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CONTENTS

SHORT NOTES

Developments in the capture and airlift of roan antelope *Hippotragus equinus equinus* under narcosis to the Etosha National Park

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(With 1 map, 1 figure, 1 table and 8 plates)

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ABSTRACT

Seventy-four free-ranging roan antelope *Hippotragus equinus equinus* (Desmarest, 1804) were captured by dart immohilisation and successfully transported under prolonged narcosis in a C130 Lockheed Hercules airfreighter over a distance of 430 nautical miles to the Etosha National Park. Struggling and exertion during handling and transport and heat stress were effectively controlled by prolonging the period of immobilisation.

I INTRODUCTION

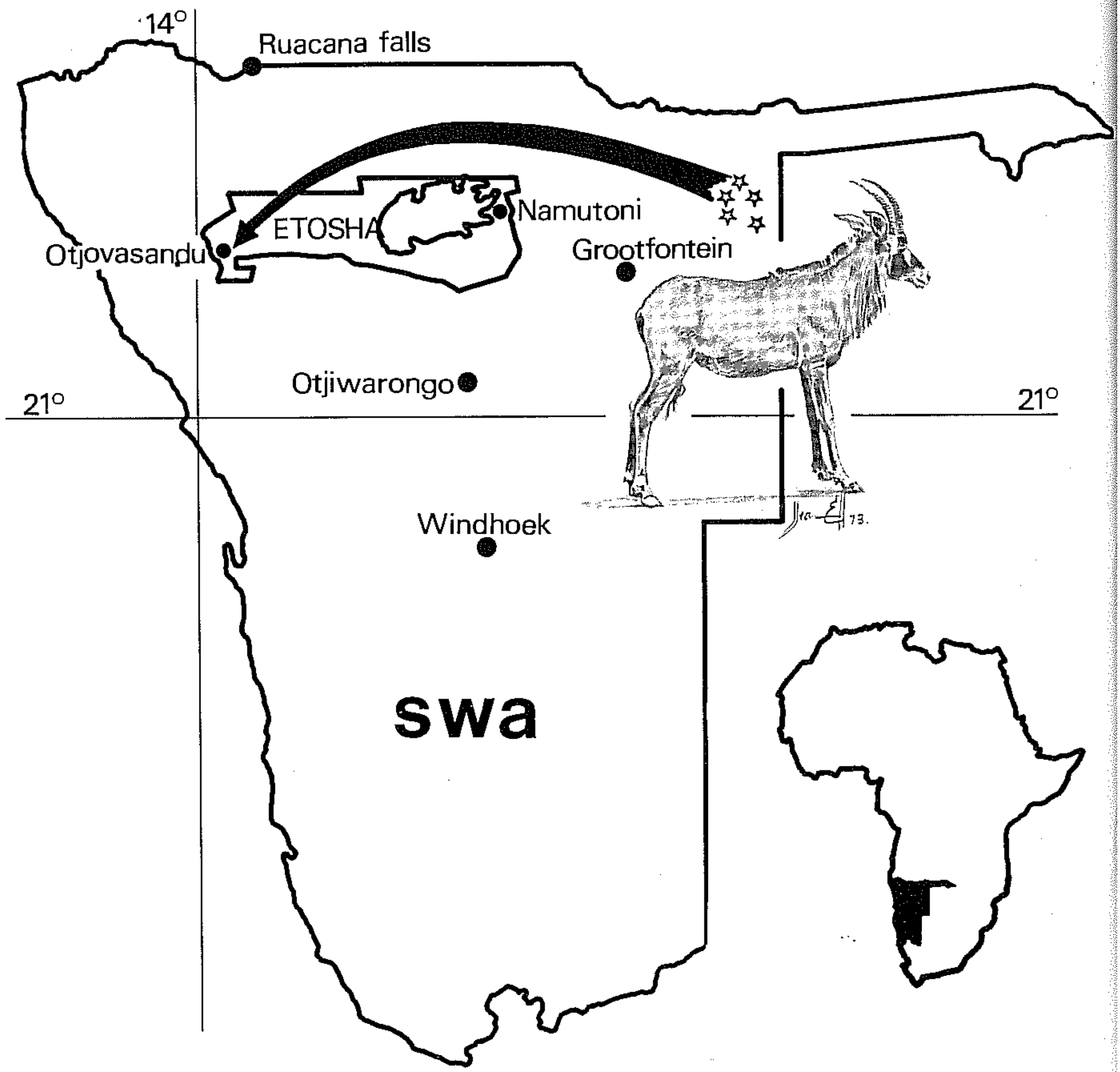
The former range of the roan antelope, *Hippotragus equinus equinus* (Desmarest, 1804) in South West Africa comprised the whole north-eastern portion of the country from the Ruacana Falls at 14° E to the Botswana border (including the Caprivi Strip) and along the eastern part, as far south as latitude 21° S. Within this area roan were widely distributed, extending as far as the eastern Namutoni area of the Etosha National Park (Shortridge, 1934). Pioneers even came across scattered roan herds in parts of the Kaokoveld, which includes the extreme western Otjovasandu area of the Etosha National Park.

In recent times there has been an alarming decline in these roan populations and they became restricted to the most north-easterly part of the country, where surveys revealed that there are no more than 400 left (excluding the Caprivi). Indeed Pienaar (1968b) points out that this antelope is now rare throughout its range in Africa. Any attempt, therefore, to capture and save it from extinction in South West Africa justified the use of the most modern technological aids and the development of new techniques for immobilisation and translocation procedures. In September and October 1970 an ambitious operation was therefore launched by the South West Africa Division of Nature Conservation and Tourism for the capture and transfer of 74 roan antelope to the Etosha National Park (Map 1) where the future of these rare animals (Southern Africa's second largest antelope) could be safeguarded.

II CAPTURE OPERATION

2.1 Locality and description of area

The operation was conducted in the dry river-bed of the Khaudum Omuramba in the north-eastern corner of South West Africa, some 460 km by road from Grootfontein (Map 1). The last 160 km consisted merely of bush tracks over loose sand and could only be traversed by four-wheel drive vehicles. The greater proportion of this country is flat and featureless and during the dry season water is limited to a few scattered pans and drainage systems (omurambas). The vegetation comprises typical



Map 1. The translocation of roan antelope to the Etosha National Park, South West Africa.

woodland savanna and forest of the northern Kalahari. Trees, predominantly *Pterocarpus angolensis* DC, reach a height of 20 m. The Khaudum Omuramba, which is 200 to 1 000 m in width, is treeless and it was within a narrow 35 km stretch of this river-bed that the roan were caught.

2.2 Immobilisation

A survey carried out earlier in 1970 indicated that the roan were dispersed over a wide area. However by September, following a severe drought, water was limited to pools in the Khaudum Omuramba and, as roan are very dependent on water, an estimated 240 animals had congregated in the vicinity. Bushmen had recently burnt the grass, which had sprouted in the river-bed and acted as an additional attraction for the animals. Therefore, although conditions were unfavourable climatologically (Hofmeyr & de Bruine, 1973), it was possible to launch a capture operation.

The work done by Pienaar (1968b) on the immobilisation of roan antelope and by Keep & Keep (1968) and Pienaar (1968a) on the introduction of the Butyrophenone compounds in the immobilising drug mixture served as most useful guides for this operation. The animals were darted from a Bell 47G4A helicopter. Initially nets were used with unsatisfactory consequences. The Palmer long range (pneumatic) projector and Palmer 3 cc darts fitted with NC2 needles (Palmer Chemical & Equipment Co.) were employed and proved to be very effective. Using this equipment the dart could safely strike almost any part of the body without inflicting any undue injury. For the safe and effective intramuscular administration of the immobilising drugs the projector was aimed at a 40° to 70° angle at the rump of the animal directly in front of the helicopter. Accurate immobilisation times, taken from the moment of impact of the dart until the animal became recumbent, were recorded with a stop watch.

Initially the roan were easy to approach but they soon learnt to make for the cover of the trees when they heard the approaching helicopter and it became increasingly difficult to drive them out into the open again (Plate 1). They therefore had to be darted before they reached the forest and, being relatively small and fast-moving targets, good co-ordination between the pilot and the gun operator was an important requisite.

Altogether 81 roan antelope were immobilised. In 61 cases 4 mg Etorphine hydrochloride/M99 (Reckitt) was used as the narcotic and 200 mg Azaperone (Janssen) as the neuroleptic. Similar dosage rates were used for animals ranging from 100 to 325 kg in weight. A parasympatholytic was not incorporated in the drug mixture. The immobilisation time varied from 3 min. 12 sec. to 19 min. 49 sec. (average 7 min. 36 sec.). In 20 cases the M99 was replaced with 40 to 60 mg of Fentanyl (Janssen). The Fentanyl/Azaperone combination took 6 min. 45 sec. to 21 min. 40 sec. (average 12 min. 7 sec.) to induce immobilisation. In the writer's experience M99 was superior. Besides being swifter acting, it produced a more complete narcosis.

The first effects could be ascertained by observing the movement of the ears. This was soon followed, usually within 2 to 4 minutes after darting, by ataxia. The roan invariably went down in the sternal position. Younger animals weighing about 100 kg usually ran harder and took longer to go down despite proportionally larger dosage rates, while pregnant cows were inclined to become immobilised more swiftly.

On rare occasions the dart struck the vertebrae and this caused the needle to become occluded before the drug was discharged. It necessitated the firing of a second dart and animals that were darted twice usually ran for long distances, often 8 to 10 km, before they were finally immobilised.

Depending on climatic conditions as many as eight roan were immobilised per day. On three occasions animals which were considered too old were released.

Once the roan became recumbent, the helicopter was landed close by, usually within 100 m, so that immediate attention could be given to the animal. In order to guide the vehicles to the capture site, close contact with the aid of radio transceivers was maintained between the helicopter and the ground staff.

Once immobilised the majority of roan could be approached almost immediately. They were most tractable when immobilisation had taken less than 10 min. On the whole, their reactions were very similar to those described by Pienaar (1968b).

2.3 Post-capture care and clinical observations

Post-capture care proved to be the most significant aspect of the operation. Of the first six roan darted, four died as a result of overstraining or capture myopathy. Roan appear to be particularly susceptible to this condition and losses were encountered despite the prophylactic administration of drugs such as Catosal (Bayer), Vecortenol (Ciba) and Thiamine hydrochloride (Peterson).

The most significant clinical signs shown by the affected animals were the development of torticollis accompanied by general muscular weakness. The syndrome was noticed as soon as 2 hours after capture and once it was manifested clinically it became an irreversible condition which was refractory to treatment. Over-exertion, hyperthermia and psychological stress appeared to be the main aetiological factors involved in precipitating the condition. It was therefore particularly evident in roan which ran excessive distances and where exertion was further aggravated when they were transported by conventional methods using crates, in which the confined space subjected the animals to further overheating.

It was clear that, if further losses were to be avoided, radical changes in the *modus operandi* were called for. Therefore, once an animal was immobilised, every attempt was made to prevent additional exertion, alleviate and prevent hyperthermia and eliminate psychological stress. A different method of transportation which obviated the use of crates was developed and proved to be of paramount importance. In addition the prompt administration of various prophylactic and therapeutic agents, in particular the use of a vitamin E-selenium preparation, appeared to be helpful. The following regime of care and therapy prevented further clinical manifestations of the syndrome.

2.3.1 Drug administration and handling

Drugs such as vitamin E and selenium (E-SE S.A. Cyanamid) at the recommended dosage rate, Thiamine hydrochloride (200 to 400 mg) and Catosal (5 to 10 ml) were promptly administered intravenously. Vecortenol (75 to 150 mg according to the weight of the animal) and a long acting antibiotic were injected intramuscularly. On account of the poor nutritional value of the grazing at the time, some individuals were not in optimum condition. The injection of a vitamin ADE preparation was therefore considered advisable for all pregnant cows, animals in poor condition and in over-exerted cases while a vitamin B complex was administered to roan in poor condition. An antibiotic mastitis ointment was inserted into the dart wound.

Age was estimated by examining the teeth. Three to six centimetres of each horn tip was sawn off to prevent serious injuries should the roan fight in their captive enclosure. An ophthalmic ointment was placed on the cornea to prevent infection and desiccation and the roan were all blindfolded to pro-

Table 1. Observations on rectal temperatures, pulse and respiration rates in roan antelope.

Exercise	Rectal Temperature				Pulse/Minute				Respiration/Minute			
	Min.	Max.	$\bar{X}$	Range	Min.	Max.	$\bar{X}$	Range	Min.	Max.	$\bar{X}$	Range
* Roan captured by immobilisation (81 animals)	37,8°C (100,0°F)	42,5°C (108,5°F)	39,7°C (103,4°F)	4,7°C (8,5°F)	87	208	140	121	10	74	31	64
** Roan immobilised for translocation (74 animals)	35,4°C (95,8°F)	40,5°C (104,9°F)	37,6°C (99,7°F)	5,1°C (9,7°F)	42	77	60	35	14	44	27	30

*Pulse and respiration rates of captured roan are averages for 45 animals.
**Clinical observation done during transport approximately 1 hour after darting.

tect their eyes against dust and the glare of the sun. Rectal temperature, respiration and pulse rates were recorded in the majority of cases and the conjunctival mucous membranes were examined. The pulse was easily felt on the middle coccygeal artery at the base of the tail. The clinical findings from 45 animals are summarized in Table 1. These findings, especially rectal temperature, were closely related to the degree of over-exertion. Markedly elevated body temperatures were usually a sequel to prolonged immobilisation times and/or high environmental temperatures. To minimise hyperthermia, roan were therefore captured during the early hours of the morning and in the late afternoon shortly before sunset.

2.3.2 Transportation and off-loading

As crates had proved to be unsatisfactory for transporting the roan, it was decided to convey them to their holding boma (enclosure) on the hack of vehicles while they were still ommobilised (Plate 2). For this purpose two open, light 1¼ ton four-wheel drive vehicles were used. Employing this method struggling was eliminated during transport and animals with elevated body temperatures soon returned to normal through convection as a result of the moving vehicle and evaporation in instances where water was poured over the animal. Thus it proved possible to successfully capture roan which had run long distances and greatly exerted themselves. In one instance a roan which received a second dart after the needle of the first had become occluded showed no ill effects after it had run an estimated 10 km. Its recorded rectal temperature was 42,5° C.

The majority of adult females were pregnant and great care was taken not to injure such animals during loading, transportation and off-loading. At least five men were required to firmly lift, load and off-load an adult roan.

During transport constant supervision was maintained over the animal, which was kept in the sternal position. It was important for the head to be held upright to allow eructation to occur and prevent the onset of tympany with possible complications of regurgitation, asphyxiation and aspiration pneumonia.

Roan were usually delivered at the holding boma within an hour after immobilisation and in some instances they remained immobilised for up to 3 hours. After off-loading the specific morphine antagonist was administered intravenously into the ear vein, either using 125 to 150 mg Nalorphine hydrobromide (Burroughs Wellcome) or 10,00 to 10,25 mg Cyprenorphine hydrochloride/M285 (Reckitt). Recovery following Nalorphine was the smoothest and quickest and, as it was advisable to get the immobilised animal to rise as soon as possible, this was preferred to M285.

Immobilised animals were placed well away from obstacles which might cause injuries and were positioned facing the far end of the boma where the rest of the herd congregated. Upon regaining consciousness they never dashed away blindly, but, though still tranquillised, walked or trotted over purposefully to join the rest of their companions (Plate 3).

2.3.3 The captive period before translocation

The holding boma or enclosure was erected within the catching area. It was 110 m in diameter and constructed of white opaque light plastic sheeting 2,5 m high reinforced with netting on the outside (Plates 4 and 5). Ample shade and drinking water were provided and the roan were fed baled lucerne and natural veld hay which were well distributed into several feeding lots. Antelope cubes (Epol) were provided *ad lib.*

Apart from veterinary quarantine measures it was essential for the roan to recover from the initial shock of capture. They settled down remarkably quickly in their holding pen but it took them some time (approximately 24 to 48 hours) to start feeding on lucerne. However, they fed on the grass provided almost immediately. Once the quota of 74 roan was caught, the animals consumed 20 to 30 bales of lucerne a day in addition to the natural grass. Antelope cubes were much sought after and during hot days water consumption was considerable. Roan of different age groups and both sexes derived from several herds readily accepted one another. No serious injuries were inflicted during their mild scrimmages, which only occurred to a limited extent — mainly when the animals became excited and closely grouped while humans were present in the enclosure.

III THE AIRLIFT OPERATION

From the outset it was clear that the translocation of the roan by road to Otjovasandu in the western part of the Etosha National Park (Map 1), a distance of over 1 000 km by road, would have been disastrous. It was originally intended to airlift them from a suitable landing strip situated 150 km from the Khaudum. After transporting the first two animals captured to this strip on an exceedingly poor, sandy bush track, it was obvious that this could not be done.

The only alternative was an airlift from the Khaudum Omuramba. The rainy season was already at hand and the possibility of a giant airfreighter landing in a river-bed not only proved to be a staggering exercise in logistics but could only be contemplated while the river was dry. A senior captain of Suidwes Lugdiens (South West Airways), Windhoek, was flown in to investigate and select a possible landing site. After a thorough investigation a landing strip 1 800 m in length was located 5 km from the roan enclosure.

Once it was established that an airlift was possible an experiment was conducted to determine the effect of prolonged immobilisation on the roan antelope. It was estimated that during the transit operation they would have to be immobilised for as long as 5 hours.

After being darted from the helicopter, three cows were retained for clinical observations and placed under the shade of a canopy (Plate 6). Body temperatures, respiration and cardiac rates were taken at 30 min. intervals. The results from one animal (HE74) are plotted in Figure 1. A marked correlation was found between the respiration rate and body temperature. The latter decreased during transport to the boma, but later increased with a rise in ambient temperature.

While immobilised the animals were moved over every 30 min. from one side to the other, maintaining a sternal position, to relieve the pressure on their legs. Roan HE75 remained down for a period of 3hours after which she stood up of her own accord and joined the rest of the herd. HE76 and HE74 received Nalorphine after 5 and 6 hours respectively.

Ptyalism was the only side effect noticed during immobilisation. These results were most favourable and it was felt that it would be perfectly feasible to transport the roan by air while they were under deep narcosis. For transit it was important to dart the animals at dawn when it was still cool, to minimise the effects of heat stress. In addition the pay load of

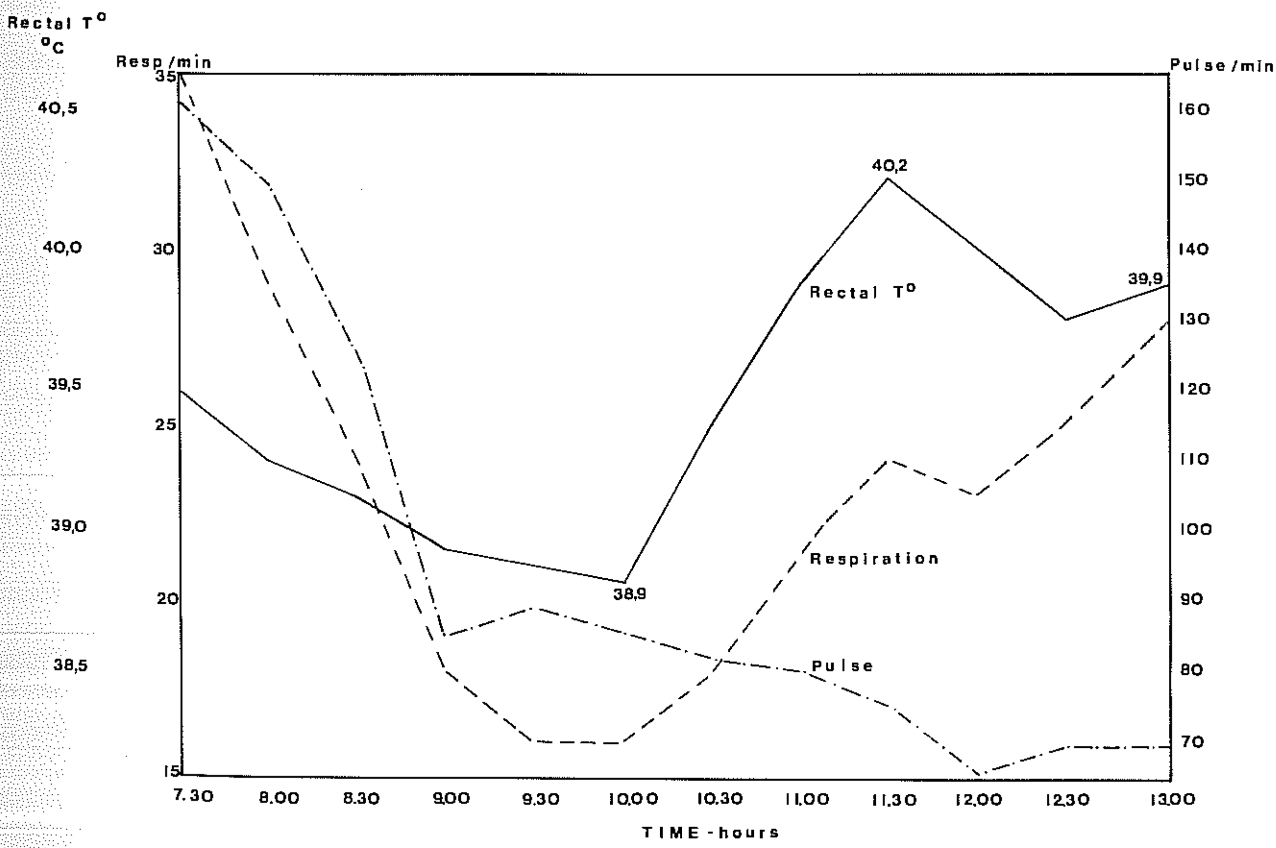


Figure 1. The effect of prolonged immobilisation on respiration, pulse and body temperature in a captured roan antelope(HE 74).

the aircraft is considerably reduced when it is operated at high environmental temperatures, especially when taking off from a makeshift landing strip.

On 20 October 1970, Safair's C130 Lockheed Hercules airfreighter touched down in a cloud of dust in the dry river-bed. The roan were reimmobilised *en masse* after groups of 10 to 15 animals had been herded into a smaller, specially constructed enclosure (Plate 5). Darts prepared with 4 mg M99 and 200 mg Azaperone were fired through slits made in the plastic sheeting. Once all the animals were down they were immediately placed on the back of open vehicles. As many as four animals per vehicle were conveyed to the plane. There they were placed three to four abreast on pallets lined with plastic and containing a layer of sawdust overlaid with hessian. Once loaded each pallet was moved into position on rollers and secured. The horns of the animals were loosely tied with ropes to suspended cross chains (Plate7) specially constructed for the purpose. This prevented the animals from accidentally injuring one another and, with their heads raised, the air passages were kept open with no danger of bloat and asphyxiation. Nets were placed over the roan to secure them during take-off and landing. Moreover, attendants were stationed at strategic points to supervise specific groups of animals and rectify their positions whenever necessary. Ventilation and the temperature inside the aircraft could be regulated as required.

With 26 roan on board and loaded to capacity the airfreighter took off with its precious cargo. The animals only showed a temporary response to the aircraft's engines when these were started. The journey of 430 nautical miles took 1 hour 10 minutes and the roan were immobilised for a period of 3 to 5 hours. On occasions it was necessary, particularly with the animals which had been immobilised first, to administer an additional 1–2 mg M99 and/or 100–200 mg Azaperone. During transit clinical observations were made which indicated that the majority of roan were not subjected to any marked degree of stress (Table 1). They all received an intramuscular injection of 5 ml Catosal plus a long acting antibiotic (Compropen, Glaxo-Allenburys) and 100 mg Thiamine hydrochloride. Eye ointment was once again applied.

On arrival at Otjovasandu vehicles were standing by to transport the roan to their new enclosure. After the intravenous administration of 150 mg Nalorphine the disembarked animals soon returned to their normal state of consciousness (Plate 8).

In order to airlift the 74 roan, three flights were made. There were four losses shortly after delivery — two being the victims of capture myopathy, and two as a result of injuries sustained in the delivery boma.

The roan were released into a specially constructed 765 ha paddock a month later, following the termination of the veterinary quarantine period. During this period a remarkable event occurred in that a cow gave normal birth one week after the animals were translocated. Furthermore during the ensuing three months a total of 26 calves were born. The roan have successfully adapted to their new environment and are steadily increasing in numbers (Hofmeyr, in press). In August, 1973, 159 roan were counted during a helicopter game census.

IV DISCUSSION AND CONCLUSIONS

During capture any animal is undoubtedly subjected to some degree of exertion and often hyperthermia when pursued by a helicopter. Although every attempt was made to limit exertion in the roan by inducing rapid immobilisation and by limiting darting to the most favourable part of the day it could not be entirely avoided. The effect of exertion is often aggravated during the handling, transport and captive phases and becames cumulative, soon leading to an irreversible shock syndrome which cannot be treated. In the roan this was particularly evident when crates were used. Prolonging the period of immobilisation to eliminate struggling during handling and transport, and combating hyperthermia by convective and evaporative cooling, therefore proved to be most effective aids for the successful capture and translocation of the roan antelope.

The Etorphine/Azaperone combination was effective in prolonging the immobilisation period, although additional drug administration was necessary on occasions. More recently Pienaar (1973) recommends an Etorphine/Xylazine drug combination for the immobilisation of roan antelope. Experiments on gemsbok *Oryx gazella gazella* in the Etosha National Park using this drug combination showed that Xylazine has a very prolonged effect (up to 8 hours). Should the same apply to roan this combination may be useful where prolonged immobilisation is indicated provided the animals are attended to until fully recovered.

Although several anti-stress agents which appeared to be of value were routinely administered prophylactically ,little is known of their real effect in limiting the onset of the shock syndrome. Until further research is done on the blood chemistry of wild ungulates in relation to stress and the use of prophylactic anti-stress agents, no definite conclusions can be drawn.

Where high environmental temperatures prevail air movement is important in regulating body temperature. In addition the effect of psychological stress is not always recognised. The provision therefore, of a large enclosure in which the roan could move about freely was a most important factor in the maintenance of their health and recovery from the initial shock of capture. Unless proper facilities are provided for the keeping of animals, management may become the most difficult part of the operation. Plastic sheeting proved to be most effective for confining the roan antelope. It was most unlikely that an animal would injure itself should it dash against the side.

Undoubtedly the most remarkable feature of the operation was the airlift of the roan. Indeed their translocation by plane over a distance of over 400 nautical miles while under deep narcosis is probably the first example of its kind involving large wild ruminants. It obviated the use of crates which would have increased the weight factor and necessitated additional flights and increased expense. Because of the fragility of the landing strip in the river-bed, a fourth landing and take-off could not have been considered. Although the roan were not adversely affected by ptyalism, it should be effectively controlled by incorporating 10 mg Hyoscine into the drug mixture. Pienaar (1973) recommends Promethazine (Phenergan, M&B) for this purpose. Noteworthy too was the successful calving of pregnant cows shortly after translocation. It shows that darting the animals twice and immobilising them for long periods had no adverse influence on either mid- or full-term pregnancy and parturition.

This operation clearly emphasises both the need for specialised equipment and the role that modern technology can play in certain capture and translocation procedures. It can probably be justifiably claimed that this operation was one of the most costly short-term game catching operations ever to have been launched in Southern Africa, as expenses were in the region of R40 000. However, in terms of saving a rare and valuable asset, such expenses are not excessive.

These immobilisation procedures for roan can be applied to other species and should provide greater scope in wildlife capture and translocation operations. Indeed they have already been successfully used for eland *Taurotragus oryx* plains zebra *Equus burchellii* and mountain zebra *Equus zebra hartmannae* in South West Africa.

V SUMMARY

Seventy-four roan antelope *Hippotragus equinus equinus* were transported successfully under narcosis in a C130 Lockheed Hercules airfreighter over a distance of 430 nautical miles from the Khaudum river-bed in north-eastern South West Africa to the Etosha National Park.

The roan were captured by dart immobilisation from a helicopter. Post capture husbandry and various anti-stress agents administered, are discussed. While chemically restrained the roan were conveyed on the back of open vehicles to a large holding pen constructed of plastic sheeting, reinforced with netting on the outside. To transfer the roan by plane, they were immobilised with Etorphine hydrochloride/M99 (Reckitt) and Azaperone (Janssen) for a period of 3 to 5 hours. Twenty-seven calves were horn in the first 3 months after translocation.

Prolonging the period of immobilisation to obviate the use of crates and thereby eliminate struggling and exertion during handling and transport, and controlling heat stress by convection and evaporative cooling, proved to be most effective aids for the successful capture and translocation of roan antelope.

VI ACKNOWLEDGEMENTS

Mr B. J. G. de la Bat, Director of Nature Conservation and Tourism, is cordially thanked for instigating this operation and in particular for making the necessary arrangements to ensure the successful translocation of the roan antelope.

I wish to thank the following for their valuable contribution and assistance:

Dr C. P. van der Merwe, Deputy Director of Veterinary Services, for laying down veterinary conditions which made the translocation both possible and practically feasible.

Dr H. Ebedes, State Wildlife Veterinarian, Etosha National Park, for his supervision during the quarantine of the roan at Otjovasandu.

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Captain David Todd ,now Managing Director of Courtline Helicopters and Captain Jeff de Jager of Safair, and their staff for the competent manner in which they handled their aircraft.

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Captain J. G. Maritz of Suidwes Lugdiens for selecting a suitable landing strip, for the final arrangements and guidance of the aircraft during the first landing in the river-bed.

The capture unit is thanked for their assistance throughout the operation and the following are thanked for assisting in innumerable ways:

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VII REFERENCES

HOFMEYR, J. M.
In press The adaptation of wild animals translocated to new areas in South West Africa. *Proceedings of the Third World Conference on Animal Production*, Melbourne, Australia.

HOFMEYR, J. M. AND DE BRUINE, J. R.
1973 The problems associated with the capture, translocation and keeping of wild ungulates in South West Africa. *Lammergeyer* 18:21 — 29.

KEEP, M. E. AND KEEP, P. J.
1968 The immobilisation of Eland *Taurotragus oryx* using new drug combinations. *Lammergeyer* 9:18 — 21.

PIENAAR, U. DE V.
1968 a Recent advances in the field immobilisation an restraint of wild ungulates in South African Na tional Parks. *Acta zool. path.* 46:17 — 38.

PIENAAR, U. DE V.
1968 b The use of immobilising drugs in conservatio procedures for roan antelope. *Acta zool. path* 46:39 — 51.

PIENAAR, U. DE V.
1973 The drug immobilization of antelope species. *In* E Young (ed.) *The capture and care of wild animals* Cape Town: Human & Rousseau.

SHORTRIDGE, G. C.
1934 *The mammals of South West Africa.* Vol. 2 London: Heinemann.

Plate 1. Trees 10 to 15 metres high fringing the Khaudum Omuramba (dry river-bed) with the helicopter herding roan into open terrain.

Plate 2. A narcotised roan on the back of an open vehicle ready to be conveyed to the holding enclosure. Note that it is blindfolded, placed in a sternal position on a layer of hessian and the head is held erect. The water container was used for wetting hyperthermic animals.

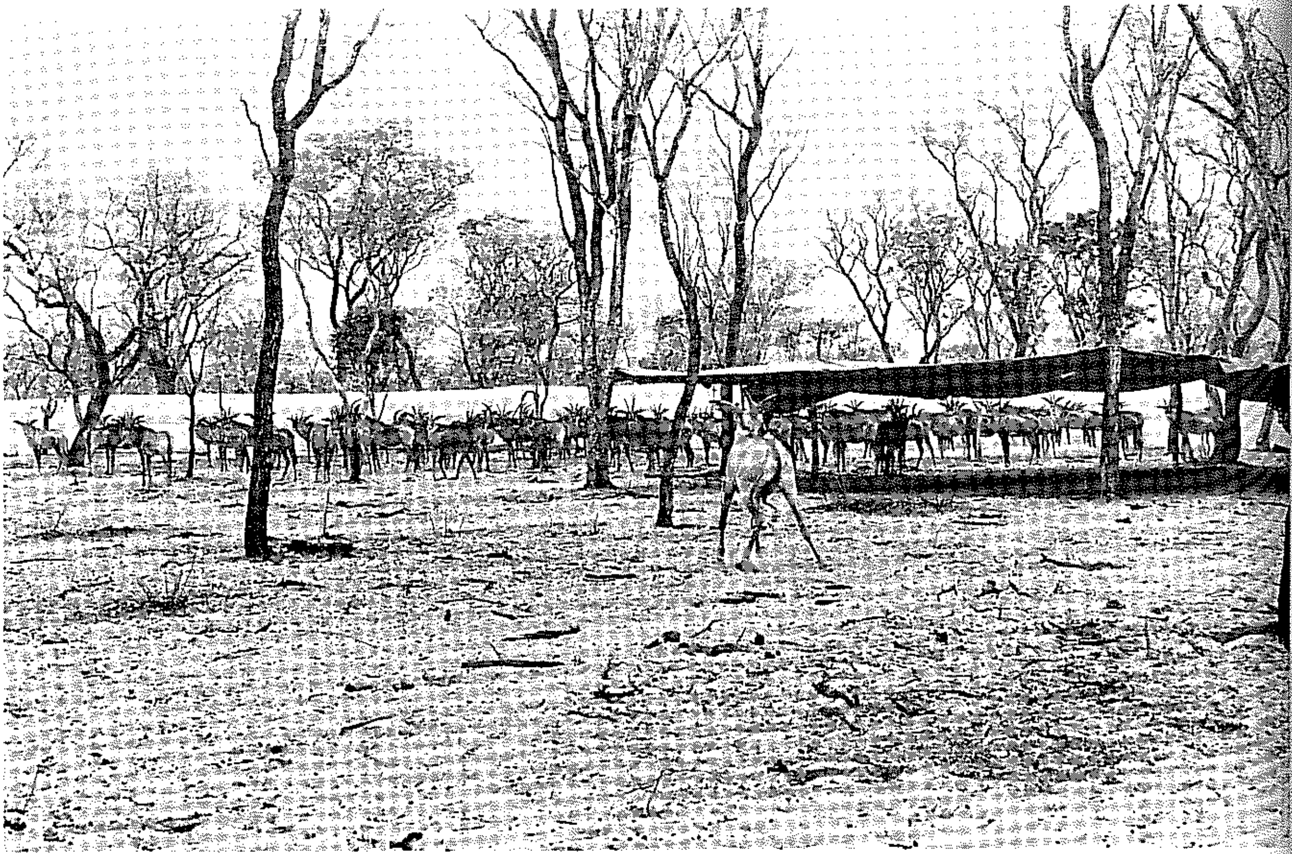

Plate 3. A newly introduced tranquillised roan joining its companions in the roan enclosure. Note the calm disposition of the animals.

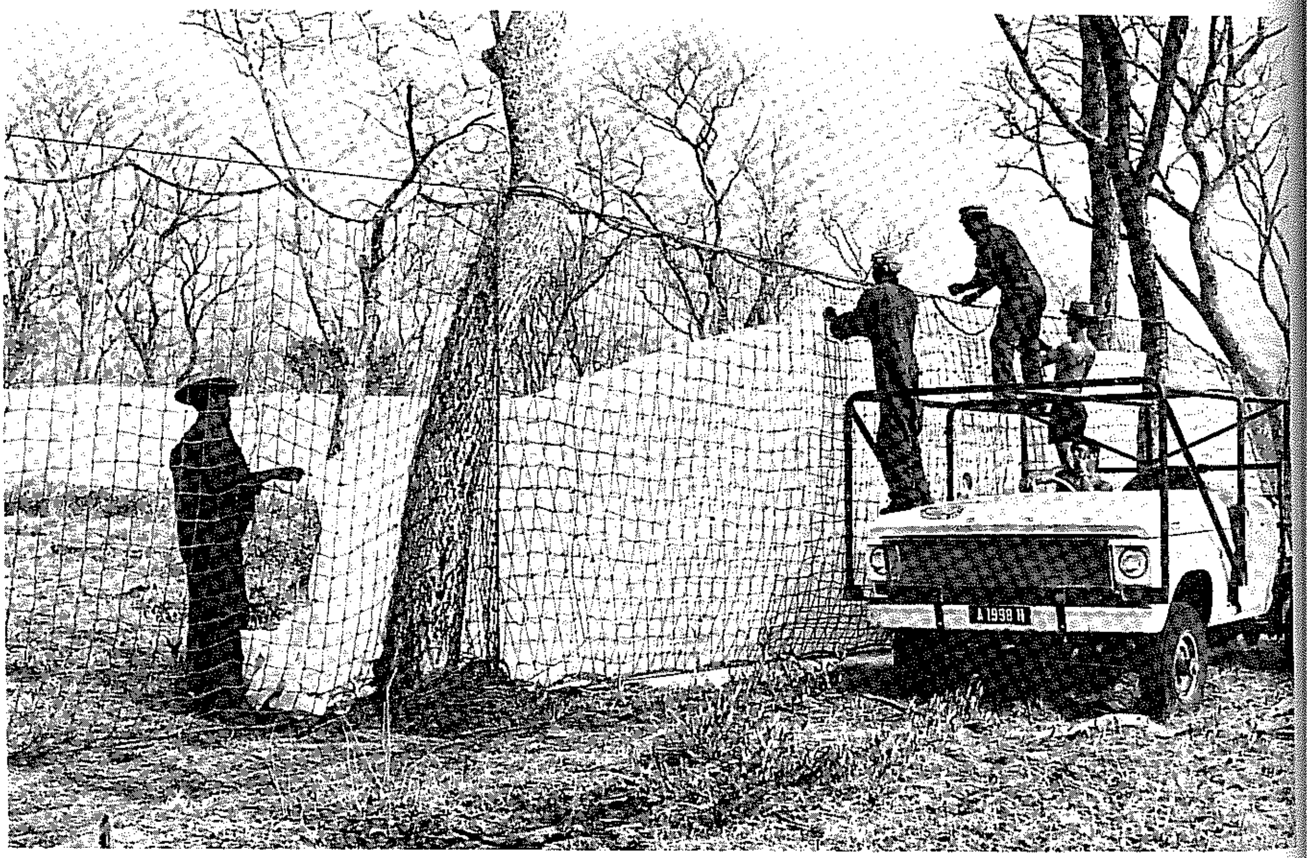

Plate 4. The roan enclosure under construction illustrating the white opaque plastic sheeting on the inside reinforced with netting on the outside.

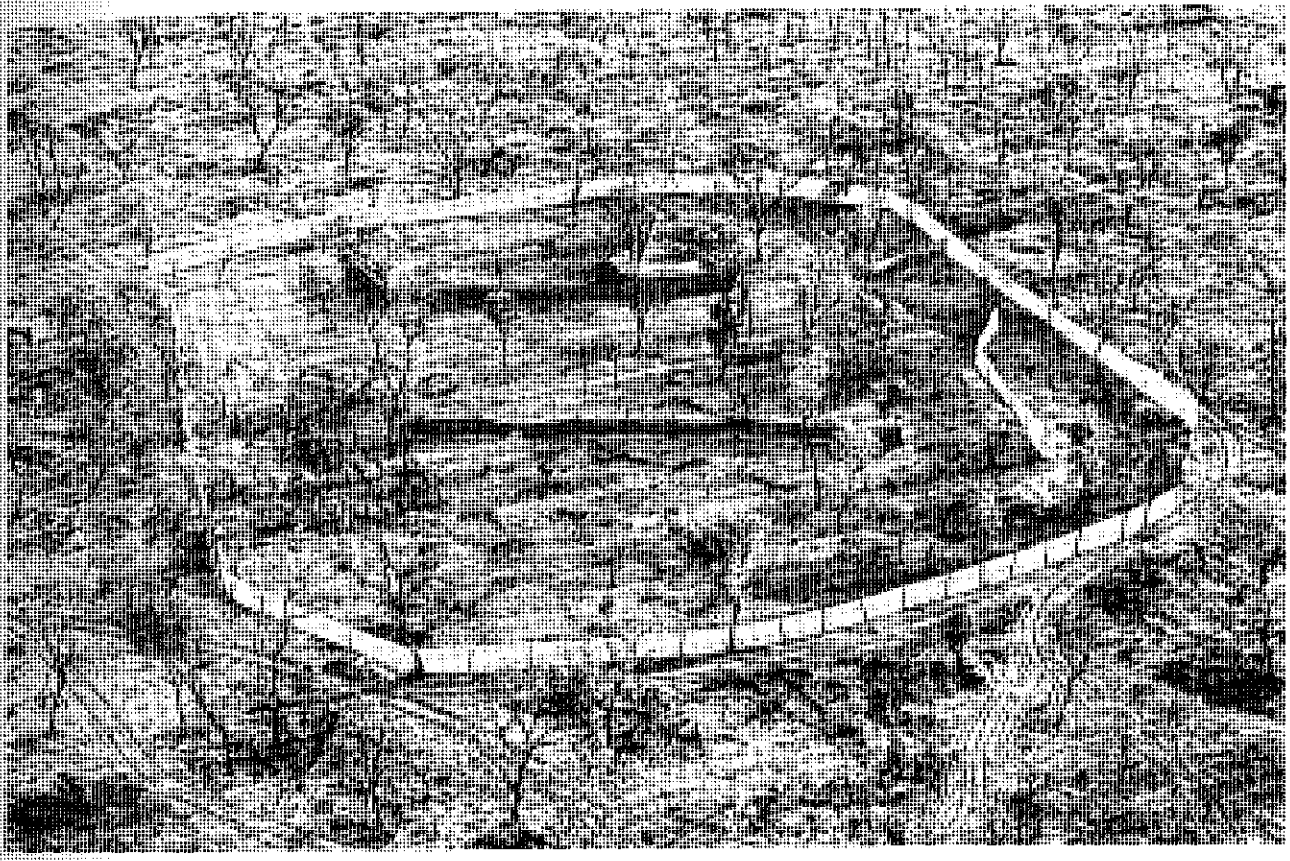

Plate 5. An aerial view of the roan enclosure illustrating the captive animals, the provision of additional shade and a specially screened section on the extreme right used for rehabilitation.

Plate 6. Three roan antelope restrained for clinical observations during prolonged immobilization. Ptyalism revealed by the wet sand is evident in the roan on the left.

Plate 7. Attending to roan antelope under deep narcosis inside the aircraft. They were secured with cargo nets and their horns were loosely tied to suspended cross chains. (Photo D. van der Heever)

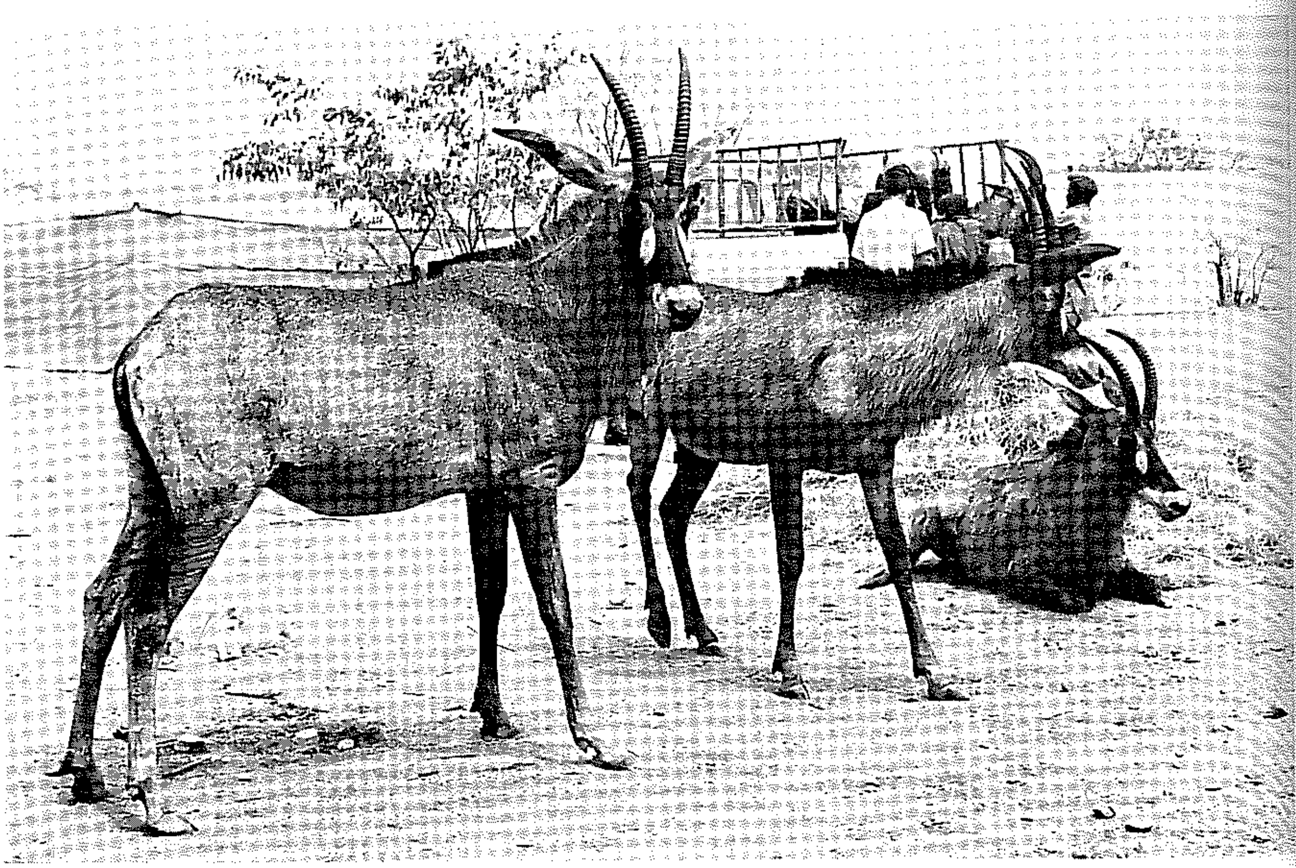

Plate 8. Following a 3-5 hour immobilisation period the disembarked roan recovering from narcosis within 2 minutes following intravenous injection of 150 mg Nalorphine hydrobromide.