Use of *Datura innoxia* by ungulates in the Hoanib River, Namibia

M. Lindeque * and J.L. Scheepers

Etosha Ecological Institute, P.O. Okaukuejo, *Via*: Outjo, Namibia

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The behaviour of springbok *Antidorcas marsupialis* feeding on the alien invasive plant *Datura innoxia* is described, as well as nervous symptoms possibly arising from tropane alkaloid poisoning. Dung collected from five herbivore species prior to 1989 contained no *D. innoxia* seeds, and other signs of use of it were rare. Feeding on this plant, principally by springbok and gemsbok, is currently limited to the vicinity of the Hoanib River floodplain. This is the first record of use of *D. innoxia* by wild ungulates in southern Africa, and further underlines the need to eradicate alien plants in protected areas.

Die gedrag van springbokke *Antidorcas marsupialis* wat die uitheemse indringerplant *Datura innoxia* vreet, word beskryf, sowel as senuwee-simptome wat moontlik toe te skryf is aan tropaan-alkaloïedvergiftiging. Mis versamel van vyf herbivoor-spesies voor 1989 het geen sade van *D. innoxia* bevat nie, en ander tekens van benutting was skaars. Gebruik van hierdie plant deur hoofsaaklik springbokke en gemsbokke is tans beperk tot die omgewing van die Hoanibrivier-vloedvlakte. Hierdie is die eerste rekord van die benutting van *D. innoxia* deur inheemse wild in suidelike Afrika en verdere bewys van die noodsaaklikheid daarvan om uitheemse plante in bewaringsgebiede uit te roei.

Keywords: *Datura innoxia,* springbok, gemsbok, feeding, invasive alien plants

* To whom correspondence should be addressed

Introduction

The Hoanib River, one of the largest seasonal rivers traversing the northern Namib Desert, serves as a linear oasis for a community of ungulates and plants typically associated with savanna regions. The occurrence of large mammals such as elephants *Loxodonta africana*, giraffe *Giraffa camelopardalis*, springbok *Antidorcas marsupialis*, and gemsbok *Oryx gazella* (and sporadically kudu *Tragelaphus strepciseros*, lion *Panthera leo*, cheetah *Acinonyx jubatus*, Hartmann's zebra *Equus zebra hartmannae* and others) in an otherwise inhospitable environment is of considerable conservation significance and is a special feature of the Kaokoveld biogeographical region of the Namib Desert. It is less well known that the same river also harbours one of the most severe infestations of invasive alien plants in Namibia, of which *Datura innoxia* (Solanaceae) is currently the most abundant. Dense vegetation (and the bulk of foodplants for ungulates) in the region is limited to the banks of the river and the stream bed, which also contain most of the alien vegetation. Other alien plant species present are *D. stramonium, D. ferox, Argemone ochroleuca, Flaveria bidentis* and *Ricinus communis*.

A series of linear dunes across the river prevents all but the most exceptional floods from reaching the coast, resulting in the formation and maintenance of a floodplain behind the dune barrier. In most years, floodwater reaches the floodplain at least once and maintains a relatively diverse and productive grass and shrub community which is of vital importance to resident ungulates. Ungulates typically concentrate in the floodplain except during the brief wet season. Alien plants currently occupy a significant portion of available space on the floodplain, and can be assumed to limit the amount of natural food available to ungulates.

D. innoxia was apparently introduced to Namibia with horse fodder at the turn of the century, and whilst the history of infestation in the Hoanib River is unknown, major stands have occurred there for at least the past three decades (Tarr & Loutit 1985). Evidence of use of this species in the Hoanib River prior to 1989 was limited to rare cases of half-eaten fruits still attached to stems, debarking of exposed roots (pers. obs.) and seed predation by francolins (S. Braine, pers. comm.). The identity of the herbivore using fruits and bark as observed was unknown and we initially suspected an invertebrate species. No records of wild ungulates using this species were known from Namibia (Tarr & Loutit 1985; Brown, Riekert & Vinjevold 1985). In this paper the use of *D. innoxia* by indigenous ungulates is described, following a chance observation of springbok feeding on this species.

Materials and Methods

Apart from incidental observations of springbok feeding behaviour, dung samples from elephant, giraffe, gemsbok, springbok and ostrich were collected from the floodplain and 60 km upstream in September 1989, December 1989 and May 1990. Approximately 100-g samples of dung were collected from as many individual deposits as possible, and mostly from dung judged to have been deposited within the previous month, as well as from obviously older deposits. Older dung samples collected in all seasons from 1985–1988 were available for all species from an ongoing study on nutritional status of ungulates in the region. Randomly selected pellets totalling *ca* 10 g dry mass were soaked in water until soft enough to be teased apart for the recovery of seeds and other large identifiable components.

The incidence of utilization of *D. innoxia* plants was estimated from five subjectively chosen belt transects covering in total approximately 3 km^2 of the Hoanib River floodplain, as the percentage of utilized individuals versus the total. The degree of utilization was estimated from a sub-sample of 50 utilized plants, where the percentage of plant components utilized versus the total available was estimated.

Fresh material was collected in December 1989 from different plant parts from at least five individual *D. innoxia* plants and lumped together as approximately 200 g composite samples. Moisture content was measured as the difference between mass immediately after collection and after drying to constant mass at 60°C. Crude protein content was estimated using standard Kjeldahl techniques (Anon. 1975; AOAC 1984) for routine assays at the Agricultural Laboratory, Windhoek.

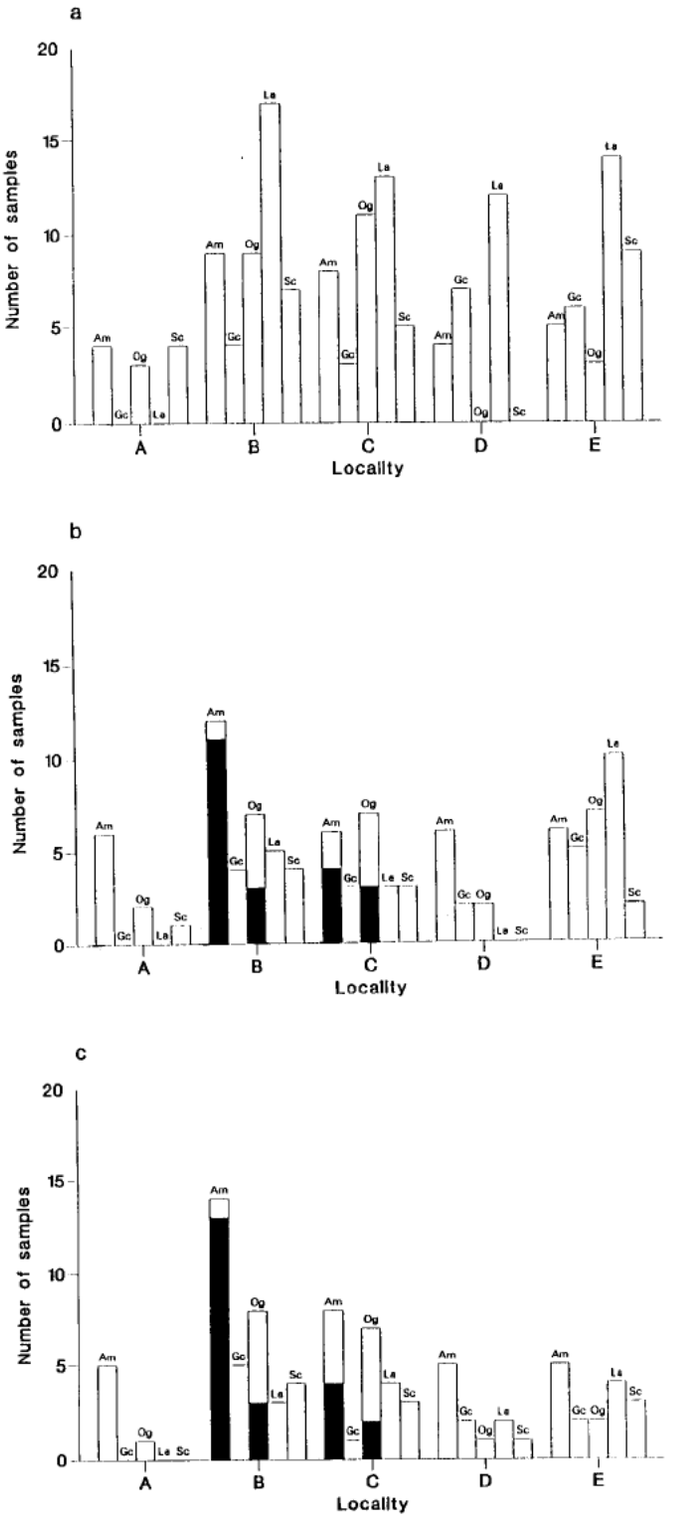

Figure 1 Occurrence of *Datura innoxia* seeds (solid areas) in springbok (Am), giraffe (Gc), gemsbok (Og), elephant (La) and ostrich (Sc) dung samples west of the Hoanib River floodplain (A), on the floodplain (B), 0–10 km upstream (east) (C), 10–20 km upstream (D) and > 20 km upstream (E) from 1985–Aug. 1989 (a), Sept.–Dec. 1989 (b) and Mar.–May 1990 (c).

Results

Adult springbok were seen feeding on *D. innoxia* plants on several occasions during October 1989 and December 1989. Individual springbok selected unripe fruits, and plucked the proximate half of the fruit off the plant and consumed these. The fruit of *D. innoxia* is similar to a tomato, except for a dense outer layer of spines which become very sharp and rigid with progressive maturation of the fruit. Fruits in all stages of development were found on individual plants during the two surveys in 1989, and the selection of some fruits appeared to have been based on trial and error. Unripe fruits with hardened spines were rejected, often accompanied by a head shake presumably to dislodge sharp spines from the mouth.

Only 4,2% of the approximately 1 500 plants occurring in 3 km^2 of transects showed signs of previous utilization by springbok and gemsbok, and of these and other utilized plants, less than 10% of the fruit crop was used. It seems that *D. innoxia* fruits are acceptable to springbok and gemsbok for a brief period during maturation only. Apart from occasional feeding by elephants on *R. communis*, no other alien plant species were used by any large herbivore.

Figure 1 illustrates the recovery of *D. innoxia* seeds from herbivore dung in the Hoanib River as an estimate of the incidence of utilization. Seeds were confined to dung collected on the floodplain and the section of river 10 km upstream from the floodplain, and occurred only in springbok and gemsbok dung. The incidence of *D. innoxia* seeds was greater in springbok than in gemsbok dung, both with respect to the percentage of occurrence and the number of seeds recovered per *ca* 10 g dung (Table 1). Both ungulate species and *D. innoxia* occur along the entire river, but all show their highest concentrations on the floodplain and adjacent 10 km section of river (pers. obs.).

Table 1 Mean (± Standard Error) number of *Datura innoxia* seeds recovered per approximately 10-g samples of springbok (Am) and gemsbok (Og) dung at two sites along the Hoanib River

Locality	Species	< Sept. 1989	Sept.–Dec. 1989	Mar.–May 1990
Floodplain	Am	0	15,6(± 5,5)	8,1(± 2,6)
	Og	0	0,7(± 0,4)	0,5(± 0,3)
0–10 km upstream	Am	0	4,3(± 2,3)	14,1(± 10,0)
	Og	0	2,6(± 1,5)	0,4(± 0,1)

Table 2 Moisture and crude protein (CP) content of *Datura innoxia* and common indigenous plants in the Hoanib River

Species	Plant part		% moisture	%CP
Datura innoxia	leaves		68,7	14,6
	bark		70,4	10,9
	roots		75,5	5,3
	flowers (calyx)		75,3	10,9
	ectocarp		73,6	11,3
	seeds & pulp		60,2	11,2
		$\bar{x}$	70,6	10,68
*Zygophyllum simplex**	S**		63,9	8,3
Psilocaulon sp.*	S		79,6	11,2
Sueda sp.*	S		78,5	15,4
*Salsola nollothensis**	S		61,0	10,4
*Pechuel-loeschea leubnitziae**	S		71,8	13,9
*Salvadora persica**	S			9,6
		$\bar{x}$	71,0	11,45
Tamarix usneoides	S		55,2	12,8
Petalidium engleranum	S			9,5
Tephrosia oxygona	S		55,3	5,6
Colophospermum mopane	L***		56,2	8,0
Acanthosicyos horridus	stem tips		60,0	10,7
Acacia albida	L			14,9
Combretum watti	L			10,4
Cordia sinensis	L		51,5	5,7
		$\bar{x}$	63,3	10,45

* Species which are relatively abundant in the floodplain area, within reach of springbok and likely to contribute the bulk to springbok diets; ** S denotes the terminal section of a twig and attached leaves as a sample browse unit; *** L denotes green leaves and petioles.

Springbok and redbilled francolins *Francolinus adspersus* also used the large flowers of this species. Springbok, as determined from tracks, frequently removed flowers from plants, consumed the ovary and sepals and rejected the rest. Francolins frequently pecked at the base of the calyx where copious nectar can be found, occasionally dislodging individual flowers. Other signs of utilization of *D. innoxia* in the Hoanib River were limited to rare occurrences of partially browsed leaves, partial debarking of stems and tuberous roots which had been exposed by stream flow or digging. Grooves left on roots were attributed to springbok, gemsbok, and possibly a rodent.

Table 2 presents a comparison between *D. innoxia* and other plant species commonly occurring in the Hoanib River, in terms of moisture content and crude protein content during December 1989. The parameters measured for *D. innoxia* were similar to the mean values for the other species.

Discussion

Evidence of the use of *D. innoxia* in the Hoanib River was rare prior to 1989, other than the utilization of seeds by redbilled francolins (S. Braine, pers. comm.). Dung samples collected in all seasons from 1985–1989 did not yield any *D. innoxia* seeds. Attempts in the 1970s and early 1980s to find an invertebrate species using *D. innoxia* as host for possible biological control of the infestation would probably have revealed the evidence we recorded if present at the time (R. Loutit, S. Braine, pers. comm.). Signs of herbivore use of the alien vegetation in the Hoanib River floodplain can, however, easily be observed at present.

It seems as if the current degree of utilization of this species has only occurred for a few years, but already involves a number of herbivores. It is likely that the gradual replacement of natural vegetation with *D. innoxia* has resulted in the relatively sudden inclusion of this species in the diet of herbivores dependent on the vegetation of the floodplain. One year of poor flooding or rainfall resulting in inadequate production by indigenous species, could have marked the sudden switch to eating an alien species.

D. innoxia, while similar to indigenous plants in terms of moisture and crude protein content, and being generally softer and greener than any other species in the region, seems to have been avoided by the herbivore community for several decades. *D. innoxia* contains toxic levels of the tropane alkaloids atropine, hyoscamine and scopolamine, as in its better-known relatives *D. stramonium*, *D. ferox*, *D. metel* and some other solanaceids (Watt & Breyer-Brandwijk 1962; List & Spencer 1979; Xiao & He 1983; Friedman & Levin 1989).

Signs of abnormal behaviour and body condition were noted for two adult male springbok with territories in a part of the floodplain containing virtually no vegetation other than a dense stand of *D. innoxia*, which thus presumably contributed the bulk of their diets. Both males moved with an unsteady and jerky gait, showed delayed responses to visual and auditory stimuli (which emanated from our vehicle) and allowed the vehicle to approach within 25 m compared with the usual 100 m flight distance elsewhere in the region (pers. obs.). Yellowish discolorations were visible on the heads and necks of these and to a lesser extent on a few other individual springbok. We were unable to determine the origin of the stains, and casual contact with *D. innoxia* plants failed to leave such stains on human observers.

The symptoms of a nervous disorder noted in some springbok are consistent with tropane alkaloid poisoning (List & Spencer 1979; Nelson, Mercer, Essig & Minyard 1982; Kellerman, Coetzer & Naude 1988; Friedman & Levin 1989), and the mere handling of fruits during collection caused severe skin irritation in one of the authors. It is thus likely that herbivores would have avoided using this plant as long as alternative food was available. The alternative food plants on the Hoanib floodplain consist of an array of toxic species, but these should presumably be less detrimental as the result of physiological tolerance acquired through co-evolution or local adaptation.

The presence of *D. innoxia* in the Hoanib River and particularly the floodplain has reduced the ecological value of the oasis-like vegetation community in this river. Not only has indigenous vegetation been replaced by alien plants, but circumstantial evidence suggests that nervous disorders noted in springbok could be due to consuming the alien species in question. Frequent consumption of large quantities of *Datura* spp. may result in permanent central nervous system impairment, death or at best chronic digestive disturbances (Nelson *et al.* 1982), and seeds are known to be fatal to ostrich chicks (Steyn 1949 in Kellerman *et al.* 1988). Renewed attempts should be made to eradicate these plants

from the Hoanib River, where their presence in the Skeleton Coast Park is in any event contrary to conservation goals.

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