NWA, 1984). The same was done with the various grass species. In this way the grass species were classified as Decreasers (i.e. species decreasing in abundance under increasing grazing pressure) and Increasers I, II and III (i.e. species increasing under various conditions of increasing grazing pressure) (Table 1). For these classifications the criteria of Bosch & Janse van Rensburg (1987) and Janse van Rensburg (1987) were used.

Table 1: Grass species classification according to their reaction to grazing.

Decreasers	Increasers II
Antephora pubescens	*Brachiaria deflexa*
Aristida meridionalis	*Chloris virgata*
Aristida pilgeri	*Eragrostis rigidior*
Brachiaria nigropedata	*Pogonarthria squarrosa*
Digitaria seriata	
Elionurus tripsacoides	**Increasers III**
Eragrostis dinteri	
Heteropogon contortus	*Aristida adscensionis*
Melinis repens subsp. *repens*	*Aristida rhiniochloa*
Schmidtia pappophoroides	*Eragrostis trichophora*
	Sporobolus fimbriatus
Increasers I	*Tragus berteronianus*
	Tragus racemosus
Brachiaria brizantha	*Triraphis purpurea*
Eragrostis nindensis	
Pogonarthria fleckii	
Urochloa brachyura	

The grasses were also classified into annuals and perennials and each group again into palatable and unpalatable (Table 2). With the division into palatable and unpalatable grasses, local knowledge, observation in the field, and also availability to cattle was taken into account. No in-depth data on the palability of the grasses is available.

The amount of palatable and unpalatable annuals and perennials was counted in each relevé, and these numbers put out against Axis 1 (the grazing gradient). Again, a polynomal regression curve was fitted.

Table 2: Palability of the various grasses

Palatable perennial grasses	Unpalatable perennial grasses
Anthephora pubescens	*Aristida congesta*
Brachiaria brizantha	*Aristida meridionalis*
Brachiaria nigropedata	*Aristida pilgerii*
Digitaria seriata	*Cymbopogon excavatus*
Eragrostis trichophora	*Elionurus muticus*
Heteropogon contortus	*Elionurus tripsacoides*
Panicum maximum	*Eragrostis nindensis*
Melinis repens subsp. *repens*	*Eragrostis rigidior*
Schmidtia pappophoroides	*Pogonarthria squarrosa*
Sporobolus fimbriatus	*Stipagrostis uniplumis*
	Triraphis schinzii
Palatable annual grasses	**Unpalatable annual grasses**
Brachiaria deflexa	*Aristida adscensionis*
Chloris virgata	*Aristida effusa*
Dactyloctenium aegyptum	*Aristida rhiniochloa*
Panicum stapfium	*Enneapogon cenchroides*
Urochloa brachyura	*Enneapogon desvauxii*
	Eragrostis dinteri
	Eragrostis pilgerana
	Eragrostis porosa
	Pogonarthria fleckii
	Setaria pallide-fusca
	Setaria verticillata
	Tragus berteronianus
	Tragus racemosus
	Triraphis purpurea

Results

Tree density and Tree species:

From Figure 3 it is clear that tree density increases (nearly doubles) with increasing grazing pressure. However it is interesting that the number of species involved in this increasing bush encroachment is lower at a stage of total overgrazing than in a stage of moderate to heavy overgrazing (Figure 4).

More significant is the decline in the number of grass species over the grazing gradient (Figure 5). The palatable perennial grasses show here the sharpest decline (Figure 6). The general tendency of the different species (Figure 7) is that of Decreasers, with only *Eragrostis trichophora* and *Sporobolus fimbriatus* as Increasers III (i.e.

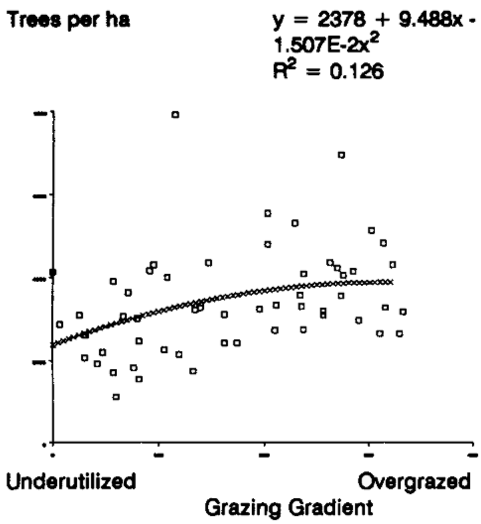


Figure 3: The increase of tree densities with increasing grazing presure.

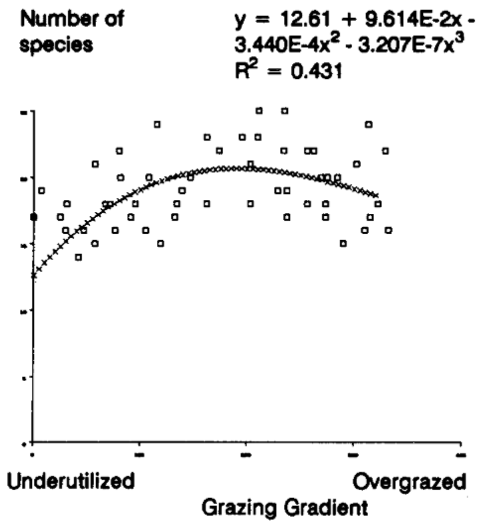


Figure 4: The number of woody species occurring at various grazing pressures.

pioneer grasses) (Figure 8). *Sporobolus fimbriatus* grows amongst denser patches of thorn bush, and is thus protected against grazing. It contributes a maximum of 4 % of the composition of the grass layer. *Eragrostis trichophora* is a creeper, and can thus escape from grazing. Because of its creeping nature it contributes a great part of the composition as depicted by the wheel-point survey, but it contributes actually very little to the available forage.

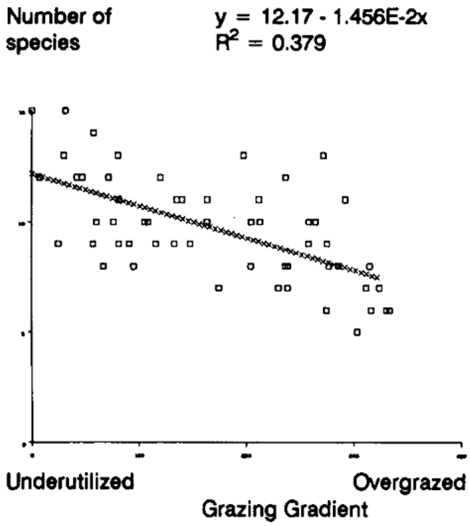


Figure 5: The number of grass species occurring at various grazing pressures.

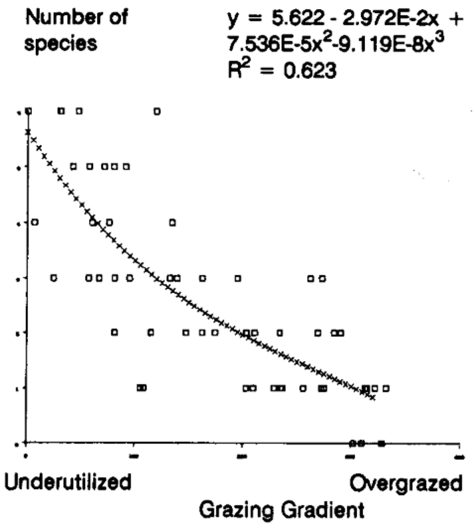


Figure 6: The number of palatable perennial grass species occurring at various grazing pressures.

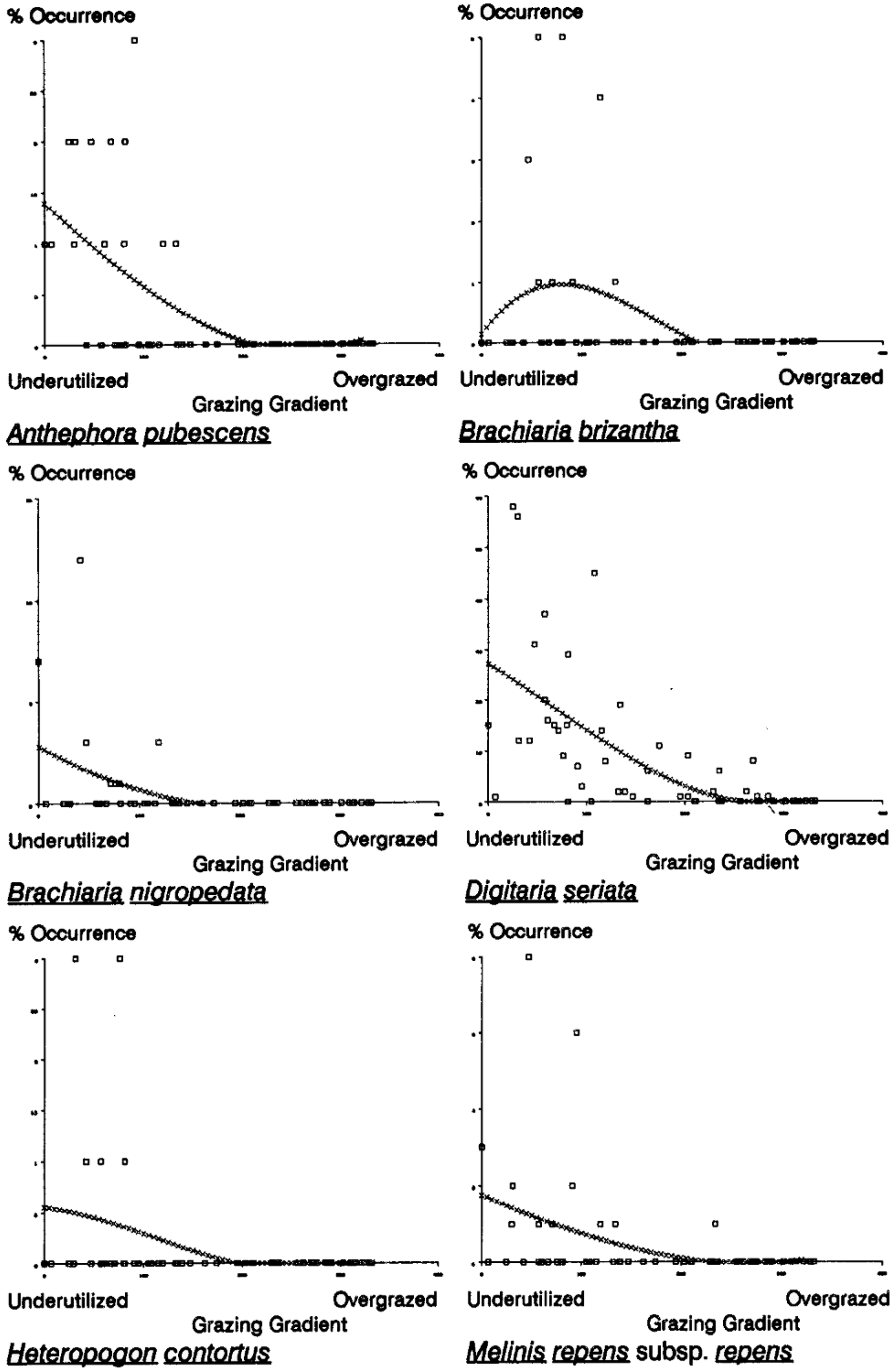


Figure 7: The reaction of perennial palatable grass species to grazing.

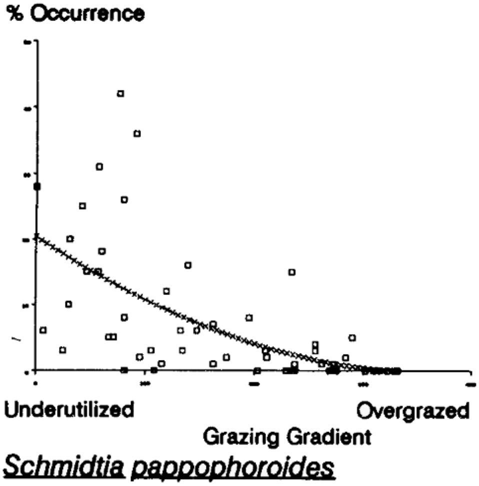


Figure 7 (continued): The reaction of perennial palatable grass species to grazing.

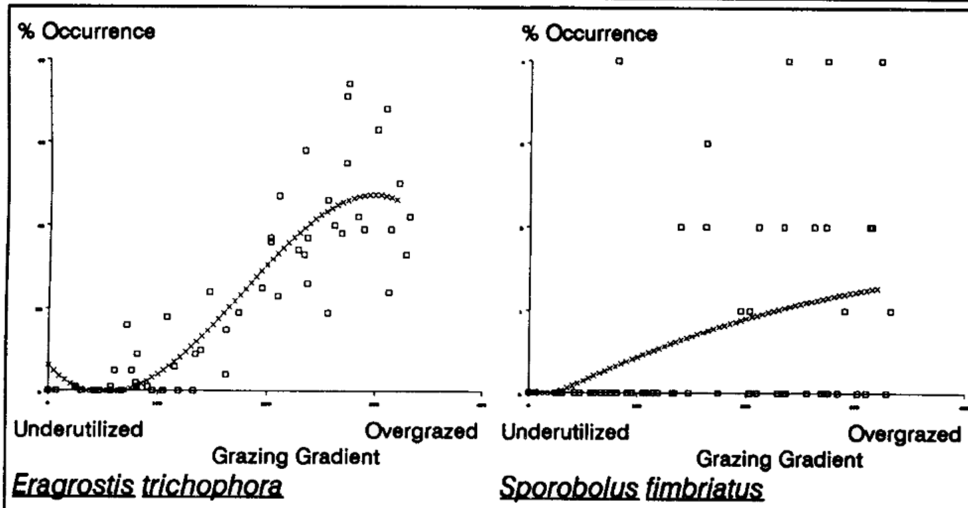


Figure 8: The reaction of perennial palatable grass species (typical Increaser III species) to grazing.

The number of unpalatable perennial grass species also declines with increasing grazing pressure (Figure 9). Several of these species also react as Decreasers, but in this case some Increasers II are also known. Especially prominent in this regard is *Eragrostis rigidior* which can totally dominate the veld in a slightly to moderately overgrazed state. (Figure 10). The number of annual grass species increases with overgrazing (Figure 11). There are only three palatable annual grasses known, which show a slight increase in occurrence in the overgrazed state (Figure 12). Here, *Urochloa brachyura*, as an Increaser II, contributes the main part (Figure 13).

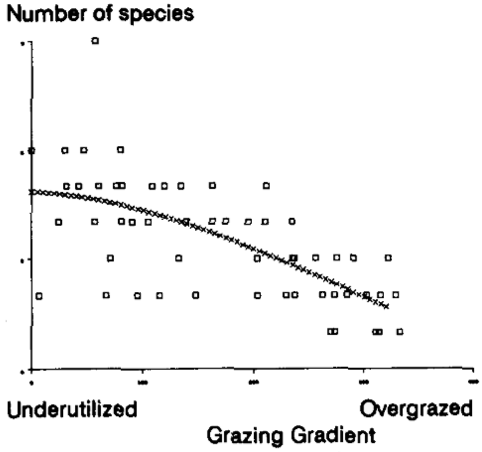


Figure 9: The number of palatable perennial grass species compared with the grazing gradient.

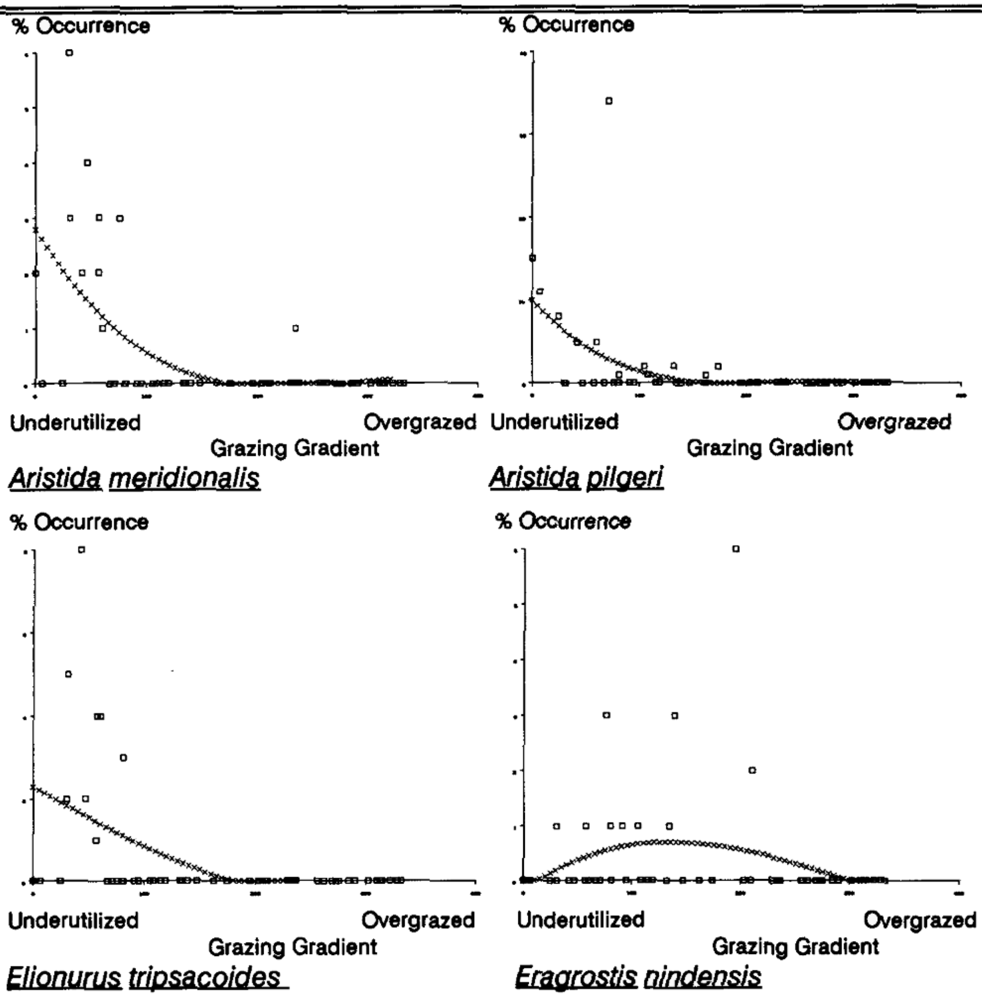
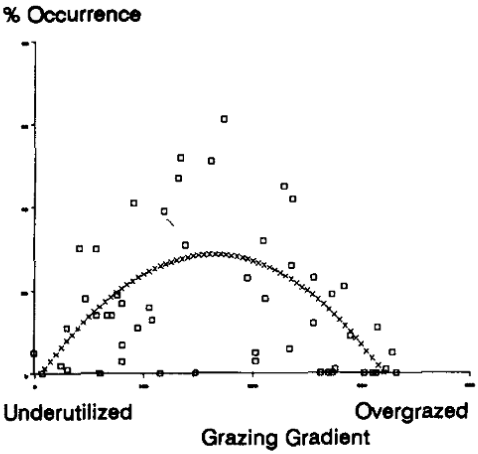
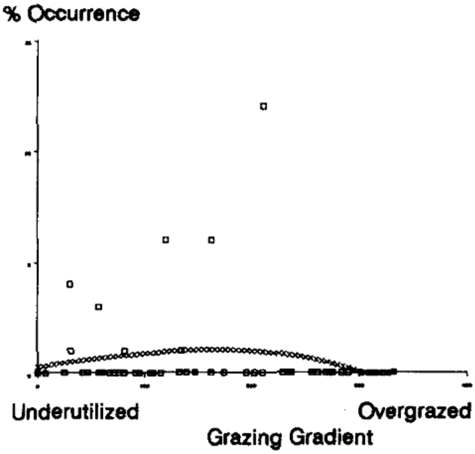


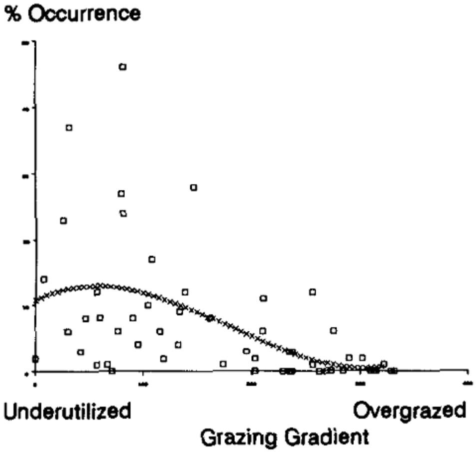
Figure 10: The reaction of unpalatable perennial grass species to grazing.



Eragrostis rigidior



Pogonarthria squarrosa



Stipagrostis uniplumis

Figure 10 (continued): The reaction of unpalatable perennial grass species to grazing.

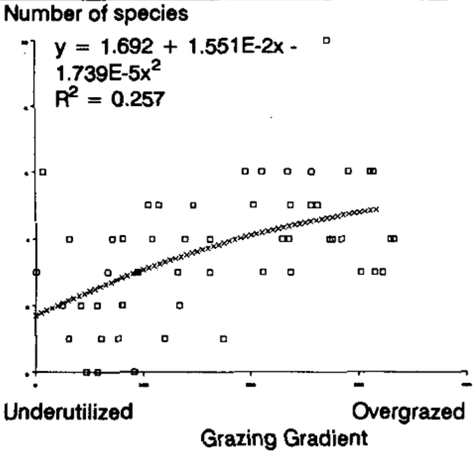


Figure 11: The number of annual grass species at various grazing pressures.

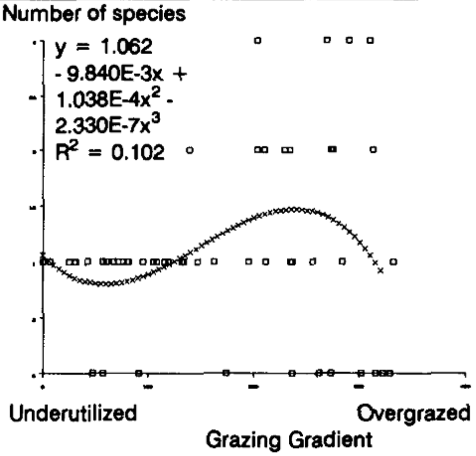


Figure 12: The number of palatable annual grass species at various grazing pressures.

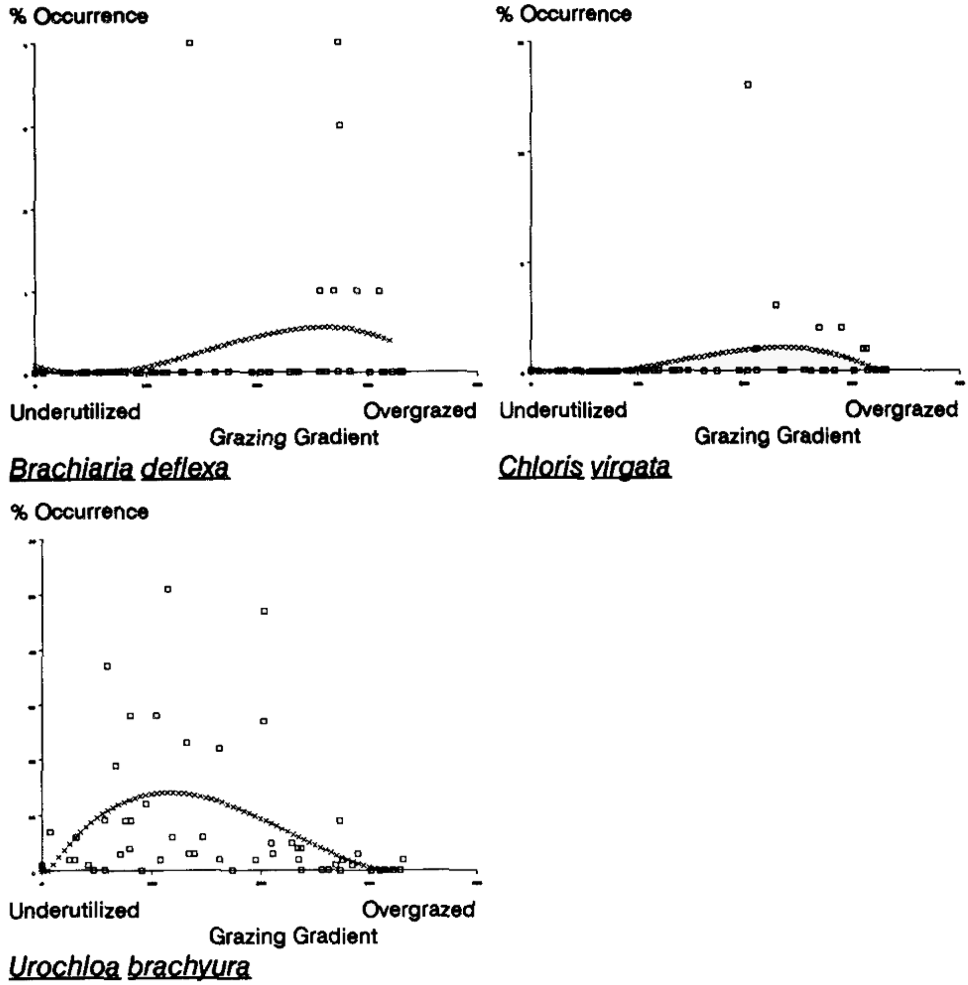


Figure 13: The reaction of the palatable annual grasses to grazing.

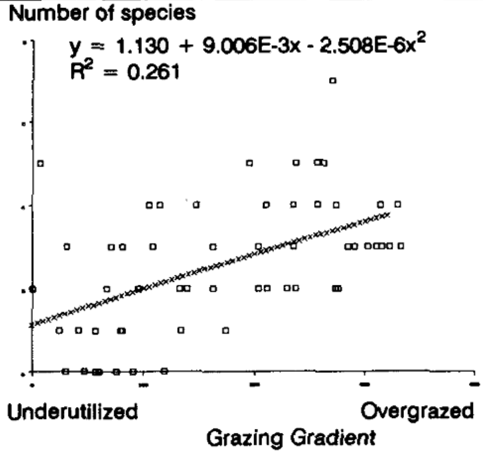


Figure 14: The number of unpalatable annual grass species at various grazing pressures.

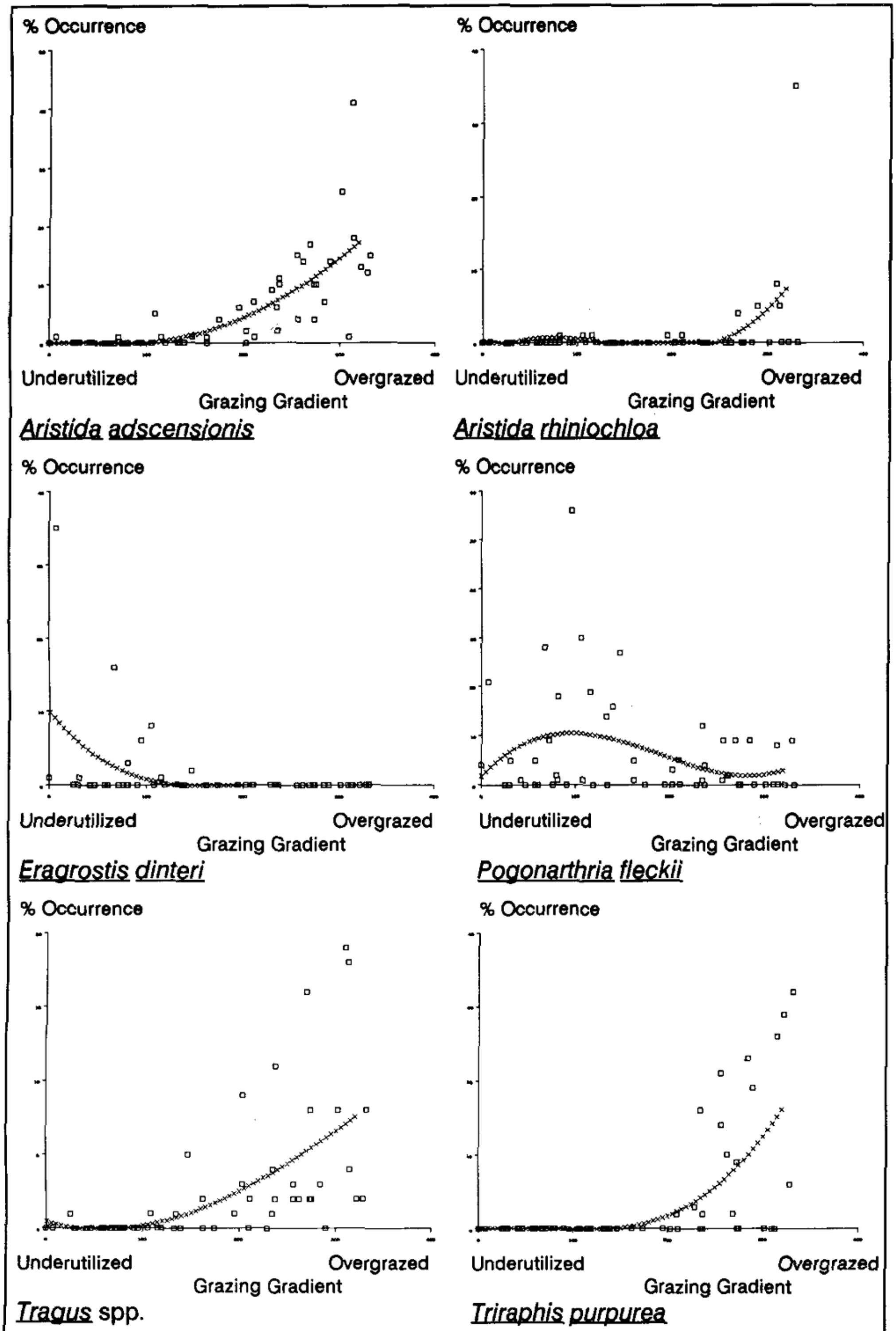


Figure 15: The reaction of the unpalatable annual grass species to grazing.

The unpalatable annual grasses show a far better trend: the number of species involved increases to a maximum of 7 under overgrazed conditions (Figure 14). Except for *Eragrostis dinteri* (Decreaser) and *Pogonathria fleckii* (Increaser I), these species all react as Increaser III (Figure 15). Dominant here are the species *Aristida adscensionis, Aristida rhiniochloa, Triraphis purpurea, Tragus berteronianus* and to a lesser extent, *Tragus racemosus*.

Conclusions

It is thus clear that the overall grazing value of the veld is reduced with overgrazing. With this there is a reduction of the species, and especially the palatable perennial species are disappearing from the veld due to overgrazing. These then are replaced by annual grasses. Except for the low forage value of the annual grasses, these also present a threat to the topsoil: Annual grasses have a very weak root system, and thus cannot protect the topsoil effectively from erosion.

References

BOSCH, O.J.H. & JANSE VAN RENSBURG, F.P. 1987. Ecological status of species on grazing gradients on shallow soils of the western Grassland Biome in South Africa. *Journal of the grassland society of southern Africa* 4(4):143-147.

GAUCH, H.G. 1982. *Multivariate analysis in community ecology*. Cambridge: Cambridge University Press.

GIESS, W. 1971. A preliminary vegetation map of South West Africa. *Dinteria* 4:3-14.

HILL, M.O. 1979. DECORANA: *A FORTRAN Program for Detrended Correspondence Analysis and Reciprocal Averaging*. Ithaca, New York: Cornell University.

JANSE VAN RENSBURG, F.P. 1987. *Plantegroeiveranderings op die ekotope van 'n aantal landtipes in die Grasveldbioom*. M.Sc. Thesis, Potchefstroom University for C.H.E., Potchefstroom.

MACVICAR, C.N., LOXTON, R.F., LAMBRECHTS, J.J.N., LE ROUX, L., DE VILLIERS, J.M., VESTER, E., MERRYWEATHER, F.R., VAN ROOYEN, T.H. & HARMSE, H.J. VON M. 1977. *Soil Classification: a binominal system for South Africa*. Pretoria: Dept. of Agriculture Technical Services.

NWA, 1984. *NWA STATPAK Version 3.1*. Portland, Oregon: Northwest Analytical, Inc.

TIDMARSH, C.E.M. & HAVENGA, C.M. 1955. The Wheel-Point Method of Survey and Measurement of Semi-open Grasslands and Karoo Vegetation in South Africa. *Memoirs of the Botanical Survey of South Africa* no. 29. Pretoria: Department of Agriculture.

WHITTAKER, R.H. (ed.) 1973. *Ordination and Classification of Communities*. The Hague: Junk.