OBSERVATIONS ON TWO INTRODUCED BLACK RHINOS IN LIWONDE NATIONAL PARK, MALAWI

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INTRODUCTION

Two black rhinos *(Diceros bicornis minor)* from Kruger National Park, South Africa, were introduced to Liwonde National Park in Malawi on 27 October 1993. This marked the re-introduction of the species to Malawi where it had been officially declared extinct in 1990.

The last natural rhino populations in Malawi occurred in Kasungu National Park and Mwabvi Wildlife Reserve, as shown on the map in Figure 1. The most recent signs of these populations were recorded in 1985 and 1989 respectively. Ansell & Dowsett (1988) stated that in the past, rhinos were found virtually throughout Malawi. For the area which is now Liwonde National Park, Dudley & Stead (1977) reported that the most pertinent record of rhinos was that of Murray (1922) which said that "rhinoceros would occasionally be tracked to the Masanje River".

The introduced rhinos are a male and a female, each about five or six years old at the time of translocation. When they were captured in Kruger, they were kept in bomas before being brought to Liwonde, where they were again kept in bomas for one-and-a-half months. They were released into a 1,500ha sanctuary with an electrified game fence. They will remain in the sanctuary until their security can be assured in the wider area of the Park.

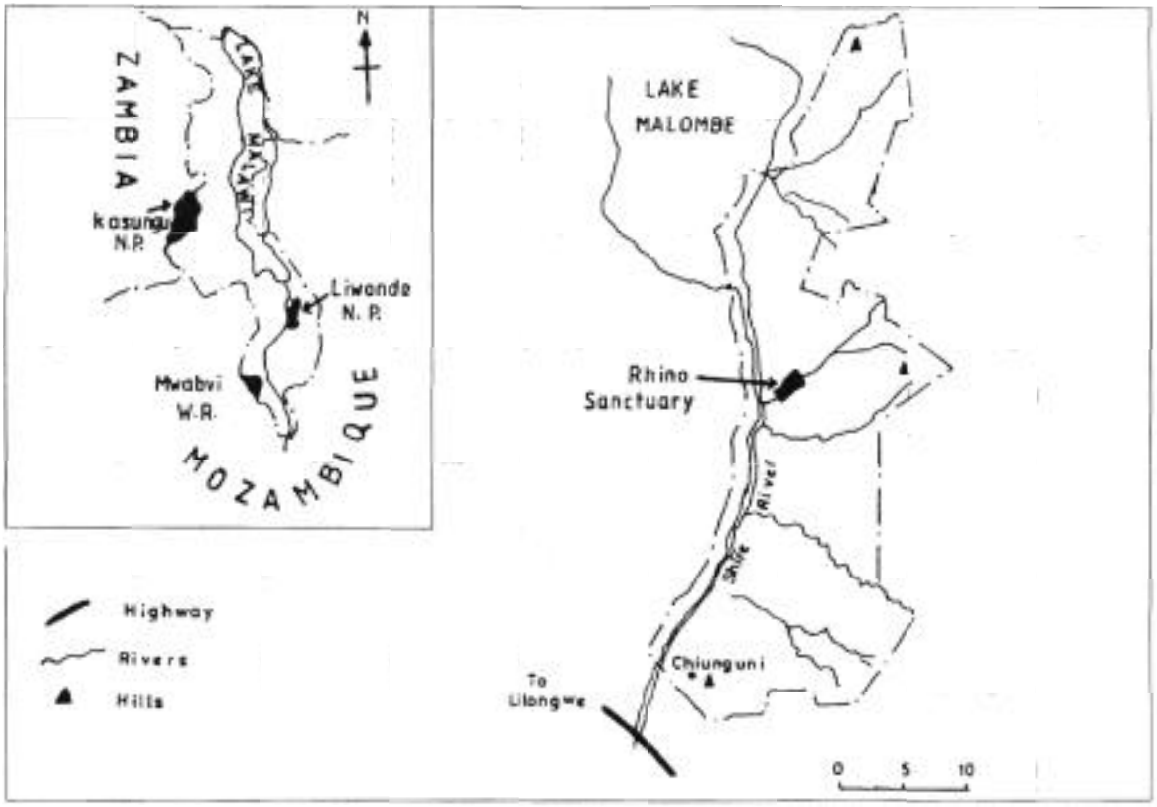

Figure 1. A map of Liwonde National Park, showing the major features and location of the rhino sanctuary The inset shows a map of Malawi with the locations of Liwonde National Park, Kasungu National Park and Mwabvi Wild life Reserve.

A programme to monitor vegetation in the sanctuary, along with the condition, movements and feeding behaviour of the rhinos, was initiated by the Wildlife Research Unit, in order to build up a base of biological information for effective management of the rhinos. This paper summarises the information collected on vegetation mapping of the sanctuary, observations of the rhinos in the bomas, their habitat preferences and movements in the sanctuary and some aspects of their feeding behaviour for the period November 1993 to April 1995.

THE STUDY AREA

Liwonde National Park (548km^2) is located in the Upper Shire Valley, which is part of the Great East African Rift Valley in southern Malawi. The terrain of the Park is generally flat except for three isolated groups of hills. The Shire River is a prominent feature along the western boundary. The full width of the river, with its riparian habitat on both sides, forms part of the Park for a stretch of over 40km, as seen in Figure 1.

The main vegetation type in the Park is *Colophospermum mopane* woodland, which occupies about 70% of the total area of the Park. Other vegetation types are mixed woodland on the hills, floodplain, grassland and riverine forests/thickets, drought deciduous forest thickets and mixed woodlands on the hills, all of which occupy minor areas. For a detailed account of the flora and plant communities, the reader is referred to Dudley (1994).

The Park has a variety of mammals, of which the elephant and the hippopotamus are the keystone species. Other common species include the water-buck, sable antelope, impala, kudu and warthog.

The rhino sanctuary is located in an area predominated by *mopane* woodland, with a variety of other species such as *Dalbergia melanoxylon, Albizia anthelmentica* and *A. harveyi*. The Ntangai River cuts through the middle of the sanctuary with a border of riverine forest/ thicket, characterised by tall trees such as *Terminalia zambesiaca, Cordyla africana, Khaya nyasica* and *Diospyros mespiliformis,* with an understorey of *Friesodeilsia obovata, Markhamia* and *Diospyros* spp. The savanna of the river's floodplain supports a variety of tall grasses (1.5 - 2.5m) which include *Digitaria milanjiana, Hyparrhenia filipendula, Panicum maximum, Setaria sphacelata* and *Sorghastrum bipennatum* as well as scattered, large trees (15 - 25m) such as *Acacia nigrescens, Sclerocarya birrea* and *Xeroderris stuhlmannii.*

The climate is characterised by a dry season from April to October and a rainy season from November to March. According to records from the Park's weather station at Chiunguni, annual rainfall ranges from 700 to 1,400mm. Mean minimum temperatures range from 12^{0}C in July to 28^{0}C in November, with mean maximum temperatures of 20^{0}C to 40^{0}C for the same months. The first year the rhinos were in the Park (1994) was very dry, with a total recorded rainfall of only 639mm (unpublished meteorogical data). All natural water pools had dried up by mid-July, 1994. However, an artificial water hole was maintained near the boma throughout the year.

Liwonde National Park was selected for the reintroduction of rhinos for security considerations. All its boundaries lie within Malawi (unlike Kasungu National Park and Mwabvi Wildlife Reserve) and it is therefore easier to police than Kasungu and Mwabvi. Access to the Park is relatively easy as the main road between Zomba and Lilongwe is only six kilometres from the Park's main entrance.

METHODS

Vegetation mapping

After identifying the sanctuary site, the area was fenced off and bomas were constructed in readiness for the rhinos. The sanctuary site was located from aerial photographs taken in May 1981 at a scale of 1:25,000. Units of vegetation which appeared to be homogenous from the photographs were marked and mapped and their area was estimated. Each unit was then checked on the ground in terms of its general structure and flora.

Rhino behaviour in the bomas

After their capture in Kruger, the rhinos were kept in bomas to minimise stress and to ensure that they were well adapted before translocation to Liwonde. On arrival in Liwonde, they were again kept in bomas where they were observed. In both places, observations were made at 07.00 hours, on body condition, health and behaviour. The results from Kruger and Liwonde were compared using the chi-squared test for significance.

While in the bomas, the rhinos were offered branches of different plants as food. The species which were eaten were recorded.

Preliminary observations of rhino movements, habitat preferences and food selection in the sanctuary

The rhinos were tracked to map out their movements in the sanctuary, to determine their preferred areas, to observe their general body condition and to record what they were eating. Their movements were marked on a vegetation map. Seasonal patterns of movement for the first year were determined by analysing data for three-month periods (January-March, April-June, July-September and October-December). The general patterns of movement for each of these three periods were then summarised and re-mapped.

The formula for preference index (PI), to determine habitat preferences, was adapted from Pienaar *et al.* (1992), for this data set. The calculations in the formula are based on the proportional occurrence of each vegetation/habitat type. A value of zero (0) indicates that a habitat type is used in the same ratio as expected from its proportional occurrence. A positive value (maximum + 1.0) indicates habitat use which is greater than expected from its proportional occurrence, while a negative value (minimum - 1.0) indicates habitat use less than expected from its proportional occurrence.

Plant species eaten by the rhinos

The plant species eaten by the rhinos were recorded by observing the rhinos feeding while they were in the bomas, and by checking for damage of the plants along the rhino tracks after their release into the sanctuary. Rhino browse characteristics are quite distinctive and are unlikely to be confused with other browser sigus in the sanctuary, such as those of the kudu or impala.

Feeding observations were also divided into threemonthly records in order to detect plant species eaten throughout the year as well as seasonal differences.

RESULTS

Sanctuary vegetation

Three major vegetation communities were identified in the sanctuary. Two of these were further subdivided, as shown on the map in Figure 2. The most important in terms of plant cover is the *mopane* woodland complex which is sub-divided into four variants: *mopane* woodland with or without coppice (45%); *mopane* woodland with *Croton* thicket (0.1%);

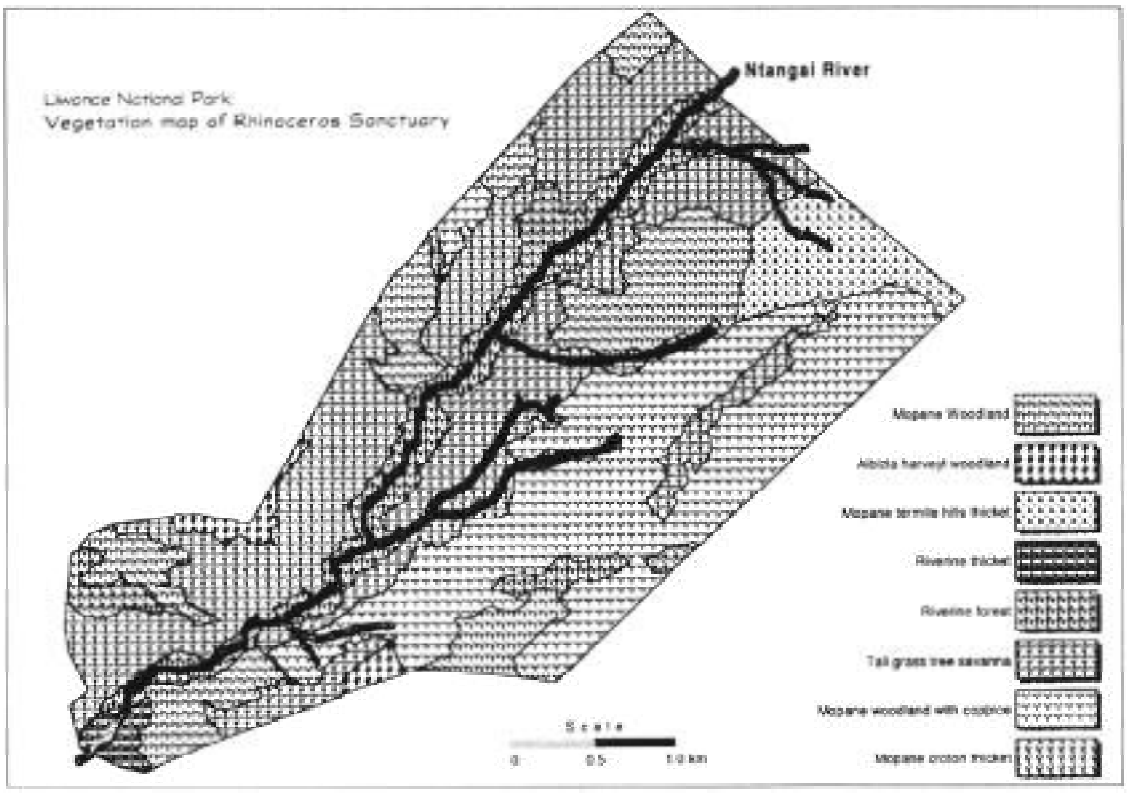

Figure 2 Vegetation map of/he rhino sanctuary in Liwonde National Park

A. harveyi woodland (1%) and *mopane* clump savanna (9%). The second most dominant community is the tall, grass-tree savanna, which covers 35% of the sanctuary. At the edges of this community, the woodland is actively invasive and small, fire-coppiced woody plants are numerous. This may prove, ultimately, to be the most important area for rhino browse. The third community is the riverine forest/ thicket covering 10% of the sanctuary. Where this community has few trees, a second variant, riverine thicket, is delineated (1%).

Observations in the bomas

At Kruger, the male rhino was watched for 18 days while the female, who was captured a few days after the male, was observed for 11 days. At Liwonde, both rhinos were observed for 47 days in the boma (27 October - 22 December 1993). There was no statistically significant difference in posture recordings (time spent standing or lying down) between Kruger and Liwonde for either animal.

There was a statistically significant difference in the behaviour of the female in the two sites (c^2= 11.51, df=3, p<0.1). She was calmer in Liwonde than at Kruger. The male, however, was calm and alert at both sites. Neither of the animals was aggressive or depressed. The general body condition of the male (as observed from the rib region) improved significantly in Liwonde (c^2=9.l, df=2, p<0.1).

All other conditions (defaecation, urination, appetite) appeared normal at both sites and were not tested statistically. There was no sign of reproductive behaviour.

Movements, habitat preferences and food selection in the sanctuary

The rhinos were released from the bomas in Liwonde on 21 and 22 December 1993. After an initial period of being solitary, they were first seen together on 16 January 1994 and have remained together ever since. Their movements are illustrated in Figure 3, and can be described as follows:

January-March (after release from the bomas)

They walked frequently up and down the sides of the Ntangai River and its two major tributaries. They were often seen resting in the southern section near the

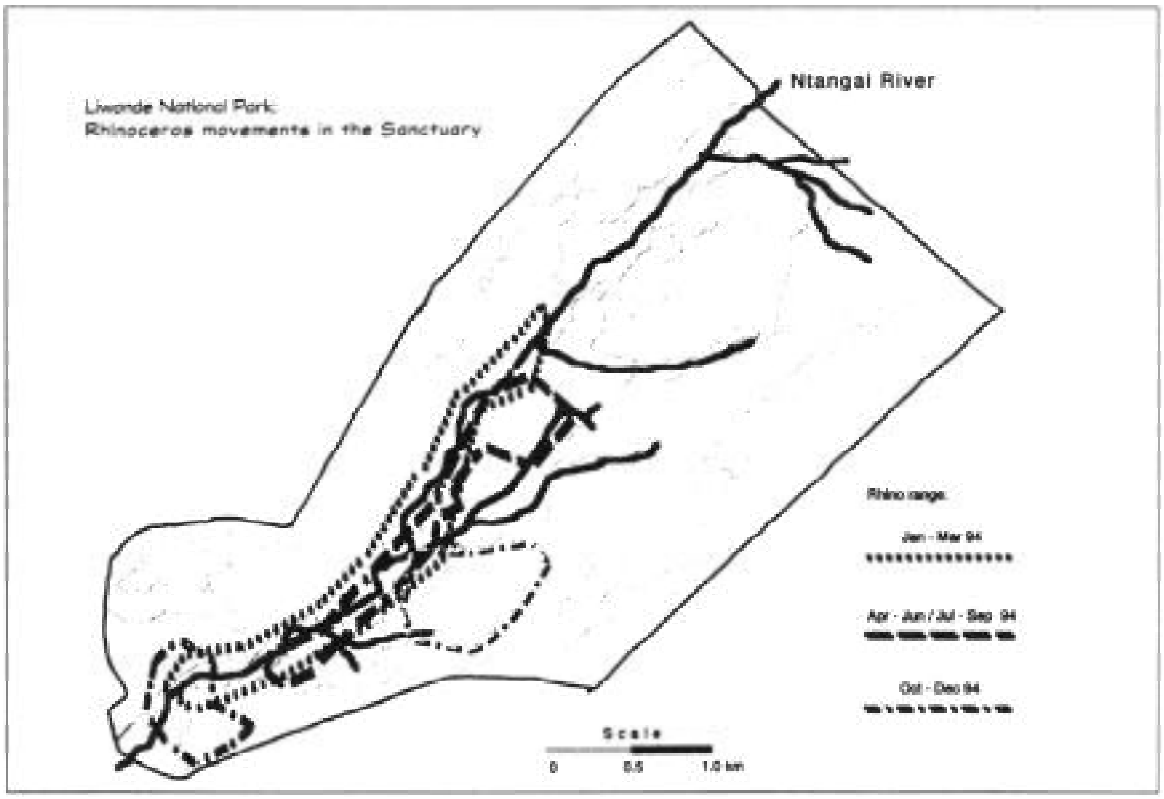

Figure 3. Rhino movements and range in the rhino sanctuary

bomas. Their range averaged approximately four square kilometres.

April-June

They were always seen together. Their activities were concentrated in the south-east and sometimes in the central area of the sanctuary. Their movements up and down the river banks continued and their range averaged at 3.5-4km2.

July-September

At the end of July all the natural water pools dried up. The rhinos moved in the same general pattern as in the previous three months. There were no signs of the rhinos drinking at the artificial water hole throughout this period. They knocked down and fed on *Euphorbia ingens* in the western area of the sanctuary.

October-December

Most of the rhinos' activity was concentrated along the Ntangai River. They were seen occasionally in the south and north of the sanctuary. They continued to knock down large numbers of *E. ingens.*

The adapted PIs for each vegetation type in the sanctuary are given in Table I. The calculations indicate that the *mopane-Croton* thicket, the *A. harveyi* woodland, the riverine thicket and the riverine forest, were the most preferred habitat types for the rhinos. All these areas occupy small proportions of the sanctuary.

Table 1. Vegetation communities in the rhino sanctuary showing the proportion of sanctuary area, with rhino frequencies observed in each community and the calculated preference index (PI) for each community.

Vegetation Community Type	**Proportion of sanctuary**	**Number of times rhino seen**	**Proportion of count**	**Preference index**
1. Riverine forest	0.09	8	0.1026	0.122
2. Tall grass tree savanna	0.35	15	0.1923	- 0.451
3. *Albizzia harveyii* woodland	0.011	7	0.0897	0.988
4.Mopane-*Croton* thicket	0.001	7	0.0897	0.989
5.Riverine thicket	0.01	6	0.077	0.870
6. *Mopane* woodland with coppice	0.45	33	0.423	- 0.060
7. *Mopane* termite hill thicket	0.09	2	0.423	0.715

Plant species eaten

There are 40 species of woody plants from 18 families which have so far been selected by the rhinos, as listed in Table 2. Woody species which were eaten throughout the year were *A. nigrescens, A. sp., C. mopane, Combretum fragrans, E. ingens and Ziziphus mucronata*. In the drier half of the year, *D. melanoxylon* was eaten in large quantities.

Table 2 Plant species eaten by rhinos in the sanctuary during their first year in Liwonde, in four periods: January to March (J-M), April to June (A-J,), July to September (J-S) and October to December (O-D). The list for J-M includes plants which were eaten in the Liwonde bomas.

Plant species eaten under each family	**Period of year**			
	J-M	**A-J**	**J-S**	**O-D**
Annonaceae	*			
Anisotes formosissimus	*	*		
Cleistochlamys kirkii	*			
Friesodielsia obovata				
Asclepiadaceae				
Fockea multiflora				*
Apolynaceae				
Strophanthus nicholsonii			*	
Burseraceae				
Commiphora africana	*			
Caesalpinoideae				
Cassia abbreviata	*			
Colophosopermum mopane	*	*	*	*
Capparanceae				
Capparis tomentosa	*			
Thilachium africanum	*			
Combretaceae				
Combretum apiculatum				*
Combretrum fragrans	*	*	*	*
Combretum imberbe	*	*		
Combretum mossambicense	*			
Terminalia stenostachya	*			
Euphorbiaceae				
Croton gratissimus	*			
Croton megalobotrys	*	*		

Table 2(contd,)

	J-M	A-J	J-S	O-D
Euphoiphia ingens	*	*	*	*
Phyllanthus reticulatus	*			
Malvaceae				
Azanza garckeana	*		*	
Mimosaceae				
Acacia sp.	*	*	*	*
Acacia nigrescens	*	*	*	*
Acacia polyacantha	*			
Acacia xanthophloea	*			
Albizia anthemintica	*			
Fabaceae				
Dalbergia boehmii	*			
Dalbergia melanoxylon			*	*
Lonchocaipus capassa	*			
Melletia usaramensis	*			
Pericopsis angolensis	*	*		
Rhamnaceae				
Ziziphus mucronata	*	*	*	*
Rubiaceace				
Canthium frangula				*
Crossopteryx febrifuga	*			
Xeromphis obovata				*
Salvadoraceae				
Salvadora persica	*			
Sapindaceae				
Lecaniodiscus fraxinifolius	*			
Solanacae				
Solanum incanum	*			
Tiliaceae				
Grewia bicolor		*		
Grewia monticola				*
Grewia stolzii				*

DISCUSSION

The potential for additional rhino introductions can be assessed in the sanctuary because the vegetation communities in the sanctuary represent some of the major communities of the Park, with the notable exception of the *Typha* and *Phragmites* swamps, the floodplain/grasslands and the mixed woodlands of the hills. *The mopane* complex communities, which occupy the biggest proportion of the sanctuary (55%) are more dominant in the Park itself (74%), while the tall grass-tree savanna occupies about twice the area in the sanctuary as in the Park. In spite of the differences in these proportions, the sanctuary is still representative of the Park's woodland communities. This is important from a management point of view, because the success or failure of rhino survival in the sanctuary may reflect the future survival of rhinos in the Park.

Observations in the bomas indicated that the rhinos were well adapted to the Liwonde environment by the time they were released into the sanctuary. The lack of reproductive signs was expected because the animals had not yet reached sexual maturity. Most researchers agree that sexual maturity in the black rhino is attained at about seven years of age for females and eight years in bulls (Bertschinger, 1994). The two rhinos in Liwonde are now sexually mature and the female shows signs of being pregnant.

The initial movements of the rhinos after their release from the bomas seemed to be exploratory. They may have been looking for the most suitable habitat. Their average range of approximately four square kilometres is similar to that of rhinos in Hluhluwe, (1.7-4.2km^2) and Andries Vosloo (0.5-2.0km^2) in South Africa (Adcock, 1994).

The habitats preferred by the rhinos all occupy minor proportions of the sanctuary. However, this interpretation is based on a very limited number of observations and is only indicative of true preference. Despite this, the results bear some similarity to observations made by Emslie & Adcock (1994) in Hluhluwe-Umfolozi National Park in South Africa where dense, riverine forest was the most preferred rhino habitat. Riverine forest/thicket was also preferred by the rhinos in Liwonde. Emslie & Adcock (1994) also reported that very tall grassy areas were rejected by rhinos, which seemed to be the case in the sanctuary too.

The application of an adapted PI formula to this data worked well. However, more observations need to be included from vegetation communities which occupy larger proportions of the sanctuary in order to establish the validity of the PIs for the sanctuary.

Although 40 species of plants are listed as being eaten by the rhinos, the number will probably increase substantially, particularly when herbacious species are recorded and when observations intensify. Smithers (1983) stated that over 200 plant species are eaten by the black rhino, while Goddard (1970) recorded 102 species eaten in Tsavo National Park, Kenya. However, Emslie & Adcock (1994) found that only a few woody species (about ten) account for the bulk of the black rhino's diet. In Liwonde, six "key" species were utilised throughout the year, namely *C. mopane, A. nigrescens, A. sp., E. ingens. C. fragrans* and *Z mucronata.*

Emslie & Adcock (1994) noted that plants with a high moisture content, such as leguminous plants and species in the Euphorbiaceae family, are important dietary items for black rhinos. Both Goddard (1968) and *Loutit et al.* (1987) specified that the *Euphorbia* was an important food item and that *Euphorbia* species, along with other succulent plant species, provide rhinos with water in the absence of free water. These findings seem consistent with those of the Liwonde sanctuary study, from which it was noted that ten leguminous species, four *Euphorbia* species and one species each from the Asclepiadaceae and Apolynaceae families, were among the list of browsed species.

We believe that *E. ingens* played an important role in providing moisture during the late dry season in 1994. This woody plant is filled with a white latex fluid which is toxic to some animals but does not seem to harm the rhino. The rhinos began to feed on the *E. ingens* very soon after their release from the boma and have caused major destruction of the species over the last 16 months. In the western half of the sanctuary, where E. ingens is very common, all the *E. ingens* less than 17cm in diameter in the monitoring plots have been destroyed. The feeding is wasteful, as the rhinos usually push the plants over and feed on the stems lying on the ground. Plants over 20cm in basal diameter are probably safe from being pushed over. There was a noticeable increase in the amount of woody parts from *Euphorbia* species found in rhino dung in the late dry season.

Fockea multiflora, a large, latex-filled liana, also showed signs of being fed upon heavily as the dry season progressed in 1994. Some of these plants have had most of their basal stems eaten away by rhinos.

However, none of them has died so far due to damage. Hall-Martin *et al.* (1982) reported that *F edulis* was eaten by rhinos in Addo National Park, South Africa.

While the two rhinos in Liwonde were able to survive comfortably throughout the long dry season, presumably due to feeding on succulent plants, this does pose a problem for any future rhino introductions into the sanctuary. Artificial water holes will be needed if the succulent plants become too few.

ACKNOWLEDGEMENTS

The rhino introductions were made possible by the generous assistance of the South African government through the Malawi/South Africa Wildlife Project, the J and B Distilleries "Care for the Rare" programme (UK), the J and B Circle (Malawi) and the South African Air Force, which transported the rhinos to Malawi. We would like to thank the Parks and Wildlife Research Assistant, E. Sichali, and Research Scouts, A. Gausi, J. Mtima and C. Engelesi, for their dedication during data collection. We thank Central African Wilderness Safaris for their hospitality and for providing accommodation and general help to C.Dudley while in the Park. Thanks are also due to Dr. F. non Roene, the GTZ Technical Adviser at Liwonde Hospital, for allowing us access to the computer to draw the sanctuary maps. Finally, our thanks to the Director, National Parks and Wildlife, for granting permission to publish this paper and to Mrs. Bhima for typing the final manuscript.

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