Koedoe 20: 147–162 (1977)

BEHAVIOUR AND RECRUITMENT OF TRANSLOCATED BLACK RHINOCEROS *DICEROS BICORNIS*

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Abstract – Black rhinoceros were translocated to the Addo Elephant National Park from Kenya and released into a small fenced enclosure. Serious fighting attributed to the conditions under which the animals were released, the unusually high population density, the meeting of strange animals, aggression associated with mating and individual temperament resulted in the deaths of three animals within three weeks. Later fighting between bulls accounted for two more animals. A peak in mating activity was recorded during spring to midsummer, followed by a peak calving period in late summer. The calving interval (35 months) is longer than that of unrestricted populations but ages at first mating in cows (4 years 6 months, 4 years 7 months) are comparable. First parturition at Addo occurs later (8 years, 8 years 5 months) than in wild animals and the young are hidden for the first few days after birth. Under conditions of stress a subadult bull readily took to swimming as a means of escaping from other animals.

Introduction

Black rhinoceros *Diceros bicornis michaeli* Zukowsky (Ansell 1971) were translocated to the Addo Elephant National Park (AENP), Republic of South Africa, in 1961 and 1962 from the Kiboko area in southeast Kenya (Carter 1965; Penzhorn 1971). The southern subspecies *D.b.bicornis* Linn. had been exterminated from the Addo area by 1853 (Shortridge 1934); though still surviving in Zululand, none were available for translocation. After acclimatizing, the Kenya animals were released into a fenced paddock. The rhinoceros were individually recognised and named, and records were kept of matings, births, deaths and overt behaviour. During June 1977 they were released into a much larger area where, due to the dense nature of the vegetation, it is unlikely that further regular observations will be made. The purpose of this report is therefore, to place on record the re-establishment of the black rhinoceros at the AENP and observations on behaviour and reproduction.

Study area

The AENP, 7 735 ha in extent, is situated in the southeastern Cape Province of South Africa at 33°13'S, 25°45'E. The AENP lies 25 km from the coast of Algoa Bay and is 60 km from the metropolitan area of Port Elizabeth. The rhinoceros enclosure, in the southwestern corner of the Park lies at an altitude of 75–100 m above sea level. The vegetation is partly spekboomveld and partly karoo-bushveld (Archibald 1954; Penzhorn and Olivier 1974) which is well adapted to local climatic conditions. The spekboomveld is dense, low, multi-stemmed, evergreen tree and shrub thicket dominated by *Portulacaria afra, Schotia afra, Euclea undulata, Capparis sepiaria* var. *citrifolia* and *Azima tetracantha*. The karoo-bushveld is an open community of low karroid shrubs such as *Pentzia globosa, Justicia orchioides, Lampranthus productus, Ruschia* spp. and grasses with scattered clumps of tall shrubs and small trees chiefly *Rhus* spp. The climate is semi-arid with rain falling during all seasons. The wettest months are August and March to May. The summer months (November–March) are hot and the winters (June–August) mild; frost is rare. Mean annual rainfall for the period 1961–1975 was 399,7 mm (recorded at Sundays River Research Station, 3 km south of the rhinoceros enclosure). Rainfall and temperature are summarised in a climatic diagram (Fig. 1) after Walther (1963).

Methods

This paper is based on observations made by ourselves over the period 1968–1977, and information gleaned from relevant reports since 1961 by other officials of the National Parks Board. We consider some reports to be speculative or based on misidentifications. All such suspect reports have been ignored. Wherever possible we have interviewed the people associated with the re-introduction project. The Kenya animals are referred to throughout this paper by the names given them by Carter (1965), and those born in the AENP by the prefix 'A' and a number, rather than by their names.

Observations and discussion

After successful negotiations with the Kenya Game Department the first consignment of two adult black rhinoceros arrived at the AENP on 1961.03.20. The capture and transport of these animals is described by Carter (1965). He had named the bull "J.A." (later corrupted to Jack) and the cow "Brunni". The animals were kept in separate, but adjoining quarantine pens at the Park Headquarters for three weeks, and on 1961.04.15 were crated and moved to a 2 ha enclosure near Caesar's Dam in the southwest of the Park. The two rhinoceros were restless during the move and both crates, which were placed next to one another were unfortunately opened simultaneously. The cow Brunni came out first and attacked JA who was still backing out of his crate. This was followed by some sparring, but no serious injuries were reported. On

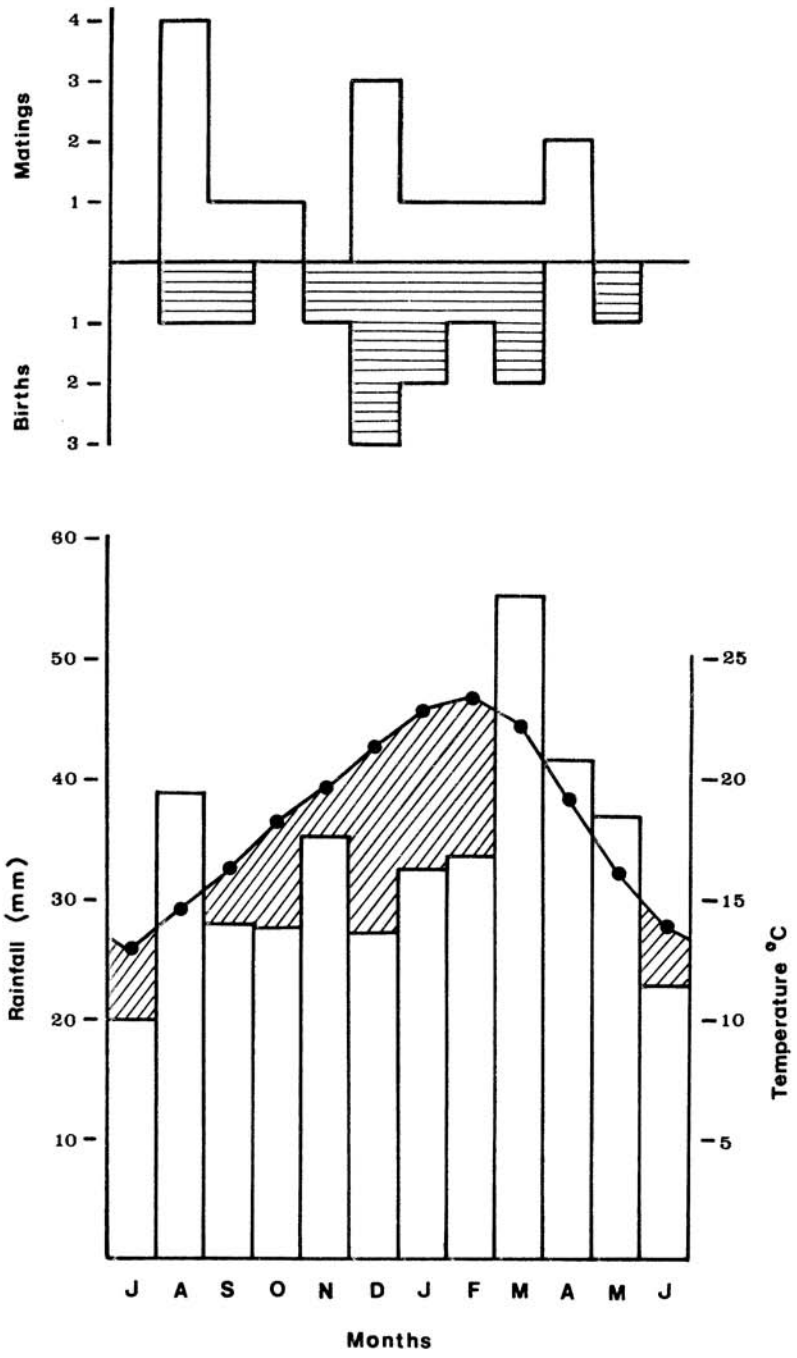

Fig. 1. Climatic diagram for Addo (Sundays River Research Station, 1961–1975) showing arid period (diagonal hatching) prevailing for most of the year. Relative frequency of black rhinoceros matings and births in each month for the same period are also shown.

1961.06.12 they were released into a large enclosure (152 ha). By the end of that month the fighting bouts had ended and the animals were thereafter regularly seen together. Mating was reported on 1961.08.14.

Translocation of second group

A second group of five black rhinoceros was delivered to the AENP quarantine pens on 1962.01.22. Carter (1965) who described their capture, and journey to South Africa, had also named these animals. There was an adult bull "Darkie"; a subadult bull "Christopher" who was still with his mother when captured and was therefore likely to be less than 4 years old, a large cow named "Ida", and two other cows "Marty" and "Jenny". Marty was about 2 years old and still accompanying her mother Brunni when the latter was captured in 1960 (Carter 1965). She would therefore have been 3–4 years old when she arrived at the AENP, having been separated from her mother for at least 16 months (October 1960–January 1962). On 1962.02.24 the five animals were loaded into crates at the quarantine pens for the 13 km journey to their release point in the 152 ha enclosure occupied by J.A. and Brunni. The crates, which were fitted with sliding doors lifted by men perched on top, were offloaded about 5 m apart and the rhinoceros were released in quick succession. There were many onlookers and vehicles moving around the release point; full coverage was provided by press and radio teams and it can only be concluded that the resultant noise and activity contributed to the extreme state of excitement in which the animals left the crates. One charged a truckload of spectators, one chased a Land Rover full of radio engineers recording the event, one attacked its crate and fighting among the newly released animals, as well as between the new animals and the resident cow Brunni erupted immediately after the release. The first fatality was Marty, who was gored by her mother Brunni and was subsequently found dead in Caesars Dam seven days after the release. A post mortem examination revealed many internal bruises and external wounds. On 12 March after a week of heavy rains (102 mm) another cow of the new batch, Jenny, was injured in a fight with Brunni and died during the night of 14 March. On 15 March the subadult bull Christopher was badly injured in a fight with Ida who also received severe wounds, Christopher died the same afternoon. The Warden feared that Brunni might kill the wounded Ida as they had been fighting regularly since the release and he spent many nights in the enclosure trying to keep them apart. He finally succeeded in isolating Ida by dividing the enclosure on 6 April. However, as Ida was considerably larger than Brunni (Nick Carter, *pers. comm.*) she was probably not as vulnerable as the smaller cows.

The situation remained stable until October 1962 with Ida alone in her enclosure of 32 ha and Brunni together with the two bulls J.A. and Darkie (who had taken no part in the fighting) in the other enclosure of 120 hectares.After friendly contact was established between Darkie and Ida, as shown by nuzzling through the fence, the Warden succeeded in

getting Darkie into Ida's enclosure on 1962.10.14. This was followed by a report of these two animals mating. The enclosure containing Ida and Darkie was enlarged by the addition of 105 ha in August 1963; a more equitable division of the area between the two pairs of rhinoceros was also made. In 1965 the fence separating the two groups of rhinoceros was removed and all the animals (by then a total of six) shared an area of 257 hectare. In 1967 this was reduced to 152 ha (seven animals) and finally increased again in 1969 to 210 hectare. The crude population densities resulting from these changes are shown in Table 1.

Table 1

Crude population densities and intra-specific aggression of black rhinoceros in the Addo Elephant National Park, 1961–1977

Year	Rhinoceros Adult ♂	Adult ♀	Subad. ♂	Subad. ♀	Total	Area (ha)	Density (Rhino/km²)	Aggression
1961	1	1	0	0	2	152	1,3	Low intensity
1962	2	3	1	1	7	152	4,6	Serious fighting, 3 deaths
1965	2	2	0	2	6	257	2,3	None
1967	2	2	1	2	7	152	4,6	Some fighting, soon stopped
1969	2	3	1	2	8	210	3,8	None
1972	3	3	0	1	7	210	3,3	Serious fighting between older bulls, 1 death
1974	2	4	2	1	9	210	4,3	Serious fighting between bulls, younger bull killed
1975	1	4	3	2	10	210	4,8	None
1977	1	4	3	3	11	210	5,2	Some fighting between sub-bulls

Behaviour

Aggression

The fighting between J.A. and Brunni, when they were in the 2 ha enclosure, was due to Brunni being aggressive, but this stopped when they were released into a larger area. It appears from reports that initially all the fighting after the release of the second group was between cows, with Brunni killing off her daughter Marty, and then Jenny, and also fighting with Ida. Christopher, the subadult bull, was also involved in aggressive encounters with Brunni, his attempts to avoid contact by swimming through a dam to get to a neutral corner are discussed below. The encounter which led to his death occurred when Ida was on heat, having mated with one of the adult bulls (J.A.) the previous day. That there was thus a sexual connotation to the fight between Christopher and Ida is a possibility, because if the estimate of his age is correct he would have been close to the age of sexual maturity as given by Goddard (1970). However, he was still with his mother when captured (Carter 1965) and

it is thus more realistic to assume that the only sexual influence on the event was that Ida was highly excitable.

There are no reports of the two adult bulls fighting either with one another, or with the cows, during the initial period or during the time that they shared the 120 ha enclosure with Brunni (April to October 1962). However, soon after the bulls were separated, regular bouts of fighting through the boundary fence erupted between them, being particularly notable from December 1962 to April 1963. These engagements always took place at night. During this period Brunni, who was pregnant, became increasingly intolerant of J.A., particularly so in February 1963, when she was 8 months pregnant. Any vehicles that ventured into her enclosure were also charged. She apparently did not allow J.A. to approach her again until May 1963 when she was 11 months pregnant.

Ida was generally reported to be intolerant of Darkie, especially at the feeding site where *Euphorbia bothae* (noors) branches were regularly put out for them. If Darkie approached too closely he was charged and he invariably fled.

Despite the apparent regular aggressive encounters between the bulls and cows, successful mating took place and both cows calved. In September 1964 when Brunni's calf was one year old and Ida's was six months old, the Warden noted new outbreaks of fighting between the bulls and their respective cows. This he considered to be a good indication of imminent mating. In January 1965 Darkie managed to get into his neighbours section and after some fighting with J.A. he fled back into his own area. In December 1965 Ida and her 21 month old female calf broke into J.A. and Brunni's section. Ida charged Brunni on sight and the latter cow fled, very likely still weak from having given birth to a male calf a few days earlier. A Park employee in a vehicle approached the scene and was also promptly charged by Ida and her calf and the vehicle was severely damaged. No further incidents of fighting were noted, even after the intervening fence between the two sections of the rhinoceros paddock was removed and during later changes to the paddock size (Table 1), until February 1972 when Darkie killed J.A. after a period of regular fighting lasting 4–6 weeks. In May 1974 Darkie killed a bull which was 8 years 5 months old (offspring of Brunni and J.A.) after fighting regularly for several days. This was the last serious fight reported.

The extreme intra-specific aggressiveness of the introduced rhinoceros is contrary to their behaviour in the natural state. Thus Schenkel and Schenkel – Hulliger (1969) who studied black rhinoceros in Tsavo National Park East, only 80 km–100 km east of where the Addo rhinoceros were caught, reported that intolerance and hostility between females is extremely rare, while they found intolerance between bulls to be somewhat more frequent. Similar findings that intra-specific intolerance and aggression are not important features of behaviour within established communities, where individual animals are known to one another, have also been reported for black rhinoceros in Ngorongoro crater (Goddard 1967), and in South West Africa (Joubert and Eloff

1971). However, Goddard (1967) noted aggressive behaviour shown towards "strange" rhinoceros entering the Ngorongoro crater, and both Ritchie (1963) and Guggisberg (1966) considered regular fighting between cows in oestrus and bulls to be normal. This 'fighting' may be nothing more serious than the pre-copulatory 'jousting' reported by Goddard (1966) who, however, also reported vicious fights between bulls over an oestrus cow and vicious attacks by cows on bulls before and after copulation.

A parallel case of serious fighting following introductions of black rhinoceros to confined areas occupied by a resident population has been reported from South West Africa (Hofmeyr 1975; Hofmeyr, Ebedes, Fryer and de Bruine 1975). Twenty black rhinoceros (males, females, adults and young) were released into a 13 550 ha enclosure in the western part of the Etosha National Park. This enclosure supported a resident population of 11 animals (eight of which were adults). Five of the introduced animals were killed in fights from 2–6 weeks after the introductions, and one bull had to be recaptured and moved to another part of the Park. Subsequently another three fatalities were recorded, but it is not certain that these were due to fighting (E. Joubert *pers. comm.*). Both bulls and cows were involved in the fighting and Hofmeyr (1975) and Hofmeyr *et al.* (1975) suggested that there was evidence that in some cases the fighting had been between animals which had developed hostility towards one another during a protracted period of captivity. Herbert and Austen (1972) reported a similar occurrence in Rhodesia among black rhinoceros translocated from Kariba to the Wankie National Park. A successful translocation of six males and two females was carried out in October 1962. A second group of three females and one male was moved to the same area in March 1963, and in April 1963 one of these females was found dead. Her injuries indicated that she had died as a result of fighting with another rhinoceros. In May 1963 a male rhinoceros was found that had also died of injuries sustained in a fight and it was assumed that this was the animal which had fought and killed the female. The report does not state whether the male belonged to the first or second group of animals.

The facts of the Addo case thus sit easily with reports of other workers – and the fighting can most probably be attributed to the release of strangers into the home range of established animals; a predisposition to aggression in some mating animals (Ida was mated during the period of greatest fighting); and the possible effect of unusually high population densities. The temperament of the individual animal also seems to have played a role. Carter (1965) had come to know his charges intimately and he describes Brunni, Ida and Darkie as fierce and antagonistic, whereas J.A. and Jenny were more tranquil beasts. In all cases the fierce animals killed the meek. The 16 month period of separation of Brunni from her calf Marty was apparently sufficient to negate the cow-calf bond, which is usually broken by the time the calf reaches 3–4 years of age, or earlier if there is a new calf (Schenkel and Schenkel-Hulliger

1969; Goddard 1967; Joubert and Eloff 1971). It was ironic that the first animal to be killed by Brunni was her calf.

An important aspect of both the Addo and Etosha black rhinoceros situations which might have influenced the aggressive encounters, is the artificially created high population densities which would have resulted in more contacts between individuals than would be the case in the wild where the species is essentially non-gregarious (Goddard 1967; Schenkel and Schenkel-Hulliger 1969; Joubert and Eloff 1971). The crude population densities (Table 1) of black rhinoceros at the AENP were considerably higher than those in wild populations as tabulated by Hitchins (1976) for Zululand and several East African localities. These data show that in East African populations the crude population density ranges from 0,02–0,75 rhinoceros per km² and in Zululand from 0,05–1,7 per km². The densities reached at Tsavo, 0,3–0,4 per km² (Goddard 1969) or 0,6 km² (Schenkel and Schenkel-Hulliger 1969) would represent the maximum densities to which the Addo rhinoceros might have been exposed before being moved. Though it is far more likely that they were found at much lower densities than in Tsavo National Park as they were all caught in a settled area outside the Park. As shown in Table 1 there was little or no fighting at the lower densities, but serious fighting at the high densities, except when there was only one adult bull. The rhinoceros translocated to Etosha occurred in small groups with shared home ranges scattered over very large areas (Joubert and Eloff 1971; Hofmeyr *et.al.* 1975). From the data of Joubert and Eloff (1971) a rough population density of 0,14–0,18 per km² is inferred (mean family group of 5,7 animals occupying a home range of approximately 31,0 km–41,0 km²) for the western parts of Etosha National Park, where the density is likely to be considerably higher than among the scattered and persecuted animals which were captured for translocation (Hofmeyr *et al.* 1975). The crude population density in the Kaross paddock would have been 0,23 per km² – considerably greater than that which the captives had experienced previously. Though Hitchins (1976) has shown a density dependant mortality in black rhinoceros due to competition for food, there is no further information in the literature on density dependant aggression resulting in increased mortality in the black rhinoceros.

Behaviour of cows with new calves

Brunni gave birth to a female calf (A1) on 1963.09.06, which she kept hidden with her in dense thicket until late in October 1963. During this period she only drank at night, the calf accompanying her to the water. This was her first calf in the AENP, and it stayed with her until chased away in December 1965 at the age of about 27 months when she produced her next calf. This behaviour was repeated at each subsequent birth in August 1968, December 1972 and November 1975. Ida gave birth to her first calf in the AENP, also a female (A2), on 1964.03.26. At the time she was completely habituated to the feeding of *Euphorbia bothae*

branches by the Ranger whose call she would answer by trotting out of the bush. However, after giving birth she ignored the call to be fed for two nights, staying among dense thickets with her calf. On the third evening she came to eat without her calf, leaving it alone in dense bush. This was repeated for a week or so until early April when the calf came out with her to the feeding place. A similar case of a black rhinoceros cow leaving her new calf hidden for about three nights was reported by Joubert and Eloff (1971). A second calf (A4) was born to Ida in January 1968 and was killed in August 1968. It was not known whether she had chased the first calf (A2) away, however, A2 was accompanying her at the time of her third calving in January 1970. She then chased A2 away and only allowed A2 to rejoin her and the new calf (A6) after about three months, at this time A2 was 6 years old and already sexually mature.

Two of Brunni's offspring A5 and A9 when chased away by her in December 1972 and November 1975 respectively, joined up with a cow (A1) who herself had a young calf (A7) born in February 1972. This foursome was regularly seen together until late 1976 when increased sparring between bulls A7 (4 years 10 months old) and A9 (4 years old) led to A9 becoming solitary for extended periods. Mostly, however, the four animals behaved as one activity unit – moving, resting and feeding in unison.

When the cow A2 gave birth to her second calf (A10) she chased away her first calf (A8) then 4 years 9 months old. This animal (A8) has remained solitary ever since and is seldom seen in company with others. On 1977.05.28 when A10 was 29 months old she was found alone and in a very restless state. Later the same day her mother A2 was found in dense bush with a new calf whose age was estimated at 7 days. Over the following few days many unsuccessful attempts by A10 to rejoin her mother were seen, but A2 consistently charged at her viciously and chased her off. In one incident the infant was also seen to charge at A10. Later A10 was several times seen in company with her older sister A8. The discarding of older calves by rhinoceros cows at the birth of a new calf, and the attempts of such rejected animals to join up with other rhinoceros as soon as possible, or to rejoin the mother and the new calf after some time is also well known (Goddard 1967; Schenkel and Schenkel-Hulliger 1969; Joubert and Eloff 1971).

Inter-specific association

A young female eland *Taurotragus oryx* and male red hartebeest *Alcelaphus buselaphus* were released into the rhinoceros enclosure some time before 1968. The hartebeest was often seen close to rhinoceros but more commonly alone. The eland cow, however, is a constant companion of the group of four black rhinoceros (A1, A5, A7 and A9) moving, feeding and resting with them. On many occasions – due to her superior eyesight – she warned the rhinoceros of the approach of a person or vehicle by staring intently at the intruder, snorting or running away. When the eland cow fled from the resting group the rhinoceros

would immediately rise and follow even though they might not have detected the source of disturbance.

Cattle egrets *Ardeola ibis* regularly hunt insects while striding along next to feeding black rhinoceros. On numerous occasions they were seen perched on the backs of standing, feeding or sleeping rhinoceros of both sexes and all ages. A similar association has been observed in East Africa (Schenkel and Schenkel-Hulliger 1969).

Reactions to dead rhinoceros

When the old cow Ida died in 1970 her body was guarded for several days by Darkie. He charged the vehicle which tried to get to the carcass on several occasions. Though a pair-bond is not a feature of black rhinoceros behaviour, Darkie was more often in Ida's company than the other bull and he was the father of at least one of her calves (A2) if not all of them.

Darkie died late in the afternoon of 1977.06.09. The following morning fresh rhinoceros droppings and tracks were found about 15 m from the body. There was no indication that any of the rhinoceros had approached any closer, though the eland cow had stood within 2 m of the body and urinated.

Swimming

During the period of intense fighting after the introduction of the second group of rhinoceros, a sharp corner of the enclosure was fenced off to prevent any animal from being trapped there by an attacker. The elevator cables forming this fence were carried 20 m into Caesar's Dam where the water was over 1 m deep. The Warden records that the subadult bull Christopher used to swim around this fence to get to the cut-off corner where he was safe from the attacks of the cows. Elsewhere black rhinoceros are poor swimmers and do not like deep water (Child 1968). All the instances quoted by Child (1968) of black rhinoceros swimming, referred to animals trapped on islands by the rising waters of the newly formed Lake Kariba.

Recruitment

Mating and Calving

During the period 1961–1977 matings were reported on 14 occasions. Whether intromission always occurred cannot be stated with confidence as all reports came from lay observers. Only one of these observed matings was apparently fertile, assuming a gestation period of about 454 days in this species (Joubert and Eloff 1971; Mentis 1972). The distribution of these matings would, nevertheless, presumably reflect oestrous periods in cows (Fig. 1). Most matings (64%) were reported between August and December (spring to mid-summer) and none were reported from May to July (late autumn and winter).

During August temperatures are rising (Fig. 1), photoperiod is increasing markedly (List 1951) and the small rainfall peak which marks the end of the relatively dry winter period stimulates new plant growth. A spring to mid-summer peak in mating activity would be expected to result in a peak calving period in mid- to late summer. The records of 12 births (Table 2 and Fig. 1) show that 66% of these occurred during this period from December to March. Among other black rhinoceros populations, though mating activity has also been observed throughout the year, wet season (summer) mating (Schenkel and Schenkel-Hulliger 1969) and birth peaks have been reported (Ritchie 1963; Goddard 1966; Klingel and Klingel 1966; Joubert and Eloff 1971).

Table 2

Summary of black rhinoceros births and deaths in the Addo Elephant National Park, 1961–1977

(a)

Date	Sex	Code	Births Name[1]	Mother[1]
1963–09–06	♀	A1	Lucky Star	Brunni
1964–03–26	♀	A2	Doreen	Ida
1965–12–?	♂	A3	Klein Jack	Brunni
1968–01–27	♀	A4		Ida
1968–08–?	♀	A5	Blom	Brunni
1970–01–20	♂	A6		Ida
1972–02–07	♂	A7	Rosenblum	Lucky Star
1972–03–16	♀	A8	Klein Ida	Doreen
1972–10–29	♂	A9	Jack	Brunni
1974–12–28	♀	A10	Slattery	Doreen
1975–11–02	♂	A11	G. Edwards	Brunni
1977–05–21	♀	A12	Vossie	Doreen

(b)

Date	Sex	Code	Deaths Name[1]	Age/Class	Cause
1962–03–03	♀		Marty	Subadult	Fighting – Brunni
1962–03–15	♀		Jenny	Adult	Fighting – Brunni
1962–04–02	♂		Christopher	Subadult	Fighting – Ida
1968–08–?	♀	A4		7 months	Killed by buffalo
1970–03–?	♂	A6		3 months	Killed by dogs
1970–09–01	♀		Ida	Old adult	Natural
1972–02–04	♂		J.A.	Adult	Fighting – Darkie
1974–05–?	♂	A3	Klein Jack	$8^{1}/_{2}$ years	Fighting – Darkie
1977–06–09	♂		Darkie	Old adult	Natural

[1]Names given to the animals by Carter (1965) or subsequently by the rangers at the AENP.

Calving Interval

Even though the rhinoceros at the AENP were subjected to social conditions which they would not normally have encountered in the wild, 12 calves were born in 15 years (Table 2a). The cows Brunni, Ida and A2 each produced three or more calves, with a mean calving interval of 35 months (Table 3). This is longer than the 27 months suggested for wild black rhinoceros (Goddard 1967; Joubert and Eloff 1971). Three of the AENP records (24, 27 and 29 months) are close to Goddard's (1967) and Joubert and Eloff's (1971) figures and fall within the range for both captive and wild black rhinoceros as given by Mentis (1972). The shortest calving interval (24 months) occurred when Ida's second calf was killed (Table 2b), mating must have taken place *ca.* 2 months after the loss of the calf. Shorter calving intervals resulting from lost calves and a rapid return to oestrus in the cow have also been reported in the giraffe *Giraffa camelopardalis* (Foster and Dagg 1972).

Table 3

Calving intervals of known black rhinoceros cows in the Addo Elephant National Park, 1961–1977

Cow	Calving intervals (months)	Mean (months)
Brunni	27 + 32 + 52 + 34	36
Ida	46 + 24	35
A2 – Doreen	33 + 28	31
	Mean for all cows	35

Gestation period

Only one recorded mating was followed by the birth of a calf within a period considered reasonably close to the mean gestation period of black rhinoceros as reviewed by Joubert and Eloff (1971) and Mentis (1972). This was a record of 455 days.

Lactation

During August 1976, the 19-month-old female calf (A10) of A2 was seen to suckle on several occasions. As she was too large to drink from a standing position she would lie down parallel to her mother, facing the opposite direction, and drink from the lying position. Similar behaviour in calves up to one year of age has been described by Schenkel and Schenkel-Hulliger (1969).

Age at sexual maturity and first parturition

The female A1 was mated for the first time at 4 years 7 months of age, and again at 5 years 6 months; she calved for the first time when she was

8 years 5 months old. The female A2 produced her first calf when she was 8 years old. A5 was first mated at 4 years 6 months and again at 6 years 6 months but with no success; she is now 8 years 10 months old (June 1977) and not obviously pregnant.

There is no direct evidence of the age at sexual maturity of male rhinoceros at the Park. However, A3 was killed at the age of 8 years 5 months by Darkie after protracted bouts of fighting. It is, therefore, assumed that A3 was mature at the time and was viewed as a competitor by the old bull who killed him. By contrast, Darkie never showed any interest in the young bulls A7 and A9 (5 years 4 months and 4 years 7 months old respectively) up to the time of his death in June 1977. The young bull A7 is still constantly with his mother (A1) and follows close behind her in the calf position. The other animal A9 tries to keep close to A1 as well and this often results in spirited sparring between the two young bulls. The cow (A1) usually supports her calf and the result is that A9 is often seen alone. During catching and marking operations in May 1977 the present calf (A11) of Brunni was separated from her for a day. The young bull A9, her previous calf, then rejoined her and was seen trotting behind her in the calf position. On the grounds of the immature behaviour of both A7 and A9, and that no manifestation of sexual behaviour towards cows has ever been seen, we conclude that these bulls are not yet sexually mature.

Goddard (1970) gives ages at sexual maturity of three black rhinoceros cows between 3,8–5,7 years and first mating of a bull at 4,3 years. Schenkel and Schenkel-Hulliger (1969) assume that cows in Tsavo reach sexual maturity at 3,5 to 4 years, and that first parturition occurs at 4,75–5,25 years. They state that bulls reach sexual maturity at 5,5–6,0 years but only reach full status at 8 to 10 years. Mentis (1972) cites records of first successful mating in captive black rhinoceros females at 6 and 8 years of age, but first matings occurred at 4,5 and 7 years respectively. First parturition in captives is given as 7+ years, 8+ years and 9+ years and age at first mating in a captive male is given as 6 years. Ages at first mating of the AENP females do not therefore, differ greatly from those reported elsewhere, though age at first parturition is closer to the records for captive animals than wild animals.

Lifetime production of calves

When Brunni was captured in October 1960 she was accompanied by Marty, a two-year-old calf (Carter 1965). If this was her first calf, then Brunni might have been 7–8 years old at the time. This estimate is based on an age at first calving in wild rhinoceros of 5–6 years (Goddard 1967, 1970; Schenkel and Schenkel-Hulliger 1969). Therefore, Brunni could have been born as early as 1952, and she would now (1977) be 25 years old. This estimate of her birth date and the record of her calf in Kenya plus the further five calves born to her at the AENP are, so far as is known, a unique record for black rhinoceros. If her reproductive life lasts to an age of 30–35 years (Schenkel and Schenkel-Hulliger 1969) she

might be expected to produce another two to four calves, giving a possible total of 8 to 10 calves in her lifetime.

Sex ratio

Of the 12 births recorded at the AENP, seven were females and five were males (Table 2a). This 1:1,3 sex ratio does not depart significantly from the theoretical 1:1 ratio ($P > 0,5$), and this agrees with the records cited by Mentis (1972).

Calf mortality

Two calf mortalities were recorded (Table 2b). A 7-month-old calf (A4) was trampled and killed by a bull buffalo *Syncerus caffer,* but no details of the incident are known. The second calf (A6) died at the age of 3 months after being savaged by a pack of marauding dogs *Canis familiaris.*

Conclusions

The black rhinoceros, an endangered species (von Richter 1974; Bothma 1975), has been re-established in part of its former range. With their release into a much larger area (4 000 ha) during June 1977 the rhinoceros population density of the AENP was reduced to a more realistic level of 0,25 per km^2. It is unlikely, therefore, that there will be any further deaths due to fighting in the forseeable future as weaker animals will be able to escape from stronger rivals, and all the animals know each other.

The experience at the AENP emphasises that the translocation of rare animals, especially aggressive animals, such as black rhinoceros, should only be undertaken with great circumspection. Adequate areas should be available for released animals so that crowding, and resultant fighting, are avoided. The release of animals separately, under calm conditions as advocated by Hitchins, Keep and Rochat (1972), is also clearly in the best interests of the animals.

Though scanty, the data on reproduction might indicate that the compression of the population has had an adverse effect on recruitment rate. This is shown by extended calving intervals and delayed sexual maturity (advanced age at first parturition) as compared with unrestrained animals. There are, however, also other factors, such as the availability of bulls and the possible effects of inbreeding which make firm conclusions difficult.

Acknowledgements

We thank E. Joubert, P.M. Hitchins and J. M. Hofmeyr for their valuable comments. We also thank P. van Straaten and K. Goliath for their assistance in the field.

REFERENCES

ANSELL, W. F. H. 1971. Part 14: Order Perissodactyla. *In:* MEESTER, J. and H. W. SETZER. Eds.: *The mammals of Africa: an identification manual.* Washington D.C.: Smithsonian Institution Press.

ARCHIBALD, E. A. A. 1954. An ecological survey of the Addo Elephant National Park. *J. S. Afr. Bot.* 20:137–154.

BOTHMA, J. DU P. 1975. Conservation status of the larger mammals of Southern Africa. *Biol. Conserv.* 7:87–95.

CARTER, N. 1965. *The arm'd rhinoceros.* London: Deutsch.

CHILD, G. 1968. Behaviour of large mammals during the formation of Lake Kariba. *Kariba Studies.* Salisbury: National Museums of Rhodesia.

FOSTER, B. and A. I. DAGG. 1972. Notes on the biology of the giraffe. *E. Afr. Wildl. J.* 10:1–16.

GODDARD, J. 1966. Mating and courtship of the black rhinoceros (*Diceros bicornis* L). *E. Afr. Wildl. J.* 4:69–75.

GODDARD, J. 1967. Home range, behaviour and recruitment rates of two black rhinoceros populations. *E. Afr. Wildl. J.* 5:133–150.

GODDARD, J. 1969. Aerial census of black rhinoceros using stratified random sampling. *E. Afr. Wildl.* 7:105–114.

GODDARD, J. 1970. A note on age at sexual maturity in wild black rhinoceros. *E. Afr. Wildl. J.* 8:205.

GUGGISBERG, C. A. W. 1966. *S.O.S. Rhino.* London: Deutsch.

HERBERT, H. J. and B. AUSTEN. 1972. The past and present distribution of the black and square lipped rhinoceros in the Wankie National Park. *Arnoldia (Rhod.)* 5(26):1–6.

HITCHINS, P. M. 1976. The status of the black rhinoceros, *Diceros bicornis* Linn., in the Zululand Game and Nature Reserves. *Proceedings of a Symposium on endangered wildlife in Southern Africa.* Johannesburg: Endangered Wildlife Trust.

HITCHINS, P. M., M. E. KEEP and K. ROCHAT. 1972. The capture of black rhinoceros in Hluhluwe Game Reserve and their translocation to the Kruger National Park. *Lammergeyer* 17:18–30.

HOFMEYR, J. M. 1975. The adaptation of wild animals translocated to new areas in South West Africa. *In:* REID, R. Ed.: *Proceedings of the Third World Conference on Animal Production.* Sydney: University Press.

HOFMEYR, J. M., H. EBEDES, R. E. M. FRYER and J. R. DE BRUINE. 1975. The capture and translocation of the black rhinoceros *Diceros bicornis* Linn. in South West Africa. *Madoqua* 9(2):35–44.

JOUBERT, E. and F. C. ELOFF. 1971. Notes on the ecology and behaviour of the black rhinoceros *Diceros bicornis* Linn. 1758 in South West Africa. *Madoqua Ser. 1.* 3:5–54.

KLINGEL, H. and U. KLINGEL. 1966. The rhinoceros of Ngorongoro Crater. *Oryx* 8:302–306.

LIST, R. J. (Ed.) 1951. *Smithsonian Meteorological Tables.* Smithsonian Publication No. 4114, Washington D.C., Smithsonian Institution.

MENTIS, M. T. 1972. A review of some life history features of the large herbivores of Africa. *Lammergeyer* 16:1–89.

PENZHORN, B. L. 1971. A summary of the re-introduction of ungulates into South African National Parks (to 31 December 1970). *Koedoe* 14:145–149.

PENZHORN, B. L. and MARIA C. OLIVIER. 1974. A systematic check list of the flowering plants of the Addo Elephant National Park. *Koedoe* 17:121–136.

RITCHIE, A. T. A. 1963. The black rhinoceros (*Diceros bicornis* L.). *E. Afr. Wildl. J.* 1:54–62.

SCHENKEL, R. and L. SCHENKEL-HULLIGER. 1969. *Ecology and behaviour of the black rhinoceros* (Diceros bicornis L.). *Mammalia depicta.* Hamburg and Berlin: Parey.

SHORTRIDGE, E. C. 1934. *The mammals of South West Africa.* London: William Heinemann.

VON RICHTER, W. 1974. Survey of the adequacy of existing conserved areas in relation to wild animal species. *Koedoe* 17:39–70.

WALTHER, H. 1963. Climatic diagrams as a means to comprehend the various climatic types for ecological and agricultural purposes. *In:* RUTTER, A. J. and F. H. WHITEHEAD. Eds.: *The water relations of plants.* Oxford: Blackwells.