Mistletoes, their host plants and the effects of browsing by large mammals in Addo Elephant National Park

J.J. MIDGLEY and D. JOUBERT

Midgley, J.J. and D. Joubert. 1991. Mistletoes, their host plants and the effects of browsing by large mammals in Addo Elephant National Park. *Koedoe* 34(2): 149-152. Pretoria. ISSN 0075-6458.

There are at least four plant hemiparasites [=mistletoes, viz. Viscaceae (3 species), Loranthaceae (1 species)] within the Addo Elephant National Park. Highly selective utilisation of these plant parasites by large browsing animals has resulted in severe decline of these plants within the elephant enclosure. The parasites are often associated with spinescent host plants. We suggest this has less to do with escaping herbivory by large mammals and more to do with spinescent plants being optimum hosts because they are a richer nutritient source for plant parasites than most non-spinescent plants.

Keywords: parasitic plants, *Viscum*, *Moquinella*, herbivores, spinescence, Addo Elephant National Park.

J.J. Midgley, CSIR Division of Forest Science and Technology, Saasveld, Private Bag X6515, George, 6530 Republic of South Africa; D. Joubert, Addo Elephant National Park, Private Bag Addo, 6105 Republic of South Africa.

Introduction

Mistletoes are well known to be plants which have a high nutrient and water content (Lamont 1982; Ehleringer *et al.* 1986), and they are therefore probably highly selected for by indigenous browsers. We were interested in determining the effect of large browsers on mistletoes in the Addo Elephant National Park. The park is useful for this purpose because contrasts of the effects of large browsing animals [mainly elephants *Loxodonta africana* (Blumenbach, 1797) but also black rhinoceros *Diceros bicornis michaeli* Zukowsky, 1964] can be made on either side of the elephant-proof fence, yet still within the park. The main vegetation in the park is Valley Bushveld and present stocking rate of elephants is about 2/km^2 (Novellie 1991). For details of the park, its history, flora and fauna, see Penzhorn *et al.* 1974) and Novellie (1991). We were also interested in the choice of host species by the mistletoes and how this may relate to browsing by large mammals. Lamont (1982) argued that because mistletoes are highly palatable, they may be associated with spinescent plants because they could benefit from sharing this structural defence. However, he found little support for this association at a study site in the Great Karoo. The dense and nutrituous nature of the Addo Valley Bushveld (Hall-Martin *et al.* 1982) has probably always attracted large herbivores and thus it may be a suitable study site for an investigation into the host specificity of plant parasites in relation to herbivory.

Methods

During visits by J.J. Midgley and routine work in the park by D. Joubert a list was made of all mistletoes and their respective host species. Due to the highly dispersed nature of the various parasite species, no direct measurements of host specificity were made (i.e. the percentage of individuals of a particular host that were infected). Based on our experience we have merely subjectively rated the importance of various species as hosts.

Comparisons of the frequency and size of the common mistletoes within and immediately outside the elephant enclosure were made and differences are attributed to the large browsing mammals. Comparisons were made with mistletoe/host pairs sampled at several locations within the park depending on the mistletoes concerned. At each individual of a given host species encountered along a belt transect a note was made of the species, number and estimated maximum diameter of its parasites. We sampled *Moquinella rubra* and *Viscum rotundifolium* growing on *Acacia karroo* along the northern edge of the elephant fence, *Viscum crassulae* on *Portulacaria afra* and *Viscum rotundifolium* on *Maytenus heterophylla* on the western perimeter near the rail-

Table 1

Plant parasites and their host species in the Addo Elephant National Park. The values in brackets are subjective frequency ratings of host species; +++ indicates relatively frequent and + indicates a rare occurrence

Parasite species	Host species	Host traits
Moquinella rubra	*Acacia karroo* (+++)	Spinescent
	Rhus longispina (++)	Spinescent
Viscum rotundifolium	*Capparis sepiaria* (+++)	Spinescent
	Azima tetracantha (++)	Spinescent
	Maytenus heterophylla (++)	Spinescent
	Grewia occidentalis (+)	Non-spinescent
	Carissa haematocarpa (+)	Spinescent
	Rhigozum obovatum (+)	Spinescent
	Ptaeroxylon obliquum (+)	Non-spinescent
Viscum obscurum	*Rhus longispina* (+++)	Spinescent
	Azima tetracantha (+)	Spinescent
	Acacia karoo (+)	Spinescent
	Olea europaea (+)	Non-spinescent
Viscum crassulae	*Portulacaria afra* (+++)	Non-spinescent

way line and *Viscum rotundifolium* on *Capparis sepiaria* along the western boundary of the botanical reserve which is situated inside the elephant enclosure [see Penzhorn *et al.* (1974) for map of the park]. Nomenclature of parasites follows Wiens & Tolken (1979).

Because of the high density of Valley Bushveld and the multi-stemmed nature of most of the constituent species, it is difficult to determine the beginning and end of an individual (except for *Acacia karroo*). Our working definition of a new host individual was that it must be at least five metres from the centre of a previous conspecific individual and that such an individual occupied a maximum of 2 m x 2 m. Sampling took place never further than 10 metres from the elephant fence. We avoided exceptionally degraded areas (e.g. around water holes). Because almost all individuals of the woody plants are shorter and smaller within the elephant enclosure, where possible, we surveyed 2-3 times as many individuals inside the enclosure.

Results

See Tables 1 and 2.

Discussion

We have extended the list of hemiparasites in the park by a further two species (*Viscum crassulae* and *V. obscurum* on Table 1). Penzhorn & Olivier (1974) noted three mistletoes in the park. *Loranthus elegans* is a synonym for *Moquinella rubra* (Wiens & Tolken 1979). Their *Viscum* cf *eucleae* (synonym for *V. pauciflorum*) is problematic because this is a species from the south-west Cape (Wiens & Tolken 1979). Their other species was the ubiquitous *V. rotundifolium*.

It is clear that large herbivores at Addo have a negative effect on the abundance and size of parasitic plants (Table 2). It is exceptionally difficult to find parasites within the elephant enclosure (we have observed only a few very small individuals of *M. rubra* and *V. rotundifolium* scattered throughout the park). Previously, Penzhorn *et al.* (1974) suggested that the absence of *V. rotundifolium* in the elephant enclosure could be due to either

Table 2
Numbers of mistletoe individuals on numbers of individuals of various host species inside and outside the elephant enclosure in the Addo Elephant National Park. Probabilities were derived from a G-*test*

		Inside	Outside
1	*Moquinella rubra* on *Acacia karroo*	0/60	5/30 † ($P < 0.03$)
2	*Viscum crassulae* on *Portulacaria afra*	0/300	42/100 †† ($P < 0.001$)
3	*Viscum rotundifolium* on *Capparis sepiaria* var *citrifolia*	0/100	14/100 ($P < 0{,}016$)
4	*Viscum rotundifolium* on *Acacia karroo*	0/60	2/30 ($P < 0{,}018$)
5	*Viscum rotundifolium* on *Maytenus heterophylla*	0/50	23/30 ($P < 0{,}002$)

† mean of 2,0 parasites per infected host plan — max. diameter of parasite 2,5 m.
†† Mean of 2,4 parasites per infected host plant — max. diameter of parasite 1,0 m.

it or its host species being preferred by the elephants. The second part of this argument can be questioned. Firstly, one of the primary hosts is *Capparis sepiaria*, a species which has apparently relatively benefited by activities of elephants (Penzhorn *et al.* 1974). Secondly, mistletoes are well-known as being nutritious (Lamont 1982; Ehleringer *et al.* 1986) and they are therefore likely to be more sought out by browsing mammals than their hosts. If replication of our study yields similar results then it suggests that misletoes may thus be useful indicators of the levels of browsing in an area.

No plant species was host to all parasites, therefore there is a measure of host specificity and this was mainly (10 out of 14 entries on Table 1) for spinescent species. Common canopy species (Penzhorn *et al.* 1974) which apparently had no parasites (*pers. obs.*) were *Euclea undulata*, *Schotia afra* and *Sideroxylon inerme*. Since none of these abundant species is spinescent, it thus indicates that infection by mistletoes is not a random process depending on abundance of various host species.

Thorns do not deter herbivores from visiting spinescent species, although they do reduce the feeding rates of the smaller herbivores (Cooper & Owen-Smith 1986). At Addo we observed elephants consuming plant material comprising dense clusters of large spines. It is therefore unlikely that the association between parasites and spinescent hosts is merely due to simultaneous parasitism of the structural defence system of the host. The relative absence of mistletoes inside the elephant fence, despite the persistence of their spinescent host species, also demonstrates this.

We believe the reason for the association is physiological. Spinescence, in the context of herbivory, has evolved in plants that are especially nutrituous and thus they have the need to minimize levels of herbivory (Cooper & Owen-Smith 1986; Owen-Smith & Cooper 1988). However, since parasitic plants derive, besides water, carbohydrates and mineral nutrients from their hosts (Marshall & Ehleringer 1990), like herbivores, they too may have selected the more nutrituous plants. This physiological mechanism may explain why *Portulacaria afra*, despite it being unarmed, is nevertheless a preferred host species. *Portulacaria afra* is a preferred food of elephants and not unexpectedly has a relatively high dry matter leaf nitrogen content of up to 16,61 mg N/g (Lithauer 1989). Its parasite, *Viscum crassulae* has levels of up to 24,95 mg N/g, making it a highly desirable food plant. Interestingly, the leaves of *V. crassulae* mimic the form of those of its host (Wiens & Tolken 1979). It is especially cryptic when it is not fruiting (*pers. obs.*). Despite this visual mimicry, this species and all the other mistletoes are virually locally extinct within the enclosure. This points to the exceptionally selective feeding habits of the large mammalian browsers. Based on this preliminary study we predict that in any plant community, among the canopy components, the selective utilization of plants by plant parasites and large mammalian browsers, may be similar.

Acknowlegements

We thank the National Parks Board for the opportunity of working at Addo Elephant National Park and P. Novellie and referees for comments on the manuscript.

References

COOPER, S.M. and N. OWEN-SMITH. 1986. The effects of plant spinescence on large mammalian herbivores. *Oecologia* 68: 446-455.

EHLERINGER, J.R., I. ULLMAN, O.L. LANGE, G.D. FARQUHAR, I.R. COWAN and E.D. SCHULZE. 1986. Mistletoes: a hypothesis concerning morphological and chemical avoidance of herbivory. *Oecologia*. 70: 234-237.

HALL-MARTIN, A.J., T. ERASMUS and B.P. BOTHA. 1982. Seasonal variation of diet and faeces composition of black rhino *Diceros bicornis* in the Addo Elephant National Park. *Koedoe* 25: 63-82.

LAMONT, B. 1982. Host range and germination requirements of some South African mistletoes. *South African Journal of Science* 78: 41-42.

LITHAUER, P.A. 1989. *An ecophysiological investigation into the water relations and nutrient partitioning between the parasite* V. crassulae *and its host* Portulacaria afra. B.Sc. (Hons) thesis. University of Port Elizabeth.

MARSHALL, J.D. and J.R. EHLERINGER. 1990. Are xylem-tapping mistletoes partially heterotrophic? *Oecologia* 84: 244-248.

NOVELLIE, P. 1991. National Parks Board and Valley Bushveld. Pp. 11-13. *In:* ZACHARIAS, P.J.K., G.C. STUART-HILL and J.J. MIDGLEY. *Proceedings of the first Valley Bushveld/Sub-Tropical Thicket Symposium*. Special Publication. The Grassland Society of South Africa. Howick.

OWEN-SMITH, N. and S.M. COOPER. 1988. Plant palatability assessment and its implications for plant-herbivore relations. *Journal of Grassland Society of South Africa* 5(2): 72-75.

PENZHORN, B.L., P.J. ROBBERTSE and M.C. OLIVIER. 1974. The infleunce of the African elephant on the vegetation of the Addo Elephant National Park. *Koedoe* 17: 137-158.

PENZHORN, B. and M.C. OLIVIER. 1974. A systematic check list of flowering plants collected in the Addo Elephant National Park. *Koedoe* 17:121-136.

WIENS, D. and H.R. TOLKEN. 1979. Viscaceae and Loranthaceae. *Flora of South Africa* 10(2): 1-59.