EXPERIMENTS IN IMMOBILISING UNGULATE MAMMALS

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INTRODUCTION

The technique of immobilising wild mammals by injecting them with drugs has received more attention in East Africa than in other parts of the continent. A number of papers by Buechner, Harthoorn and Lock (e.g. 1960), Talbot (1961), Talbot and Lamprey (1961) and other workers have reported the results of experiments on a range of mammal species. The first results of research on immobilisation in Southern Africa appeared in 1962 (Ebedes 1962, Bigalke 1962, Harthoorn 1962, Van Niekerk and Pienaar 1962). Since then Van Niekerk and Pienaar (1963) and Van Niekerk, Pienaar and Fairall (1963 a & b) have reported on further work in the Kruger National and other Parks.

The present author became interested in immobilisation as a means of capturing springbok *Antidorcas marsupialis* which were to be marked and released for life history studies. Advantage was taken of opportunities to experiment on other species and the results of this work are presented here.

MATERIALS AND METHODS

The drugs were administered either by means of standard projectile syringes fired from a Cap-Chur gun (Palmer Chemical and Equipment Co., Atlanta, Ga.) or with darts fired from a cross-bow, as described by Van Niekerk and Pienaar (1962). The Cap-Chur equipment has the advantages of lightness and manoeuvrability in a confined space such as a hide, while both gun and syringes are quick and easy to load. However the maximum effective range of the two Cap-Chur guns used in this study was only about 40–45 yd. An added disadvantage is that changes in air temperature alter the gas pressure in the gun, thus affecting the performance of the equipment considerably. On cold mornings projectiles tend to drop below the target while in the heat of midday they usually strike above the point of aim.

The cross-bow is a little awkward to load and fire in a confined space. The darts used in the work here reported were neither as quick nor as easy to load as the Cap-Chur syringes. (It should be noted that darts for the cross-bow have since been modified and much simplified.) However the cross-bow was found to be consistently accurate at ranges of up to 70 yd. and its maximum effective range is probably in the region of 100 yd. Hence the cross-bow proved to be the more versatile and satisfactory weapon of the two.

The following drugs were used:

Gallamine triethiodide—in the form of Flaxedil (Maybaker (S.A.) (Pty.) Ltd.)—solutions made up from powder.

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Succinylcholine chloride either in the form of Scoline (Glaxo-Allenbury's (S.A.) (Pty.) Ltd.) or as a solution made up from powder supplied by the same firm.
Cap-Chur-Barb (a barbiturate compound, composition not disclosed by the manufacturers)—Palmer Chemical and Equipment Co.
Neostigmine in the form of Prostigmin-Vet (Roche).
Atropine sulphate—solution made up from powder.
Hyaluronidase B.P. (Ovine) in the form of Hyalase (Benger Laboratories Ltd.).
Chlorpromazine hydrochloride in the form of Largactil (Maybaker (S.A.) (Pty.) Ltd.).

RESULTS

(a) Springbok *Antidorcas marsupialis*

Thirteen springbok were darted with succinylcholine chloride and the results are presented in Table I.

The weights of all animals except nos. 4 and 7, whose carcasses were weighed, were estimated on the basis of experience gained in weighing several hundred springbok. The estimates are believed to be close approximations of the true values except in the cases of nos. 11–13. These three animals are representatives of the large northern race, with which the writer has had little field experience. According to the very few records in the literature, the weights of nos. 11–13 given in Table I are probably underestimates.

Two of the 13 animals were not immobilised. No. 2 received a relatively large dose but the succinylcholine chloride in use at the time was old and had probably lost a good deal of its potency (see Talbot and Lamprey 1961). The behaviour of No. 11 indicated that slightly too low a dose had been administered. This is supported by the fact that two males of similar size, nos. 12 and 13, were immobilised by larger doses.

Three animals died. In the case of no. 4 the dart was found to have penetrated one lung. No. 7 was hit near the vertebral column, the dart striking hard and penetrating deeply. The resulting injury is thought to have been the cause of death, perhaps partly because it accentuated the effect of the drug. Only in no. 10 was death attributable solely to overdosage with succinylcholine chloride. A dose measured out for an adult male was inadvertently used on this rather small female.

The remaining eight springbok were successfully immobilised, six of them with doses ranging from 10 to 14 mg. at rates of 0·15 to 0·25 mg./estimated lb. body weight. For the other two, representing the large race, succinylcholine chloride doses of 20 and 22·5 mg. respectively were used. Since, as we have seen, the weights of these two animals were probably underestimated, the dosage rates must in fact have been lower than the 0·20 mg./lb. shown in Table I.

Immobilisation tended to be more rapid in animals darted in the gluteal muscles than in those where the projectiles struck poorly vascularised areas such as the intercostal muscles.

As the weights of the springbok were only estimated, these results do no more than

indicate that the effective dosage rate is of the order of 0·15–0·20 mg./lb. Despite the lack of precision in the method, the results are in close agreement with the dosage rates established by Buechner, Harthoorn and Lock (1960) and Talbot and Lamprey (1961) for several other species of medium-sized antelope. The successful immobilisation of our animals on the basis of visual weight estimates also indicates that succinylcholine chloride has a relatively wide margin of safety in this species. The animals went down in from 2½ to 9½ minutes and remained immobile for 11–43 minutes. This latter figure represents an extreme following a high dose and most of the animals recovered in less than half an hour. No signs of distress were observed, even when the animals were left lying on their sides. Recovery was complete as soon as the drug had been broken down, a pleasant feature of succinylcholine chloride.

Our findings may be used to develop the following rule-of-thumb guide: 12·5–14 mg. succinylcholine chloride (in the form of Scoline or powder solution) is effective for adult males and 10 mg. for adult females of the small race; 20–22·5 mg. immobilises adult males of the large race and 15 mg. will probably be found suitable for adult females. It should be noted that this guide may not be applicable to other makes of succinylcholine chloride, since Talbot and Lamprey (*loc. cit.*) have found considerable differences in the potency of different preparations of the drug.

TABLE 1: IMMOBILISATION OF SPRINGBOK WITH SUCCINYLCHOLINE CHLORIDE

No.	Sex and age	Form of Drug	Dose (mg.)	Body Weight (est. lb.)	Dosage Rate (mg./est. lb.)	Time to go down (min.)	Time immobile (min.)
1	ad. ♂	Scoline	12·5	75	0·17	3	26
2	ad. ♂	,,	15	75	0·20	—	—
3	juv. ♀	,,	12·5	50	0·25	4	43
4	ad. ♀	,,	10	45·5*	0·22	2¾	died
5	ad. ♀	,,	10	65	0·15	7	? 13
6	ad. ♀	,,	10	65	0·15	3	? 11
7	ad. ♂	,,	10	69·5*	0·14	2½	died
8	ad. ♂	powder sol.	12	75	0·16	9½	? 15
9	ad. ♂	,,	14	80	0·18	9	? 21
10	ad. ♀	,,	12	55	0·22	4	died
11	ad. ♂	Scoline	15	110	0·14	—	—
12	ad. ♂	,,	20	100	0·2	8½	18½
13	ad. ♂	,,	22·5	115	0·2	5	38

* = weighed

? = return of mobility judged approximately as animal was being held in sack.

(b) Gemsbok *Oryx gazella*

Eight gemsbok were darted with gallamine triethiodide given together with atropine at the rate of approximately 0·03–0·06 mg./lb. The results are presented in Table II.

TABLE 2: IMMOBILISATION OF GEMSBOK WITH GALLAMINE TRIETHIODIDE

No.	Sex and age	Est. Body Wt. (lb.)	Dose (mg.)	Dosage Rate (mg./est. lb.)	Neostigmine (mg.)	Time to go down (min.)	Time immobile (hrs.)
1	young ♂	425	318	0·75	—	—	—
2	ad. ♀	500	441	0·88	—	—	—
3	ad. ♀	500	483	0·97	—	—	—
4	ad. ♂	530	540	0·98	12·5+ 5	12½	+4
5	ad. ♀	500	483	0·97	10 +12·5	?	4½
6	ad. ♀	450	483	1·07	12·5+10+7·5	?	+2
7	ad. ♂	500	422	0·84	5	7½	died
8	ad. ♂	450	464	1·03	9	4¾	died

Nos. 5 and 6 ran out of sight when darted and were only found 35 to 50 minutes later respectively. Hence the time to go down was not determined.

Three animals showed no reaction, two died and only three were successfully immobilised. These unsatisfactory results are doubtless partly due to inaccurate assessments of body weights. The literature contains very little data on the weights of gemsbok and our estimates were therefore based on foundations far less secure than in the case of springbok. Some gross inconsistencies in reaction were observed. Thus no. 3 was not affected by a dose of 483 mg. while no. 5, an animal judged to weigh the same as no. 3, was immobilised for 4½ hrs. with an equal dose. The limited data do not permit conclusions about any influence which the site of injection might have had on the action of the drug.

It is significant that although the weights of kudu were also merely visually estimated (see below), no difficulty was experienced in immobilising five of these animals with gallamine triethiodide. This suggests that gemsbok have a critical tolerance of the drug and that even with an adequate knowledge of body weights on which to base their estimation in the field, gallamine triethiodide will be found to have a narrow margin of safety for this species.

Another unsatisfactory feature of the drug was that initial intramuscular injections of the antidote neostigmine at the rate of approximately 0·02–0·03 mg./lb., produced only temporary recovery. In all three cases additional injections were required for the animals to regain permanent mobility. Talbot and Talbot (1962) experienced the same difficulty with about 25 per cent of the animals of various species which they immobilised with gallamine triethiodide. It is of interest to note that these authors suggest 1·4 mg./lb. as the probable optimum dosage

of the drug for the East African relative of the gemsbok *Oryx beisa*. If our weight estimations are not grossly inaccurate, the optimal dosage rate for *O. gazella* would appear to be of the order of only 1·0 mg./lb.

The same workers say that: "It is essential to inject the antidote, neostigmine, within about eight minutes of collapse. When no antidote is given, the immobilising dosage of Flaxedil paralyses respiratory muscles and produces death in 15 to 20 minutes." This is borne out by the reactions of two of our animals. In no. 7 the antidote was deliberately withheld in order to observe the effect of what appeared to be a relatively low dose of gallamine triethiodide. Thirty-one minutes after collapse, when respiratory distress became apparent, a small dose (approx. 0·01 mg./lb.) of neostigmine was injected without effect. A large dose of gallamine triethiodide produced rapid collapse of no. 8. The injection of approximately 0·02 mg./lb. neostigmine six minutes after immobilisation was apparently given too late to prevent respiratory paralysis and death.

Our results from this small series of gemsbok are not claimed to be conclusive but they suggest that gallamine triethiodide is not a particularly satisfactory immobilising drug for the species.

(c) Kudu *Tragelaphus* (*Strepsiceros*) *strepsiceros*

Five kudu were successfully immobilised with gallamine triethiodide to which was added atropine at the rate of approximately 0·03–0·06 mg./lb. The results are presented in Table III.

Weight estimations were little better than guesswork due once again to the lack of records and the absence of facilities to weigh immobilised animals. The successful outcome of the experiment in spite of this drawback indicates that kudu are highly tolerant of gallamine triethiodide. In all animals except no. 3, recovery was very slow, suggesting that the doses employed were higher than was necessary. In all cases the darts struck the neck or shoulder regions. The optimal dose for adults will be probably be found to lie within the range 400–500 mg., below 450 mg. for females and above 450 mg. for males.

TABLE 3: IMMOBILISATION OF KUDU WITH GALLAMINE TRIETHIODIDE

No.	Sex and age	Est. Body Wt. (lb.)	Dose (mg.)	Dosage Rate (mg./est. lb.)	Neostigmine (mg.)	Time to go down (min.)	Time immobile (hrs.)
1	ad. ♂	550	504	0·92	12·5+10+10	?	+4½
2	ad. ♂	625	590	0·94	15+10	9½	+5
3	ad. ♀	425	464	1·09	7·5	?	+1½
4	subad. ♀	325	459	1·41	10+7·5+10	6½	3½
5	subad. ♀	325	504	1·55	60 in 7 injections	3¼	+6½

? = went down out of sight. Already down when found.

As with the gemsbok, all except one of the kudu had to be given repeated injections of neostigmine. This was administered by the intramuscular route at the rate of approximately 0·02 mg./est. lb., in some cases together with atropine. The reaction of no. 5 calls for comment. The animal collapsed quickly (3¼ min.) and became completely inert following a high dose of gallamine triethiodide. Over a period of 2½ hours 60 mg. neostigmine was administered in injections of 5–10 mg. each. The onset of darkness made it necessary to leave her. She recovered completely more than 3½ hours after the last injection and was seen several times subsequently.

Our results indicate that for kudu, gallamine triethiodide has a wide margin of safety and is a satisfactory immobilising agent. Further work with animals of known weight should make the determination of optimal dosage rates relatively easy. When these are used the recovery time is likely to be considerably shorter than it was in our animals.

(d) Zebra *Equus* (*Hippotigris*) *burchelli*

Experience with two zebra tends to confirm the view of Talbot and Talbot (*loc. cit.*) that gallamine triethiodide is unsuitable for immobilising this species since its tolerance of the drug is critical. One male which weighed 553 lb. died shortly after the administration of 780 mg. gallamine triethiodide, a dosage rate of 1·41 mg./lb. (by coincidence this happens to be the same as the figure listed by the Talbots as the lethal dosage for zebra). Another animal estimated to weigh 650 lb. was not affected by a dose of 688 mg., a dosage rate of 1·06 mg./est. lb.

Another two zebra were darted using a freshly prepared solution of succinylcholine chloride. An adult male weighing 800 lb. was given 216 mg. (0·27 mg./lb., in the neck muscles), went down in 1¾ min. and died shortly afterwards. A female, apparently of equal size and thus estimated to weigh 800 lb. also, was given the same dose of 216 mg. in the gluteal muscles. She went down in 2½ min., remained immobile for 19 minutes, showed no signs of distress and recovered rapidly and completely. Although the different sites of injection must be expected to have influenced the action of the drug, the radically different reactions of these two semi-captive animals from the same herd is surprising. Talbot and Lamprey (*loc. cit.*) report excellent results using succinylcholine chloride on zebra.

A point arising from the work of these authors calls for comment. For the East African form of Burchell's zebra they found 0·36 mg./lb. of succinylcholine chloride to be an effective dosage rate; 0·29 mg./lb. was ineffective and 0·42 mg./lb. was lethal. Their dosage rates were "standardised to full strength, new Midarine or Anectine or succinylcholine chloride solution freshly prepared from powder". Preliminary experiments on topi and wildebeest showed that the optimal dosage rates of Scoline were considerably higher than those of the other preparations (Talbot & Lamprey 1961).

It is noteworthy that we were able to immobilise a zebra with a dosage of our solution (0·27 mg./lb.) lower than the ineffective dosage (0·29 mg./lb.) of the succinylcholine chloride preparations used by Talbot and Lamprey. Since our powder was obtained from the manufacturers of Scoline, the solution prepared from it would be expected to possess properties similar to those of this commercial preparation. If this is so, the difference between our results

and those of Talbot and Lamprey may be due to physiological differences between the races of zebra.

(e) Wildebeest *Connochaetes* (*Gorgon*) *taurinus*

Two adult male wildebeest were immobilised with gallamine triethiodide. On the basis of weights recorded in the area in which we worked, the animals were both estimated to weigh 500 lb. The treatment was as follows:

No.	Dosage (mg.)	Dosage Rate (mg./est. lb.)	Neostigmine (mg.)	Time to go down (min.)	Time immobile (min.)
1	459+	0·92	15	?	*ca* 50
2	459+	0·92	10	?	*ca* 20

\+ plus 13·3 mg. Atropine (0·03 mg./est. lb.)
? ran out of sight, already down when found

Neither animal appeared to be deeply under the influence of the drug and recovery followed rapidly on the administration of neostigmine at the rate of 0·03 and 0·02 mg./est. lb. respectively. Talbot and Talbot (*loc. cit.*) believe the probable optimal dosage of Flaxedil for East African wildebeest *C. albojubatus* to be 1·3 mg./lb., considerably higher than our dosage rates if the weight estimations are roughly correct as they are believed to be. Our findings agree with those of Van Niekerk and Pienaar (1963) who established 0·8 mg./lb. as the optimal dosage for *C. taurinus* in the Kruger National Park.

(f) Eland *Taurotragus oryx*

Two adult female eland were darted experimentally. In the first case, an animal weighing 740 lb., 450 mg. gallamine triethiodide (0·6 mg./lb.) + 22·5 mg. atropine (0·03 mg./lb.) + 1500 I.U. Hyaluronidase was injected. She went down in just under three minutes and soon showed respiratory distress. Over a period of four hours, during most of which time artificial respiration was given, a total of 52 mg. neostigmine was administered, mostly by intramuscular injection, but small amounts also intravenously. In addition small quantities of stimulants such as Lobelin and Coramine-Adenosine were given. The animal died. By comparison with other species the dosage rate of gallamine triethiodide was low and it is possible that this drug may not be suitable for eland.

The second female, weight 571 lb., was given 7,300 mg. Cap-Chur-Barb (12·8 mg./lb.). She went down at 70 minutes, remaining alert and struggling when handled. She was then tranquilised with 750 mg. chlorpromazine hydrochloride (on the mistaken assumption that she weighed about 750 lb.) before being crated for transport. After a long journey she was found unable to rise and died two days later, presumably because of secondary complications arising from a long period of immobility.

It is not clear whether the immobilising drug, the tranquiliser or the combination of the two, was responsible for the prolonged immobility which seems to have led to the subject's death. Hence the experiment does not contribute much towards the evaluation of Cap-Chur-Barb as an immobilising drug. The long induction period would be a grave disadvantage in most field situations. If recovery is also slow, as our result might be interpreted to suggest, the drug would probably not be suitable for large animals which must be brought to their feet soon if complications are to be avoided.

(g) Hartebeest *Alcelaphus buselaphus*

One adult male hartebeest, estimated to weigh 350 lb., was given 55 mg. succinylcholine chloride, a dosage rate of 0·16 mg./est. lb. He went down in 10 minutes and remained immobile for 15 minutes. This result agrees with that reported by Buechner, Harthoorn and Lock (*loc. cit.*), who immobilised a Jackson's hartebeest *A. buselaphus lelwel* with 0·30 mg./Kg. of succinylcholine chloride.

(h) Warthog *Phacochoerus aethiopicus*

Succinylcholine chloride was used on two warthog with negative results. No dosages of any drug for this species are recorded in the literature. Working at the Bloemfontein Zoo, Coetzee and van Ee (pers. comm.) were able to immobilise bush pig *Potamochoerus porcus* with succinylcholine chloride administered at the rate of 0·26–0·28 mg./lb. and this dosage was used as a basis for our trials on warthog.

One adult male, tentatively estimated to weigh 110 lb., was given 30 mg. (0·28 mg./est. lb.). A larger male estimated at 178 lb. (this weight had previously been recorded for a large warthog in the same area) was given 50 mg. (0·28 mg./est. lb.). Immobilisation was not achieved, suggesting either that the weights of the animals had been considerably underestimated or that this species requires a higher dosage than bush pig. Talbot and Talbot (*loc. cit.*) note that both domestic pigs and bush pigs are particularly resistant to Flaxedil.

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SUMMARY

The results of experiments in immobilising springbok *Antidorcas marsupialis*, gemsbok *Oryx gazella*, kudu *Tragelaphus* (*Strepsiceros*) *strepsiceros*, zebra *Equus* (*Hippotigris*) *burchelli*, wildebeest *Connochaetes* (*Gorgon*) *taurinus*, eland *Taurotragus oryx*, hartebeest *Alcelaphus buselaphus* and warthog *Phacochoerus aethiopicus* are reported. In most cases the muscle relaxant drugs gallamine triethiodide (Flaxedil) and succinylcholine chloride (Scoline) were used. The paper records doses and dosage rates of the drugs and the reactions of the animals to their administration.

REFERENCES

BIGALKE, R. C. 1962. A note on the use of succinylcholine chloride in cattle. *J. S. Afr. Vet. Med. Ass.* 33 (2): 239–241.

BUECHNER, H. K., A. M. HARTHOORN and J. A. LOCK. 1960. Recent advances in field immobilization of large mammals with drugs. *Trans. 25th N. Amer. Wildl. Conf.:* 415–422.

EBEDES, H. 1962. Practical experience in the use of the Cap-Chur gun. *J. S. Afr. Vet. Med. Ass.* 33 (1): 87–91.

HARTHOORN, A. M. 1962. The capture and relocation of the white (square-lipped) rhinoceros *Ceratotherium simumsimum*. *Lammergeyer* 2 (2): 1–9.

TALBOT, L. M. 1961. Field immobilization of some East African wild animals and cattle. I. *E. Afr. Agr. & For. J.* 26 (2): 92–102.

TALBOT, L. M. and M. H. TALBOT. 1962. Flaxedil and other drugs in field immobilization and translocation of large mammals in East Africa. *J. Mammal.* 43 (1): 76–88.

TALBOT, L. M. and H. F. LAMPREY. 1961. Immobilization of free-ranging East African ungulates with succinylcholine chloride. *J. Wildl. Mgmt.* 25 (3): 303–310.

VAN NIEKERK, J. W. and U. DE V. PIENAAR. 1962. Adaptations of the immobilizing technique to the capture, marking and translocation of game animals in the Kruger National Park. *Koedoe* 5: 137–143.

VAN NIEKERK, J. W. and U. DE V. PIENAAR. 1963. A report on some immobilizing drugs used in the capture of wild animals in the Kruger National Park. *Koedoe* 6: 126–133.

VAN NIEKERK, J. W., U. DE V. PIENAAR and N. FAIRALL. 1963 a. A preliminary note on the use of Quiloflex (Benzodioxane Hydrochloride) in the immobilization of game. *Koedoe* 6: 109–114.

VAN NIEKERK, J. W., U. DE V. PIENAAR and N. FAIRALL. 1963 b. Immobilizing drugs used in the capture of wild animals in the Kruger National Park. *J. S. Afr. Vet. Med. Ass.* 34 (3): 403–411.