The capture and translocation of the black rhinoceros *Diceros bicornis* Linn. in South West Africa

by

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ABSTRACT

Between 1970 and 1972 forty three black rhinoceroses *Diceros bicornis* Linn., were darted from a helicopter and transferred to the Etosha National Park, where they have become well established and now constitute a viable population. Using an etorphine/azaperone combination, a mean immobilisation time of 8 min 22 s was obtained. A multi-lift system fitted to the transport vehicle facilitated the loading of rhinos in difficult terrain.

Clinical observations, immobilisation data, sex and estimated age of the rhinos captured are presented and discussed. Serum transaminase values were obtained from nine of the rhinos captured.

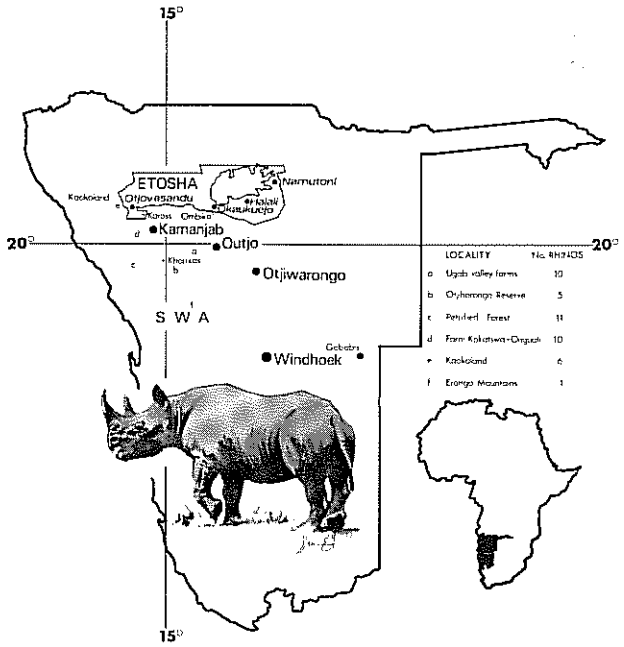
1 INTRODUCTION

The former distribution of the black rhinoceros, *Diceros bicornis* Linn. 1758, in South West Africa extended from the Kunene river southwards along the escarpment to the Orange river and eastwards past Gobabis at 22°S (Joubert, 1971). However, in more recent times there has been an alarming decline in the rhino population, which has become restricted mainly to the more rugged and almost inaccessible mountainous terrain (Plate 1) of the northwestern parts of the country. Even in these areas they were not safe from the onslaughts of man and poaching continued on an organised scale. Indeed, a census conducted in 1966 revealed only 90 black rhinos remaining in the whole of South West Africa, of which 17 % were in the Etosha National Park (Joubert, 1971). Some rhinos inhabited the farming areas, where they were considered dangerous to humans and, unless they were removed, would eventually have been shot. Further isolated groups of one to five rhinos, which did not constitute viable breeding units, were distributed over a large area. Any attempt to safeguard the future of the species therefore necessitated the capture and transfer of as many rhinos as possible to suitable habitats in the Etosha National Park. Consequently from 1970 to 1972 the South West Africa Nature Conservation and Tourism Division captured and transferred 43 black rhinos to the Etosha National Park (Map 1).

2 CAPTURE OPERATIONS

2.1 Localities and description of area

The rhinos were caught in five principal localities which included; farms in the Ugab Valley, the Otjihorongo Reserve, the immediate vicinity of the petrified forest west of Khorixas, on farms to the south-west of Kamanjab and in Kaokoland in an area adjoining the western boundary of the Etosha National Park. A solitary bull was caught in the Erongo mountains (Map 1).



Map 1. The translocation of the black rhinoceros *Diceros bicornis* Linn. to the Etosha National Park.

The terrain inhabited by the rhinos is mostly mountainous, interspersed with plains and dry river courses. It becomes extremely rugged in Kaokoland and west of Kamanjab and Khorixas. Roads were generally poor in most areas and in Kaokoland bush tracks were almost non-existent.

2.2 Field reconnaissance

The capture of black rhinos was preceded by a study of the bio-ecology and general distribution of the species in the territory (Joubert, 1971; Joubert & Eloff, 1971). The ruggedness of the terrain coupled with the solitary, elusive nature of the rhino, necessitated an intensive reconnaissance to be conducted in the proposed catching area. The home ranges of the animals were thus established and aimless flying in a helicopter was avoided.

The activities of rhinos were found to be dependant on several factors, the most important being; human interference, the availability of water and suitable feeding areas. During the rainy season rhinos are inclined to scatter over a wide area and are not dependant on any particular water-hole. The proposed capture operations, carried out in May and June 1970 and 1971, were therefore planned to coincide with the onset of the dry season and cooler weather. During these periods the animals were dependant on permanent water. Natural browse could be supplied to the rhinos while they were in captivity as deciduous trees and shrubs retain their leaves at this time of year. Before the capture operation several days were spent tracking the rhinos on foot. All the water-holes in their area were located and those indicating rhino activity were kept under observation. The feeding areas, which were up to 15 km from the nearest water, were then located by following fresh rhino tracks from the water-hole to the feeding area, paying particular attention to the freshness and frequency of dung scrapings, the utilisation of vegetation and rhino dust baths. The latter were more frequently encountered in white chalky ground than in red soil. Once the feeding area was established, the rhinos were identified and the number of adults, adolescents and calves noted. Data were also obtained on the terrain itself, including its general accessibility and condition of the roads, the denseness of vegetation and suitable camping sites. This information was essential for the success of the capture operation.

2.3 Capture procedure and immobilisation

A Bell 47 G4A helicopter was used to locate and dart the rhinos, which usually inhabited the mountainous terrain (Plate 1). Once located, they were herded to the flatter, more accessible country, where vehicles could be used. During the 1970 operation, 21 rhinos were immobilised with a combination of etorphine hydrochloride/M99 (Reckitt) and acepromazine maleate (Boots) or triflupromazine hydrochloride (Squibb). Adult and subadult rhinos received 3 mg etorphine together with either 10 mg acepromazine or 20 mg triflupromazine (Ebedes, 1966). Initially, 50 to 100 mg hyoscine hydrobromide were incorporated into the drug mixture, but as no additional advantages were evident for immobilising black rhinos, its use was discontinued. In 1971, a combination of etorphine and azaperone (Janssen Pharm.) was used to capture 20 rhinos. Two more rhinos were immobilised with it the following year. Adult and subadult rhinos, with estimated masses of 500 to 1300 kg, each received 3 mg etorphine and 225 mg azaperone, while calves with estimated masses of 100 to 500 kg, were each immobilised with 1,5 to 2 mg etorphine and 75 mg azaperone. The etorphine solution, which was prepared at a concentration of 4 mg/ml, was always kept in a cool thermos flask at 5 to 15 °C to prevent possible deterioration of the drug at high environmental temperatures.

Initially both the Palmer Extra-long Range (powder-charge) and Long Range (pneumatic) projectors (Palmer Chemical and Equipment Co.) were used, but as the latter had a less severe impact and was more satisfactory, the former was discontinued. Palmer 3 ml darts fitted with Palmer NC3 needles were employed in 1970. The needles almost invariably broke off at the nose plug on impact and in 1971 were replaced with special fortified needles obtained from the Kruger National Park. These were identical to those described by Hitchins, Keep and Rochat (1972) for darting black rhinos in the Hluhluwe Game Reserve.

The dart was only loaded with the drugs after the rhino had been sighted and herded into suitable terrain. For the purpose of immobilisation, the animal was approached by the helicopter directly from behind and at a speed slightly exceeding its trotting

Plate 1. A black rhino located from a helicopter in rocky mountainous terrain.

pace. It was darted into the rump at a distance ranging from 10 to 25 m. After darting, the helicopter was used to keep the rhino in accessible terrain reasonably close to the loading vehicle. Guiding the animal became increasingly difficult as narcosis developed.

On account of the difficulties initially experienced when the needles broke, most rhinos became partially drugged and occasionally up to five darts had to be fired before a rhino was finally immobilised. Dosage rates, therefore, had to be estimated and immobilisation times could not be established; they depended on the time lapse after a dart was fired and the extent to which the rhino was drugged. However, etorphine had a wide therapeutic index in the rhino, and apart from a depressed respiration caused by possible over-dosage, there were no apparent side effects. In view of these problems it was difficult to prevent darted rhinos from re-entering rugged terrain and this resulted in the loss of two animals. One was a cow which dropped from a 50 m precipice while in a semiconscious state. The other was a bull which fractured his mandible after slipping off a 2 m ledge shortly before becoming immobilised.

Over-exertion was unavoidable in some animals. To complicate matters further, the darting of calves was impractical, so they had to be roped and caught by hand while standing next to the immobilised dam. This procedure presented problems arising from the possibility of the calf separating from and losing its mother before the latter became immobilised.

These problems were successfully overcome in 1971 and 1972 when the fortified needles were employed, enabling accurate dosage rates and immobilisation times to be determined (Table 1). Moreover, the incorporation of azaperone as a neuroleptic had the advantage of inducing a quick and effective restraint of the rhinos. Ataxia usually developed within five minutes after darting. Immobilisation times ranged from 4 min 39 s to 17 min 56 s, with a mean of 8 min 22 s, and was determined from the time of darting until the rhino became recumbent or, on the rare occasions when it remained standing, completely immobile and leaning against a tree. Using etorphine and azaperone at the specified dosage rates, a deep narcosis was maintained from 1 to 2½ hours without the injection of additional immobilising drugs.

In instances where a cow and a calf-at-foot were found, the latter was darted first. Once immobilised, the calf was left in the care of an attendant and the cow was immediately pursued and immobilised. Following this procedure, there was no danger of the calf separating from the dam and getting lost.

Little difficulty was experienced in relocating the cow provided she was immediately followed up.

Every attempt was made to capture and remove all the rhinos within an area. Initially they were easy to locate and immediately ran upon hearing the approaching helicopter. As the operation proceeded, however, it became increasingly difficult to locate them as they remained stationary under dense bush or left the area and did not respond to the approaching helicopter. Rhinos were observed to drink at least once every second night, and water-holes were constantly surveyed for fresh tracks. Although all the rhinos on the Ugab Valley farms were captured, this could not be achieved in the more rugged areas, despite intensive searching.

Age classes and sex ratios of captured rhinos are summarised in Table 2. A calf is classed as being dependent on its dam for milk and a juvenile as being weaned but still attached to the dam. Of the total captured, 35 % were juveniles/calves. Furthermore, of the 14 adult cows caught, 11 had juveniles/calves at foot. One cow was captured in an isolated area where no other rhinos were present, while another was lactating but without a calf. These findings are in close agreement with those obtained by Joubert *et al.* (1971). However, the male to female ratio of 1 : 1,15 differs from the 1 : 0,87 ratio established by Joubert *et al.* (1971) in their study area.

2.4 Post-capture husbandry and clinical findings

Once a rhino was immobilised the helicopter landed close by and various prophylactic drugs were

Table 1. Immobilisation and clinical data on 20 black rhinos captured in 1971.

Ear Tag No.	Sex	Estimated mass (kg)	Narcotic M99 (mg)	Tranquilliser azaperone (mg)	Immobilisation Time min/s	Rectal T° °C	Pulse per min	Resp. per min	Remarks
R25	M	750	3	150	5/11	37,0	76	10	
R26	M	1100	3	200	9/15	38,0	71	9	
R27	F	1100	3	200	6/53	37,7	64	11	
R28	M	250	1,5	75	7/17	39,5	—	9	Calf of R27
R29	F	800	—	—	—	38,2	91	11	1st dart partially effective
R30	M	1250	3	225	7/03	38,5	74	11	
R31	F	600	3	225	17/56	39,4	114	9	Calf of R32
R32	F	1200	3	225	10/33	39,2	79	8	Advanced stage of pregnancy
R33	F	700	3	225	6/37	39,5	118	10	
R34	M	1250	3	225	5/52	39,1	73	11	
R35	F	250	1,5	75	10/51	37,6	87	15	Calf of R36
R36	F	1200	3	225	9/03	38,2	61	10	
R37	F	1200	3	225	6/17	37,2	89	7	
R38	F	1200	3	225	5/00	37,1	72	8	
R39	M	1300	3	225	14/37	38,0	76	10	
R40	M	1300	3	225	7/09	38,1	88	7	
R41	M	500	3	225	10/19	37,4	85	6	
R42	M	1000	3	225	8/11	37,5	87	7	
R43	M	200	1,5	75	4/39	36,3	72	9	Calf of R44
R44	F	1200	3	225	6/12	37,6	82	9	
$\bar{x}$					8/22	38,0	82	9	

Table 2. Age classification, sex and sex ratios of captured black rhinos.

	Total number	Adult M	Adult F	Subadult M	Subadult F	Juvenile M	Juvenile F	Calf M	Calf F	Total M	Total F	Ratio M : F	Percentage Juveniles/calves
Operation 1970	21	4	7	2	2	1	2	2	1	9	12	1 : 1,33	40,0
Operation 1971	20	5	6	2	2	1	2	2	—	10	10	1 : 1	33,3
Operation 1972	2	1	1	—	—	—	—	—	—	1	1	1 : 1	—
TOTAL	43	10	14	4	4	2	4	4	1	20	23	1 : 1,15	35,0
Total for each age class		24		8		6		5					

promptly administered to the animal. These included: a vitamin E and selenium preparation in the form of E-SE (S.A. Cyanamid), injected intravenously at the recommended dosage rate; Catosal (Bayer) or Metabolic (Wera-Vet), injected intravenously at a dosage rate of 10 to 40 ml depending on the mass of the rhino and the degree of exertion; thiamine hydrochloride (Petersen) 200 to 500 mg, injected intravenously; Vecortenol (Ciba), and Compropen (Glaxo-Allenburys), injected intramuscularly. Eyes, skin abrasions and dart wounds were routinely treated with an antibiotic aerosol or ointment and a numbered ear tag was inserted for future identification.

Clinical observations (Table 1) on 20 rhinos darted in 1971 were recorded within five minutes of immobilisation, and were as follows: Respiration rate: range 6—15/min, mean 9; cardiac rate: range 61—118/min, mean 82; rectal temperature: range 36,3—39,5 °C, mean 38,0 °C.

Except for slightly elevated body temperature and cardiac rates, these results do not differ markedly from those obtained from resting rhinos (n = 10) (Table 3) immobilised in the holding pens. In addition, the majority of rhinos only showed mild perspiration, in marked contrast to the rhinos captured the previous year. Eleven of those rhinos were finally immobilised after broken dart needles had caused exertion. An etorphine/triflupromazine combination was used and clinical data obtained from the animals showed the following: respiration rate: range 4—17/min, mean 9; cardiac rate: 73—142/min, mean 101; rectal temperature: range 37,7—41,3 °C, mean 39,3 °C.

Within five minutes of becoming recumbent a heparinised blood sample was drawn from the ear vein of nine rhinos. The samples were centrifuged in the field, immediately frozen and stored for later analysis. The sampling was later repeated in the same rhinos following re-immobilisation in captivity. Analysis included determination of transaminases using the colorimetric method of Reitman and Frankel (1957).

3 TRANSLOCATION

3.1 Loading and transport

Radio contact was maintained between the helicopter and the ground crew. Two 5-ton, four-wheel-drive trucks were used for transportation. Each vehicle was fitted with a multi-lift system (Triplejay Equipment (SWA) (Pty) Ltd.) onto which the rhino crate was attached (Plate 2); it could

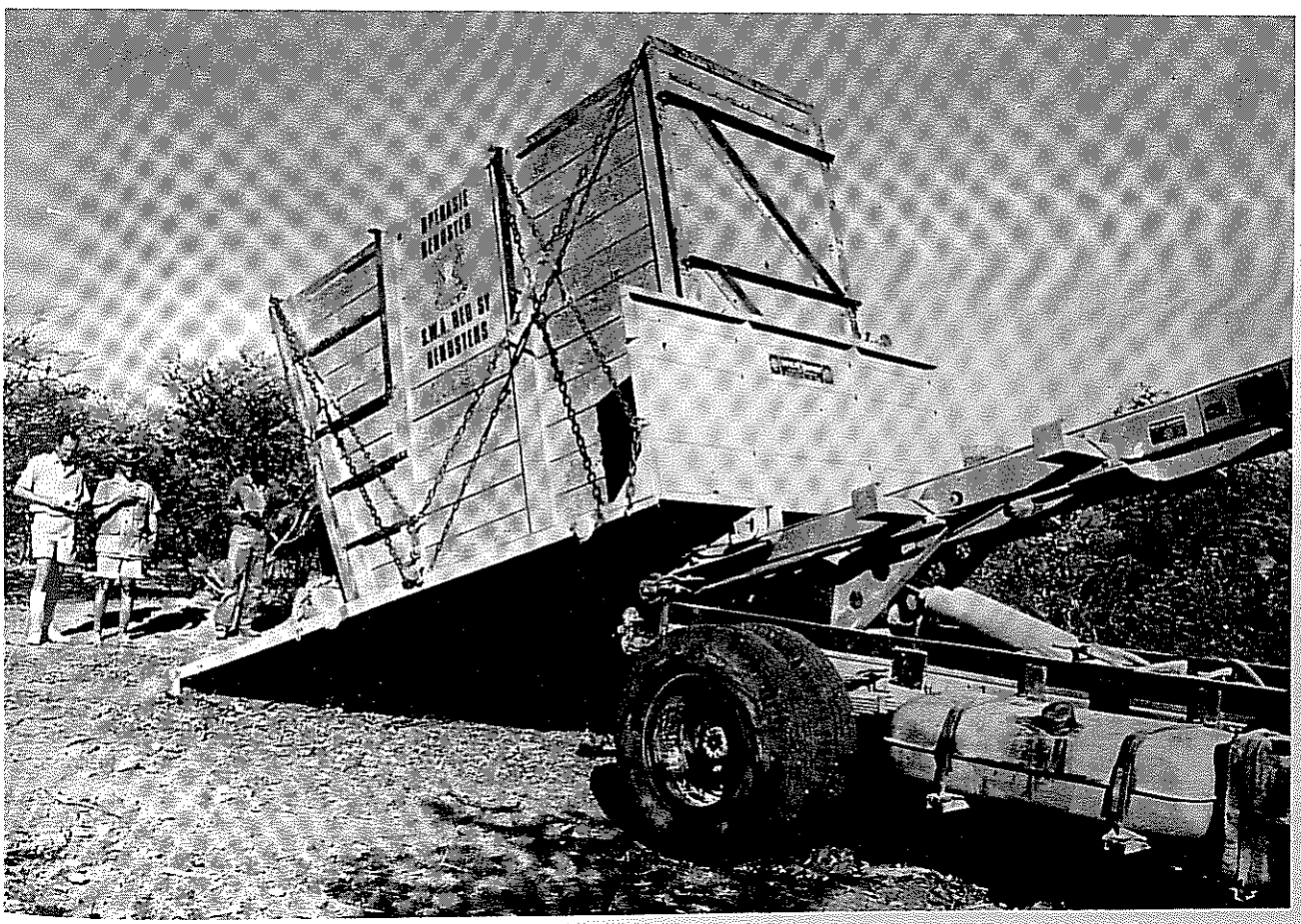


Plate 2. The multilift system used for loading black rhinos.

Table 3. Comparison of immobilisation data, clinical findings and serum transaminases in black rhinos under field and captive conditions.

No.	Sex	Estimated mass (kg)	M99 (mg)		azaperone (mg)		Immobilisation min/s		Rectal T° °C		Pulse Rate per min		Respiration Rate per min		Serum Transaminases				Date	Interval Days
															SGOT i.u./l		SGPT i.u./l			
			F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C		
R26	M	1100	3		200		9/15		38,0		71		9		39		5		20/5/71	
RR26				3		225		6/15		37,0		54		5		35		8	3/7/71	44
R28	M	250	1,5		75		7/17		39,5		—		9		38		2		21/5/71	
RR28				1,5		100		5/31		36,9		65		4		38		3	24/7/71	64
R34	M	1250	3		225		5/52		39,1		73		11		18		4		29/5/71	
RR34				3		150		8/04		37,4		84		8		67		5	4/6/71	6
R35	F	250	1,5		75		10/51		37,6		87		15		36		4		3/6/71	
RR35				1,5		100		6/25		36,8		44		5		22		6	24/7/71	51
R38	F	1200	3		225		5/00		37,1		72		8		40		4		5/6/71	
RR38				3		225		10/45		37,3		93		9		39		6	24/7/71	49
R39	M	1300	3		225		14/37		38,0		76		10		36		7		5/6/71	
RR39				3		225		9/39		36,8		70		9		43		7	25/7/71	45
R40	M	1300	3		225		7/09		38,1		88		7		31		7		10/6/71	
RR40				3		225		8/05		37,1		74		5		167		40	3/7/71	23
RRR40				3		225		10/30		36,6		90		6		41		4	24/7/71	44
R41	M	500	3		225		10/19		37,4		85		6		42		6		11/6/71	
RR41				3		175		6/22		37,7		76		9		25		15	4/7/71	23
R42	M	1000	3		225		8/11		37,5		87		7		35		7		12/6/71	
RR42				3+1,5		225		37/21		37,2		82		9		32		7	25/7/71	43
$\bar{x}$							8/43	10/53	38,0	37,1	80	73	9	7	35,0	*34,4	5,1	*7,0		
SD															7,12	7,56	1,76	3,62		

R = Immobilisation of rhino — during capture.
RR = Immobilisation of rhino — during captivity.
RRR = Immobilisation of rhino — during captivity.

F = Data obtained in field during capture.
C = Data obtained in bomas during captivity.
RR34 = Anorexia and suspected head injury from charging boma. Treated systemically.
RR40 = Penetration wound into buccal cavity resulting from combat. Treated systemically.
*RR34 and RR40 not included in mean.

then be lowered to the ground with an hydraulic device. This greatly facilitated loading of the rhinos, which could be achieved in 15 minutes (Hofmeyr & de Bruine, 1973). They were transported facing the opposite direction from which the vehicle was travelling. This was done to prevent possible injuries to the head region should the vehicle suddenly halt.

In instances where a rhino went down in a laterally recumbent position, it was first rolled onto its sternum. Three guide ropes were then placed around the head and one was tied around the hind leg. The crate was always placed a few metres away from the rhino to prevent the animal from injuring itself on the edge of the platform as it rose to its feet (Plate 3). An initial dose of 25 mg of the morphine antagonist, nalorphine hydrobromide (Burroughs Wellcome), at a concentration of 25 mg/ml, was injected intravenously into the ear vein. This was sufficient for the animal to regain a degree of consciousness after two to three minutes, but nevertheless to remain sufficiently tractable thus enabling it to be led into the crate with the aid of guide ropes. The needle was left in position in the vein and secured to the pinna with masking tape. The first signs of recovery were a deeper and increased rate of respiration, movement of the ears and response to touch and auditory stimuli. Once the rhino was crated, a further 150 to 175 mg nalorphine was administered, of which a portion (up to 50 mg) was injected intramuscularly. Finally the needle in the ear vein was removed.

With the use of azaperone, rhinos were easy to handle and no additional tranquilliser was required before administering the antidote. On a few occasions it was impossible to get the vehicle very close and in one instance a rhino had to be led 100 m to the crate. Once loaded the rhinos were immediately transported to their destinations. There were occasions when a journey of 450 km lasting up to 10 hours necessitated the administering of 100 to 200 mg azaperone to some animals which became restless. During transit the majority of rhinos remained standing. In a few instances calves were successfully transported under narcosis for a period of three to five hours. During transport they were moved from one side to the other at 30 minute intervals to relieve the pressure on their limbs.

4 CAPTIVITY PERIOD

4.1 Boma structure

Except for minor structural differences, the bomas were basically similar to those described by Hitchins *et al.* (1972). An important difference, however, was that in this case all the poles were creosoted whereas in the Umfolozi bomas only the corner poles were treated.

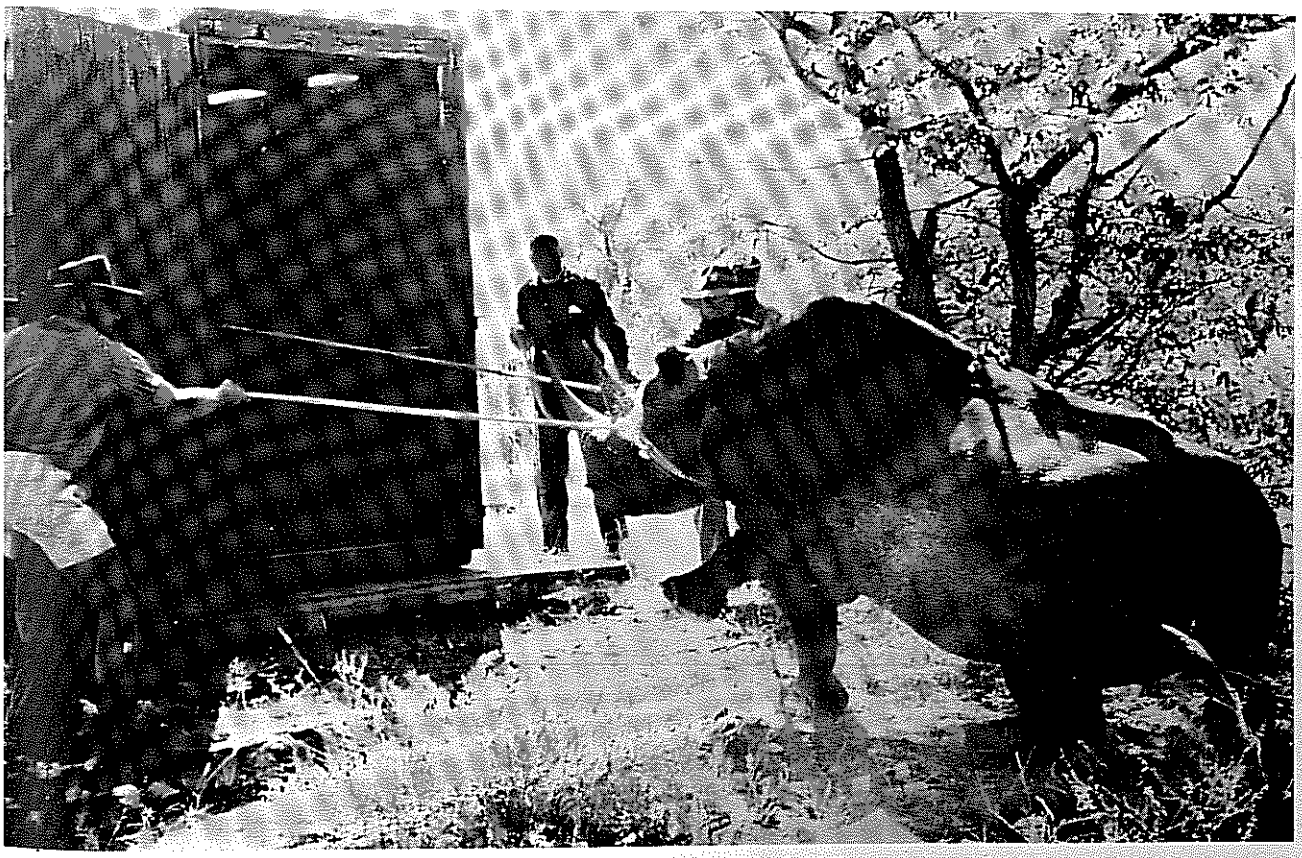


Plate 3. Guiding a black rhino into the crate following the intravenous injection of 25 mg nalorphine.

4.2 Off-loading and captivity period

The rhinos were transported to holding pens at Kaross, Ombika and Halali in the Etosha National Park (Map 1). There they were kept for an adaptation period of four to six weeks before they were finally released. On arrival at the pens most of the rhinos were still tranquil and off-loading presented no problems. On entering the boma some almost immediately drank and commenced feeding within a few hours. In addition to lucerne (alfalfa) hay, which most animals ate readily after a few days, cut branches from a variety of trees and shrubs were provided. These were: *Acacia mellifera* (Vahl) Bentham ssp. *detinens* (Burch). Brenan, *A. reficiens* Wawra, *Catophractes alexandri* D. Don, *Combretum apiculatum* Sonder, *Dichrostachys cinerea* (L.) Wight and Arnott ssp. *africana* Brenan and Brummit and *Terminalia prunioides* Lawson.

The majority of rhinos soon settled down in their holding pens. There were, however, attempts by some animals to escape, and one cow succeeded in doing so after she had removed the entrance poles. Two bulls fought after one had removed the poles from the interleading doorway. The aggressor was soon immobilised and the door structure reinforced.

Cows with calves were initially placed in separate pens, which had interleading doors, but they were reunited soon after off-loading. Later, however, calves were released with their dams into the same pens, and no complications arose. Young calves which were entirely dependent on milk started to browse at an early age. Agalactia, presumably as a result of exertion and stress, developed in two cows captured in 1970. Consequently their calves, which were deprived of milk, developed a sudden hypoglycaemic coma approximately ten days after capture. One calf died but the other estimated to be six months old, was saved following the prompt intravenous injection of one litre, 10 % dextrose saline solution. Its recovery was dramatic; it regained conciousness and was on its feet within an hour. While in a comatosed state, hypothermia with a rectal temperature of 26 °C was recorded. The respiration rate was six per minute and neither the cardiac rate nor the pulse could be determined. It was removed from its dam and thereafter fed on an artificial diet of Nespray (Nestlé) prepared as per manufacturer's instructions, but with the addition of the following constituents to every 2,4 litres of milk: dextrose, one to two tablespoons; Pronutro (Hind Bros. & Co.), four to eight tablespoons and one raw egg. The mixture was heated to 35 °C and one to two litres were fed three times a day. It was weaned a year later and released in a 700 ha paddock on Kaross in the Otjovasandu area.

Fatal cases of creosote poisoning occurred in four rhinos, all of which were animals which had endeavoured to escape and were constantly in contact with the creosoted poles. The post mortem findings included, raised and crusted weals on the skin, hepatic necrosis and gastric ulcers (Basson & Hofmeyr, 1973).

5 RELEASE AND READAPTATION

The rhinos were found to differ markedly in temperament. Those animals which had become docile during captivity usually turned aggressive and charged out of their pens when the entrance poles were removed. On the other hand, troublesome rhinos were often reluctant to leave once they had the opportunity to do so and only vacated their pens after night-fall.

Between 1970 and 1972, 13 rhinos were released at Halali, four in the Ombika area and 20 in the Kaross camp (Map 1). A more detailed account of their readaptation is given by Hofmeyr (1975), where particular reference is made to rhinos being involved in mortal combat two to six weeks after their release. No concrete explanation can be given for this behaviour, as both cows and bulls were involved and, furthermore, Joubert *et al.* (1971) do not consider the black rhino to be territorial. They suggest rather that the rhinos have a definite home-range and form clans in association with other rhinos. It is noteworthy that in at least two cases, involving combat between two cows and between two bulls, the conflict arose where the rhinos had been kept in adjoining bomas. Both cows originally came from the same home range and the bulls had fought previously when they were in captivity. It therefore appears that, in these instances, the rhinos developed a hostility towards one another during a protracted period of confinement.

6 DISCUSSION AND CONCLUSIONS

Data on the drug immobilisation of the black rhino, using etorphine in combination with other drugs, have been published by King and Carter (1965), Ebedes (1966), Jones (1966), Roth (1967), Denney (1969), Keep, Tinley, Rochat and Clarke (1969), King (1969), Hitchins *et al.* (1972) and Harthoorn (1973). The advantages of combining azaperone with etorphine for the immobilisation of black rhinos have been discussed by Denny (1969) and Hitchins *et al.* (1972). The results obtained in the present investigation support their findings and an etorphine/azaperone combination presently appears to yield the most favourable results. Furthermore, rapid immobilisation to avoid unnecessary exertion and reduce the chances of rhinos fatally injuring themselves, particularly in rugged terrain, was successfully obtained in the present investigation by using fortified rhino dart needles and using a relatively high dose of etorphine. The administering of up to 3 mg etorphine for adults and sub-adults and 1,5 mg for calves, resulted in a mean immobilisation

time of 8 min 22 s being obtained in 19 animals. Denney (1969), obtained slightly longer immobilisation times in three rhinos immobilised with 2,0 to 2,5 mg etorphine and 350 to 400 mg azaperone. Hitchins *et al.* (1972) report immobilisation times varying from 7 to 22 min with 2 mg etorphine and 300 mg azaperone in adult rhinos. In their cases complete immobilisation was not achieved in all the animals and some had to be restrained by means of a rope.

The use of nalorphine as an antidote had several advantages. The aggressive temperament of the black rhinoceros is well known and the initial intravenous injection of 25 mg nalorphine, to facilitate handling and guiding of the rhino into the crate, gave excellent results. Clinical observations on 20 rhinos (Table 1) correspond favourably with those recorded by Denney (1969) in his immobilisation trials. Comparing these results with those obtained for resting rhinos (Table 1), it would appear that these rhinos had not exerted themselves excessively during capture, but exertion was a feature in some rhinos which endeavoured to escape from their holding pens. The prompt injection of anti-stress agents such as E-SE, Catosal or Metabolic, thiamine hydrochloride and Vecortenol, was considered a valuable aid in preventing the clinical manifestation of capture myopathy.

Serum transaminase activities (values converted to i.u./1 at 25 °C) obtained from nine rhinos following field immobilisation and immobilisation during captivity are given in Table 3. Using Student's t-test, serum glutamic-oxalacetic transaminase (SGOT) and serum glutamic-pyruvic transaminase (SGPT) activities determined in apparently healthy rhinos, do not differ significantly ($P \geq 0{,}05$) between the two groups. Data on transaminase activities in black rhinos are not available and unless influenced by the immobilising drugs, these values should therefore fall within the normal range for black rhinos. The high SGOT (167 i.u./1) and SGPT (40 i.u./1) activities obtained in RR 40, may be ascribed to a horn penetration wound into the buccal cavity caused through fighting. Similarly the relatively high SGOT (67 i.u./1) value in RR 34 may be the result of a suspected head injury sustained when the animal charged the boma structure. Both rhinos were successfully treated systemically with antibiotics.

The problems encountered with creosote poisoning during captivity of the rhinos, and with fighting following their release, are not insurmountable. In the Etosha National Park, where permanent water is sparsely distributed, a captivity period is vital for acclimatisation and to safeguard the return of released rhinos to the pens to obtain water. This is necessary until the animals have explored their surroundings and are able to venture further afield and establish themselves elsewhere. The construction of removable temporary pens using untreated poles, erected in suitable habitats where rhinos are either scarce or absent, should produce more favourable results, but care should be taken not to introduce too large a number in any given locality. A prolonged captivity period should be avoided and it may be advisable to introduce and release rhinos over a period of time. The significance of large predators, notably lions, on black rhinoceros populations and on the recruitment rate of this species, (Herbert & Austin, 1972; Hofmeyr, 1975) should be taken into consideration when introducing these animals into areas where these predators occur.

Despite the initial setbacks, the black rhinos have adapted well to their new surroundings, are reproducing successfully and in 1973 numbered approximately 80 animals together with the resident population (Hofmeyr, 1975). They constitute a viable entity in the Etosha National Park and can therefore be considered well-established.

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