

THE CONTRIBUTION OF EXSITU MANAGEMENT TO CONSERVATION OF THE NORTHERN TUATARA.

(Sphenodon punctatus punctatus)

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ABSTRACT

In 1990, the Department of Conservation uplifted 31 remnant tuatara (*Sphenodon punctatus punctatus*) from Northern offshore Islands; Red Mercury Island, Cuvier Island and Stanley Island, in order to eradicate the Islands of the polynesian rat (*Rattus exulans*) and provide the opportunity for the animals to breed in captivity. Polynesian rats compete for food and space and are capable of eating juvenile tuatara.

The tuatara captured were taken into captivity at Auckland Zoo and 3 gravid Red Mercury Island females were induced. The eggs were sent to Victoria University where they were incubated and hatched before being sent to Otorohanga Kiwi House in mid 1992 where they were reared.

All 31 animals captured were mature adults and there were no young or juvenile animals seen which suggested there had probably been no recruitment of young animals into the population for some time. One animal died shortly after arriving in captivity. Studies were carried out at Auckland Zoo to determine whether the animals were likely to breed.

The group of Stanley Island tuatara were sent to Hamilton Zoo and Wellington Zoo in August 1993 so staff at Auckland Zoo could concentrate their efforts on the Cuvier and Red Mercury Island populations.

In November 1995, 4 females (3 Red Mercury Island and 1 Cuvier Island) collectively laid 49 eggs at Auckland Zoo. The eggs were sent to Victoria University where they were divided into 3 groups to be incubated at 3 different temperature settings in order to manipulate the gender ratio. The 17 eggs that hatched were returned to Auckland Zoo for rearing.

By 1994, the Polynesian rats were eradicated from the Islands and the islands can once again be home to tuatara. In November 1996, 9 of the original adult Red Mercury Island tuatara salvaged in 1990 were released back onto Red Mercury Island along with 12 reared at the Otorohanga Kiwi House.

The baby tuatara being reared at Auckland Zoo will be taken to their respective islands when they are considered large enough to fend for themselves.

This paper looks at the contribution several key agencies and people have made to the conservation of Northern tuatara in the wild to date.

Introduction

Tuatara (*Sphenodon*) are a medium sized reptile which is unique to New Zealand. They are the only surviving members of the order Sphenodontida (Fraser 1988). As a result of electrophoretic studies, the tuatara has been divided into two species, *Sphenodon punctatus* and *S. guntheri* (Brothers Island tuatara) and one sub-species *S.p.punctatus* (Northern tuatara), (Daugherty et al.1990, Whitaker & Daugherty, 1991). The introduction of mammalian predators and competitors have been responsible for the extinction of tuatara on the mainland 100 years ago (Crook 1973; Whitaker 1978; Newman and McFadden 1990; Towns 1991).

Tuatara now remain on 30 offshore Islands. Four populations of Northern tuatara (*S. p. punctatus*) are in danger of extinction (Cree, Daugherty, Hay et al; 1991) and these islands account for 75% of the area occupied by northern tuatara (Cree, Daugherty, Hay et al, 1991). The 4 populations reside on; Little Barrier Island, Cuvier Island, Stanley Island , and Red Mercury Island. Surveys carried out between 1989 and 1991 found between 4 and 21 tuatara in each population. The major threats to these populations has been forest clearance, introduced grazers, introduction of the polynesian rat (*Rattus exulans*), and rabbits found only on Stanley Island. Kiore compete for food with tuatara and probably prey on juvenile tuatara and tuatara eggs (Crook, 1973; Newman & McFaden 1990; Cree, 1990).

A Recovery Plan for tuatara was officially published in 1993 by the Department of Conservation and under the sub heading “Northern tuatara”, objective 4 covers the need for “Captive breeding of Northern tuatara from Stanley, Red Mercury, and Cuvier Island.” The purpose; “To survey these islands, collect any tuatara found, establish them in a captive breeding facility on the mainland, and attempt to raise juveniles for re-introduction to the source island following kiore eradication.”

Beginning in August 1990, as many animals as possible were removed from Red Mercury Island, Stanley Island and Cuvier Island and taken into captivity at Auckland Zoo. The very small population of 4 Little Barrier Island tuatara were taken into captivity on the Island.

The New Zealand Department of Conservation began a rat eradication programme on the Islands, beginning with Stanley Island which was successfully cleared of rats and rabbits by February 1992 (Cree, Butler et al, 1993) “Tuatara Recovery Plan”. While the rat eradication programme was being carried out (which was expected to take 5 years), it was hoped that the animals removed from the islands would breed in captivity, despite speculation that the animals were old and may be past breeding age (Newman, McFadden, 1990 Unpublished).

For the purposes of this paper, I have chosen to focus on the Red Mercury Island and Cuvier Island tuatara. The Stanley Island animals were moved to Wellington Zoo and Hamilton Zoo in 1993.

Eleven tuatara were uplifted from Red Mercury Island and 6 from Cuvier Island, and held in their respective groups in large enclosures at Auckland Zoo.

Twenty-two eggs were induced (following an injection of oxytocin) from 3 of the Red Mercury females at the time of their collection in October 1990. The eggs were sent to Victoria University in Wellington for incubation where 14 successfully hatched.

Since 1991, attempts have been made to breed the northern tuatara at the Auckland Zoo. The captive breeding of these tuatara forms one part of the three phase recovery plan. The three phases are; eradication of introduced mammals from the source islands, captive breeding of most of the remaining adult tuatara from these relictual populations, and reintroduction of captive bred young to the source islands following eradication of introduced animals.

Many of the tuatara collected were in poor condition and at least some were probably aged animals (Cree et al. 1991). There was no evidence of young animals in any of the populations. There appeared to be a lack of food in the wild and some tuatara were widely dispersed suggesting reduced opportunities for mates to encounter one another (Cree et al, 1993). It was believed that captivity could potentially address these problems.

Contribution by Otago University

Otago University looked at three main areas as part of monitoring reproductive activity in the captive northern tuatara; hormonal levels in both females and males, the use of laparoscope to assess ovarian condition, and analysis of nutrition in captive tuatara compared to wild animals.

The Department of Conservation tuatara recovery group recommended that captive breeding be attempted for 5 years beginning 1990 (the time it was expected to eradicate the islands of rats and rabbits). The Recovery Group also approved monitoring of reproductive activity through identification of ovulating females by hormonal assays which would enable eggs to be collected for artificial incubation, maximising hatching success. Monitoring work was carried out by Dr Alison Cree, Department of Zoology at University of Otago. Blood samples were collected in the mating season (February to April) in 1991 to 1993 inclusive to analyse testosterone levels in males, testosterone, estradiol and progesterone in females, the 'stress hormone' corticosterone (which can suppress reproduction), and nutritional indicators (total protein, glucose, cholesterol and triacylglycerol levels). The results were compared with samples from wild animals.

Results of the monitoring revealed that some of the captive male tuatara at Auckland Zoo showed elevated testosterone levels in 1991 and 1993 indicative of breeding condition and females had low levels of testosterone in the 3 consecutive years suggesting little or no yolk production. (Cree et al, 1993): "Results from monitoring of reproductive activity in Northern Tuatara at Auckland Zoo 1991-1993". Plasma corticosterone levels were compared over 3 years from 1991 to 1993. 1993 results

suggested that basal corticosterone levels were low in both males and females suggesting stress is unlikely to be preventing the animals from breeding. (Cree et al, 1993).

Laparoscopies were carried out on 7 Stanley Island and both Cuvier Island females following the results of the testosterone levels in March 1993 to assess ovarian condition. There was a significantly high proportion of females with regressed/atretic follicles, compared to the wild sample (Cree et al, 1993). The 2 Cuvier Island females appeared to have more than one vitellogenic follicle (Cree et al, 1993).

Nutritional analysis of captive tuatara compared to the wild showed that total protein levels were higher in captive animals (Cree et al, 1993). There was no evidence of high cholesterol levels in Northern captive tuatara as there was in captive Stephens Island tuatara (Cree et al, 1993).

“Results of the monitoring between 1991 and 1993 suggest that it is unlikely that captive northern tuatara will produce significant numbers of offspring within 5 years of capture..... The Tuatara Recovery Group will need to consider other sources of northern tuatara if the source islands are to be restocked with tuatara within 5 years of 1990.” (Cree et al 1993).

Cree suggested that, “Current routine monitoring by twice-yearly blood-sampling is unlikely to serve further purpose in the short-term, and will be discontinued unless Auckland Zoo or the Tuatara Recovery Group requests otherwise” (Cree et al, 1993). It was discontinued.

Contribution by the University of Western Australia (Gerald Kuchling)

Through ultra-sound scanning, Kuchling looked at the condition of the ovaries in captive northern tuatara.

On 21 March 1994, Gerald Kuchling performed ultra-sound scanning on the Cuvier and Red Mercury Island female tuatara held at Auckland Zoo. This was a research project identified under objective 14 in the Recovery Plan (although given a lower priority). Kuchling's study evaluated whether ultra-sound scanning as used on the Western Swamp turtle (*Pseudemydura umbrina*) also works to monitor ovarian activity in tuatara.

His results which included those from Stanley Island animals at Wellington Zoo showed up a high incidence of atresia in the tuatara (Kuchling et al 1994) “Assessment of the reproductive condition of female tuatara of critically Endangered populations by ultra-sound scanning”.

Kuchling recommended, “...Ultra-sound tomographic scanning.....be further explored for reproductive studies in tuatara”.(Kuchling et al, 1993).

Contribution by Auckland Zoo

Auckland Zoo housed and managed the salvaged northern tuatara. These captive groups provided opportunities for close observations and research.

Each population of tuatara were housed separately in their own predator proof enclosures ranging from 20m sq to 50m sq. The animals were provided with artificial burrows, enough for each animal to have its own.

The sex ratio of each group varied; 2.9:0 Red Mercury Island animals, and in the case of the Cuvier Island group, there was a bias to males (4.2:0.). Two of the male Cuvier animals have what appears to be irreversible snout damage which is probably as a result of rubbing on the netting and timber perimeter of the enclosure, and fighting between males (particularly during the breeding season, Feb-April). Both behaviours could be attributed to male bias in the population, and or design and layout of the enclosure. This requires researching more fully in the future. This snout damage has not been seen in females.

In February 1995, 4 baby Cuvier Island tuatara were discovered in the enclosure with the adults at Auckland Zoo. They were healthy and appeared to be less than three weeks old (based on their size, weight, and absence of egg teeth). They were removed from the enclosure to be reared separately. Because only 4 were found, it raised the question of whether more were present or had some been cannibalised by the adults. Despite intensive searching, no eggs or other juveniles were found. The adult female who produced these offspring was RS0047.

In June 1995 Lindsay Hazley of Southland Museum and Art Gallery commented (in a personal discussion with me) that female tuatara can be X-rayed in October and any eggs present will be easily detected if their shells have calcified. In addition, weight monitoring during the year will show a marked increase in body weight leading up to egg laying. As a result, all female Red Mercury Island tuatara and Cuvier Island tuatara weights were monitored and they were X-rayed in October 1995. Four animals (including 1 Cuvier) were carrying a total of 49 eggs. On November 16 1995, the gravid females were induced to lay their eggs. This was to ensure the eggs could be collected with minimum risk of damage or loss. The animals were X-rayed again before being injected with oxytocin (dosage of 0.1ml per 100gms body mass) and they were individually placed in a darkened, padded box to lay their eggs. The X-rays revealed that 2 animals, (both Red Mercury) had already laid their eggs. One of the clutches (of 12 eggs) was recovered but ants had damaged some of the eggs. The other clutch was never recovered.

The eggs were carefully weighed and measured as they were laid (see Fig.1). They were then partially submerged in moistened vermiculite (96ml distilled water per 120gms vermiculite), in ice cream

containers. The ice-cream containers were carefully packed in a chillybin and flown to Victoria University in Wellington on 17 November 1995, accompanied by Chris Hibbard from Auckland Zoo.

The opportunity was taken to film the egg laying. This was done by TVNZ cameraman Wayne Johnson, using a tiny sophisticated pencil camera and a standard TV camera.

Fig: 1 Below are tables showing details of the clutches and their identifying mother.

Female ID	Egg #	Time laid	Egg Weight	Comments
Cuvier RSOO35	35-0	prior oxytocin	3.127gms	Very soft, dirty
	35-1	1605	4.468	Well formed, well shelled
	35-2	1625	4.393	Well formed slightly soft
	35-3	1650	4.495	Left end thin shell
	35-4	1700	2.680	Right end no shell only membrane
	35-5	1730	4.620	Well formed
	35-6	1825	4.694	Well formed slight ribbing
	35-7	1915	4.579	Well formed slight ribbing
	35-8	1940	2.726	Front & back has no shell
	35-9	1950	3.034	33% left end membrane only.
	35-10	2010	2.969	33% right end membrane only
	35-11	2015	3.341	40% right end membrane only
	35-12	2024	4.722	Well formed,

				slightly ribbed
	35-13	2037	4.553	Right end slightly thin shell
	35-14	2130	4.247	Right end slightly thin shell
	35-15	2222	4.652	Lengthwise ribs. Well formed
	35-16	2245	2.827	Left end 25% membrane only. Right end flattened. 3 deep grooves.

Female ID	Egg #	Time laid	Weight	Comment
Red Mercury RS0117	17-1	1410	5.353	Dimpled on upper surface at wide end
	17-2	1440	5.006	
	17-3	1505	5.230	Very slight dent at right end
	17-4	1600	5.549	Left end crescent of thinner calcification.
	17-5	2025	5.402	Well formed
	17-6	2145	5.360	Well formed
	17-7	0025	5.665	Well formed but irregular calcification over 75% surface
	17-8	0050	5.426	Slightly translucent, bit soft.
	17-9	Between 0230 and 0630	5.397	Well formed
	17-10	“ “	5.209	Well formed, bit soft
	17-11	18/11/95	5.290	Received 23 Jan 1996

Female ID	Egg #	Time laid	Weight	Comments
Red Mercury RS0087	87-1	1720	3.803	Slightly soft
	87-2	1740	3.433	Irregularly shaped,leathery
	87-3	1800	3.693	Slightly irregular shape
	87-4	1840	4.773	Well formed
	87-5	1855	3.738	Well formed, a bit sticky
	87-6	1945	3.324	Slightly irreg shape.Blood/muc us on near side
	87-7	1950	3.376	Well formed
	87-8	2005	3.180	Left end blood/mucuc stain, sticky
	87-9	2145	4.115	Well formed,very slightly soft
	87-10	0035	3.374	Soft,long & narrow.

Female ID	Egg #	time laid	Weight	Comments
Unknown Red Merc	-9	Found 16/11/95	4.805	Part of main clump
	-10	“ “	4.285	On own
	-11	“ “	4.614	Joined to egg#12
	-Group of 7	“ “	30.615	Egg #8 & #12 removed/bad.

Contribution by Victoria University

Victoria University incubated the tuatara eggs.

The eggs were divided into three groups at Victoria University and each was incubated at a different temperature; 18 degrees C, 22 degrees C and Var degrees C in order to manipulate the gender ratio. Temperatures of 18.C and below favour females and above 18.C males (Cree, et al, 1995).

The first Cuvier egg 35-13 (incubated at Var.C) hatched on 4 June 1996 and the last 2 incubated at 18.C hatched 12 August 1996. The first Red Mercury Island egg 17-11 (incubated at 22.C) hatched on

10 June 1996 and the last egg 17-4 (incubated at 18.C) hatched 17 September 1996. A total of 17 eggs hatched, 6 Cuvier Island tuatara and 11 Red Mercury Island tuatara.

Fig: 2. Tables showing results of eggs that hatched.

Female ID	Egg #	Hatch date	Hatch weight	Toe clip ID	Incubation temp
Cuvier RS0035	35-13	4/6/96	5.106	2555	Var.C
	35-12	14/6/96	5.092	2554	Var.C
	35-15	20/6/96	5.115	2553	22.C
	35-5	25/6/96	5.284	2552	22.C
	35-6	7/9/96	5.054	2545	18.C
	35-7	12/9/96	4.740	2544	18.C

Female ID	Egg #	Hatch date	Hatch weight	Toe clip ID	Incubation temp
Red Merc RS0117	17-11	10/6/96	5.825	5-31	22.C
	17-9	29/6/96	5.858	5-25	22.C
	17-3	1/7/96	5.851	5-24	Var.C
	17-2	3/7/96	5.722	5-22	Var.C
	17-1	3/7/96	5.885	5-23	22.C
	17-6	6/7/96	5.990	5-15	Var.C
	17-7	6/7/96	6.172	5-21	Var.C
	17-10	9/9/96	5.671	5-13	18.C
	17-5	12/9/96	6.080	5-12	18.C
	17-4	17/9/96	5.935	5-11	18.C
Female ID	Egg #	Hatch date	hatch weight	Toe clip ID	Incubation temp
Red Merc RS0087	87-4	7/9/96	5.456	5-14	18.C

Approximately 40% of the 49 eggs hatched. Those that hatched are expected to provide a sex ratio of roughly 50:50.

All juvenile tuatara were returned to Auckland Zoo from Victoria University for rearing.

Reintroduction of Northern tuatara to Red Mercury Island.

In 1995, the Recovery group decided to release the 11 adult tuatara originally salvaged from Red Mercury Island back to the Island now free of Kioere. In addition, their 12, 5 year old offspring reared at the Otorohanga kiwi House were also to be released. MSC student, Graham Ussher (University of Auckland) prepared radio transmitters which were trialed on the adult animals at Auckland Zoo leading up to their release.

Before the Red Mercury Island animals were transferred from Auckland Zoo to the Island, they were isolated for 28 days. To reduce the risk of cross contamination, the tuatara were serviced before other reptiles each day. Entry to the enclosure was through a footbath of Verkon solution which was changed daily. The animals were only fed cultured food and feeding stopped 2 days before their release.

Faecal samples were collected at the beginning and end of the isolation period to check for parasites, including cryptosporidia. Cloacal swabs were cultured for salmonella and blood samples were taken to check for parasites. A complete physical examination was carried out by the zoo veterinarian before their departure.

On 1 November 1996, 9 adult and 12, 5 year old Red Mercury Island tuatara were released on Red Mercury Island. Two adult female tuatara were left at Auckland Zoo because they were not in ideal condition for release. In the pre-release ceremony at Whitianga harbour, Maniapoto iwi, who had spiritual guardianship of the tuatara in the King country, led by kaumatua Richard Rangitaawa, handed over the tuatara to local iwi, the Ngati Maru sub-tribe of the Hauraki people. Mata Owens welcomed the King Country visitors (representatives from Auckland Zoo, DoC, Victoria University, Auckland University, Auckland Zoo and Otorohanga Kiwi house) with their precious gifts, singing that this was a day of great significance.

The Cuvier Island adults will remain at Auckland Zoo for further captive breeding. The 20 juvenile Northern tuatara will be returned to their islands of origin in 3 to 5 years time (consistent with objective 4 of the Recovery plan).

SUMMARY

The future of the Red Mercury, Cuvier, and Stanley Island tuatara was reliant foremostly on their exsitu management. At the very least, they needed to be kept alive long enough in captivity for their islands of origin to be freed of kioere before they could be returned. Leaving the animals insitu was not a serious option because they were considered old, in poor condition and widely dispersed significantly reducing mating opportunities. Leaving them could have spelled extinction of these island populations as distinct pure races.

The primary objective of exsitu management was to breed the animals in captivity within 5 years, and re-stock the former Islands with the offspring once they were given a head start in captivity. This was looking unlikely up until October 1995 and the Recovery Group were preparing to return all adult tuatara to their islands of origin and mix with tuatara from adjacent islands to encourage breeding (minutes of the Recovery group meeting in, Nelson, 1995). In spite of evidence suggesting that the animals may have been unable to breed it was achieved in 1995 and 1996 by the Red Mercury and Cuvier Island animals, and the mixing of animals from different islands has so far been unnecessary.

Having the animals in captivity has provided opportunities for comparative research to be carried out with wild tuatara. In captivity, there is the opportunity to provide the animals with optimum conditions for breeding. One of the benefits is more regular breeding which has already been observed and documented in some captive tuatara. Some females are regularly laying clutches every second year (Bell Unpublished) compared to the more erratic 2 -4 yearly cycles being recorded in the wild.

Exsitu management is expected to continue to form a major part of the conservation strategy for the Northern tuatara.

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