Preliminary Report on Drug Immobilisation and Transport of the Great Indian Rhinoceros

By

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1. INTRODUCTION

1.1 Distribution and status of the Great Indian Rhinoceros

Formerly the distribution of the Great Indian rhinoceros (*Rhinoceros unicornis*) extended across the foothills of the Himalayas and the plains of the Indus, Ganges and Brahmaputra rivers from the Hindu Kush in the West to the Burmese border in the East. Its southern limits seem somewhat uncertain but presumably it did not extend into the drier areas. Today only a few isolated pockets of the species remain, its former range having been enormously reduced due to the spread of human activities that conflict with the rhino's way of life, including cultivation of its natural habitat and hunting. These localised populations occur in the Brahmaputra valley of Assam, West Bengal and the Chitawan region of the Nepalese terai. Most of these animals are in protected areas such as sanctuaries and national parks and overall numbers have greatly increased since the turn of the century when Kaziranga had only a dozen animals. While the status of the Great Indian rhino has undoubtedly improved, its future is not yet absolutely guaranteed and it is currently on the I.U.C.N. 'endangered' list.

The present total for the species is approximately 1,500 animals, of which 1,000 are in Kaziranga National Park in Assam and 300 are in Nepal. Of the remaining 200, most are scattered throughout Assam, both in sanctuaries and elsewhere, and there are about 30 in two small sanctuaries in northern Bengal.

1.2 The need for capture trials

Two recent studies (Patar, 1977 ; Laurie, 1978) have revealed many details of the basic ecology of the Great Indian rhinoceros, forming useful background for the planning of future management strategy. There is growing recognition within India and internationally that this should include the re-introduction of rhinos from Kaziranga into well protected areas of suitable habitat of the species' former geographical range. Such translocations necessitate the capture and transport of number of rhinos, over a period of several years. In this context the Government of India requested F.A.O. advice on techniques of rhino translocation.

The traditional methods of capturing rhinos in Assam is a pit method, whereby unwary rhinos fall into a camouflaged pit dug in one of their regular paths. Bodily damage to the animals sometimes results and great stress is experienced during subsequent handling and transfer to the holding stockade. Furthermore, the method is unselective. In Africa, drug immobilisation has been used very successfully on both the Black rhinoceros (Jones, 1966; King, 1969) and the White rhino, (Harthoorn & Player, 1963 ; Player, 1967). Drug doses and handling procedure are now well established for both species (Harthoorn, 1976 ; Keep, 1971 ; Young, 1973). However, there was only very limited experience of chemical capture with the Great Indian species, one case of which was with a zoo animal probably requiring a lower dose than individuals in the wild (Young, *op. cit.* ; Laurie, 1979). Thus it was felt that there was an urgent need to establish procedure for the series of translocations envisaged within India.

In view of the fact that the Great Indian rhino is an 'endangered' species, it was felt prudent that the assistance of a wildlife veterinarian, experienced in chemical capture, should be sought for this initial trial. Accordingly the services of Dr. M.H. Woodford were arranged on a consultancy basis for the period 4 January to 14 February 1980. In addition to the technical inputs of the consultancy, there was an instructional component, whereby capture and translocation methodology would be demonstrated to Government wildlife personnel. The terms of reference of the consultancy, which should be seen in the above context, included the following :

- Advise and assist the Government with its plans for wild animal capture and translocation.
- Advise on appropriate methods and techniques to be adopted for the capture and translocation of wild animal species as

required by the Government and to demonstrate these to various Government counterpart personnel and to trainees of the Central Crocodile Breeding and Management Training Institute, Hyderabad.

— Give a course of lectures on wild animal capture and translocation and on wildlife diseases to the trainees of the Central Crocodile Breeding and Management Training Institute, Hyderabad.

2. OBJECTIVES

The objectives of the capture trials may be stated as follows :

2.1 In the light of the intention of the Government of India to carry out translocation of the Great Indian rhinoceros, involving reintroduction to protected portions of its former habitat, the trials should establish the parameters of a sound capture and translocation method using drug immobilisation and including ;

(i) the best mode of approach to the candidate for capture,

(ii) an appropriate delivery system, preferred range sites for 'darting',

(iii) a suitable drug and its safe dosage limits for (a) immobilisation and (b) revival,

(iv) procedure for safe transport from immobilisation site to an enclosure where rhinos would be held pending transfer to the site of reintroduction,

(v) suitable medications to be used for treatment of immobilised rhinos,

(vi) provision of training in these procedures to Government personnel, including the current course of trainees (Assistant Conservators of Forests and Range Officers) at the Central Crocodile Breeding and Management Training Institute, Hyderabad and officers of the Government of Assam.

Trial capture operations based on these objectives were carried out by the authors at two locations in Assam between 17 January and 10 February, 1980.

3. TRIAL LOCATIONS

During a preliminary visit to Assam in November 1979, Dr. J.B. Sale visited a number of possible sites for the trials. Since the removal (to sanctuaries) of several small isolated groups of rhinosin agricultural areas was under consideration, it was decided to start the capture trial at one such site. This was at Kurua, some 50 km from Gauhati, on the northern bank of the Brahmaputra river. The rhinos, thought to number about ten, live in a series of rocky hills covered with thick secondary jungle and surrounded by paddy fields and sugarcane. The plan was to transport any animals captured to holding accommodation at Gauhati Zoo and also, if needed, to stockades to be constructed in a forest area outside of Gauhati.

A second phase of the trials was carried out in the open grasslands adjoining Kaziranga National Park, providing completely different conditions from the first site. The second candidate for darting had to be 'herded' to the capture area from tall grassland, where capture would have been impossible. On immobilisation, rhinos were transported over a distance of 3-4 km to stockades, constructed from sal poles in the traditional manner.

4. METHODS & EQUIPMENT

Specifications of suitable equipment for rhino immobilisation and transport are given in Appendix A.

4.1 **Location of rhinos for 'darting'**

At Kurua initial attempts were made on foot to locate rhinos that were proceeding to or returning from crop raiding away from the hills at dusk and dawn. However, in spite of various times being tried, no contact with the rhinos was made and it was concluded that raiding forays were confined to the dead of night, which is unsuitable for darting.

Consequently, it was decided to comb the jungle-covered hills during daytime, for rhino lairs and riding elephants were assembled for this operation (Plate Ia). When flushed from cover, the rhino usually ran a short distance along one of its own well-worn tracks to an adjacent thicket, where it took shelter. After a series of these alternating searches and 'chases', the rhino eventually stopped in a position where a suitable part of its anatomy was exposed for long enough to aim and fire the syringe projectile from the safety of an elephant's back. The report of

the rifle and the impact of the projectile usually produced no more than a further short run into cover. Provided the animal was not harassed for 10 minutes or so while the drug took effect, no further attempt to escape was made.

The efficiency of this method or rhino 'stalking' improved once the elephants and their mahouts get used to encountering rhinos in thick cover, sometimes at close quarters. Initially the elephants were nervous and sometimes turned and bolted, especially when faced by a rhino charge. This could prove dangerous, as for example, when all three riders of one bolting elephant were removed by thorny branches observed that a nervous elephant could quickly be transformed into a reliable, efficient animal in the firm hands of an experienced and fearless mahout.

The most useful hunting technique proved to involve two or three elephants. Once a rhino was located in cover, the team member performing the darting positioned his elephant beyond it, while the other (one or two) elephants were used to attempt to drive the rhino into the open towards the waiting 'darter'. Greatest difficulty was experienced while attempting to capture a sub-adult (595 kg), which first had to be separated from its aggressive mother so that she would not interfere with operations once the younger animal was immobilised.

In the open terrain at Kaziranga it proved possible to approach rhinos standing in the open, since these animals are used to being approached by tourists on elephant back. Six to eight elephants were available so that it was possible to 'hold' the target rhino in a circle of elephants, while the elephant bearing the darter slowly moved in until he was close enough for a shot.

If no suitable animal was available in the short grassland, it was necessary to locate one in adjacent swamp and attempt to drive it into the 'darting area', sufficiently away from thick cover to prevent losing it between darting and onset of immobility. To locate an animal in the swamps the elephants were walked abreast in a long line, combing likely patches of tall grassland. Once a suitable individual was identified, the elephants were formed into a large semi-circle behind it in an attempt to herd it slowly in the desired direction. Great care was needed when open ground was approached as the rhino, feeling exposed, frequently tried to rush back into the cover of the tall grasses. However, with a little practice by the mahouts, it proved possible to drive rhinos into a suitable open area for

immobilisation and to hold them there during and after the delivery of the dart (Plate Ib). Clearly, in the Kaziranga conditions the greater number of riding elephants available was a distinct advantage and ideally eight to ten could be usefully employed in this type of operation.

Apart from their value in locating and herding target rhinos, the elephant proved an ideal 'darting platform'. The height of the elephant's back affords a good view and allows a descending shot into the target areas of the rhino's anatomy (see below). When the elephant is standing still it provides a firm, vibration-free seat from which to take careful aim with the dart gun. Their equal versatility in thick jungle, on steep slopes or in deep swamps makes elephants the ideal 'vehicle' for approaching rhino during capture using the drug darting method.

4.2 Delivery system, syringe and target sites

The anatomy of the animal must be considered when selecting a delivery system, appropriate syringe and injection site for darting the Great Indian rhinoceros. Most of the body is covered by a thick hide consisting of epidermis, vascular epidermis and fibrous subcutis (King, 1969). The epidermis is heavily keratinised into numerous domed tubercles, particularly on the thigh and lower shoulder. Sections of this 'armour' are joined by heavy folds of loose skin, where the thickness is doubled. Furthermore, there are ribs just below the skin along the entire flank of the animal, as the rhino has ribs protecting its abdomen as well as the thorax.

Delivery system and range

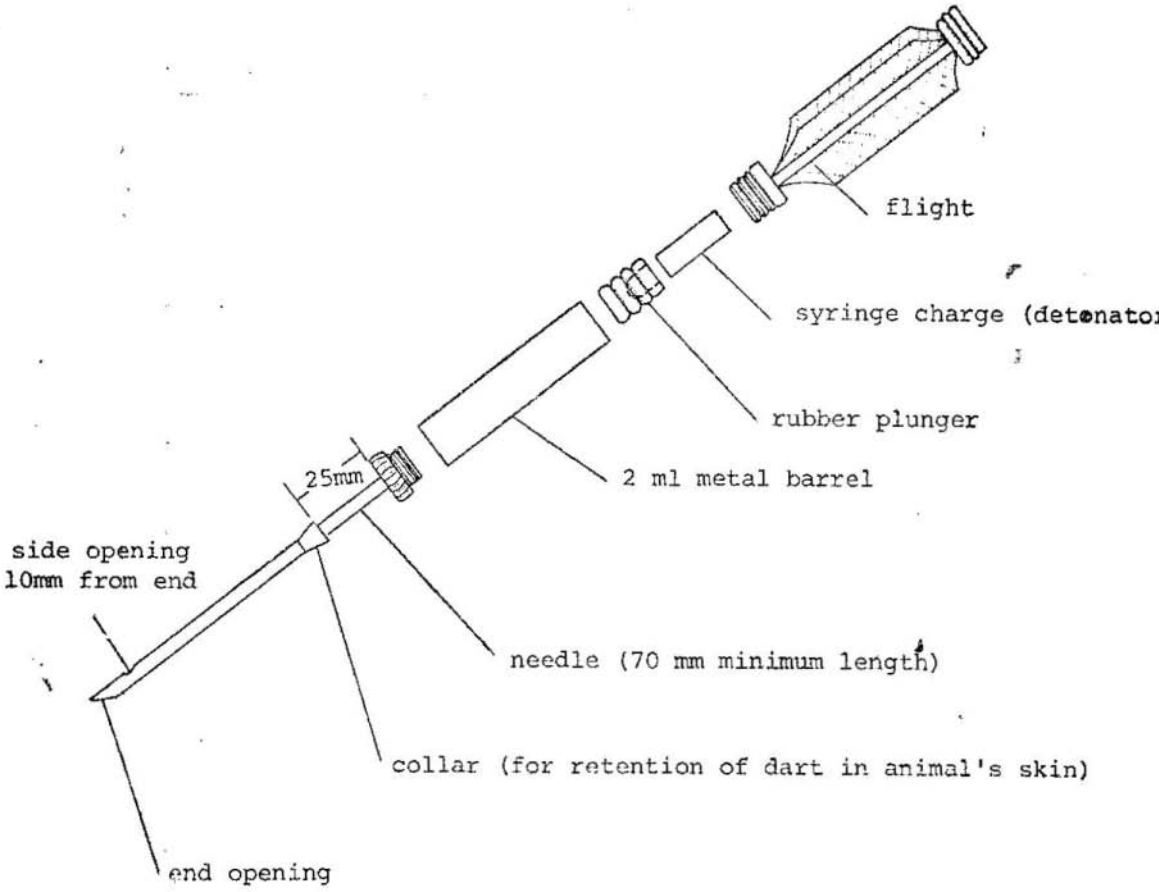
The equipment used for darting was the 'Dist-Inject' Model 50 rifle which fires a metal syringe projectile propelled by a .22 blank cartridge (Peter Ott & Co , Basel, Switzerland).

The Dist-Inject system allows accurate aiming by means of an adjustable back sight, set according to a combination of values for projectile weight and distance to the target. Similarly, .22 blanks of various powers are available and appropriate propelling power is selected according to the same combination of projectile weight and range values. A propellent cartridge of too high a power for the actual range is liable to cause the projectile to bounce off on impact, with a thick skinned species such as rhino. The most satisfactory range was found to be 30 to 40 m for which the 'white' blanks of the correct propellent when using a 2 ml syringe barrel. In most cases, with careful manoeuvring, it was possible to achieve this range on elephant back.

It proved essential to clean the barrel of the rifle, with the brass wire brush provided, after every shot. Failure to do this results in fouling of the bore to the extent that the dart may fail to emerge from the barrel, especially when using blanks of the lowest power.

Syringe projectile ('dart')

The syringe used has aluminium alloy barrel. It is preferable with the Indian rhino to use a system employing metal rather than plastic syringe barrels. The impact with such a hard inflexible skin could shatter a plastic syringe, particularly if the range happened to be rather short for the power of propellent used or the plastic brittle, due to age of the syringe.



Recommended type of 'dart' for delivering etorphine to rhino

The precision flight stabilizer of the Dist-Inject equipment assists in accurate placement of the projectile on the target site (see below).

It was decided in these trials to standardize projectile weight (and therefore trajectory characteristics) by using a 2 ml capacity syringe, irrespective of the quantity of drug loaded and always topping up completely with sterile water. The syringe is loaded from the front, after unscrewing the nozzle bearing the needle. This type of syringe is easy to load and there is little danger of spillage.

Syringe activation in the Dist-Inject system is by means of a detonator in the rear of the plunger which explodes on impact with the animal (providing an audible indication of successful injection). Accidental activation is impossible—an important consideration when a drug highly toxic to man is being used. The type of syringe which is activated by pumping compressed air behind the plunger after loading is not advisable for dangerous drugs such as M. 99. Inadvertent displacement of the sliding collar over the needle opening, after pressurization, results in the drug being squirred out under high pressure possibly entering the eyes or mouth of the operator or assistants.

Needles

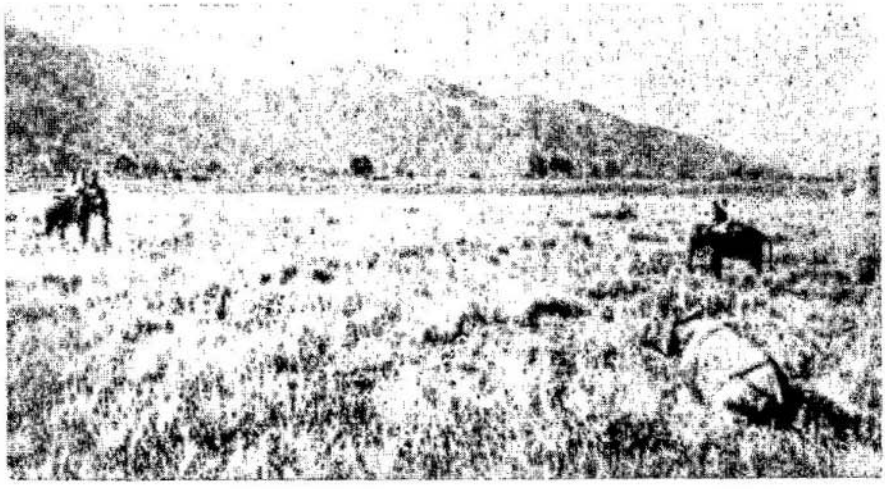
Needle length and strength are critical factors with rhinoceros darting. The NM6 needle, the longest supplied by Peter Ott, proved the most satisfactory and has the following features :

(a) It has an outside diameter of 2 mm and is 63 mm long. Slow induction and incomplete imobilisation caused some doubt as to the adequacy of this length and it is recommended that a 70 mm long needle, strengthened at the base to prevent snapping off on impact but of otherwise similar design, be tried on the Indian rhino.

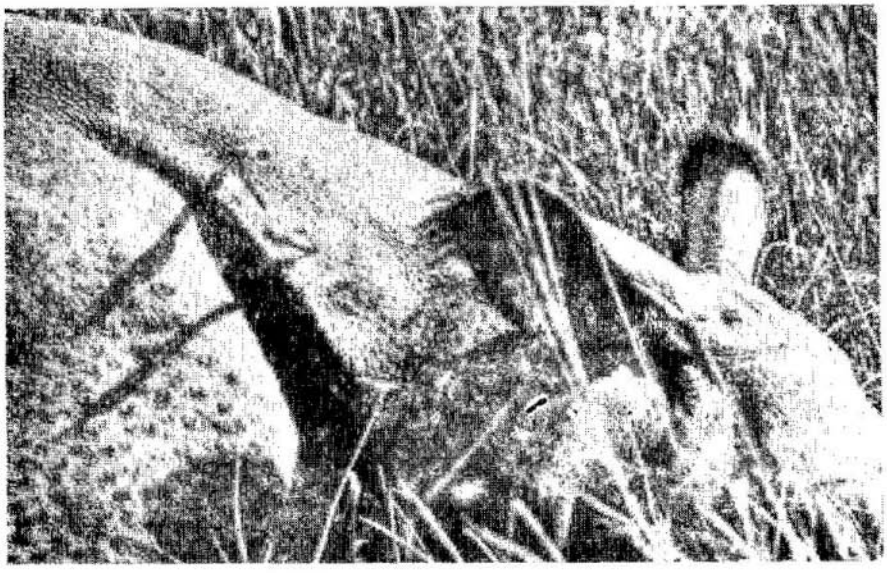
(b) In addition to the normal terminal opening, the NM6 needle has a side opening 10 mm back from the tip. This allows injection to be achieved, even if the terminal opening is blocked by 'coring' as the needle enters the skin ; a common occurance in rhinoceros darting.

(c) There is a collar 25 mm back from the tip, which, providing proper penetration was achieved, kept the dart in place until removed manually following immobilisation. A better position

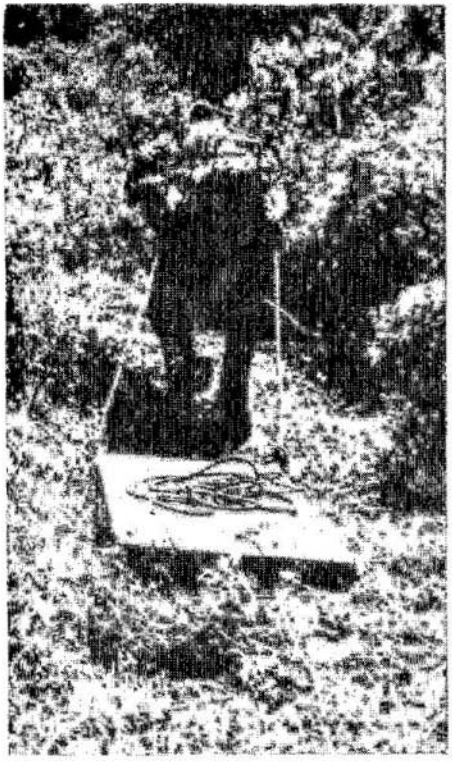
Elephants provide an ideal platform for darting rhinos in thick jungle.



Rhino at moment of 'going down' in open grassland. Elephants surround the Rhino preventing escape while the drug takes effect.



Preferred site for the dart is the upper part of the neck, above the fold. This animal received a second dart to 'top-up' the initial dose. Dart on right is in best position; left dart is too high and too far back from head.



Once a rhino is immobilised the sledge is movad up via a path hastily cut through the jungle.

for the collar would be 25 mm from the base of the needle, as this would avoid the risk of damaging delicate tissues deep below the skin.

Target site

Careful choice of target site on the animal's body is critical when darting the Great Indian rhino (Figure 1). First choice is the upper third of the neck above the fold, which has relatively thin skin and is resilient due to underlying muscle (Plate Ic). When using this site great care must be exercised in order to ensure that the dart does not accidentally hit the head. The site should not be used by unskilled marksmen. The upper anterior portion of the shoulder is also a possible site. At the rear end of the animal the only suitable site is the upper part of the rump, above the horizontal fold separating it from the thigh. However, in older animals the skin can be quite thick and kerotinised in this area which also suffers the disadvantage of a sloping presentation, making a 90° hit difficult unless the dart is fired from a tall elephant particularly close to the rhino.

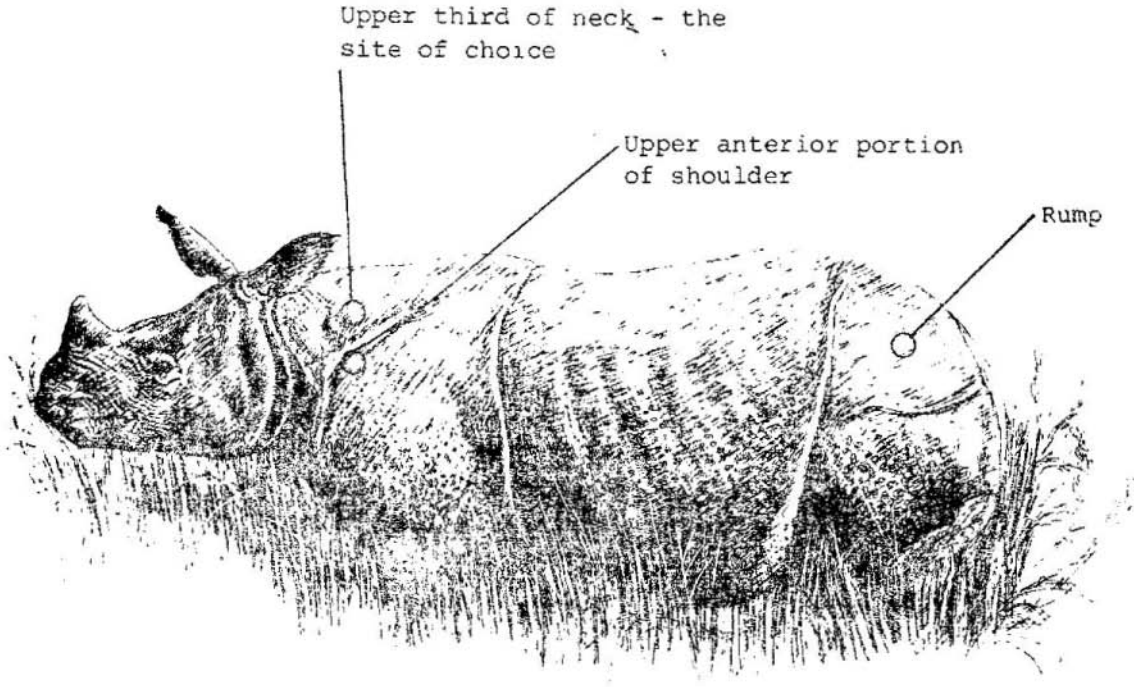


Fig. 1. Target sites for darting the Great Indian rhinoceros

Veins in the back of the ear pinna were confirmed as the best site for intravenous (manual) injection of Revivon (Harthoorn, 1976). However, on one occasion the position of the animal in the crate made the ears inaccessible and an intra-muscular injection in the rump proved a satisfactory alrernative (Case 4 Table 1).

4.3 Drugs used for immobilisation

The drug combination was Immobilon L.A. (Reckitt and Colman Pharmaceutical Division, Hull, England). This consists of etorphine hydrochloride 2.45 mg and acepromezine maleate B. Vet C 10 mg in each ml. The drug was delivered by the syringe projectile intramuscularly as far as possible. The effects of Immobilon were reversed by the intravenous injection of an equal quantity of Revivon L.A. containing diprenorphine hydrochloride 3 mg per ml.

One advantage of etorphine is that being extremely potent (10,000 times the potency of morphine) only small quantities are required. This makes particularly suitable for delivery by a syringe projectile system, where a lighter 'dart' has more stable flight characteristics than a heavier one, assisting accurate placement at the target site. The case with which the effects of etorphine can be reversed using diprenorphine is another reason for the choice of this drug. A further feature is that it has a wide safety margin, reducing the possibility of overdosage.

Immobilon L.A. is extremely dangerous if accidentally injected into humans or even absorbed through the skin and great care must be exercised in its use. The best antidote in cases of accidental administration to man is Narcan (Winthrop Laboratories, Surbiton, U.K.) which is naloxone hydrochloride 0.4 mg/ml. A 'human kit' containing vials of this drug and a suitable syringe for injection was carried at all times in the field. One serious problem with the use of etorphine in India is that neither of the human antidotes are available in the country (the second choice antidote is Lethidrone). It is therefore vitally important that Narcan or Lethidrone be imported along with Immobilon, the use of which should not be contemplated under any circumstances unless one of the human antidotes is to hand.

4.4. Transport procedure

The removal of a very heavy animal such as rhino from the site of immobilisation to the holding enclosure presents some of the greatest

Table 1

Summary of five immobilisations carried out during the trials

Passage of time (in minutes) is shown cumulatively throughout an operation, commencing with the actual time when the first 'dart' penetrated the rhino, i.e. zero minutes

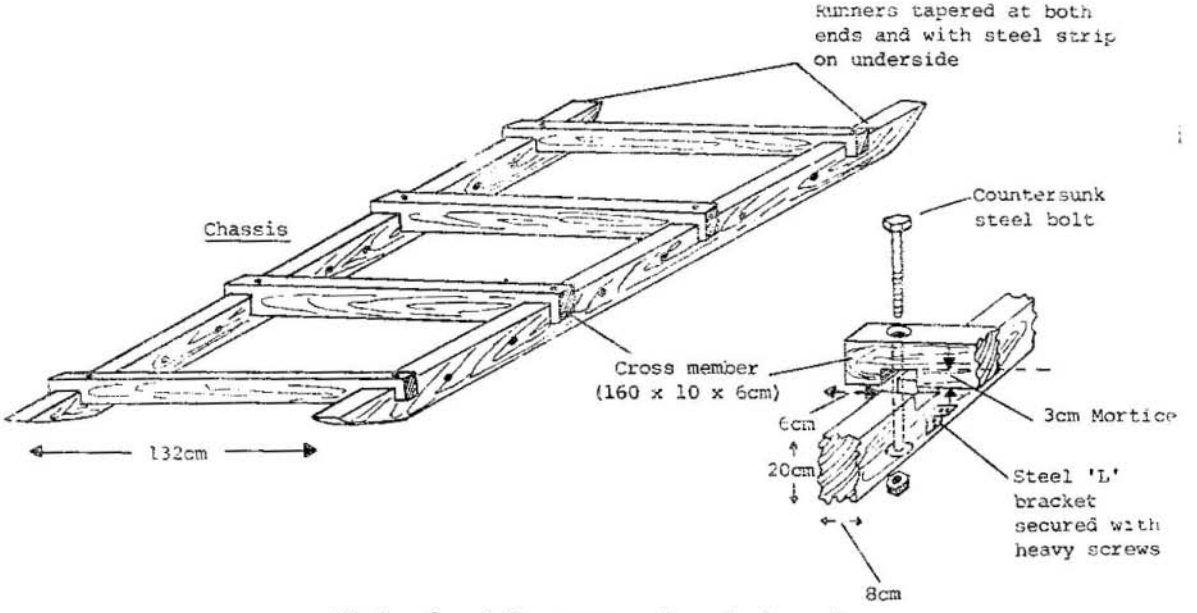
	Case 1	Case 2	Case 3	Case 4	Case 5
DATE	24.1.1980	25.1.1980	27.1.1980	8.2.1980	9.2.1980
SITE	Kurua	Kurua	Kurua	Kaziranga	Kaziranga
HABITAT	Wooded hillside	Wooded hillside	Wooded flat ground	Short grassland	Short grassland
SEX	Male	Male	Male	Male	Male
WEIGHT	1,300kg (est.)	2,500kg (est.)	995kg (weighed)	1,800kg (est.)	1,000kg (est.)
IMMOBILISATION (Immobilon)	0.6ml/shoulder (Hidden) ±13 min: Down Disturbed by people ±30 min: Ran 500m into open and lay down. ±45 min: 0.4ml/ rump. Immobilised Total Dose:1.0ml (2.45mg etorphine)	0.8ml/rump (Hidden) ±12 min: Down Immobilised ±120 min: Standing, incoordinate walking. Non-aggressive. Attempts to lead/ drive into crate failed. ±150 min:0.3ml Revivon i.v./ear. ±160 min:Ranoff dragging rope. ±170 min:0.5ml/ rump. Standing. ±190 min: Down. Rope removed. Total Dose:1.3ml (3.2mg etorphine) N.B. Not loaded	0.66ml/shoulder (partly hidden) Staggering. Incoordinate but mobile. ±60 min: 0.5ml/ shoulder. Walking, incoordinate, standing. ±120 min: 0.5ml/ rump. Down. ±133min:Immobilised. Total Dose:1.66ml (4.1mg etorphine)	0.5ml/neck Ran 200m. Swaying 12 min: Down (disturbed) 15 min:Walking 22 min: Down, alert.0.5ml/neck. 32min:Immobilised Total Dose:1.0ml (2.45mg etorphine)	1.0ml/high on shoulder Ran 400m. 6 min:Staggering 14 min: Down 24 min:Immobilised Total dose: 1.0ml (2.45mg etorphine)
LOADING/ TRANSPORT	Loaded directly into crate (on truck) by labour, using sledge as a ramp.		Dragged 100m on sledge by elephants to crate (on truck dug into ground). Loaded into crate by elephants and labour.	Towed ±1 km on sledge by tractor to crate (on truck dug into ground). Loaded by elephants and labour. Rhino beginning to revive.	Towed ±1 km on sledge by Land Rover to truck (dug into ground). Sledge loaded directly onto truck (by elephants).
REVIVAL (Revivon)	In Crate. 160 min: 1.0 ml (3.0 mg diprenorphine) i.v./ear. ±162 min:Revived	In Forest. 200 min: 1.0 ml (3.0 mg diprenorphine) i.v./ear. ±206 min:Revived Moved off.	In Crate. ±180 min: 1.7 ml (5.0 mg diprenorphine) i.v./ear. ±182 min:Revived	In Crate. ±100 min: 2.0 ml (6.0 mg diprenorphine) i.m./rump. 110 min:Revived	In Stockade. 86 min: 1.0 ml (3.0 mg diprenorphine) i.v./ear. 88 min:Revived
FINAL LOCATION	Crate unloaded by crane and rhino released into pen at Gauhati Zoo.	Animal released in forest due to inability to load into crate.	Crate unloaded by crane and rhino released into pen at Gauhati Zoo.	Crate unloaded from truck (dug into ground) by elephant and rhino released into stockade at Kaziranga 155 min after darting.	Sledge unloaded from truck (dug into ground) by labour and pulled to door of stockade. Rhino pulled from sledge and into stockade. Release 88 min after darting.

problems of capture operation. In particular, the immobilisation imparted to the animal by the drug begins to wear off after 1½ to 2 hours, which can seriously impede the loading operation if not completed by this time. In any case, it should always be the aim to keep the animal immobilised in a recumbent position for as short a time as possible, making speed of loading a critical factor to the success of the operation.

Unless the animal can be transferred to the holding pen well within the natural recovery time, it is necessary to load it into a crate near the immobilisation site and transport it in this (in revived state), on a truck, to the holding area. In South Africa it proved possible to walk White rhinos into a crate while in semi-conscious state, shortly after the administration of the antidote (Keep, 1971). The first rhino in the present trial was loaded directly into the crate while fully immobilised, using a ramp and the assistance of two elephants.

Sledge

It is often impossible to get a truck to the immobilisation site due to steep slopes, uneven or swampy ground or thick jungle. In such cases an interim transport phase is necessary wherein the still immobilised rhino is moved from its resting place to the waiting crate and truck from 50 m to 2 km away. For this initial journey the rhino is placed on a sledge (King 1969) which is then pulled by elephants or a vehicle to the site where the animal will be transferred to a Crate.

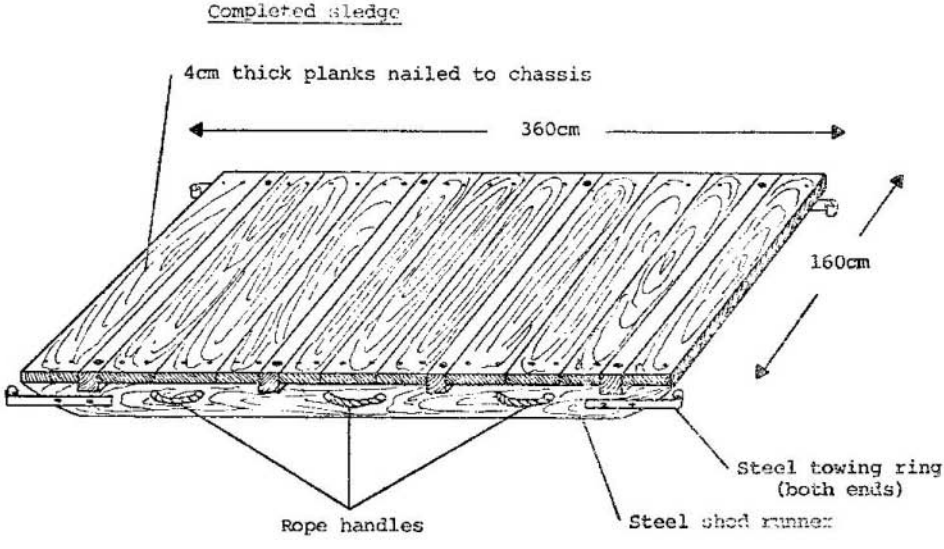


Timber for sledge, crate and stockade - sal

The sledge should be very strongly constructed (Appendix A) as the weight of a 1 to 2 tonne rhino places enormous strains on the structure as it is dragged over rough terrain. It should have sufficient clearance (14 cm) to avoid smaller boulders and stumps and yet be low enough (24 cm) to facilitate loading of the rhino onto it. Length should be slightly longer than a large rhino and 360 cm was found to be satisfactory. Width of the sledge should be such as to comfortably accommodate a rhino lying on its side (and also be capable of being inserted into the crate to facilitate loading—see below) and 160 cm was found satisfactory. Strong towing hooks should be fixed at both ends of the sledge to enable it to be pulled in either direction, which is important when manoeuvring it into position. Runners should likewise be tapered at both ends and steel shod to reduce drag and damage by stones. Handles on both sides of the sledge facilitate shifting it into position alongside the rhino by hand and also provide anchorages for ropes used to secure the rhino to the sledge when loaded. Nylon ropes should not be used for this purpose as they may cause 'burns' on the skin.

Loading Sledge

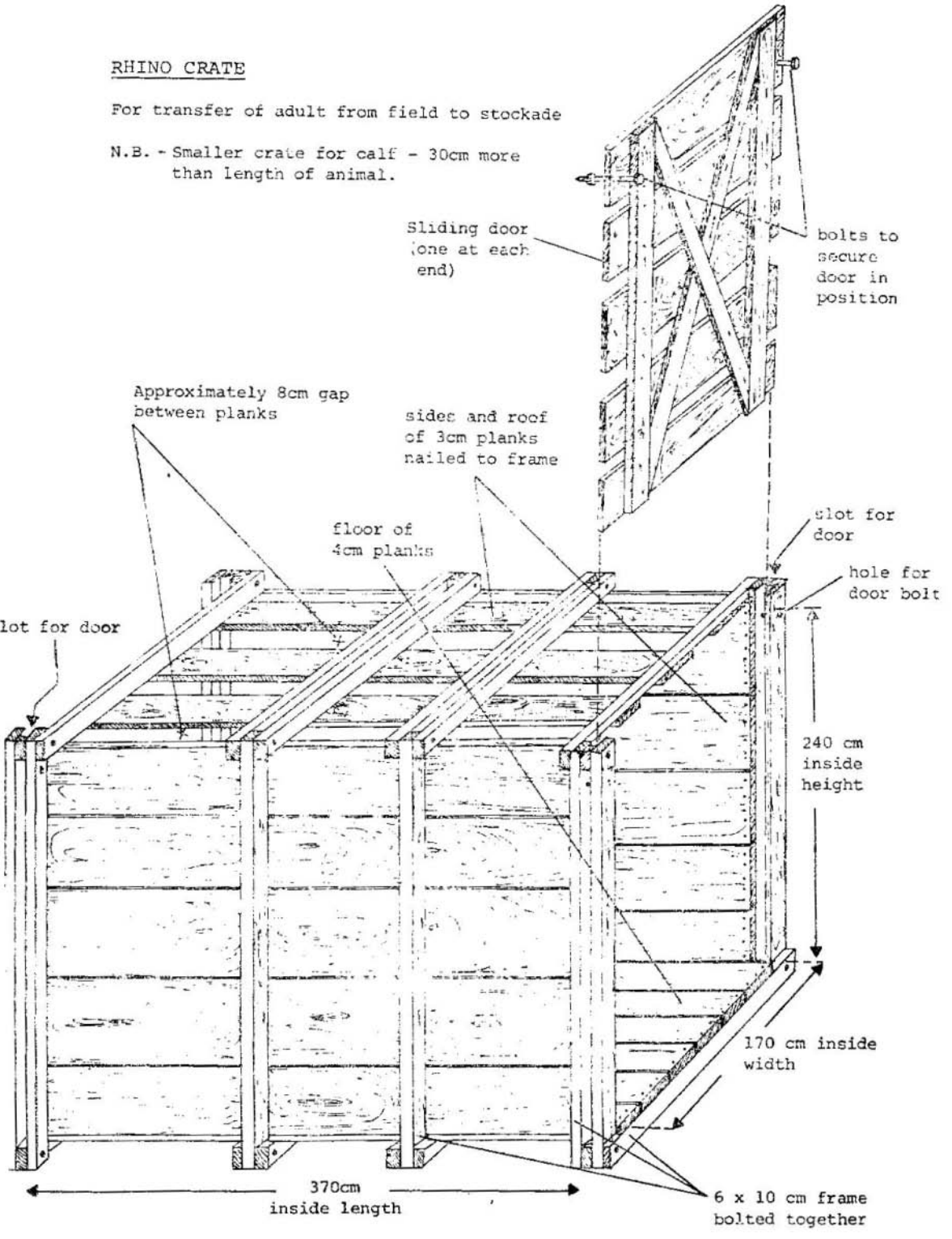
As soon as full immobilisation is confirmed, the sledge is brought into position (Plate IIa) beside the back of the recumbent rhino, whose legs are roped together as a precaution against partial revival and attempts to gain its feet during handling. A disciplined and experienced team of 15 men is required to manoeuvre the rhino on to the sledge. In these trials a smaller animal (995 kg) was lifted onto the sledge, with valuable assis-



RHINO CRATE

For transfer of adult from field to stockade

N.B. - Smaller crate for calf - 30cm more than length of animal.



tance from two elephants who placed their tusks under the rhino's body in a lifting-cum-pushing action. Two others were carefully rolled onto the sledge by men alone (Carter, King, 1979), which proved a much easier method.

Great care must be taken with the rhino's head which should be held out in a natural position by a couple of men while loading takes place. Kinking of the neck may impede breathing and/or circulation to the head. The eyes, which are open, should be constantly covered with a cloth or clean gunny bag to prevent damage by dust or bright sunlight throughout the time the rhino is immobilised.

Once the rhino is in a natural position on its side on the sledge, it should be secured by ropes passing transversely across its body and tied to the handles of the runners.

Elephants are the best power source for dragging the sledge in dense jungles or over extremely uneven ground (Plate IIa). On flat, fairly even ground at Kaziranga it was found that a tractor or jeep (Land Rover, in lowest gear and four-wheel drive) was adequate for towing the sledge to the crate loading site.

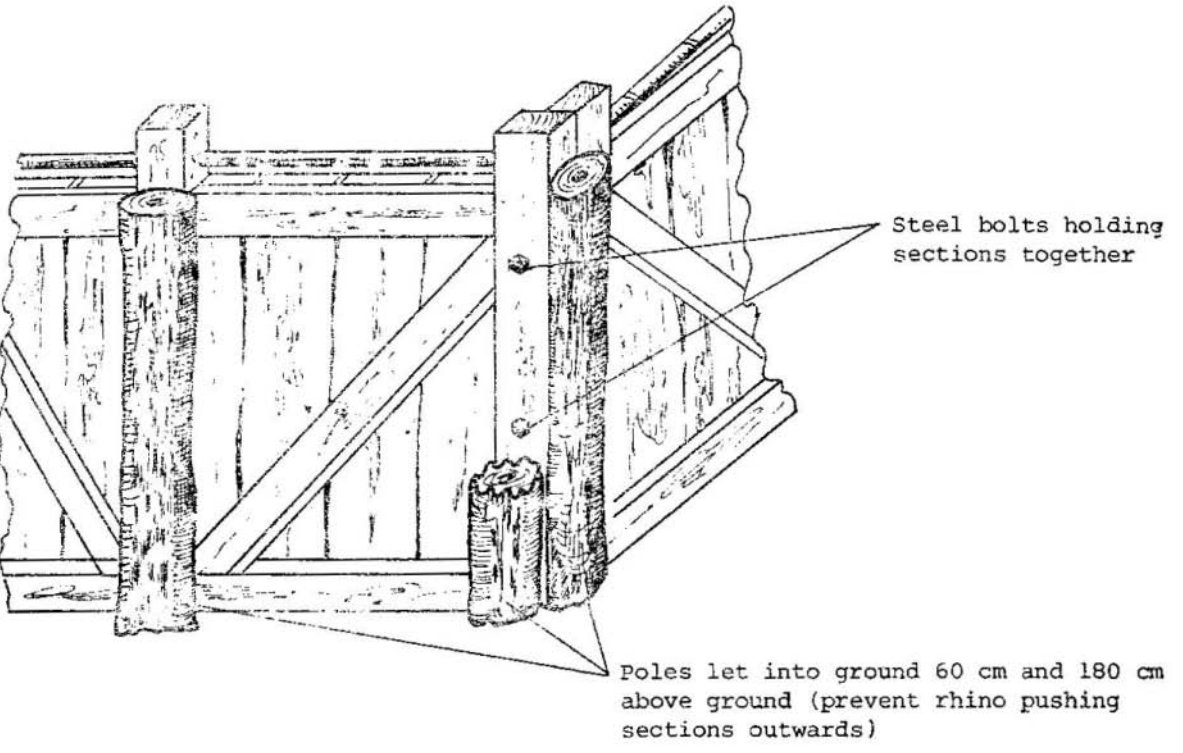
Crate

The crate should be extremely robust construction (Appendix A) as a rhino makes persistent attempts to destroy it after revival. Internal dimensions recommended are 370 cm long, 170 cm wide and 240 cm high. Side timbers should be planed smooth to prevent them from scratching the rhino, as it is jolted around during travel. It should have a drop door in runners at both ends, allowing manipulation of the rhino in the crate from the front or back and enabling it to exit from the crate forwards, on arrival at its destination.

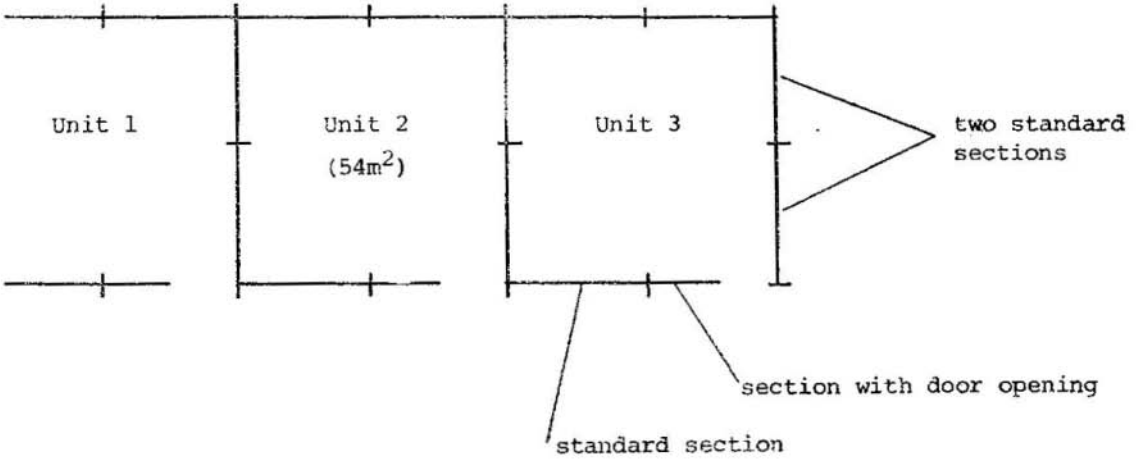
Loading crate

Because of the impossibility of lifting a loaded crate onto a truck in the field, it is necessary to load the rhino into the crate while it is roped to the truck. In order to facilitate this difficult operation it is desirable to lower the rear of the truck into the ground to bring the floor of the crate to a level near that of the sledge (Figure 2).

If it is impossible to dig a ramp into the ground, it is necessary to have a short wooden ramp available to bridge the gap between the sledge and the crate. As nearly as possible, sledge and crate should be horizontal



Formation of sections into units



and the sledge should be correctly aligned with the crate to facilitate loading of the rhino (Plate IIb).

After untying the ropes attaching the rhino to the sledge, it should be lifted/pushed forward into the crate. This is an extremely difficult task for men alone and tuskers proved invaluable in assisting with it. While the rhino's held up by two men, one elephant pushes/lifts the body behind the forelegs, while the second elephant pushes/lifts the rump. It is essential that they work in unison in providing slow, steady push, rather than sudden jerky movements which might injure the rhino. A pair of large, well trained and controlled tuskers can execute this task with great skill, without the risk of damage to the immobilised rhino.

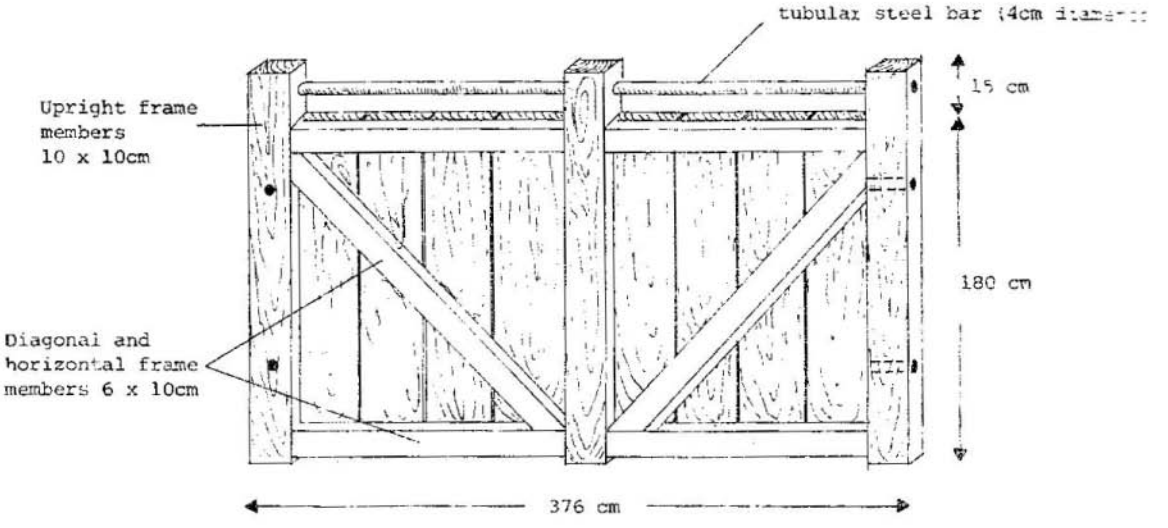
Once the rhino is safely in the crate, its legs can be untied and the Revivon injection administered. The crate door(s) should then be quickly closed and secured with bolts in anticipation of the animal reviving within several minutes of the Revivon injection.

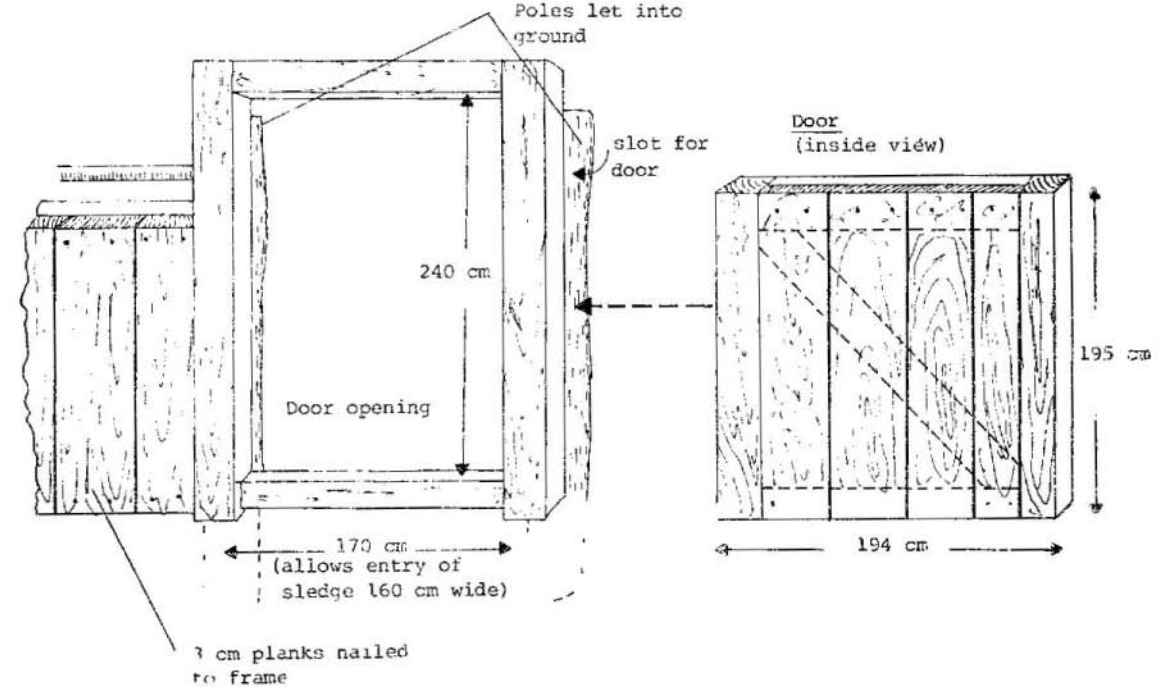
A great improvement on the above transfer procedure from sledge to crate would be to winch the sledge (with the rhino still on it) into the crate and bolt it firmly to the crate floor during transport. (Alternatively, the sledge could be carefully removed, under the sliding door, using a winch or elephant, once the rhino was on its feet.) This procedure would eliminate the difficult transfer of the rhino from the sledge into the crate. It necessitates the sledge being so designed as to fit into the crate and dimensions above have allowed for this. A winch should be fitted behind the cob of the truck to pull the loaded sledge (up a wooden ramp where necessary) into the crate. In the absence of a winch, elephants or cable through the crate and round a pulley behind the truck cab and out again. Alternatively, the loaded sledge could be pushed into the crate.

Unloading crate

The crate containing the rhino is best removed from the truck by using a crane. If a crane is not available, a ramp may be dug into the ground (Figure 2) near to the door of the holding accommodation. After the truck has been reversed into the ramp, men or elephants (Plate IIc) may be used to push the crate from the truck to the door of the holding pen using poles as rollers.

Once the front door of the crate is aligned to the door of the pen, both these doors should be opened and the rhino allowed to walk (down on earth ramp) out of the crate on its own, even if this takes time. As soon as the rhino is in the pen, the pen should be closed and the crate removed or reloaded onto the truck for a further operation.


tubular steel bar (4cm diameter)
Upright frame members 10 x 10cm
Diagonal and horizontal frame members 6 x 10cm
15 cm
180 cm
376 cm


Poles let into ground
slot for door
Door (inside view)
240 cm
Door opening
195 cm
170 cm
(allows entry of sledge 160 cm wide)
194 cm
3 cm planks nailed to frame

In cases where the holding accommodation is close to the immobilisation site, the sledge can be used to transport the rhino over the whole distance between these two points, eliminating the difficult crating operation. It is essential that the rhino be securely tied to the sledge, which can either be transported on the truck or pulled over the ground to the holding site where conditions permit.

4.5. Holding strategy and accommodation

Strategy

Ideally, captured rhinos should be held for 1 to 3 weeks in accommodation near to the capture site before being transported over a long distance in a crate. This reduces the stress of early captivity by allowing the animals relatively familiar surroundings and normal diet collected from their home range. Should holding near the home range not be possible, central facilities may be provided. Whenever possible, this should be at a forest site away from human and other disturbances and where plenty of fodder and water is available. The alternative is a zoo enclosure but the unfamiliar noises, smells and sights of a zoo may disturb the animal and detract from its acceptance of (temporary) captivity.

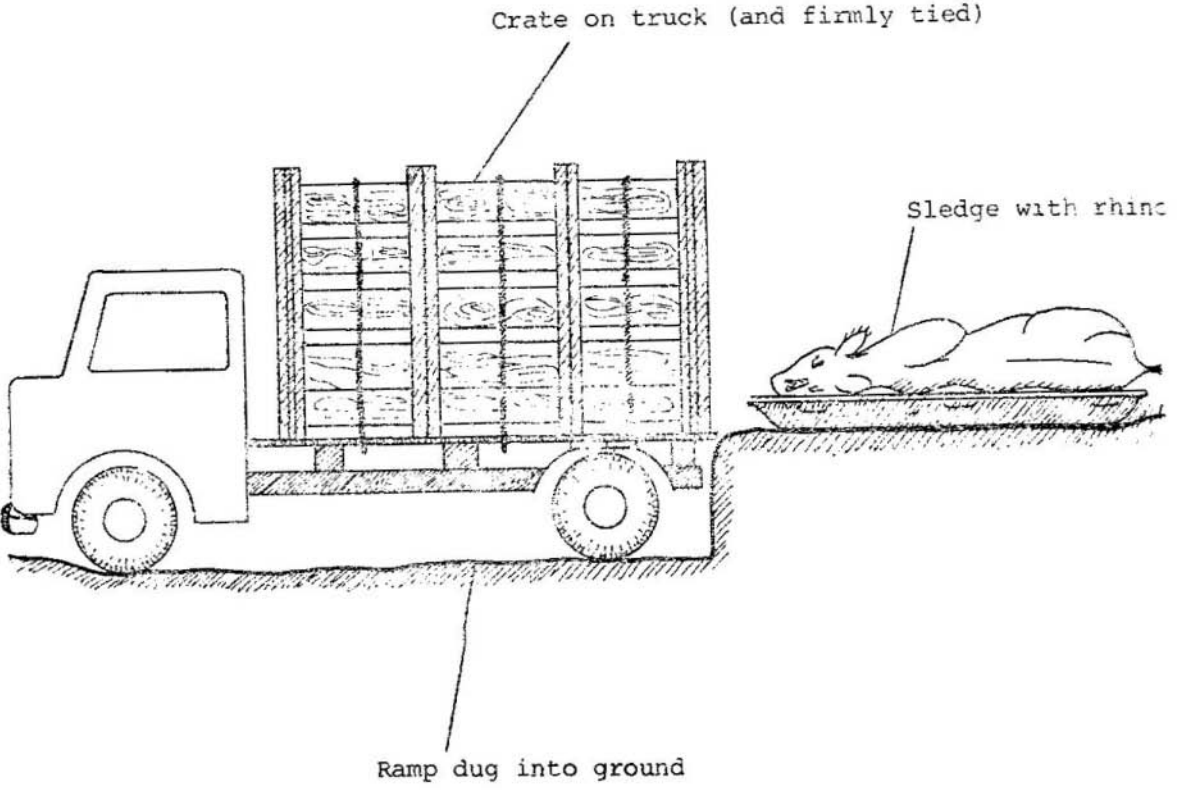
After a period of quietening down subsequent to capture, the animals can be moved, possibly over a long distance, to their ultimate new location. Here they should be held for a longer period (approximately 2 months) to allow them to gain familiarity with local food, water, sounds, smells, and climate before release into the wild.

Holding accommodation

Two types of holding enclosures were utilised in the present trials and a third type awaits testing under Indian conditions.

At Kaziranga traditional stockades were used made from vertical sal poles side-by-side, let into the ground and tightly bound together horizontally at several levels. The poles were of minimum 250 cm height above ground level. The stockades were constructed on the edge of a stream in such a manner that part of the stream provided a large wallow. The door was of the vertically sliding type, raised by a stout rope, passing over a gantry above the doorway. The dimensions of these stockades were approximately 20m × 12m which was adequate as a temporary holding area.

The first two animals captured were placed in spare rhinoceros accommodation at Gauhati Zoo, which consisted of rhino stable (house) attached to which was a walled exercise yard. A 200 cm high wall is essential for rhinoceros, as well as shade and a wallow.



For repeated capture and release operations in different locations the merits of a more portable stockade design are worth considering (Appendix A). A set of timber sections is constructed which can be used to erect stockades of various ground areas, at any given site and then dismantled, transported and re-erected elsewhere. The completely smooth and opaque walls eliminate the tendency of rhinos to try and prize their way out between the poles of traditional stockades, which has some times resulted in a broken horn or damage to the newly captured animal. Furthermore, rhinos settle down more quickly in a solid-walled stockade, preventing visual disturbance from outside (Harthoorn, 1976). If traditional stockades are used, cracks between the vertical poles should be stuffed with grass initially to give the appearance of a completely solid wall.

4.6 Medication carried/used

In addition to the immobilising drug and its animal and human antidotes, it is essential to carry a small number of medications for routine and emergency treatment of the captured rhinos. The following or local equivalent are recommended:

(i) Orbenin intramammary suspension (Beecham Animal Health, Brentford, U.K.) is a convenient semi-synthetic penicillin in a disposable syringe, containing 500 mg cloxacillin benzathine B.Vet.C. It was used for routine dressing of dart punctures and any minor injuries sustained by the rhino during handling.

(ii) Terramycin/L.A. Injectable Solution (Pfizer Ltd., Sandwich, U.K.) Each rhino captured received 40 ml i/m of this long acting formulation of oxytetracycline, as a general precaution against infection.

(iii) Concentrated Tetanus Antitoxin (wellcome Foundation Ltd., Crewe, U.K.). Each rhino received 2,500 IU s/c as a routine precaution.

(iv) Dexafort (Intervet Laboratories Ltd., Cambridge, U.K.). Each ml contains dexamethasone as phenylpropionate 2 mg and dexamethasone as sodium phosphate 1 mg. This drug exhibits potent gluconeogenic and anti-shock properties and was carried in case of acute shock symptoms following capture, such as circulatory failure.

(v) Parentrovite Multidose Injection (Beecham Animal Health, Brentford, U.K.) is a concentrated preparation of the B-complex vitamins together with vitamin C. It was carried for use in case of shock or stress due to prolonged recovery from the effects of immobilisation.

5. RESULTS

Five male animals were successfully immobilised during the trials, three at Karua and two at Kaziranga ; four of which were transferred to holding accommodation. The lack of females in the sample was not planned and reflects their greater elusiveness as well as the difficulty of distinguishing the sex of young adult rhinos in the field. Essential details of the five immobilisations are given in Table 1. Total doses of Immobilon administered ranged from 1.0 to 1.66 ml (2.45 to 4.1 mg etorphine) and of Revivon from 1.0 to 2.0 ml (3 to 6 mg diprenorphine). Complete revival was rapidly achieved in all cases and no significant side effects of immobilisation were observed. No medical problems were experienced and there were no casualties. Comments on problems that were encountered are given below, together with a statement on training achieved.

5.1 Problems encountered

A number of 'bounce-offs' of the projectile on impact with the rhino's skin were experienced. Several were perhaps due to using too powerful a charge for the range. Another cause was probably too great an angle between line of flight of the projectile and the rhino's skin on impact. It is essential to have a 90° angle of impact to guarantee proper penetration of the dart. Undoubtedly the heavy keratinisation of the rhino's skin was the major contributory factor in causing failure of needle penetration. The only way to avoid this problem is to strictly limit shots to the target areas indicated in Figure 1. This, of course, demands a high standard of marksmanship in the person operating the dart gun.

Slow and/or inadequate induction of immobilisation was common and four out of five rhinos had to be given a 'topping-up' dose of Immobilon (by re-darting) before adequate immobilisation was achieved. The causative factor may have been inadequate needle length, resulting in subcutaneous delivery of the drug, rather than intramuscular delivery essential for rapid and complete immobilisation (see. 4 2). However, the only animal that did not have to be topped-up (case 5) received the highest initial dose (1.0 ml) and it may be that, due to excessive caution, too low an initial dosage for a fresh species, which is also on the 'endangered' list, great care should be exercised to avoid an overdose. The only published dose of etorphine for the species is 0.001 mg/kg (Harthoorn, 1976). The mean initial dose in the present trials is 0.0013 mg/kg, while the mean total dose is 0.0022 mg/kg, more than twice the published figure. However, it should be borne in mind that the published cause was a zoo animal. A practical difficulty in dose calculation arises from the fact that in the field one frequently has to estimate the weight of an animal which is partly hidden by vegetation.

Case 2, the largest of rhinos in the series, partially recovered after 120 minutes, due to the unduly long time taken with loading arrangements (much jungle clearing was necessary in order to get the sledge to the animal and the labour failed to lift him onto the sledge). The standing rhino was in a non-aggressive, uncoordinated state and after attaching a neck rope, he was led 100 m to the truck with some difficulty but could not be persuaded to walk up the rather steep ramp to the crate. A small dose (0.3 ml) of Revivon was administered i/v in an attempt to improve coordination but the animal ran off dragging two neck ropes and had to be reimmobilised in order to remove these. Had there been time to dig the truck into the ground to reduce the angle of the ramp up to the crate, it might have been possible to walk this large animal into the crate.

The failure to load the Case 2 animal underscores the need for a well disciplined labour force, welded into a coordinated team. Undoubtedly repeated experience of such an operation by the labourers would help in the task of loading a large rhino. It is significant that the much smaller but well disciplined force of 13 trainees from the Central Crocodile Breeding and Management Training Institute had no difficulty in loading the two Kaziranga rhinos onto the sledge, although these were smaller than the Case 2 male and rolling rather than lifting the rhino was employed.

At Karua, a problem which had not been anticipated was large crowds of spectators (numbering up to 1000) which severely hampered the operations and increased the element of danger.

In all cases except 4, an interavenous dose of Revivon of equal volume to Immobilon received, produced rapid revival (mean 3 minutes, range 2-6 minutes). Case 4 was given an intra-muscular injection in the rump (due to inaccessability of its ears) of twice the Immobilon volume, in order to counteract the slower drug dispersal by this route. Even so, revival was slower (10 minutes) than in other animals, demonstrating the value of the intravenous route.

Communication between members of the team was sometimes a problem, both during the 'stalking' operation when elephants become widely separated and during loading when several separate aspects (positioning of truck, cutting track for sledge, care of immobilised animal etc.) needed careful coordination. The availability of 'walkie-talkie' radio would have greately helped in overcoming this difficulty and its use is recommended in future operations, as is standard practice in other countries.

5.2 Training achieved

Training in various aspects of drug capture and translocation was imparted to a total of twelve senior officers and thirteen trainees (Assistant Conservators of Forests/Range Officers level) as follows :

(a) Lectures on wild animal capture and translocation, given by Dr. M.H. Woodford at Central Crocodile Breeding and Management Training Institute, Hyderabad, were attended by all trainees of the 1979/1980 Course, the Assistant Instructor at the Insitute and three Government veterinarians engaged in wildlife work.

(b) The Veterinary Officer at Gauhati Zoo assisted Dr. M.H. Woodford in veterinary aspects of the operations at Karua, including drug preparation and loading of the projectile ; care

medication of the rhino during and after immobilisation. The District Veterinary Officer, Bokakhat similarly participated in the Kaziranga operations.

(c) The Senior Wild Life Warden, Assam Forest Department, fully participated in all aspects of operations at both sites. In consultation with FAO personnel, he was responsible for all logistic arrangements such as location of rhinos, transport, elephants, labour and liaison with local authorities. He was ably assisted by the Divisional Forest Officer, Bokakhat and Range Officer, Kaziranga, both of whom fully participated in operations there.

(d) The Divisional Forest Officer in charge of Gauhati Zoo and his Chief Engineer built (and later modified) the sledge and crate used, arranged appropriate holding accommodation in the zoo, supervised unloading of the crate and care of the rhino after unloading. The Divisional Forest Officer, South Kamrup Division designed and supervised the construction of traditional stockades.

(e) The Assistant Instructor and all trainees of the Central Crocodile Breeding and Management Training Institute participated in the Kaziranga captures, as part of a training tour, involving field exercises and a study of management in Kaziranga National Park. Care and handling of drugs (including human antidote) and delivery equipment was demonstrated ; a number participated in actual stalking and darting operations on elephant back and all took part in handling and loading of immobilised rhino and in the transfer of both the immobilised and revived animal into the stockades. The administration of Revivon and various medications and after-care were demonstrated.

6. CONCLUSIONS

All major objectives (see Section 2) of the trials were fulfilled and conclusions may be summarised as follows :

6.1 The usefulness of the drug immobilisation technique in the capture of the Great Indian rhinoceros was successfully demonstrated without casualities. Although certain details require further experimentation, there is little doubt that the technique can be used humanly and with complete safety on this species, provided proper precautions are exercised. In particular it should be noted that :

(a) Etorphine is a suitable immobilising agent and a dose of up to 0.0025 mg/kg appears to be safe for the species. It is highly toxic to man and should never be used in the absence of a specific human antidote. Strict regulations govern the importation of this narcotic drug into India.

(b) The delivery system should be one which minimizes the possibility of drug spillage and enables precise placing of the 'dart' on one of the limited target sites on the rhino. A long needle is essential.

(c) Diprenorphine is a suitable antidote and effects rapid and complete recovery, particularly when administered via the i/v route.

6.2 Capture and transport procedures were developed (as far as the holding stage). The use of well trained elephants, in the hands of experienced mahouts, proved vital to both 'darting' and loading procedures. The experience gained allows improvement in the design of equipment and a plan of operation, so as to reduce the time needed for the capture and transfer of a rhino to the holding pen. Basically, the approach involving the use of a sledge (and crate when necessary) proved to be a suitable one for the Great Indian rhinoceros in both types of habitat (forested hill side and grass covered, flat terrain).

6.3 A number of wildlife officers and 2 veterinarians in the service of the Assam Government and 13 trainees of Central Crocodile Breeding and Management Training Institute participated in the operations.

6.4 Further development and training in the capture and translocation of the rhinoceros is necessary. A fully competent capture team, incorporating all levels of capture and handling expertise, should be trained up if immobilisation and translocation is to play an important role in rhinoceros management in India. Such a team should include a Team Leader (Deputy Conservator of Forests with wildlife training prior to selection) ; and Assistant Leader (Assistant Conservator of Forests with wildlife training) ; Wildlife Veterinarian ; Veterinary Assistant and a Chief Field Technician (Range Officer with wildlife training). Only a professionally trained person, normally the veterinarian, should be involved in the handling of the potent drugs used in immobilisation. Several members of the team should be fully conversant with emergency procedure following accidental administration of a drug to a human subject. The handling of an endangered species such as the Great Indian rhinoceros, should only be

entrusted to a carefully trained, experienced capture team all of whom should have a background of training and experience in wildlife work, before selection for specialised training in the capture team).

6.5 Important aspects of rhino translocation yet to be tried and developed are long-distance transportation and the release of animals at new locations.

7. ACKNOWLEDGEMENTS

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