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THE EFFECTS OF GRAZING-INDUCED SHRUB ENCROACHMENT ON ANIMAL DIVERSITY IN SOUTHERN KALAHARI RANGELANDS

INTRODUCTION

One of the most threatening forms of rangeland degradation in southern African savannas is shrub encroachment resulting from heavy grazing by domestic livestock, in conjunction with good rainfall years (Kraaij & Ward, 2006). The increase in shrubs at the cost of palatable vegetation reduces the carrying capacity of rangelands and hence the economic output of stock farmers. However, although dramatic grazing-induced changes in savanna vegetation are well documented (Skarpe, 1990), possible indirect effects on native animal abundance and diversity are often overlooked when predicting the long-term effects of overgrazing.

We present here results of four studies investigating possible effects of shrub density on four animal groups: wingless arthropods (insects and scorpions), reptiles, rodents, and carnivores (up to the size of black-backed jackals). These groups were investigated along a grazing gradient in southern Kalahari rangelands. The groups were selected as potential indicators to assist farmers to evaluate changes in rangeland quality and to emphasise the point that sustainable farming is crucial to nature conservation.

METHODS

Species diversity was monitored from 2001 to 2006 in the southern Kalahari rangelands between Twee Rivieren and Askham (26°15' S and 20°35' E), in the Northern Cape Province, South Africa. Mixed grazing predominated in the study area. Livestock consisted of sheep (75 %), goats (15 %), and cattle (10 %) for meat production (South African Department of Agriculture, 2004). Native antelope (mainly springbok, *Antidorcas marsupialis*; gemsbok, *Oryx gazella*; common duiker, *Sylvicapra grimmia*; and steenbok, *Raphicerus campestris*) occurred throughout the study area.

The savanna vegetation, with a sparse grassy layer of bushman grass (*Stipagrostis* spp.), love grass (*Eragrostis* spp.) and Kalahari sour grass (*Schmidtia kalahariensis*), is dominated by a low shrub layer of black-thorns (*Acacia mellifera*) and three-thorns (*Rhigozum trichotomum*), with widely scattered camel-thorns (*Acacia erioloba*), grey camel-thorns (*Acacia haematoxylon*) and shepherd's trees (*Boscia albitrunca*) and is described as Aoub duneveld (Mucina, Rutherford & Powrie, 2005). Animal abundance and vegetation cover was monitored in 20 study sites of 1 hectare (100 m x 100 m) each. Study sites were selected to represent a gradient of shrub cover ranging from low (< 5 %) to high (> 25 %), which varied largely the result of different stocking rates over periods of time.

Details of the animal and vegetation surveys are described elsewhere (vegetation: Blaum, Rossmanith, Schwager & Jeltsch, 2007a; arthropods: Blaum, Seymour, Rossmanith, Schwager & Jeltsch, in press; reptiles: Wasiolka 2007; rodents: Blaum, Rossmanith, Jeltsch, 2007b; carnivores: Blaum *et al*., 2007a).

RESULTS AND CONCLUSIONS

Land use induced shrub encroachment had various effects on species diversity. Reptile and rodent diversity declined with shrub cover, whereas responses of carnivores and wingless arthropods produced bell-shaped curves with maximum species diversity at shrub cover values between 12 % and 18 % (Figure 1).

The decline in reptile and rodent diversity in response to shrub encroachment may have knock-on effects, impacting on, e.g., small carnivore abundance, which can generate effects throughout the food web involving insects, rodents, carnivores and plants (Gutiérrez, Meserve, Herrera, Contreras & Jaksic, 1997).

The bell-shaped graphs showing arthropod and carnivore responses to shrub cover can be explained by the habitat-heterogeneity-hypothesis (MacArthur & Wilson, 1967). This hypothesis predicts that structurally complex habitats (i.e. with many different vegetation structures) provide more niches for plants and animals, thus increasing species diversity. At low shrub cover, savannas are characterised by a structurally poor grassy matrix with few trees and shrubs. The increase of shrubs therefore first enriches the structural diversity of savanna habitats, until in overgrazed areas, shrubs become the dominant vegetation, generating

homogeneous patches with low habitat heterogeneity (Scholes & Walker, 1993). The bell-shaped relationship between shrub cover and carnivore/arthropod diversity thus reflects the significant yet changing responses to shrub density.

To conclude, in highly shrub-encroached areas, species diversity for all studied animal groups was low, indicating that rangeland degradation reduces species diversity across levels of the food web. However, medium shrub cover (12–18 %) enriches savanna rangelands, and consequently promotes species diversity. This needs to be considered when initiating shrub removal programs that aim at increasing grazing capacity.

Understanding the relationships between species diversity and shrub encroachment is crucial in developing management strategies that sustain both species diversity and the land user's profit.

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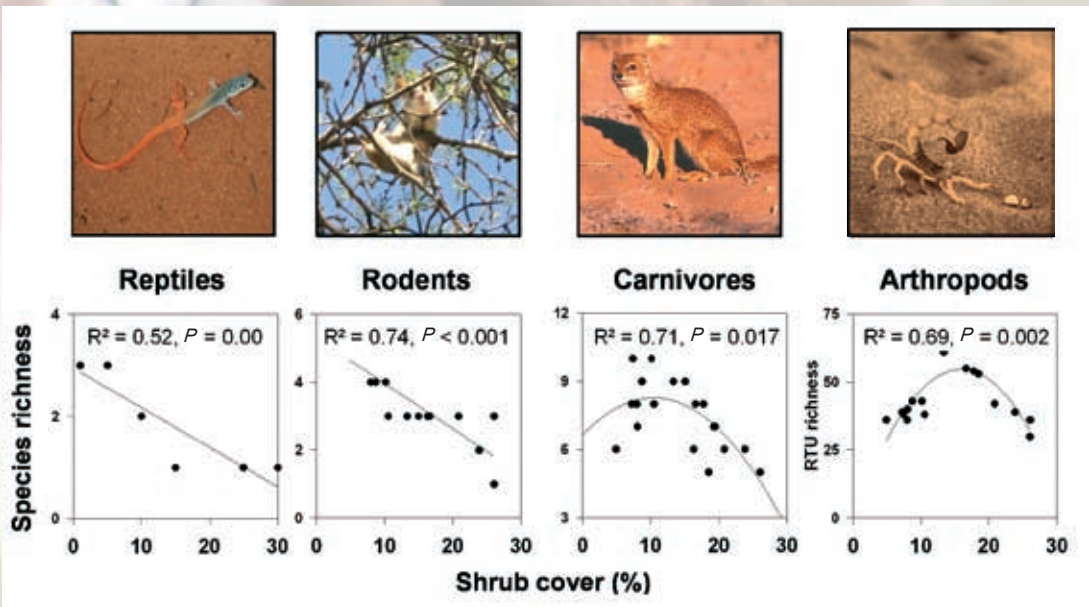

Figure 1. Effects of grazing-induced shrub encroachment on reptile, rodent, carnivore and arthropod diversity in the southern Kalahari rangelands, Northern Cape Province, South Africa.

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