ACCLIMATIZATION

Too often, however, animals are transported before they are fully acclimatized, while still suffering from changes in diet, and stress. These animals may be in a worse condition to stand the stress of transport and relocation than newly caught animals. When the requisite factors do not obtain, a number of problems arise, each of which may readily precipitate disease, injury or death.

Transportation of animals immediately after capture is the more hazardous procedure. Even under optimal conditions, the wild animal after capture is subject to a number of stressing factors. These may be divided into physiological, pathological, pharmacological and environmental stresses. These can be ameliorated but hardly eliminated.

The acclimatization period to captivity, crates, and food may show surprising differences among various animals. That for white rhinoceros is a minimum of 8 weeks, while the black rhinoceros takes only 3 days to adjust to taking food from the hand, despite its more aggressive nature (Wallach 1966).

As indicated, animals newly captured under optimal conditions by the correct drug mixtures may be in a better condition to survive transport and relocation than those that have undergone periods of acclimatization. Also deaths from disease and accident may occur during this time.

To reduce the costly and hazardous period of acclimatization to capture conditions, animals may be moved directly from the field to their destinations. Rhinoceros have been moved directly from the Umfolozi Game Reserve, to Kyle Dam Reserve in Rhodesia, a distance of nearly 1000 miles. These journeys took between 26 and 28 hours. Chlorpromazine hydrochloride was administered as required, in doses of 250 mg intramuscularly, approximately $2\frac{1}{2}$ hours after capture and at intervals of 8 to 9 hours, for a male rhinoceros weighing 1125 kg. A female rhinoceros weighing 1800 kg was given 500 mg followed by four doses of 250 mg each spaced throughout the journey (Wallach 1966).

PHYSIOLOGICAL FACTORS

Physiological factors are associated with fear and rage, and with exercise. Continuous secretion of adrenaline which occurs in animals subjected to conditions outside their experience, can by itself result in shock and death in the short period of a day. Stress associated with activity of the adrenal cortex can likewise cause collapse and death, albeit over a somewhat longer period. Intensive exercise such as running over even short distances of 1 or 2 km may cause stress in a high proportion of

Group transportation

Some species of animals need not be individually crated and can be moved in groups. When groups from the same herd are captured, the risk of injury is reduced, although still remaining high, but is offset against mortality attendant on increased handling for individual crating. Aggressive animals such as roan antelope cannot be transported in this way, but herds of zebra and wildebeest have survived journeys packed 30 to 40 in large trucks and trailers with retention of herd cohesion; conducive to increased survival on arrival. As for crates, floors of trucks, and trailers, these should be covered with earth, sand and litter to give adequate purchase for hooves and reduced injury when animals fall. The sides and top of trucks and trailers should be covered with canvas to reduce exposure from sun and wind and to provide a darkened interior which reduces activity.

Individual transportation

Besides the methods of crating or transporting animals loose in a truck, individual animals may also be transported tied. For short journeys animals are frequently tied in lateral recumbency, using soft ropes or preferably nylon stockings to tie the legs together. If transported in this way the head of the animals should be held and struggling prevented. To overcome this problem, a rope truss has been devised for deer in which the animal may be transported in sternal recumbency (Thomas et al. 1967a). The material used is cotton clothes-line rope. The legs are flexed in normal lying position and tied by ropes over the back and under the abdomen. The loops are then tied by lateral ropes to a loop round the neck and then tied together behind the rump. Care must be taken to prevent pressure on the trachea. Deer have been kept trussed in this way for periods of up to 6 hours. One deer out of 25 was injured. Use of tranquillizer and blindfolds assisted quiet transport.

The methods of crate construction and the optimal sizes for the various species and age groups are readily obtained from professional trappers and wildlife authorities.

GENERAL PRINCIPLES

Damage may be incurred to animals as a result of sharp braking or travelling down steep declivities. Antelope in crates travel better when these are placed sideways to the direction of travel (see Plate 17), and rhinoceros with the tail end forward (Player 1967). All animals should

be watched or checked at frequent intervals. Rhinoceros especially, may roll onto their backs or get jammed into their crates unable to move.

AIR TRANSPORT

Air transport presents special difficulties (Williamson 1974). Air temperature is regulated in accordance with human comfort. This, and the temperature generated by the animal in their boxes, is high for most animals, and special arrangements have to be made to lower the temperature control for the animals' comfort. Long hours of flying and stopovers without facilities for taking in food and water may subject animals to certain stresses (Williamson 1974). Animals appear to survive air travel well, however, and this form of transport is greatly preferable to movement by rail with its exposure to extremes of temperature, shunting and delays on sidelines. The principal problems associated with air travel are expense, regulations with regard to containers, and difficulties often experienced with suitable aircraft landing facilities near to where animal capture takes place. Anaesthetization or immobilization of wild animals for air transport appears to be a possibility (Hofmeyr 1974) to save the expense of weight and space consumption by crates and other containers, and to overcome the real danger of animals getting out of control and damaging the vital structure of the aircraft. Roan antelope have been carried immobilized with the head raised by tying the horns to an overhead rail in a *Hercules* transport aircraft (Hofmeyr 1974).

Reception and adaptation

The planning of animal transport should include the reception facilities at the termination of the journey. Suitable temporary accommodation should be provided for animals to be released. All objects on which animals may injure themselves should be removed until the new individuals have settled down. Wire fence enclosures should be avoided unless covered by reeds, plastic sheeting or grass so that the animal cannot see through and take fright or injure themselves by attempting to run through. They should be high enough to discourage jumping.

Artificial or concrete floors are often unsuitable unless covered by earth, grass, etc. If this is omitted the animals will not settle and may die from retention of urine.

Gradual adaptation to the type of food in the new environment is necessary for ruminants in particular. Adaptation may be hastened through providing the bacteria necessary for ruminal digestion in the form of a cud obtained from a local animal of the same species, sprinkled over the food.

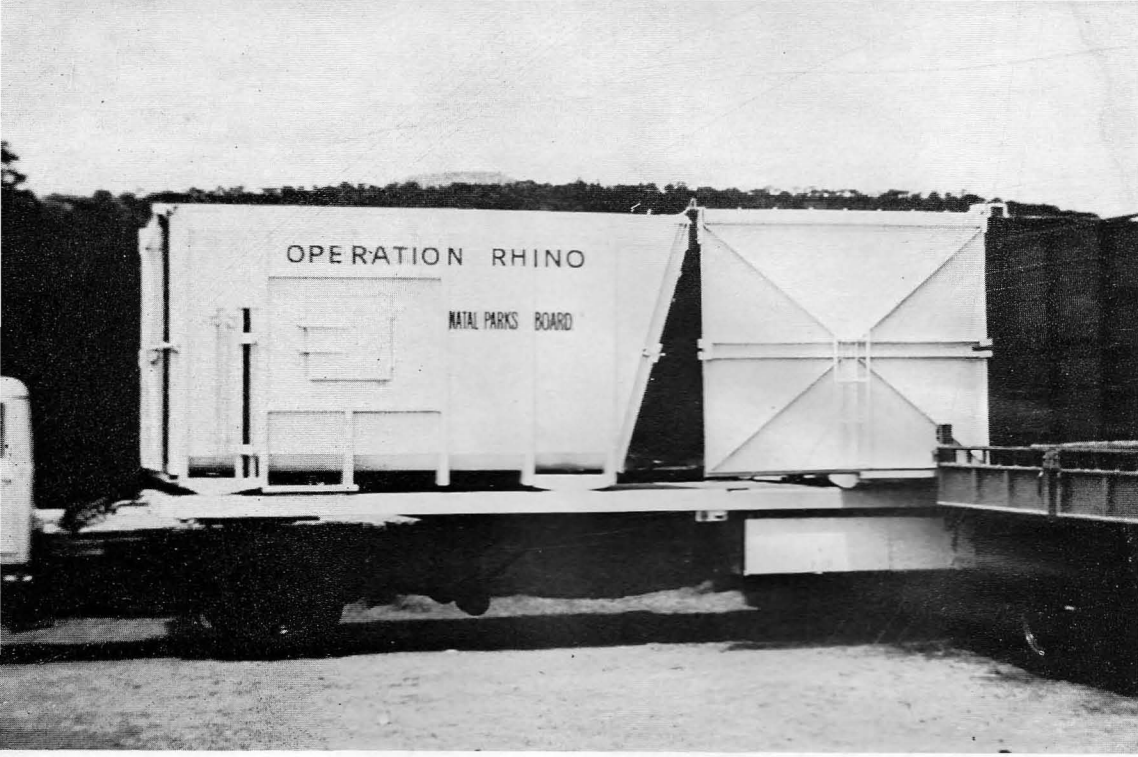
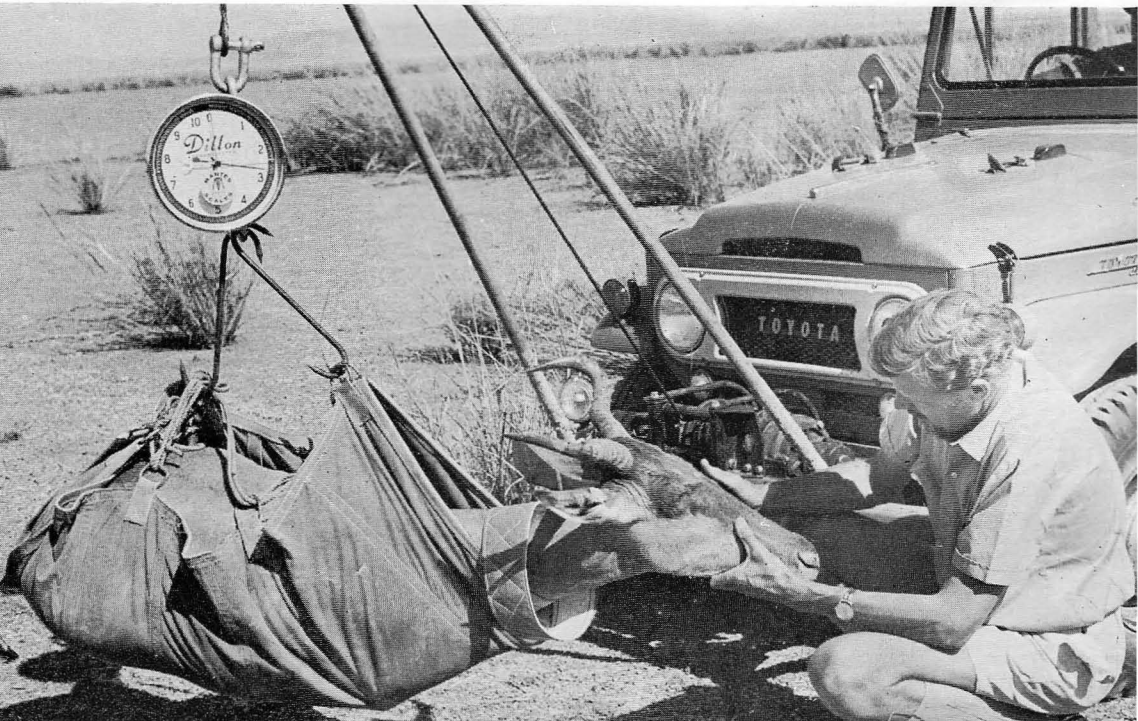


Plate 17 Swivel crates for rhinoceros long-distance transportation: the sloping front exit door prevents damage to horn. Each crate holds two rhinoceros and has a passage for attendant.

Plate 18 A simple portable system designed to weigh immobilized animals: the animal's head is held as the sling is raised.



lization within 20 minutes and observed to continue for 6 to 7 hours. But a longer period of tranquillization may actually have been present, symptoms being obscured by darkness. Animals were transported for periods lasting up to 5 hours.

IMPALA

For impala captured by spotlight at night, diazepam was given initially at 5 mg/kg. This dosage rate produced effects in 5 minutes with muscle relaxation which lasted for 12 hours, with tranquillization for another 10 hours. At a rate of 2·2 mg/kg, effects were similar but the animals were able to assume sternal recumbency after 1 to 2 hours. A still lower dose of 1·1 mg/kg produced effects in 5 to 15 minutes with slight ataxia and anxiolysis. The latter dose was thought to be adequate for impala captured at night and placed immediately into suitable crates.

ELAND AND RED HARTEBEEST

Eland were given high doses (relative to size) of 0·8 to 1·1 mg/kg, the higher dose being used on calves. Tranquillization occurred only after 20 to 40 minutes, and for some animals only up to 60 minutes. Similar effects occurred with doses of 0·9 to 1·3 mg/kg for red hartebeest, full effects being evident after 30 to 45 minutes.

These results suggest that this psychotherapeutic compound is suitable as tranquillizer for animals captured by mechanical means. The diazepam for large animals is supplied in strengths of 50 to 100 mg/ml in an oily base for experimental purposes. It is probable that if an alternative less viscous solvent could be found, the induction period could be reduced.

Diazepam has also been used for rhinoceros captured by chemical means, with satisfactory but inconclusive results. The optimal dosage rates were not established, largely due to individual variations in the reaction of rhinoceros to crating and transport.

RHINOCEROS

Black rhinoceros have been moved after capture in various ways. On sledges pulled up on trucks (King 1969, King & Carter 1965) and on rafts (Roth 1967), and in crates (Dennay 1969). These animals were transported while under the residual sedation of the immobilizing mixture.

A highly successful exercise involving 20 black rhinoceros captured with the aid of a *Bell* helicopter, and ranging from 700 to 1100 kg (and two immatures) were captured with etorphine 2 mg and azaperone 300 mg (Hitchins et al. 1972). Animals were drawn into a crate by a nylon rope placed round the head just behind the posterior horn about 1

minute after nalorphine administration and as the animal rose to its feet it was pulled into the crate. The crate was then winched up on rollers onto the slightly inclined tipdeck.

Additional tranquillizers were given to the rhinoceroses at the time of crating. Antibiotics, penicillin and streptomycin were also given. It was noted that azaperone given prior to the antidote resulted in perfect behaviour in the crate for periods varying from $1\frac{1}{2}$ to $5\frac{3}{4}$ hours, which covered the length of the 53 km journey. Results of tranquillization are given in Table 5·2.

Table 5.2. Tranquillization of black rhinoceros

No. tested	*Age*	*Sex*	*Azaperone*		*Nalorphine*		*Into crates*
			after recumbency (min.)*	*dose (mg)*	*after recumbency* (min.)*	*dose (mg)*	*after recumbency* (min.)*
9	adults	M	38	144	42	250	43
9	adults	F	59	160	66	250	69
2	calves	M/F	49	110	56	150	56

* refers to recumbency time after initial immobilization
adapted from Hitchins et al. (1972).

Subsequent to a two weeks taming period the rhinoceros were relocated 560 km to a national park, a journey of $9\frac{1}{2}$ to 11 hours, including periodic stops for inspection, injection and giving food and water, and for one border post stop.

Owing to difficulty experienced with injecting the rhinoceros once they had come into the crates from the quarantine enclosure, the animals were given an injection of azaperone and acetylpromazine using a gas-powered projector, before the animals were enticed into the crates. The tranquillizers given during transportation of the rhinoceroses from the Umfolozi Game Reserve to the Kruger National Park are given in Table 5·3.

Table 5.3. Tranquillizers given during transportation of black rhinoceros

No. transported	*Tranquillizer at source*		*During journey*	*Azaperone (mg)*	*Release* (hours)*
	Acetylpromazine (mg)	*Azaperone (mg)*	*Time given* (hours)*		
9	14	733	8	212	12
11	10	709	–	Nil	11

* refers to time after first tranquillization
adapted from Hitchins et al. (1972).

Release into the wild was made after an acclimatization period of 6 to 16 days. The animals' own dung had previously been scattered in the release area. The animals were released individually and each animal permitted to move out of sight before the next animal was released.

Captivity

A great number of different designs of crates and holding enclosures have been designed to accommodate the animals for the period between capture and their final destination. These have been evolved in response to the requirements of the different species moved under the peculiar local conditions obtaining in their areas. In only one chapter, a few principles must be selected from a subject that could merit a separate treatise.

Both capture and transport are highly traumatic experiences for wild animals. Many animals who survive capture, die as a result of subsequent handling and from the nervous and physical strains induced by the capture conditions. A progressively greater proportion of existing wild animals is being captured, as remnants of wild life are getting smaller and are threatened, and because of the growing desire both to safeguard the species concerned and to restock areas from which they have been extirpated.

PHYSIOLOGICAL AND PSYCHOLOGICAL FACTORS

Physiological as well as psychological factors should be considered when animals are moved or held, besides the generally accepted mechanical aspects of weight, size, ground, and floor space. In relation to the former it should be recalled that wild animals seldom survive capture by a predator, and struggle without regard for personal injury and will react with an adrenergic response that may be fatal. Lastly, some tend to destroy themselves through nervous physical action after incarceration; so-called highly strung animals such as klipspringer may die immediately on handling, unless protected by ataractics.

NEWLY CAPTURED ANIMALS

Tranquillization will protect newly captured animals during initial handling, tying or crating in the field. When the effect of the initial dose or subsequent injection of tranquillizer wears off, animals may become subject to intense fear and make desperate attempts to escape from the crate or enclosure. Death of animals placed in small enclosures has

ORDER PERISSODACTYLA (odd-toed ungulates)

Family Rhinocerotidae

A needle for rhinoceros injection may be smaller and consequently less robust than that used for elephant, and 4·5 to 6 cm in length, and external diameter of approximately 4 mm is adequate. Needles should be clean and sharp and free from burrs, with a barb on the lower third of the shaft. The rhinoceros is more inclined than most African mammals to abscess formation at the site of the injection, although this tendency is reduced now that small amounts and lower concentrations or more powerful immobilizing compounds are used.

The rhinoceros skin is particularly prone to block the needle, especially when the syringe rotates in flight. This may be prevented in

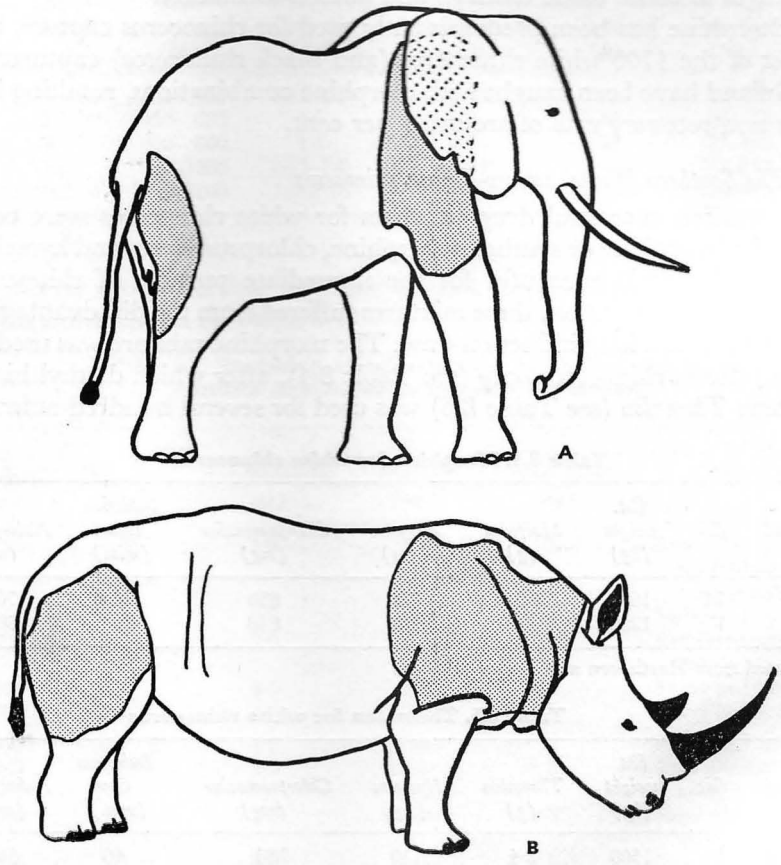


Fig. 20 Areas of the body suitable for remote injection in the pachyderm (A) elephant, (B) rhinoceros.

several ways and a small bead of weld on the bevel is adequate. More elaborate methods, such as complete closure of the needle tip and holes drilled in the shaft are not necessary and reduce the effectiveness of the injection.

Powder-charged projectors should be used with care, both because the rhinoceros is apt to suffer subcutaneous haemorrhage from severe impact, and because the syringe may break on the hard body surface. The neck of the rhinoceros is a particularly suitable area for injection as it is resilient. Otherwise the central part of the shoulder, avoiding the top edge of the scapula and the thick skin-fold above the elbow, are also suitable (see Fig. 20). The skin of the back is hard and thick and the steep angles will induce the syringes to bounce off or needles to inject intradermally or subcutaneously. Explosive cap syringe-emptying mechanisms may be used, but are more inclined than other types of syringes to cause tissue damage and abscess formation.

Etorphine has been predominantly used for rhinoceros capture, and most of the 1700 white rhinoceros (and black rhinoceros) captured in Zululand have been caught with etorphine combinations, resulting in a low non-recovery rate of around 1 per cent.

The Southern White, square-lipped, rhinoceros

The earliest successful drug mixtures for white rhinoceros were composed of morphine or synthetic morphine, chlorpromazine and hyoscine. Although highly successful for the immediate purpose of rhinoceros capture and relocation, these mixtures suffered from the disadvantage of large bulk and long induction time. The morphine mixture was used on a few dozen rhinoceros only (see Table 8·4), after which diethylthiambutene *Themalon* (see Table 8·5) was used for several hundred animals.

Table 8.4. Morphine for white rhinoceros

No. Tested	*Sex*	*Est. weight (kg)*	*Morphine (g)*	*Hyoscine (mg)*	*Chlorpromazine (mg)*	*Induction time (min.)*	*Nalorphine (mg)*
4	M	1600	1·75	120	650	40	760
5	F	1200	1·4	110	840	50	600

adapted from Harthoorn and Player (1963)

Table 8.5. Themalon for white rhinoceros

No. Tested	*Sex*	*Est. weight (kg)*	*Themalon (g)*	*Hyoscine (mg)*	*Chlorpromazine (mg)*	*Induction time (min.)*	*Nalorphine (mg)*
4	M	1100	3·4	110	760	40	300
5	F	1300	3·5	125	845	35	230

adapted from Harthoorn and Player (1963)

The deaths from non-recovery were few, amounting to less than 1 per cent, although a larger number of deaths occurred from misadventure such as narcotized rhinoceros falling into rivers or over cliffs. The latter deaths may, however, be indirectly ascribed to the excessively long induction period during which the animals often ran long distances.

Etorphine, mixed with other compounds is now the drug of choice, largely due to the small amounts which are necessary and its much more rapid action. The mortality resultant on etorphine is slightly higher than that of *Themalon*, but deaths from attendant causes are much reduced owing to the rapid induction time.

Dosages of etorphine, acetylpromazine and hyoscine, with nalorphine as antidote for white rhinoceros are given in Table 8·6.

Table 8.6. Etorphine and acetylpromazine for white rhinoceros

No. tested	*Est. weight (kg)*	*Etorphine (mg)*	*Acetylpromazine (mg)*	*Hyoscine (mg)*	*Nalorphine (mg)*
5	300– 450	0·25–0·5	0·5–1·0	25	50–100
7	350– 600	0·5	1·0	50	90–175
9	600– 800	1·0	2·0	50	75–150
75	600–1000	0·75–2·0	1·5–4·0	25–100	125–250
201	1100–2200	1·5–2·25	3·0–4·5	25–100	250–375

adapted from Keep (1971)

Rhinoceros receiving hyoscine do not respond readily to antidote. This is illustrated in Table 8·7.

Table 8.7. Etorphine, acetylpromazine and hyoscine, and antidote diprenorphine for white rhinoceros

Est. weight (kg)	*Etorphine (mg)*	*Acetylpromazine (mg)*	*Hyoscine (mg)*	*Diprenorphine (mg)*	*Remarks*
1400	1·5	3·0	50	2	Rose after additional antidote of 375 mg nalorphine
1600	1·5	3·0	50	4	Stood in 3 minutes
1800	1·5	3·0	50	4	Respiratory reaction only
2000	1·5	3·0	50	6	Stood in 14 minutes
700	1·0	2·0	25	2	Stood in 8 minutes
800	0·5	1·0	None	2	Stood in 3 minutes
900	1·75	3·5	None	3	Rose and walked away
900	1·75	3·5	None	3	Rose and walked away
2000	2·0	4·0	None	5	Stood in 3 minutes

adapted from Keep (1971)

However, those that received no hyoscine are difficult to crate as their ability to see is not impaired.

Cyprenorphine was somewhat less efficient as an antidote for rhinoceros (Keep 1971). There are several factors, however, which may influence the reaction, such as the time lapse between the original injection and the administration of the antidote. After a lapse of 1 to 2 hours the response to antidote, as may be expected, is much more rapid. If there is no response to intravenous antidote injection, a further injection is unlikely to be effective if given less than 2 hours later. In Table 8·8 the animals were lifted and pulled into the crates.

Table 8.8. Etorphine, acetylpromazine and hyoscine, and antidote cyprenorphine for white rhinoceros

Est. weight (kg)	*Etorphine (mg)*	*Acetylpromazine (mg)*	*Hyoscine (mg)*	*Cyprenorphine (mg)*	*Remarks*
450	0·5	1·0	50	20	Unable to rise at first
600	0·75	1·5	50	20	Respiratory response only
700	0·75	1·5	40	2	Unable to stand
900	1·0	2·0	25	3	Stood in 2 minutes
900	1·25	2·5	25	5	Respiratory response only
1000	1·0	2·0	25	10	Respiratory response only
1800	2·0	4·0	100	50	Unable to stand
2300	1·5	3·0	100	3	Unable to stand
1400	1·5	3·0	50	5	Unable to stand
900	1·0	2·0	None	4	Unable to stand
1000	1·5	3·0	None	5	Unable to stand
1000	1·5	3·0	None	10	Respiratory response only
700	1·0	None	None	4	Stood in 6 minutes
900	1·0	None	None	5	Stood in 3 minutes
1100	1·0	None	None	3	Stood in 10 minutes

adapted from Keep (1971)

Somewhat more speedy results are obtained with diprenorphine. The dose of diprenorphine was two-thirds to one-half that of the cyprenorphine used. It should be noted that any but small rhinoceros cannot be crated in the normal way unless they are ambulant.

As a general guidance the dosage schedule given in Table 8·9 may be followed.

Recently it was found that a mixture of etorphine and fentanyl was more effective and required less antidote than either given alone (see Table 8·10). It significantly shortened the time lapse between injection and recumbency.

Table 8.9. Etorphine, acetylpromazine, hyoscine and nalorphine antidote for white rhinoceros

Est. weight (kg)	*Etorphine (mg)*	*Acetylpromazine (mg)*	*Hyoscine (mg)*	*Nalorphine (mg)*
360– 560	0·5	1	25	90–175
560–1100	1·0	2	25	175–250
1100–2300	1·5–2·0	3–4	50	375

adapted from Keep (1971)

Table 8.10. Etorphine and fentanyl for white rhinoceros

Sex	*Est. weight (kg)*	*Etorphine (mg)*	*Fentanyl (mg)*	*Hyoscine (mg)*	*Nalorphine (mg)*
F	1800	1·0	35	50	375
F	1600	1·0	35	50	275
M	350	0·25	15	12	100
F	600	0·25	20	25	100
F	300	0·25	15	12	50
F	600	0·25	15	12	100

adapted from Keep (1973b)

General recommended dosages are as given in Table 8·11.

Table 8.11. Etorphine and fentanyl for white rhinoceros

Est. weight (kg)	*Etorphine (mg)*	*Fentanyl (mg)*	*Hyoscine (mg)*	*Nalorphine (mg)*
1500–2000	1·0	30	50	250
750–1500	0·5	20	25	100–250
350– 750	0·25	15	12	50–100

adapted from Keep (1973b)

Xylazine has been used as a tranquillizer together with etorphine, for white rhino capture (see Table 8·12). There was negligible improvement, however, in the induction time or behaviour of the rhino after antidote injection. Xylazine given by itself to rhinoceros in pens induced an excellent state of sedation, bordering on anaesthesia. A dose of 0·25 to 0·50 mg/kg is recommended to handle rhinoceros in crates or in pens.

Table 8.12. Xylazine for white rhinoceros

No. tested	*Xylazine (mg)*	*Xylazine (mg/kg)*	*Etorphine (mg)*	*Induction time (min.)*
4	185	0·265	1	13·5

adapted from Keep (1972)

The black rhinoceros

The black (hook-lipped) rhinoceros reacts in a similar way as does the white rhinoceros described above. Syringes and needles are similar, although it is usually necessary to inject from a longer distance, as this species is more wary and aggressive than the white rhinoceros. Furthermore, he usually inhabits dense bush country. The black rhinoceros is smaller, weighing up to 1260 kg for most animals. They are best approached when feeding or asleep on a ridge in the open, as they tend to do in hot country to keep cool. In bush country, they move downwind before resting, and so cannot be surprised. Usually the ability of rhinoceros to move in thick bush greatly exceeds that of the marksman.

A gas-, or even a powder-charged projector is conveniently used from a helicopter, which is the vehicle of choice to capture black rhinoceros, as much of the country they inhabit is impracticable for motor vehicles other than large trucks with a gang of men to cut bush or make tracks through dongas.

Table 8.13. Etorphine, phencyclidine, hyoscine and antidote nalorphine or cyprenorphine for black rhinoceros

Sex	*Est. weight (kg)*	*Etorphine (mg)*	*Sernylan (mg)*	*Hyoscine (mg)*	*Nalorphine (mg)*	*Cyprenorphine (mg)*	*Induction time (min.)*
F	700	1·3	550	85	400		15
						3	
						4	
M	900	1·5	645	100	400		16
F	900	1·12	465	56		10	16
					400		
M	1100	1·4	600	100		15	20
					190		
M	1000	1·2	500	100	200	17	90

adapted from King and Carter (1965)

Black rhinoceros have been captured in East Africa using a mixture of etorphine with phencyclidine and hyoscine (see Table 8·13). This mixture, although effective for immobilization, is not conducive to

crating of black rhinoceros without further tranquillization. These rhinoceros were therefore tied in lateral recumbency onto a sledge and transported in this position by lorry. The chance of leg paralysis after tying, or even after recumbency in a crate, is considerable.

Greater attention must be paid to tranquillizing, if undue morphine excitement is to be prevented. Good results were obtained using acetylpromazine together with azaperone as tranquillizers (see Table 8·14).

Table 8.14. Etorphine, acetylpromazine and azaperone, and antidote nalorphine for black rhinoceros

Sex	*Weight*	*Etorphine (kg)*	*Acetylpromazine (mg)*	*Azaperone (mg)*	*Nalorphine (mg)*	*Induction time (min.)*
F	818	2·0	25	—	200	15
M	1185	2·0	20	250	200	25
M	1085	2·0	20	—	300	7
M	1196	2·0	25	—	300	25
M	955	2·0	25	200	—	18
M	1033	2·0	25	200	300	42
M	700	2·0	25	200	250	12
F	400	1·0	20	200	200	12
M	600	2·0	—	350	200	13
M	750	2·5	—	400	250	9
F	820	2·25	—	400	180	10

adapted from Denney (1969)

The black rhinoceros is likely to run fast after he is injected and is difficult to follow. Recovery after antidote administration is usually rapid and aggression may be exhibited when the animal regains its feet. Rhinoceros immobilized with the azaperone and acetylpromazine mixture may be crated in the field (see Table 8·15). The crating of the

Table 8.15. Acetylpromazine and azaperone for relocation of black rhinoceros

No. tested	*Tranquillizers before crating*		*Tranquillizers* during journey*			*Time lapse between capture and release*	
	Acetylpromazine (mg)	*Azaperone (mg)*	*After first dose (hr min.)*		*Azaperone (mg)*	*(hr min.)*	
20	12	720	7	50	189	12	30

* 11 animals were not given tranquillizers during the journey
adapted from Hitchins et al. (1972)

rhino in the field has obvious advantages over transporting them tied and lying on their side.

The Indian rhinoceros

The Indian rhinoceros has been immobilized less frequently. A successful result on a captive animal reported by the American Association of Zoo Veterinarians is given in Table 8·16.

Table 8.16. Etorphine for Indian rhinoceros

Sex	*Est. Weight (kg)*	*Etorphine*	*Induction time (min.)*	*Effect*	*Duration (min.)*	*Nalorphine (mg)*
F	900	0·9	6	ataxia	8	2

adapted from American Association of Zoo Veterinarians (1967)

General

Aftercare of immobilized wild rhinoceros is especially important. The black rhinoceros tends to be infested with filaria and trypanosomes and tends to die of acute trypanosomiasis as the premunity breaks down after capture stress. Routine injection of *Berenil* (Bayer) on capture prevents this condition. White rhinoceros were found to be advantageously wormed immediately on capture, especially to reduce stomach bots. Black rhinoceros feed sooner after capture and tame down more readily when the walls of their enclosures are solid.

Family Equidae

The plains zebra

Needles for zebra need not exceed 3 cm in length. Collared, instead of barbed needles may be used but are not always effective and the skin puncture is larger, tending to permit backflow of the injected material. Zebra are more inclined than are antelope to develop reactions to needle punctures and clean, sharp needles of 3 to 4 mm outside diameter should be used, and the syringe should strike the body only at the end of its trajectory. The zebra has a well-developed panniculus muscle under the skin and most parts of the body are suitable for injection. However, great care should be taken to prevent fast projectiles hitting the abdomen or perineum, as the tight skin predisposes to the whole syringe entering and indeed disappearing into the body, with fatal results.

Large numbers of zebra have been immobilized. Etorphine as the principal compound has been the drug of choice for most zebra captures and with good results.

A series of 106 zebra (60 males and 46 females) have been immobilized with a mortality of 7, 2 of which were directly due to drug action. Doses used are given in Table 8·17.

and phenothiazine tranquillizers (Kuntze 1967) and for a variety of animals, including axis deer, eland, elk (wapiti), European bison, fallow deer, moose, mouflon, red deer, and Siberian deer. Results with impala rams are given in Table 10.1.

Table 10.1. Benzodioxane hydrochloride for impala rams

No. tested	*Age*	*Ave. weight (kg)*	*Ave. dose (mg)*	*Ave. induction time (min.)*	*Ave. recovery time (hours)*
10	Adult	51	975	50	4-5
2	Young	28	750	22	4-25

adapted from van Niekerk et al. (1963)

Benzodioxane hydrochloride is probably best used in conjunction with other compounds as a tranquillizer to reduce the chance of agitation and excitement. The resulting salivation may be controlled with atropine.

The compound is readily taken by mouth, being odourless and apparently tasteless, so that it may be useful in restraint of ungulates that cannot readily be injected. The safety margin is very wide and the degree of restraint even in wild animals is remarkable when high dosage rates are used (20 to 25 mg/kg). Curious postures of a cataleptoid nature are sometimes evinced. At higher dosage rates the animals go down, but a degree of postural control remains. Animals that are apparently immobilized will often run off when approached. The effects take several hours to wear off, and the prolonged incapacitation may be disadvantageous to ruminants, as bloating tends to occur. The effects of this compound cannot be reversed.

Toxic reactions include tachycardia, increased systolic and diastolic blood pressure, hyperpnoea and nervous agitation.

The value of this substance for chemical capture is further reduced by the large doses required and the resulting bulk of the injection.

CI-395 (see PHENCYCLIDINE HYDROCHLORIDE)
CI-581 (see KETAMINE)

DIETHYLTHIAMBUTENE (THEMALON)

Formula: 3–diethylamino–1,1–dithien–2′–ylbut–1–ene hydrochloride

Diethylthiambutene is a white crystalline powder, almost odourless, soluble in 2 parts water and 1 part alcohol.

This substance is one of the dienylakenylamines and closely resembles

without sedative or analgesic activity (Lister 1964). Various other derivatives of thebaine were also found to have analgesic potencies exceeding that of morphine, and in spite of their high activity, these compounds are relatively non-toxic (Bentley 1964, Bentley et al. 1965) and unlike morphine, do not liberate histamine even at very high dosage rates (Lister 1964).

Etorphine hydrochloride is a colourless, white crystalline powder, which should **on no account be tasted or smelt**.* The hydrochloride salt is soluble at 20° in about 40 parts of water. This solubility is greatly influenced by both pH and the presence of other ions. It is soluble in 30 parts 95 per cent ethanol. The water should be slightly acidified with hydrochloric acid to pH 4 so as to assist solubility and prevent precipitation due to contamination by alkalis. Care should be taken to use chemically clean and preferably alkali-free bottles for the solutions. As there tends to be a loss from adsorption of the etorphine onto glass, the size of the bottles used for various capture exercises should be standardized. Solutions of higher concentration may be made up in dimethylsulphoxide (DMSO) but there is little indication for this, while there is a greatly enhanced possibility of accidental adsorption through the skin from spillage and the handling of used projectile syringes.

Etorphine may be procured as a powder or as solutions of varying strengths. It is marketed under the trade name of *Immobilon: Immobilon Large Animal* (2·45 mg/ml etorphine hydrochloride, 10 mg/ml acetylpromazine maleate and chlorocresol 0·1 per cent in saline); *Immobilon Small Animal* (0·07 mg/ml etorphine hydrochloride, 18 mg/ml methotrimeprazine, chlorocresol, sodium citrate, citric acid and sodium bisulphate, ascorbic acid and sodium EDTA). Results with elephant and adult springbok are given in Table 10.3.

Table 10.3. Etorphine hydrochloride for elephant and adult springbok

Species	*No. tested*	*Ave. dose (mg)*	*Induction time (min.)*	*Mortality*
Elephant	42	8·8	15	1
Springbok	19	1·25*	20	2

*additives: xylazine hydrochloride (*Rompun*) or phencyclidine hydrochloride (*Sernylan*), plus hyoscine.
adapted from Ebedes (1973a, b)

* A 1 per cent w/v solution of etorphine hydrochloride yields, with strong solution of ammonia, a white precipitate which dissolves to a limited extent in excess of the reagent.

A 1 per cent w/v solution of etorphine hydrochloride yields, with test solution of ferric chloride, a violet colour (distinction from thebaine and precursors).

Sulphuric acid added to a small amount in powder form yields a red-brown colour (distinction from precursors).

morphine in its analgesic and hypnotic action. It is reported to produce a greater insensitivity to pain, and has no tendency to cause vomiting. Like morphine, an excitatory phase is manifested, while at high dosages a depression of respiration and body temperature, and muscular spasticity occurs. Diethylthiambutene is considerably more soluble than morphine, but this is partly offset by the greater quantity needed. It has been used principally for rhinoceros capture for which it proved rewardingly safe, a series numbering more than 150 white and black rhinoceros being captured with its use without fatality from non-recovery. Its disadvantage is the large bulk needed and consequent slow absorption. Dosage for white rhinoceros is shown in Table 10.2.

Table 10.2. Diethylthiambutene, chlorpromazine and hyoscine for white rhinoceros

No. tested	*Sex*	*Ave. weight (kg)*	*Diethylthiambutene (g)*	*Chlorpromazine (mg)*	*Hyoscine (mg)*	*Induction time (min.)*
5	M	1194	3·1	715	125	65
5	F	1268	3·2	735	151	44

The effect of diethylthiambutene may be reversed with the usual morphine antagonists.

Undesirable side-effects are rare. Salivation may occur as well as involuntary urination and defaecation. Rapid intravenous administration causes tetany or convulsions. Other effects include depression and emesis. Although it has a wide safety margin, an overdose causes respiratory depression and possible respiratory failure.

ETORPHINE ACETATE (see under ETORPHINE HYDROCHLORIDE)

ETORPHINE HYDROCHLORIDE (M99)

Formula (see Fig. 22): 7a-(-hydroxy-l-methylbutyl)-6,14-endo-etheno-tetrahydro-oripavine hydrochloride (Blane et al. 1967).

Etorphine, a derivative of thebaine 6,14-endoentheno-tetrahydro-oripavine (see Fig. 22) is stated to be 1000 to 10 000 times more potent than morphine (Blane et al. 1967).

The base is soluble in about 30 000 parts of water, readily soluble in alcohol, solvent in ether, chloroform and carbon tetrachloride. It is also soluble in alkaline solutions of pH above 10.

Etorphine causes analgesia and catatonia, the latter at low dosage levels, and renders it an extremely potent compound for the restraint of large hoofed animals.

Thebaine is a by-product of morphine and codeine manufacture

without sedative or analgesic activity (Lister 1964). Various other derivatives of thebaine were also found to have analgesic potencies exceeding that of morphine, and in spite of their high activity, these compounds are relatively non-toxic (Bentley 1964, Bentley et al. 1965) and unlike morphine, do not liberate histamine even at very high dosage rates (Lister 1964).

Etorphine hydrochloride is a colourless, white crystalline powder, which should **on no account be tasted or smelt**.* The hydrochloride salt is soluble at 20° in about 40 parts of water. This solubility is greatly influenced by both pH and the presence of other ions. It is soluble in 30 parts 95 per cent ethanol. The water should be slightly acidified with hydrochloric acid to pH 4 so as to assist solubility and prevent precipitation due to contamination by alkalis. Care should be taken to use chemically clean and preferably alkali-free bottles for the solutions. As there tends to be a loss from adsorption of the etorphine onto glass, the size of the bottles used for various capture exercises should be standardized. Solutions of higher concentration may be made up in dimethylsulphoxide (DMSO) but there is little indication for this, while there is a greatly enhanced possibility of accidental adsorption through the skin from spillage and the handling of used projectile syringes.

Etorphine may be procured as a powder or as solutions of varying strengths. It is marketed under the trade name of *Immobilon: Immobilon Large Animal* (2·45 mg/ml etorphine hydrochloride, 10 mg/ml acetylpromazine maleate and chlorocresol 0·1 per cent in saline); *Immobilon Small Animal* (0·07 mg/ml etorphine hydrochloride, 18 mg/ml methotrimeprazine, chlorocresol, sodium citrate, citric acid and sodium bisulphate, ascorbic acid and sodium EDTA). Results with elephant and adult springbok are given in Table 10.3.

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* A 1 per cent w/v solution of etorphine hydrochloride yields, with strong solution of ammonia, a white precipitate which dissolves to a limited extent in excess of the reagent.

A 1 per cent w/v solution of etorphine hydrochloride yields, with test solution of ferric chloride, a violet colour (distinction from thebaine and precursors).

Sulphuric acid added to a small amount in powder form yields a red-brown colour (distinction from precursors).