CHAPTER 27

Crocodile Immobilization and Anaesthesia

John P. Loveridge[1] and David K. Blake[2,3]

THE use of drugs for mammal capture and translocation is an established practice for wildlife managers and veterinarians (Young 1973; Harthoorn 1976). By contrast, techniques for the chemical capture of crocodilians do not yet exist, partly because their amphibious habits make a relatively long-acting drug applied with a projectile dart impractical to use. The techniques developed for crocodilians thus far are limited to captive situations or where an animal is caught in a trap or noose.

Many drugs have been tried on crocodilians, but mostly with limited success (see review by Loveridge 1979). This chapter describes further experiments carried out on *Crocodylus niloticus* with a variety of drugs. It also reviews the techniques that can be used to immobilize animals for translocation, measurement, for immobilization and local anaesthesia associated with minor surgical procedures, or for when complete anaesthesia is needed.

Densmore (1983) recognizes 21 species of living crocodilians, and until proved otherwise, we have adopted the conservative view that drug suitability and dosages are different in different species. This, taken together with the large size range in crocodilians (from 40 g to over 500 kg) makes generalizations difficult. A further variable, that is not encountered in mammalian and bird work, is body temperature. It is probable that body temperature will have far-reaching effects on such factors as drug absorption, metabolism and excretion in crocodilians, and should be taken into account when selecting drugs and dosages.

IMMOBILIZATION

The drugs to be described in this section are the so-called muscle relaxants. They block neuromuscular transmission, and any animal immobilized with them has its sensory and nervous system intact and can feel pain. It should be emphasized that no procedures involving the possibility of pain should be attempted while crocodiles are immobilized with neuromuscular blockers alone.

Gallamine triethiodide

Gallamine is a phenolic ether with quarternary ammonium groups, similar in its action to curare, which raises the threshold for depolarization of the motor end plate by acetylcholine (Strobel and Wollman 1969). It is excreted unchanged via the kidneys in mammals (Feldman *et al.* 1969) and its elimination is therefore dependent upon intact renal function. Gallamine has been successfully used for the immobilization of *Crocodylus niloticus*, mainly in Zimbabwe (Loveridge and Blake 1972; Loveridge 1979). Up to the end of 1983 gallamine had been used in 558 trials on crocodiles weighing from 1.75 to 423 kg. Gallamine has a wide therapeutic index with doses ranging from 0.64 to 7.74 mg kg^{-1} i.m. having been used successfully. No undue bradycardia or respiratory impairment are evident following gallamine injection (Fig. 1). The tachycardia of 60 beats min^{-1} is attributed to the handling

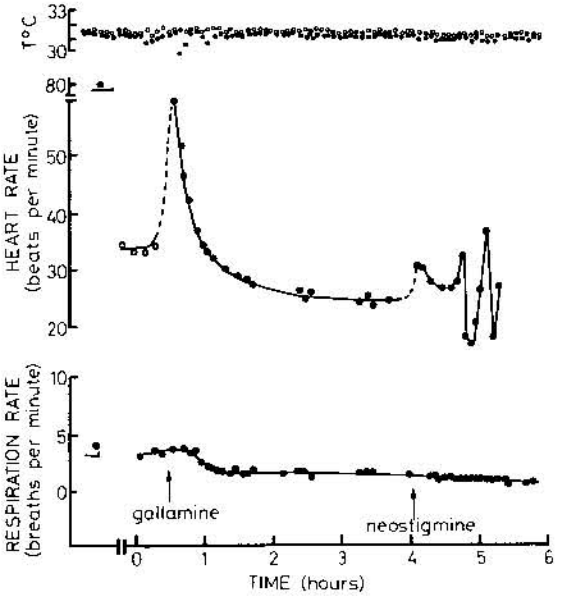

Fig. 1. The effect of gallamine and neostigmine on the respiratory frequency, heart rate and body temperature of a 4.8 kg *Crocodylus niloticus*. At the first arrow 9.6 mg gallamine was injected i.m. and at the second arrow 0.3 mg neostigmine was injected i.m.

[1]Department of Biological Sciences, University of Zimbabwe, P.O. Box M.P. 167, Harare, Zimbabwe.
[2]Department of National Parks and Wild Life Management, P.O. Box 8365, Causeway, Zimbabwe.
[3]Present Address: Natal Parks Board, P.O. Box 127, St. Lucia Estuary 3936, South Africa.

Pages 259-67 *in* WILDLIFE MANAGEMENT: CROCODILES AND ALLIGATORS ed by Grahame J. W. Webb, S. Charlie Manolis and Peter J. Whitehead. Surrey Beatty and Sons Pty Limited in association with the Conservation Commission of the Northern Territory.

Fig. 2. A large (312 kg) *Crocodylus niloticus* immobilized with gallamine. Note the relaxed jaws and the hole lined with canvas used as a recovery pond.

during injection and fell to 30 beats min^{-1} after 20 min. Other effects of gallamine immobilization are mouth-gaping (Fig. 2), probably due to the relaxation of the jaw musculature. Sometimes lachrymation and salivation are also observed. In many cases crocodiles have been immobilized several times with gallamine without ill effect, and translocations over distances of up to 2400 km have been undertaken with animals immobilised with gallamine.

Neostigmine methyl sulphate (0.03-0.06 mg kg^{-1} i.m.) is the antidote to gallamine. As an antidote on its own it has resulted in some undesirable side-effects, including lachrymation, purgation and emesis. On two occasions we have tried the injection of atropine prior to neostigmine injection. Atropine sulphate at the dosage of 0.03 mg kg^{-1} i.m. was used successfully, but further work is clearly necessary; crocodiles do not always show adverse reactions to neostigmine. In cases where immediate recovery is not important or the crocodile has been immobilized for an extended period of time we have not administered the neostigmine and have allowed the crocodiles to recover without the antidote. In any event, it is important to allow crocodiles access to shallow water immediately after the recovery period. Even a hole dug in the ground, lined with a tarpaulin and filled with water (Fig. 2) is suitable for this purpose.

The mortality in 558 trials using gallamine was seven animals, or 1.25%. In none of the seven cases is it certain that gallamine or neostigmine *per se* was the cause of death. Twice, death was due to drowning after administration of gallamine by dart to free-ranging crocodiles. In one of these cases an experimental dart with a floating tail-section attached by a nylon cord to the main body of the dart was used. The cord broke and the drugged animal was lost. One drugged adult crocodile in a temporary holding pen was asphyxiated when a larger drugged animal lay across its snout, blocking the external nares. Another fatality has been attributed to very cold weather. The antidote was administered in this case, but we think the neostigmine was metabolized much more quickly than the gallamine was excreted owing to reduced renal function at the low temperatures, leading to further immobilization and drowning.

Recommendations are: gallamine at the rate of 0.5-2.0 mg kg^{-1} is satisfactory but an easier rule of thumb is 1.0 mg kg^{-1} i.m. While immobilized, the eyes and ears should be covered to reduce stress from sensory input and the animals should be handled carefully, carried on a stretcher, and kept warm but out of hot and direct sunlight. Neostigmine (0.03-0.06 mg kg^{-1} i.m.) can be used with or without preatropinisation (0.03 mg kg^{-1} i.m.) or can be dispensed with altogether following a low dose of

gallamine or an extended period of immobilization. Recovery should take place in warm surroundings with access to clean water for excretion of gallamine.

Succinylcholine chloride

Succinylcholine or suxamethonium chloride depolarises the muscle end-plate without the release of acetylcholine. It is quite rapidly hydrolysed by plasma pseudocholinesterase, but has no antidote. Succinylcholine chloride was used by Brisbin (1966) at dosages of 3.0-5.0 mg kg^{-1} i.m. to immobilize juvenile *Alligator mississippiensis* in 4 min; complete recovery took 7-9 h. Klide and Klein (1973) used it successfully at dosages of 0.3-2.2 mg kg^{-1} on young *Caiman crocodilus* which were immobilized in 5-7 min and recovered in 30-40 min. They also used it when moving a 200 kg *Crocodylus acutus* (9.3 mg kg^{-1} i.m.) and a 160 kg *C. palustris* (6.1 mg kg^{-1}).

Table 1. Immobilizing dosages of suxamethonium chloride for two crocodile species (after Messel and Stephens 1980).

Body Weight kg	DOSAGE *Crocodylus johnstoni* mg kg^{-1}	*Crocodylus porosus* mg kg^{-1}
5	2.2	20
10	1.7	10
15	1.4	9
20	1.2	8
25	1.0	7.5
30	0.9	7
50	—	5
100	—	4
150	—	3
200	—	3
250	—	3

Suxamethonium chloride has been successfully used with the Australian crocodiles *C. porosus* and *C. johnstoni* (Messel and Stephens 1980). It was administered intramuscularly when mixed with hyaluronidase, to promote absorption, and took effect in 15-30 min; crocodiles were immobilized for 30-40 min. Dosages were larger for small crocodiles, and the dosage for *C. porosus* was much larger than that for *C. johnstoni* of the same weight (Table 1). Care must be taken to prevent overheating as crocodiles immobilized with suxamethonium do not gape (Messel and Stephens 1980). As with gallamine, precautions must be taken to avoid drowning, so crocodiles to be immobilized must be already securely captured before the drug is administered.

IMMOBILIZATION AND ANALGESIA FOR MINOR SURGICAL PROCEDURES

To avoid inflicting pain when treating superficial wounds or for such minor surgical procedures as removal of osteoderm sections for ageing, crocodiles can be immobilized using gallamine (see above) followed by field block of the area with procaine hydrochloride or lidocaine hydrochloride. When removing neck scute sections from *C. niloticus*, 250 mg of procaine HCl was injected under the scute, half from in front and the rest from behind. After washing with surgical spirit a section about 5 mm thick was cut with an amputation saw, and the wound was packed with antibiotic powder. No infection was recorded in captive crocodiles or in recaptured wild individuals treated in this way (Hutton 1984).

A similar technique has been employed for toe-amputation. Cold has been used as a local anaesthetic by spraying ethyl chloride onto single tail scutes prior to marking them by amputation or punching a hole in them for tags. It is not clear whether cold does provide adequate analgesia and in cases where local anaesthesia is required, lidocaine or procaine is preferred.

ANAESTHESIA

For major surgical procedures such as gastrotomy, laparotomy or limb amputation, surgical plane anaesthesia is a necessity. Although inhalation anaesthesia using halothane is perfectly satisfactory in the veterinary surgery or laboratory (Calderwood 1971), its use assumes both prior immobilization to minimize stress and the availability of equipment for artificial ventilation. The search for an injectable anaesthetic suitable for use in crocodilian species has, so far, not been rewarded. A few drugs have shown potential, but further work has either not duplicated the results or has failed to extend the observations to other species.

Ketamine hydrochloride

Beck (1972) used ketamine (44-50 mg kg^{-1}) to anaesthetise *Caiman crocodilus* (sizes, route of administration and other data not given) and Cooper (1974) used it on a variety of East African reptiles (25-220 mg kg^{-1}). Jones (1977) recommended 50 mg kg^{-1} for 2.5-3.0 kg *Alligator mississippiensis*. Terpin *et al.* (1978) made six trials on *A. mississippiensis* weighing from 0.8 to 100 kg, and used dosages of 40-106 mg kg^{-1}. Dosages of 45-75 mg kg^{-1} rendered alligators unconscious in 10-20 min when injected i.m. and sensitivity to tactile stimuli reappeared in 40 min. For surgery 80-100 mg kg^{-1} is recommended; unconsciousness results in 20 min, deep anaesthesia lasts for 2-4 h, and recovery occurs after 12-24 h. No antidote for ketamine is available.

We were unable to duplicate these results with *Crocodylus niloticus*. Ketamine dosages of 18-45 mg kg^{-1} injected i.m. did not immobilize the crocodiles (Table 2), so even if analgesia was induced, surgery would not have been possible. Dosages in the range 59-110 mg kg^{-1} caused death either in the short or long term (Table 2). A *Crocodylus niloticus* injected with 30 mg kg^{-1} ketamine showed very little change

Table 2. The effects of different doses of ketamine hydrochloride on *Crocodylus niloticus*.

Body Weight (kg)	Route	Dosage (mg kg^{-1})	Body Temperature (°C)	Comments
17.0	i.m.	17.6	31.2	Never properly immobilized; slowed for 30 min from 25 min after injection; recovered.
3.6	i.m.	30.0	30.0	Never properly immobilized; recovered after 20 h.
3.0	i.m.	30.0	30.0	Never properly immobilized; recovered after 20 h.
3.3	i.m.	30.0	30.0	Never properly immobilized; recovered after 20 h.
16.0	i.m.	31.3	31.5	Never properly immobilized; recovered in 2 h.
2.1	i.m.	44.9	25.9	Slowed and unresponsive for 1 h from 15 min after injection, never immobile. Recovered in 4 h.
0.07	i.m.	59.0	—	Dead after 1 h (Cooper 1974).
0.4	i.m.	60.0	—	Less reactive after 20 min, respiration ceased after 130 min, died.
4.8	i.m.	62.5	19.0	Never properly immobile; blood taken by cardiac puncture after 2 h; died after 7 days.
5.7	i.m.	63.2	19.8	Slowed but never properly immobile; blood taken by cardiac puncture after 2 h; died after 9 days.
0.67	i.m.	90.0	—	Immobile for 10 min after 4 h cumulative injections 90 mg kg^{-1}.
		110.0	—	1 h later with a total of 110 mg kg^{-1}, no respiration or heart beat.

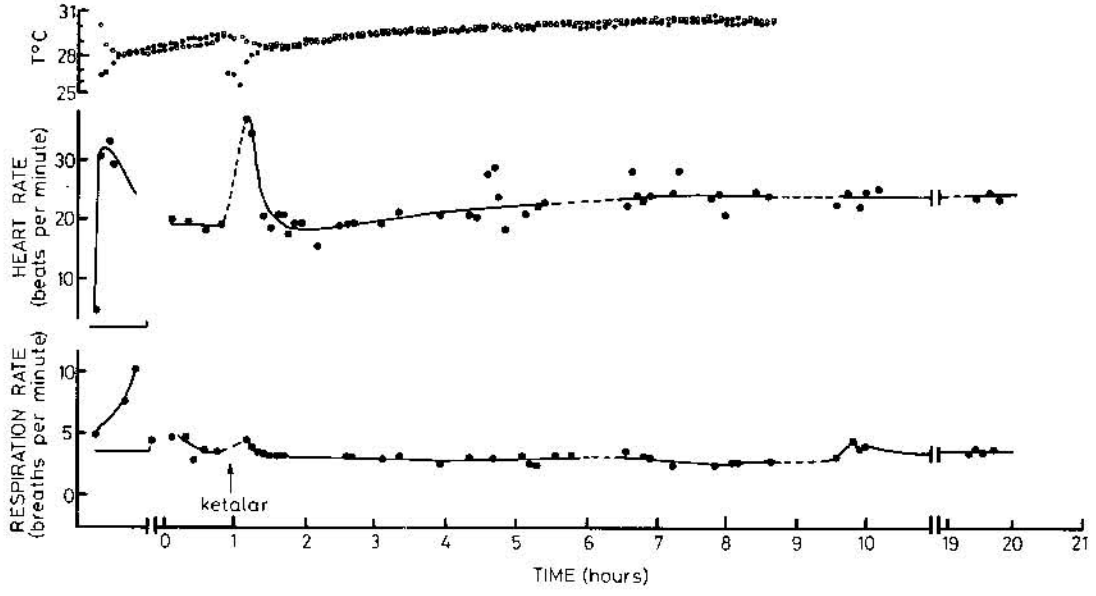

Fig. 3. The effect of ketamine on the respiratory frequency, heart rate and body temperature of a 3.6 kg *Crocodylus niloticus*. At the arrow 108 mg of ketamine was injected i.m.

in heart or respiration rate except for a doubling of heart rate for the first 15 min after injection (Fig. 3), which is probably attributable to handling. It seems clear that ketamine is a suitable anaesthetic for *Alligator mississippiensis* and perhaps for *Caiman crocodilus*, but is unsuitable for *Crocodylus niloticus*.

Etorphine hydrochloride

Wallach and Hoessle (1970) and Frye (1973) recommend the use of etorphine to induce anaesthesia in crocodilians. The drug was injected intraperitoneally (i.p.) or i.m., using projectiles for large animals and hand-held syringes for small ones. Dosages ranged from 0.03 mg kg^{-1} for a 1.7 kg *Alligator mississippiensis*, which was immobile after 30 min, to 44 mg kg^{-1} for a 0.11 kg *Caiman crocodilus* which was immobilized in 11 min and affected for 40 min (Wallach and Hoessle 1970). Good results were reported after i.m. injection into 40-68 kg *A. mississippiensis* at dosages of 0.29-0.51 mg kg^{-1}. The alligators became immobile after 20-25 min and remained so for 60-180 min. The usefulness of etorphine was not confirmed in *Caiman crocodilus*

Table 3. The effects of various drugs on *Crocodylus niloticus*.

Name of drug	Body Weight (kg)	Route	Dosage (mg kg^{-1})	Body Temperature (°C)	Comments
Phencyclidine hydrochloride	0.37	i.m.	27.0	30.4	Respiratory distress in 15 min, unable to right in 25 min, death in 35 min.
Phencyclidine hydrochloride	18.0	i.m.	12.2	23.9	Respiratory distress in 30 min, immobile after 45 min, vomited and died after 2.5 h.
Pentobarbitone sodium	13.5	i.m.	28.0	26.0	Immobilized after 2 h. Used doxapram HCl (6 mg kg^{-1}) after 3 days, recovered after 12 days.
Pentobarbitone sodium	16.0	i.m.	52.9	27.0	Immobilized after 2 h, respiration ceased in 3.5 h, died after 5 h.
5-sec-Butyl-5-ethyl-2-thiobarbituric acid	0.45	i.m.	66.7	—	After 30 min unreactive, no respiration; dead in 1 h.
Xylazine	16.5	i.m.	3.0	24.8	The drug had no effect on any of the crocodiles at the stated dosages.
Xylazine	22.5	i.m.	5.9	25.4	
Xylazine	2.41	i.m.	11.6	24.2	
Tricaine	0.45	i.m.	244	—	Dosages of 100 mg kg^{-1} added within 2 h and no effects noted.

(dosage 0.5 mg kg^{-1} i.m.; Hinsch and Gandal 1969) nor in *Crocodylus niloticus* (dosage 8 mg kg^{-1} i.m.; Loveridge and Blake 1972).

At a recommended dosage of 0.2-1.0 mg kg^{-1}, 20-100 mg would be required for a 100 kg crocodile. The expense, large injection volumes required and safety of handling such large amounts of a potent drug mean that it is unlikely to find ready use in crocodile management. Neither Wallach and Hoessle (1970) nor Frye (1973) mention the use of antidotes to etorphine to assist recovery of crocodiles.

Pentobarbitone sodium

According to Burke (1978), barbiturates are not recommended for reptilian anaesthesia. Earlier reports on their use in crocodilians are summarized by Loveridge (1979). In general, fairly massive doses (7-28 mg kg^{-1}) of pentobarbitone sodium are used. Induction times vary from 10-45 min, but the effects persist for up to five days (Klide and Klein 1973). Two trials with pentobarbitone sodium on *Crocodylus niloticus* are summarized in Table 3. At the higher dosage of 53 mg kg^{-1} death occurred after 5 h. At a dosage of 28 mg kg^{-1} the crocodile was unconscious after 2 h, but recovery took 12 days, despite the use of the analeptics, doxapram hydrochloride (6 mg kg^{-1}), p-hydroxyephedrine (0.44 mg kg^{-1}) and doxapram hydrochloride (6.7 mg kg^{-1}) on the third day.

It is possible that pentobarbitone sodium has some part to play in crocodilian anaesthesia, but trials at lower dosages than the recommended i.m. dosages of 10-30 mg kg^{-1} either i.p. or i.v. into the cervical venous sinus should be undertaken to establish its suitability.

Other Parenteral Anaesthetics

Phencyclidine hydrochloride has been reported to be effective in anaesthetising juvenile *Alligator mississippiensis* at dosages of 11-22 mg kg^{-1} i.m. (Brisbin 1966). It was reported to be unsuccessful in *Crocodylus porosus* and *C. johnstoni* by Messel and Stephens (1980), and we have found it to be lethal to *C. niloticus* at dosages of 12 and 27 mg kg^{-1} (Table 3). Inactin (Promonta — 5-sec-Butyl-5-ethyl-2 thiobarbituric acid) killed a 0.45 kg *C. niloticus* in 1 h at a dose of 67 mg kg^{-1} and xylazine hydrochloride was ineffective at 3, 6 and 12 mg kg^{-1} (Table 3). Although Brisbin (1966) found tricaine methane sulphonate to be effective at dosages of 88-99 mg kg^{-1} i.m. on *Alligator mississippiensis*, these results were not confirmed by Klide and Klein (1973) on *Caiman crocodilus*, Messel and Stephens (1980) on *Crocodylus porosus* and *C. johnstoni* nor by ourselves with *C. niloticus* (Table 3).

INJECTION OF DRUGS AND HANDLING CROCODILES

Bearing in mind the fact that none of the injectable immobilizing or anaesthetic drugs can be used with free-ranging animals, a method has to be found to deliver up to 5 ml of solution to the crocodile and inject it intramuscularly. Projectile syringes fired from a pistol of either the Palmer (compressed CO_2-fired and percussion injected) or Paxarms (percussion fired and compressed-air injected) type have been used with crocodiles (Figs 4 and 5). No problems have been encountered in the ability of these to penetrate crocodile skin, provided they strike the surface at nearly right angles. The high velocities of these projectiles fired at short distances can lead to dangers if the projectiles miss the target, and by far the simplest and most economical applicator is the pole-syringe or extension syringe (Harthoorn 1976). This is made up to be about 2 m long, in two 1 m sections of solid 13 mm aluminium rod. A 5 ml syringe is mounted at the tip. It is as well to have spare glass barrels and needles available as these occasionally get broken.

Once immobilized with gallamine or succinylcholine the crocodile should be lightly blindfolded and the ears covered to reduce stress from sensory

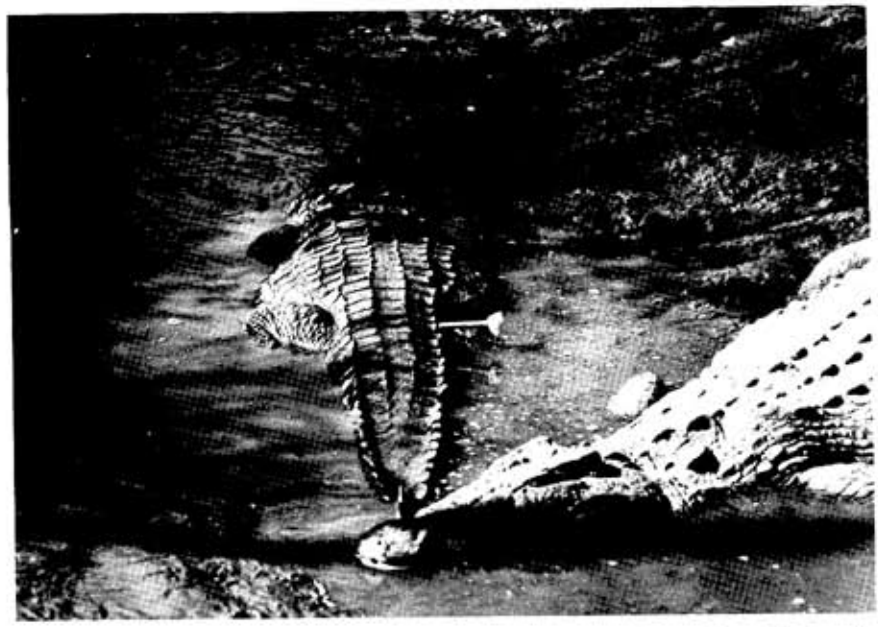

Fig. 4. Crocodile darted with projectile syringe. Note that the pond was drained before the immobilization operation started.

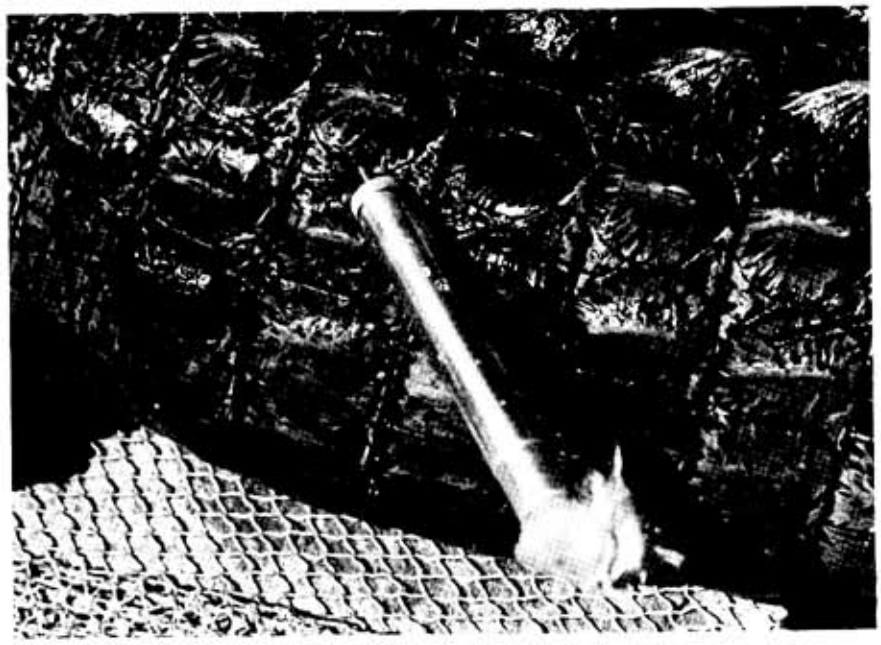

Fig. 5. Projectile syringe successfully used to inject gallamine into a crocodile.

input. Whether immobilized or anaesthetised, care should be taken at all times not to block the nostrils. Large crocodiles should be moved using a stretcher (Fig. 6). They can be rolled onto the stretcher after ensuring that the legs are tucked into the body in a backwardly directed manner. Crocodiles should not be bound with ropes; this can lead to restriction of blood supply to limbs and consequent tissue damage leading in extreme cases to gangrene.

Drugged crocodiles should be kept warm, but not exposed to excessive hot sunlight. Cloacal temperatures can be monitored using a thermistor or thermocouple meter and leads. Body temperatures should be kept below 32°C by use of shade, wet sacks or dousing with water. During recovery from drugs the crocodiles should be allowed access to clean water which is deep enough to allow the animals to drink.

OPERATOR DANGERS

As Buys (1973) has pointed out, the most important danger to those handling immobilizing drugs is accidental injection of the handler or one of his companions. It is difficult to make a serious assessment of the likely danger should the drugs used for crocodilians be accidentally injected into a human.

Fig. 6. Immobilized crocodile lying on a stretcher made of sacks and bamboo poles. The animal is blindfolded to reduce stress.

In all cases the lethal doses for humans are unknown, and projections based on LD_{50} data for small mammals are of dubious value. The emergency treatment to be followed is given by Buys (1973), who also lists the requirements for a first-aid kit.

Large dosages of gallamine triethiodide are likely to be followed by respiratory distress. Antidote administration should always be preceded by atropine injection (0.6-1.2 mg). Neostigmine (1-2.5 mg) is then injected slowly while maintaining artificial respiration as necessary. Accidental injection of neostigmine methyl sulphate is likely to be even more serious and distressing. Artificial respiration must be maintained until the antidote (2 mg atropine intravenously) is effective. Atropine may be repeated every two to four hours until normal respiration and heart rate are restored.

There is no antidote for succinylcholine chloride and under no circumstances should neostigmine or analeptics be administered (Buys 1973). Artificial respiration should be maintained until the succinylcholine has been broken down, which is reputed to be fairly rapid (Harthoorn 1976).

Mention should be made of the dangers attendant on the handling of etorphine hydrochloride. The manufacturers' literature suggests that 0.2 mg is a potentially lethal dose for a human. The *Veterinary Record* (Vol. 98, p. 371 and 373, 1976) records the death of a veterinarian after accidental self-injection of this drug while handling a foal. The dosages of up to 50 mg required to anaesthetise a 100 kg crocodilian would be extremely dangerous to handle. The first-aid procedures following poisoning with etorphine are outlined by Buys (1973).

REFERENCES

Beck, C. C., 1972. Chemical restraint of exotic species. *J. Zoo Animal Med.* **3**: 3-66.

Brisbin, I. L., 1966. Reactions of the American alligator to several immobilizing drugs. *Copeia* **1966**: 129-30.

Burke, T. J., 1978. Chemical restraint and anaesthesia. Pp. 152-4 *in* "Zoo and Wild Animal Medicine" ed by M. E. Fowler. W. B. Saunders: Philadelphia.

Buys, A. C., 1973. Operator dangers associated with the use of immobilization drugs — accidents and emergency treatment. Pp. 77-83 *in* "The Capture and Care of Wild Animals" ed by E. Young. Human and Rousseau: Cape Town and Pretoria.

Calderwood, H. W., 1971. Anaesthesia for reptiles. *J. Am. Vet. Med. Assoc.* **159**: 1618-25.

Cooper, J. E., 1974. Ketamine hydrochloride as an anaesthetic for East African reptiles. *Vet. Rec.* **95**: 37-41.

Dessmore, L. D., 1983. Biochemical and immunological systematics of the Order Crocodilia. Pp. 397-465 *in* "Evolutionary Biology" Vol. 16 ed by M. K. Hecht, B. Wallace and G. T. Prance. Plenum Press: New York.

Feldman, S. A., Cohen, E. N. and Golling, R. C., 1969. The excretion of gallamine in the dog. *Anaesthesiology* **30**: 595.

Frye, F. L., 1973. "Husbandry, Medicine and Surgery in Captive Reptiles". V. M. Publishing Inc.: Bonner Springs, Kansas.

Harthoorn, A. M., 1976. "The Chemical Capture of Animals". Bailliere Tindall: London.

HINSCH, H. AND GANDAL, C. P., 1969. The effects of etorphine (M.99) oxymorphone hydrochloride and meperidine hydrochloride in reptiles. *Copeia* **1969**: 404-5.

HUTTON, J. M., 1984. The population ecology of the Nile crocodile, *Crocodylus niloticus* Laurenti, 1768, at Ngezi, Zimbabwe. Unpublished Ph.D. Thesis, University of Zimbabwe, Zimbabwe.

JONES, D. M., 1977. The sedation and anaesthesia of birds and reptiles. *Vet. Rec.* **101**: 340-2.

KLIDE, A. M. AND KLEIN, L. V., 1973. Chemical restraint of three reptilian species. *J. Zoo Animal Med.* **4**: 8-11.

LOVERIDGE, J. P., 1979. The immobilization and anaesthesia of crocodilians. *Int. Zoo Yearb.* **19**: 103-12.

LOVERIDGE, J. P. AND BLAKE, D. K., 1972. Techniques in the immobilization and handling of the Nile crocodile, *Crocodylus niloticus*. *Arnoldia (Rhod.)* **5**: 1-14.

MESSEL, H. AND STEPHENS, D. R., 1980. Drug immobilization of crocodiles. *J. Wildl. Manag.* **44**: 295-6.

STROBEL, G. E. AND WOLLMAN, H., 1969. Pharmacology of anesthetic agents. *Fed. Proc. Fed. Am. Soc. Experim. Biol.* **28**: 1386-403.

TERPIN, K. M., DODSON, P. AND SPOTILA, J. A., 1978. Observations on ketamine hydrochloride as an anaesthetic for alligators. *Copeia* **1978**: 147-8.

WALLACH, J. D. AND HOESSLE, C., 1970. M-99 as an immobilizing agent in poikilothermes. *Vet. Med. — Small Animal Clinician* **65**: 163-7.

YOUNG, E. (ed.), 1973. "The Capture and Care of Wild Animals". Human and Rousseau: Cape Town and Pretoria.