IUCN-SSC Crocodile Specialist Group
Student Research Assistance Scheme

Minimizing the impact of cane toads on freshwater crocodiles using Conditioned Taste Aversion Learning

Project Report
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Study Purpose

Lake Argyle, with an area of 880km^2 at normal water level, is the largest man-made lake in Australia and is set in the rugged Kimberley outback. The lake contains one of the largest populations of Australian freshwater crocodiles (Johnston's crocodiles *Crocodylus johnstoni*) anywhere in Australia - the resident non-hatchling population was estimated to be 25,000 in 1989 (G Webb Pty Ltd 1989) and has increased since (WMI 2005, 2009). The crocodile population at the lake currently face the threat of individuals dying after becoming entangled in commercial fishing nets and the potential threat from the invasive toxic cane toad (*Bufo marinus*= *Rhinella marina* under the current taxonomy). Since Australia has no native bufonids, many Australian predators lack physiological resistance to toad toxins (bufadienalides), and die following the ingestion of toads. Freshwater crocodiles feed on a diversity of prey, including frogs (Tucker *et al.* 1996; Webb et al. 1982), and have been observed eating cane toads (Letnic and Ward 2005). These crocodiles have less physiological resistance to toad toxins than do sympatric saltwater crocodiles (*C. porosus*), and can die after mouthing or ingesting cane toads (Smith & Phillips 2006). Substantial mortality of freshwater crocodiles due to ingestion of cane toads has been documented at the toad invasion front and populations declined by as much as 77% following toad invasion with population size-structures changed (White 2003; Letnic *et al.* 2008).

There is a high possibility the Lake Argyle freshwater crocodile population will collapse if these threats combine. Part of my doctoral research aims to investigate the current level of impact from fisheries (the major current threat), to predict the possible impact from cane toads and, most importantly, seeks methods which can be employed to minimize these impacts.

The research supported by this grant investigates the effectiveness of a new approach to minimize the potential impacts of cane toads - Conditioned Taste Aversion Learning (CTAL).

Taste Aversion Learning is a very robust phenomenon that has been observed in a wide range of taxa. That animals can learn to avoid poisonous food, (provided their first encounter with it is not fatal) is a long-known fact (Barnett 1963). Previous studies have shown that this learning can occur due to particular tastes, visual cues, and/or odor. To produce an effective chemically induced food aversion in the field, an agent should produce a robust, long-lasting effect, not cause chronic illness or persistent detrimental effects in target (or non-target) species and be undetectable and physically stable in the bait substrate (Nicolaus *et al.* 1983). The agent Thiabendazole (TBZ) has been identified as a potential safe and effective chemical for TAL.

Main Objectives

The objectives of this component of my research are:

a) To investigate whether TBZ induces taste-aversion learning in freshwater crocodiles without causing chronic illness or persistent detrimental effects.

b) To assess the effectiveness of CTAL as a potential management and conservation tool for freshwater crocodiles.

Results to date

Lab experiments: *To investigate whether TBZ induces taste-aversion learning in freshwater crocodiles without causing chronic illness or persistent detrimental effects*

I trialed a total of 32 *C. johnstoni* hatchlings during this component of the study. The hatchlings were 4-5 months old and were housed and maintained under standard husbandry techniques at University of Sydney Tropical Ecology Research Facility in Darwin.

I tested three concentrations of TBZ to induce taste aversion learning. The doses were extrapolated by allometric scaling from work on other species and were used within their safety margins based on oral LD_{50} values in rats.

I used cane toad meat as the novel food type as taste aversion established with novel food are stronger than those with familiar food (Rozin, 1999). Accordingly, de-skinned (since most of the toxin is in the skin) and thoroughly washed quadriceps and hamstring muscles from hind limbs of freshly euthanized cane toads were used.



Fig 1. Recording the feeding responses of hatchlings after offering baits in the laboratory.

The trials were successful. I found that TBZ at 300mg/kg in toad meat produced significantly high aversion time compared to other concentrations (100, 200 and 400 mg/kg). None of the crocodiles tested displayed any symptoms of illness or signs of nausea after consuming toad meat (treated or untreated).

Field experiments: To assess the effectiveness of CTAL as a potential management and conservation tool for freshwater crocodiles

The purpose of this field experiment was to determine an effective method of presenting the baits to crocodiles while excluding other potential species from consuming them.

I selected field sites representing the mainland, big islands and small islands (each having two control sites and two treatment sites) for feeding trials at Lake Argyle depending on the abundance of crocodiles, shore characteristics and accessibility. To test the likeliness of a crocodile taking a bait at shore, I laid 20 baits, each comprising of ~50g of chicken, at ~1m distance from the highest wave level. Since the project was aimed at deploying baits, chicken was used in the first phase instead of toad meat to avoid animals getting used to the type of bait. Three remote cameras with motion detectors were placed such that the area with all baits was covered. Baits were placed at 1800hrs and any remaining were collected at 0600hrs the following morning.

However due to the plethora of land and aerial predators at the banks of Lake Argyle, I found offering a bait specifically to crocodiles is challenging. I also tried alternative methods as attaching baits to snags, placing them on weed mats and attaching baits to floats, but unfortunately I was not able to reliably record any incidents of crocodiles taking baits. Given the fact that the effect of TBZ on non-target species is not fully known, I did not continue the work using toads and TBZ. At this stage I am experimenting on improved methods of offering the baits.



Fig 2. Remote camera pictures of Dingo, Merten's Water monitor and a crow talking bait at the shore of Lake Argyle

Way forward

In another project I have previsously demonstrated that hatchling freshwater crocodiles have an innate leaning ability to avoid cane toads (Somaweera et al, submitted). Results from my current work show that this leaning behavior can be induced in crocodiles through chemicals and could increase the duration of aversion. Our results suggest that CTA could offer a viable alternative way to enhance crocodile survival. Importantly, our work demonstrates *proof of concept* of this approach. The next hurdle is to devise a system to effectively offer the baits to crocodiles, while excluding other

animals. Though this may not be practical in a mosaic, prey-rich environment like Lake Argyle, the concept may work successfully in an arid habitat with low food availability for crocodiles (such as upper reaches of rivers/water holes where the toad will invade or has invaded). This project is intended to be completed by December 2010.

The essential equipment purchased through this grant has been used for the aforementioned project and is currently in use in other ongoing projects including spotlight surveys, crocodile nesting studies and predator abundance estimation studies.

The assistance provided by the IUCN CSG through the Student Research Assistance Scheme was instrumental to the success of my research project is greatly appreciated.

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