Capture and Chemical Immobilization of the Nile Crocodile (*Crocodylus niloticus*) in South Africa

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Nile crocodiles (*Crocodylus niloticus*) are one of the most important and dangerous predators of South Africa. Due to loss of habitat their range is now limited to a small fraction of its original size. Capturing these crocodiles was part of an ongoing research project by Alison J. Leslie (Ph.D. candidate, Drexal University, Philadelphia) to understand the ecology of the Nile crocodile in the St. Lucia, Kwazulu Natal region of South Africa. One aspect of the study was to capture and tag wild adult Nile crocodiles and preform reproductive hormone and blood analysis, digestive content analysis, temperature and morphological measurements.

Capture system

The preferred trapping system in South Africa is the modified Pitman noose trap, which was developed in the 1920's at Lake Victoria[1,6]. The trap has one metal I-beam acting as a vertical upright. A metal plate attached to its base is buried in the ground. A second I-beam is bolted at right angles to the vertical I-beam. At the end of the second I-beam, is the tripping mechanism for the trap. The third piece of I-beam acts as a cross support from the vertical beam to the horizontal beam. Attached to the top of the vertical I-beam are three vehicle leaf springs which are bolted together. The holes in the leaf springs must be punched out as a cutting torch will make the metal brittle causing it to snap under pressure. Galvanized 13 mm steel cable is attached to form a noose. The main advantage to the Pitman trap is that it is collapsible and may be easily moved and installed at remote locations.

Trap placement: Pitman traps were placed in secluded locations where crocodiles were found basking in large numbers during the winter months (May-Aug). This allowed for maximum exposure to large numbers of adult crocodiles. Traps were dug into the bank approximately 2.5 m from the edge of the shore. A channel was dug 0.5 m in front of the trap base, approximately 2 m long and 1.3 m wide. The channel was dug deep enough to allow 300-400 mm of water to flow into it, allowing a crocodile to swim or crawl into the trap. A horizontal pole supported by two vertical poles was placed 1 to 1.5 m from the end of the trigger mechanism. This served as an entrance to the trap and as an anchor for the noose. The steel cable was bolted with a C-clamp to the base of the trap and wound up the I-beam and over the leaf springs to form a noose. The noose was then opened and loosely tied with thin string to the horizontal pole at the trap entrance. This held the noose open within the channel.

A piece of fencing wire was then secured to the free end of the leaf spring overhanging the water. When the leaf spring was pulled down, the fencing wire fitted into the tripping mechanism at the end of the horizontal I-beam. A piece of bait (culled game meat) was hung on a thin cable from the tripping mechanism. The bait was suspended above the surface of the water so that fish would not set off the trap. A piece of string was then tied around the tripping mechanism to ensure that wind or small animals would not inadvertently set off the trap. Three Pitman traps were set over a distance of 1 km of shore line to improve the chances of capturing a crocodile.

Capture technique: The traps were set in the late afternoon (1700). This was a two-person procedure with one person pulling down the leaf springs and watching for crocodiles, while the second person attached the bait and set the tripping mechanism. This was a potentially dangerous operation as the "trigger person" would be standing in the shallow channel, ankle deep in water holding the bait. An alarm clock with a removable STOP pin was attached to the trap. When the trap was sprung, a string attached to the noose would pull out the pin, stopping the clock. In this manner it was determined that most crocodiles were captured within 3 hr of setting the traps.

Once the team had left the trap site, crocodiles would enter the channel through the open noose to grab the bait. When the bait was grabbed, the tripping mechanism would open, releasing the spring and tightening the noose around the crocodile. If the distance from the noose to the tripping mechanism was calculated properly, the noose will snare the crocodile somewhere between the front and back legs. If this distance was too small, only the neck would be snared and the crocodile would get away. Small crocodiles <1.5 m were often snared on the tail, allowing them to slip out of the noose.

A metal eyelet in the end of the steel cable allowed the noose to remain slack, not injuring the crocodile. A heavy duty swivel was added to the cable proximal to the noose to allow the crocodile to roll and not get entangled in the cable. The traps' leaf springs acted like a large fishing rod "playing" the crocodile until it would become tired. Once the crocodile had finished struggling, it would eventually relax in the water for the night. Using this method, it was almost impossible for the crocodile to injure itself as it was in the water, away from potentially damaging objects. Only 3 of 38 crocodiles captured had minor skin abrasions to their tails.

It was not possible to observe the traps at night as it was too dangerous to gain access by boat because many hippopotamus were in the area. The traps would be checked early in the morning (0530) to see if any crocodiles had been captured.

Chemical restraint

The size of the crocodiles (2.3-4.3 m) necessitated the use of chemical restraint to insure the safety of both the crocodiles and handlers. The process required a minimum of two people to immobilize the crocodile. More people were needed with larger crocodiles.

The snared crocodile would be manipulated by the first handler into the shallow water by pulling on the steel cable of the noose. A second handler would then distract the crocodile with a 3 m wooden pole while the first handler would use a pole syringe to inject an immobilizing agent.

Pole syringes are one of the safest and most reliable ways to inject crocodiles as the injection can easily be placed between the scales[2,4,6]. Dart guns must be carefully aimed as darts may hit and bounce off osteoderms, endangering onlookers.

Immobilizing agent: The immobilizing agent of choice was gallamine triethiodide (Flaxedil, Maybaker Animal Health SA (Pty), Box 819, Halfway House, 1658, RSA)[3,4,5,7,8]. In South Africa, it is the most commonly used immobilizing agent in wild crocodile capture and crocodile farming[6]. Gallamine acts as a competitive acetylcholine antagonist, resulting in flaccid paralysis. A single dose of 1-2 mg/kg can last for up to 12 hr in the crocodile and is excreted unchanged in the urine[2,4]. It should be noted that no analgesia is induced by this drug. The sensory nerves remain unaffected, so the crocodile is aware of its surroundings and can feel pain.

Gallamine was loaded into the pole syringe and injected between scales at the base of the tail, caudal to the back leg. The needle could easily be aligned between the scales, allowing for a precise injection. Injecting in this area minimized the risk of injecting abdominal organs or hitting bone, as there is a large mass of tail muscle present at this site. The dosage of gallamine was calculated by estimating the approximate length and corresponding weight of the crocodile. Dosages varied between 1.2 - 2 mg/kg of gallamine with larger crocodiles needing smaller doses[2,4].

The drug would take effect within 20-40 min depending on the temperature, with higher temperatures producing faster induction times. In shallow water, and on land, some of the sedated crocodiles would show the so called "Flaxedil reaction" by opening their mouths as their jaw muscles relaxed due to the effects of the drug[4].

After sufficient relaxation was noted, a wet towel was thrown over the crocodiles eyes and one person would quickly grab the snout holding the jaws closed. A second person would tape the jaws shut. Care was taken not to pull on legs as they are easily dislocated[7]. This was avoided by placing a 1 m long industrial sling under the crocodiles' chest and pelvis then lifting the slings and sliding the crocodile along the ground. The crocodile would then be taken out of the noose and moved with the sling onto a stretcher that had been spread out on the shore. If a large crocodile was captured it would take up to 5 or 6 people to move it ashore and up the bank. During this procedure it was stressed that a "look out" should be watching for signs of curious crocodiles or hippos.

An emergency safety kit containing neostigmine methylsulfate as well as atropine, to counteract neostigmine side effects, was taken to each immobilization in case of accidental human injection with gallamine[4]. All handlers were instructed on its use.

Tagging and sampling procedure

Because gallamine does not have analgesic or anesthetic properties, a damp towel was placed over the eyes, and noise was kept to a minimum[2].

Morphological measurements included: head length, breadth and depth, and back leg lengths in females. Total body lengths averaged approx 3.0 m for females and 3.8 m for males. The crocodile would then be rolled into dorsal recumbency and a snout-vent measurement was taken. A thermocouple was placed 10-15 cm into the cloaca to determine a core body temperature. Sex was determined by placing a lubricated finger into the cloaca and palpating the cranial border of the cloaca. If a hard shaft was palpable, the crocodile was determined to be a male. It should also be noted that only male crocodiles reach lengths in excess of 4.0 m.

Blood samples were taken from the caudal tail vein to determine hematocrit and concentrations of reproductive hormones. This was accomplished by counting eight scales caudally from the cloaca and inserting a needle sagittally and at a 45 degree angle until the needle hit the vertebrae. The needle was then pulled back slightly until the caudal tail vein was accessed.

Stomach samples were obtained by using a self-made ladle 1 m in length with a wire handle and mesh scoop distally. The mesh scoop was bent at a 45 degree angle relative to the handle to allow it to pass through the gular flap and esophageal valve. During the collection procedure a steel ring wrapped in tape was inserted in the crocodiles mouth to keep it open. The mesh scoop of the ladle was covered in lubricant, inserted past the gular valve into the esophagus, through the esophageal sphincter, and into the stomach. The scoop was moved around in the stomach and slowly pulled out, between the crocodiles' breaths so that gastric contents would not be aspirated. This process

would be repeated 2-3 times. The stomach contents were placed into a bucket through a wire strainer. This method of stomach pumping was successful and gastric contents such as bird feathers, fish scales and cartilage, plastic bags, jelly fish, and small bones were collected.

Tagging was accomplished by using standard numbered cattle ear tags of different colors, (males red and females yellow). This allowed identification of crocodiles at a distance. The tags were inserted, with tag pliers, in the first dorsal scute, in the first single row of tail scutes. The tips of the double row of dorsal tail scutes were clipped off in a predetermined sequence to provide permanent identification if the tag fell out. Analgesia was not required as the scute tips are solid cartilage with little enervation. Minimal bleeding was observed. Recaptured crocodiles showed no ill effects of this procedure and the wounds healed well.

Crocodiles were weighed by securing the stretcher to a scale hung under a wooden pole which was held on the shoulders of the handlers. This method worked in all cases except for the largest crocodile, which measured 4.2 m and was estimated to weigh over 400 kg[6]. Photographs were taken and any distinguishing marks were recorded for future identification. After sampling and examination, crocodiles were placed 2 m from the shore and the reversal agent neostigmine, 0.025 mg/kg, was administered into the caudal tail muscle. Recovery would take from 10-40 min depending on the ambient temperature, with faster recoveries in warmer temperatures. On recovery, the crocodile would have to move under its own power to get back into the water. This ensured that the crocodiles had recovered enough to swim and not to drown.

CONCLUSION

During the capture of 38 crocodiles not one fatality occurred. Recapture was not common with only 3 of 38 crocodiles recaptured with a minimum of a 1 mo intercapture period. It must be stressed that care should be taken at all times when working around the water in crocodile habitat. All persons should stand at least 3 m back from the shore and never turn their backs to the shoreline. Working with crocodiles should never be attempted alone.

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