THE POORLY KNOWN RUSTY MONITOR *VARANUS SEMIREMEX*: HISTORY, NATURAL HISTORY, CAPTIVE BREEDING AND HUSBANDRY

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INTRODUCTION

The Rusty Monitor, *Varanus semiremex*, was described in 1869. Despite this species being recognized for so long, little is known about it in the wild or captivity and it is regarded as one of Australia's many poorly known reptile species (Cogger *et al*., 1993; Bennett, 1995). Captive specimens of *V. semiremex* have been held in the last 30 years in Germany, the United States of America and Australia. However, no detailed observations have been published on its breeding habits and maintenance. *Varanus semiremex* is a coastal Queensland species (Cogger, 2000) whose habitats and continued survival are threatened by clearing of vegetation. Thus it seems timely to report the results of recent observations in the wild (particularly in the Rockhampton district) and captive breeding at Australia Zoo, Beerwah, Queensland. This study was undertaken under permits issued by the Queensland Parks and Wildlife Service.

DESCRIPTION

Nostrils are closer to the tip of the snout than to the eye. Head colouration is predominately brown with yellow scale edges and may have a temporal mauve tinge extending along the upper neck. The lower lips have faint brown bars. Under the chin and along the throat is yellow-orange. The body is grey with irregular black flecks and the ventral surface is pale yellow, with irregular, thin, brown banding. The tail is grey-black and lacks discernable

pattern; it is round in section at the base and laterally compressed distally. Total length for adults is approximately 650 mm. The tail is between 1.3 and 1.7 times longer than the head and body. Scales around the midbody number 85-105 (Cogger, 2000).

Specimens from the west of Cape York Peninsula are darker brown with light coloured ocelli on the back (Wilson & Knowles, 1988). The Queensland Museum has four specimens from the east of Cape York Peninsula, all resembling specimens from the south and lacking the dark colour with distinct light ocelli (pers. obs.).

TAXONOMY

Varanus (*Odatria*) *semiremex* has had a long, stable taxonomic history. It was described by Wilhelm Peters in 1869. The species name means 'half rower'. Cogger *et al*. (1983) list only two names in the synonomy of *V.*(*O.*) *semiremex*: *Odatria semireme* Günther 1875 and *Varanus boulengeri* Kinghorn 1924.

DISTRIBUTION AND HABITAT

V. semiremex occurs near the coast in Queensland's tropics and subtropics (Ingram & Raven, 1991). It has been recorded from both western and eastern Cape York Peninsula and, in a number of isolated populations, including small offshore islands, south to the Gladstone area, southeast Queensland. Only one exception has been recorded, a specimen collected in November 1939, reportedly from near the Ord River, WA (Mertens, 1961). Few specimens are held in Australian museum collections; in April 2002 the Queensland Museum had 14 specimens and the Australian Museum 19.

The Rusty Monitor favours coastal and estuarine mangrove communities (Wilson & Knowles, 1988), foreshores of small islands (Cogger, 2000) and melaleuca swamps (Ehmann, 1992). In

the south of its range, *V. semiremex* appears to be restricted to coastal mangroves, with its habitat being dominated by the Spotted Mangrove *Rhizophora stylosa* and the Grey Mangrove *Avicennia marina* (pers. obs.). The monitors are particularly dependent on the Grey Mangrove, utilizing hollow limbs of mature trees and sheltering in dead, completely hollow trees. Dead Grey Mangrove trees may be a 100 years old at death, but continue to stand for a long time afterwards. They are also incredibly fragile and easily damaged. Peters (1969) recorded one specimen in a mangrove tree *Rhizophora micronanta* and noted the habitat included such other plants as *A. marina, Bruguiera gymnorrhiza* and *Sonneratia alba*. In the north, *V. semiremex* has been found in freshwater melaleuca swamps (Cameron & Cogger, 1992; S. Wilson, pers. comm.) and, in some areas, adjacent habitat to the mangroves also appears to be utilised by *V. semiremex* (pers. obs.).

NATURAL HISTORY

Tree Preference

The continual use of some mangrove trees by *V. semiremex* has given rise to what is often referred to as a ‘home tree’. These home trees are determined by shed monitor skin in the hollows and crab remains scattered at the tree’s base or crevices and hollows (Peters, 1969; pers. obs.). In the field, it has often been that certain Grey Mangrove trees seem to yield a better chance of finding a monitor present (pers. obs.); whether these are actual home trees or this is due to lack of availability in preferable hollows is undetermined. Further investigation is required to establish exactly what ties *V. semiremex* may or may not have to a home tree.

Seasonal and Daily Activity

During winter the most southerly populations of *V. semiremex* tend to move around in their

hollows, following the sun to thermoregulate, and are rarely active apart from this (pers. obs.). They are reported to be seasonally active in the north between February and June (Cameron & Cogger, 1992).

Daily activity is affected by the tide. Thus, lizards are active when the tide is out and often leave visible tracks on the mangrove mud (Dunson,1974; pers. obs). Foreshore sand behind the mangroves in some areas also often shows tracks revealing some of the day's activity and foraging.

Feeding

The known wild diet consists of crustaceans, fish and frogs (Dunson, 1974; James *et al*., 1992). One sample collected by Australia Zoo from the field was examined at the Queensland Museum and found to contain fragments of arthropods: mostly parts of a Katydid (Orthoptera:Tettigoniidae), leg parts of a spider and some crab fragments of a mangrove species, probably Grapsidae, subfamily Sesarminae. Popular literature lists crustaceans, fish, frogs, insects, lizards and small mammals (Swanson, 1976; Ehmann, 1992; Vincent & Wilson, 1999; Cogger, 2000). With most of this prey occurring in a brackish environment, the Rusty Monitor excretes excess salt through well-developed nasal salt excretion glands (Dunson, 1974; Ehmann, 1992; Vincent & Wilson, 1999).

THREATS TO SURVIVAL

Habitat Destruction

Since European settlement the estimated change in *V. semiremex* range is between 1-24% (Cogger *et al*., 1993), with loss of mangrove forests likely to be the threat of most concern to *V. semiremex*. Further, adjacent habitats to the mangroves, such as woodland or *Melaleuca*

swamps, are also often cleared for roads, agriculture, urban and industrial developments. Such activities render the mangrove habitat isolated and Australia Zoo staff have been unsuccessful in finding *V. semiremex* in such areas.

In the past there was destructive collecting for the keeping 'trade', with *V. semiremex* being heavily collected from the wild in the Rockhampton district during the 1970s (S. Irwin, pers. comm.). The destructive manner in which this was done, using chainsaws to open hollow trees, left some populations to struggle in seriously altered habitat (pers. obs.). There have been no reports of such destructive collecting occurring since the 1970s.

Cane Toad

Rusty Monitors have been found dead after having attempted to consume the Cane Toad *Bufo marinus* (S.Irwin, pers. comm.). Cane Toads have been found sheltering in hollows on the ground and close to the ground in areas where the Rusty Monitors forage (pers. obs.). However the full extent of Cane Toad impact on *V. semiremex* may be difficult to quantify. I have found *V. semiremex* to be easily located at two localities in the south of their range, despite the presence of the Cane Toad.

CAPTIVE MAINTENANCE

Housing and Husbandry

The founding four wild-caught Rusty Monitors were initially held in small individual enclosures at Australia Zoo. Enclosure size for each animal was 730 mm L x 530 mm W x 450 mm H, with newspaper for substrate, a small hollow log for shelter, large water bowl to allow soaking and fig tree branches so that the lizards could feel secure. All specimens had access to natural sunlight and a 40 watt Blue light globe provided heat. All lizards settled in

well and quickly became accustomed to cleaning procedures. They all also accepted food from forceps whilst in the security of their hollow within the first few days.

On 20 September 1999 the lizards were moved into enclosures designed for breeding arboreal lizards. The dimensions were 1.8m L x 1.8 m W x 2.1 m H (at its highest point). Keeper access was via a standard size house door measuring 175cm H x 72 cm W. The door incorporated a small viewing window 30 cm H x 18 cm W to allow viewing of the lizards with minimal disturbance. The walls were rendered concrete. The roof had a skylight, which was opened on sunny and overcast days to allow direct sunlight into the enclosure. Due to Queensland's weather conditions, the skylights were able to stay open most of the year round, but were always closed at night regardless of weather conditions. Stainless steel woven wire mesh stopped the lizards from escaping through the skylight and the lizards sometimes hung from this, sunning their bellies. No problems were encountered with nose rub using this mesh.

The rendered walls and a drain in the floor allowed hosing of the enclosure after cleaning. A 'substrate' of large gravel rocks aided drainage to avoid/reduce bacterial build-up. This was time efficient and extremely hygienic.

Two large horizontal branches approximately 60 cm apart extended across the enclosure at heights of 1.4 m and 1.7 m above the floor. They provided horizontal basking sites, with the higher branch situated 40 cm below a heat pad measuring 180cm L x 38cm W. Other branches extended to the floor, allowing lizards access to a large water bowl 40 cm in diameter × 6 cm deep. Also running between the two horizontal branches were flat pieces of bark, approximately 60 cm long and 25 cm wide. These were placed at an angle of 45° to the skylight. On sunny days when the skylight was open, the bark was a favorite basking site. On hot days, when the bark reached a temperature up to 56°C, the lizards would still bask on them. On cool days, when the skylights were closed, each enclosure had one or two 80 watt spotlights switched on. These were directed at the bark and created a basking site of 32°C,

providing an alternative to the heat pad. On cool, overcast days the lizards could still benefit from available UV light as the skylights could be opened and combined with the heat from the pad or spotlights. Ambient air temperature in each enclosure was maintained at 24-33°C.

Enclosures were decorated with 3-4 fig trees in large pots. This helped to create a naturalistic environment, increasing security for the lizards, providing dappled direct sunlight and creating a thermal gradient at the highest points of the enclosures. Both enclosures had five small hollow logs attached to branches, all at least 90 cm above the enclosure floor. The hollows were positioned horizontally, vertically and at angles. There was no preference in choosing the angle of the hollow, but individual specimens did favour particular hollows.

The diet was mainly crickets and cockroaches. Insects were offered twice a week, dusted with vitamin and calcium supplement powders. Chopped or small whitebait and prawns were also provided to replicate the fish and crustaceans in the lizard's wild diet. Pre-killed pink mice or rats were fed once a week at most. Food items were always offered individually from forceps daily or every second to third day.

Introductions and Mating

Two pairs were introduced into separate new enclosures on 20 September 1999. When first removed from a bag after capture, one lizard L268 everted a hemipenis. We paired this specimen with an assumed female L269 as a priority. Another two lizards L270 and L271 were introduced to a second enclosure. Sexing *V. semiremex* can be difficult, but subtle head differences suggested that the lizards housed together were opposite sexes. Both pairs coexisted well, sharing hollows and emerging to bask, side by side. No aggression was observed.

After nearly four months, during the wet season month of February 2000, the first mating behavior was observed. Our lizards often shared the same hollows and this often made it difficult to observe interactions between them. We suspected that copulation was taking place in the hollows, as the two pairs shared hollows more often than previously. We limited disturbance, so could not confirm copulation till 25 February 2000, when lizards L269 and L268 were observed copulating in a hollow. Throughout this breeding season both pairs constantly shared the same hollow and we believe copulation was frequent. First suspected copulation for pair L270 and L271 was on 10 February 2000. Throughout March both females increased the time spent basking on the bark, flattened with their backs exposed to the direct sun. They became distended in the abdomen, particularly just in front of the hind legs, thus displaying positive signs of having become gravid. Courtship resumed after each female had laid their first clutch (refer to “Egg Laying”).

On 21 April 2000, pair L269 and L268 were again copulating in a hollow. The other pair, L270 and L271, were found copulating again on 28 April 2000 at 0750 hrs, also in a hollow. Later that day, at 1448 hrs, they were observed copulating in the open on the bark, the first time either pair had been observed copulating outside a hollow. They were easily disturbed and retreated to a hollow. They resumed copulation in a hollow at 1515 hrs. Following this resumption of matings, both females again became gravid and laid their second clutches for the season (see below).

On 10 November 2001 we added a second female (L124) to the enclosure of pair L268

and L269. All three lived without aggression until midway through the breeding season in 2001. Females L124 and L269 had laid their first clutches of eggs in the same nest box ten days apart. The females were investigating the nest box prior to laying their second clutch when the aggression occurred, presumably over a nest site. The slightly larger, apparently more dominant female (L124), inflicted superficial lesions to female L269 on the forelimbs and snout. Subsequently, L269 was removed and allowed to recover separately. In 2001, the first confirmed mating was between L270 and L271 on 30 January. They were observed copulating at 1645 hrs in the open on the exposed bark. Copulation in the open became common in the second season, suggesting the lizards had become more accustomed to captivity.

Egg Laying

Nest boxes were constructed of plywood 680 mm L x 125 mm W x 245 mm H. A nest box was placed on the floor of each enclosure and 2/3 filled with moist potting mix covered by a layer of sphagnum moss. Water was added until the mixture was slightly moist to touch and maintained at that level by adding extra water as required. Heat tape on one side of the nest box kept the mixture at 26-30°C. Females repeatedly investigated and spent time in the nest boxes for about two weeks prior to depositing eggs. They continued to feed throughout this time and ate small amounts of food even a day prior to laying. However, if food was offered generously in the last week prior to egg deposition a decrease in appetite was apparent in the last few days. All clutches of eggs produced were laid either in the early morning, during the day or late evening.

The first clutch contained 10 eggs and was laid by L269 on 30 March 2000. On 14 April 2000 the second female (L270) laid 12 eggs. The two females fed well after depositing their eggs and retained good condition. The weather remained warm and we felt it possible that the lizards may ‘double clutch’. Food was generously supplied and on overcast days the ambient

temperature was maintained at around 26°C with the basking sites at 32°C. On 2 June 2000, L269 laid 11 eggs and L270 laid 8 eggs.

Matings in 2001 resulted in female L270 'triple clutching', female L214 produced two clutches and female L269, after having laid one clutch, was housed separately. Over the two years of breeding 125 eggs were laid. Clutch data are summarized in Table 1.

Table 1. Eggs laid by *V. semiremex* in 2000 and 2001. Mass, length and width are expressed as range (mean).

Date of Lay	**Clutch Size**	**Mass (g)**	**Length (mm)**	**Width (mm)**
Female L269				
(a) 30 March 2000	10	4-6 (5.3)	30-31.5 (31.2)	17-19 (17.8)
(b) 2 June 2000	11	5-7 (6.2)	29-34 (31.9)	17-19 (18.1)
(c) 23 March 2001	14	4-6 (4.9)	27-30 (28.0)	16-17 (16.6)
Female L270				
(d) 14 April 2000	12*	5-8 (6.8)	31.5-37 (34.2)	17.5-19.5 (18.5)
(e) 2 June 2000	8	7 (7.0)	33.5-35.5 (34.3)	18.5-20 (19.3)
(f) 26 Feb 2001	11**	-	-	-
(g) 6 April 2001	13	5-7 (6.5)	30-35 (31.9)	15-17 (16.6)
(h) 24 May 2001	10***	5-7 (6.4)	36-38 (36.4)	16-18 (17.6)
Female L124				
(i) 2 April 2001	21	6-8 (7.2)	28-33 (30.5)	17-18 (17.7)
(j) 12 May 2001	15****	6-7 (6.3)	29-33 (30.4)	16-17 (16.6)

*All eggs from this clutch appeared viable when laid; later all found to be infertile

**2 eggs discarded; 9 eggs desiccated in nest box

***2 eggs laid 23 May discarded, omitted from measurements

**** 1 egg discarded, omitted from measurements

Incubation

Eggs were removed, measured and weighed once the female had finished back-filling the soil and left the nest box. Incubation techniques were varied initially, using ratios of 1:1, 1:2 and 1:3 water/vermiculite. Greatest success was achieved with a 2.5 litre plastic container 2/3 filled with a ratio of 1:1 vermiculite to water, with approximately 12 eggs per container, incubated at 30°C. The container lid was removed briefly once a week to allow for air exchange.

Hatchlings

The first of the captive-bred *V. semiremex* hatched on 6 November 2000, after an incubation period of 242 days. Seventeen eggs successfully hatched the first year and 45 hatchlings the year after. The majority of eggs had an incubation period between 200 and 220 days.

The hatchlings were more vibrantly coloured than adults. They had a bright orange head, with a reticulated pattern on the sides; yellow flecks on the forelimbs, bright yellow under the chin and belly; while the body was dark brown with irregular white spots, some of which became ocellated within the first couple of weeks. The partly ocellated pattern of some hatchlings faded after 2-6 months of growth into the grey back, black-flecked pattern commonly seen in adults.

Table 2. Weights and lengths of neonate *V. semiremex* hatched at Australia Zoo in 2000 and 2001. Clutch labels refer to entries in Table 1. Range of dates given are from the first to the last hatched lizard for a clutch.

Clutch	No. of hatchlings	Date(s)	Mass (g)	SVL (mm)	Total length (mm)
(a)	1	6 November 2000	4	66	166
(b)	8	24 November - 9 December 2000	3-5 (4.2)	57-72 (68.3)	156-192 (172.7)
(c)	8*	31 September - 14 October 2001	3-5 (4.1)	60-81 (72.3)	143-197 (177.0)
(e)	8	8 January - 22 January 2001	3-5 (4.1)	62-79 (74.6)	161-199 (184.5)
(g)	7	29 October - 12 November 2001	4-6 (5.0)	70-81 (76.0)	175-208 (189.6)
(h)	4	20-24 December 2001	4-5 (4.5)	64-79 (74.8)	154-202 (181.8)
(i)	15	10 October - 8 November 2001	3-6 (5.1)	71-80 (76.1)	169-203 (190.8)
(j)	11	8 December - 20 December 2001	4-5 (4.3)	71-77 (75.4)	176-192 (184.2)

*Includes twin neonates from one egg

Housing, maintenance & behaviour of hatchlings through to sexual maturity

Hatchlings were initially kept in the incubator in a plastic container lined with moist paper towel. After 3-7 days they were moved to 450 litre plastic tubs, which were 120 cm L x 60 cm W floor space and had a depth of 60 cm. Each tub had a 80 watt spotlight creating a basking site of 38°C and was held in a room where the ambient temperature never dropped below 22°C. On sunny days the tubs were wheeled to half in the sun to allow access to direct

sunlight for UV and created a basking site of 42°C. Newspaper was used as a substrate and was changed daily. A fresh cut fig branch with foliage was added for security and climbing, and was replaced every two days.

Diet of the hatchlings was primarily crickets, occasionally dusted with vitamin and calcium supplement powders. As the hatchlings grew, they were gradually transferred to the adult diet previously mentioned. The lizards were fed every 1-2 days.

Housing large groups of hatchlings rarely presented a problem, with up to 20 hatchlings per 450 litre tub for the first two months. To reduce competition, the daily amount of food offered was generous. A few individuals were aggressive towards others, involving chasing, biting and sitting on the subordinate. Removal of the aggressive individual resulted in a return of harmony for the remaining group housed together. As the lizards grew they were further divided into smaller groups to maintain husbandry standards and prevent further aggression.

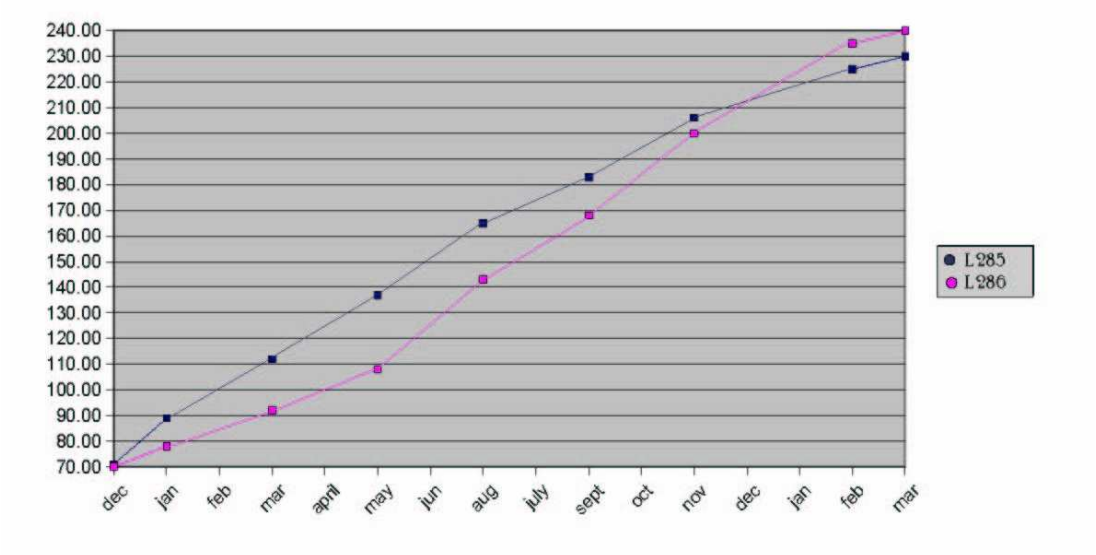
Before these *V. semiremex* reached a subadult size, two notable behaviour traits were observed. One was pseudocopulation, where no penetration occurred and the lizards were too small to reproduce. The lizard making the advances was usually a male. The second behavior was tail- waving, observed on several occasions.

The first definite copulation of the captive-raised *V. semiremex* occurred on 3 March 2002. The lizards were 15 months of age, with the male having a snout vent length of 187 mm and the female 204 mm. No ritualized combat was ever observed. Once the *V. semiremex* had become sexually mature, sexing was made easier by observing male - male aggression and male advances towards females. Females generally kept to themselves.

Growth rates

A total of 17 lizards, from clutches (a), (b) and (e) were weighed and measured from hatching through to sexually maturity. The two lizards chosen for figure 1 are representative of the growth patterns of all lizards. No outstanding variation in growth between the three clutches occurred.

Figure 1. Growth rates for two captive-raised *V. semiremex* at Australia Zoo.



DISCUSSION

Based on the examination of museum specimens, the Rusty Monitor is a wet season breeder (James *et al*., 1992). The Australia Zoo, Beerwah wet season (January – April) coincides with that of the collection site in the Rockhampton area. The monitors in this study were constantly exposed to natural stimuli, such as seasonal temperature and photoperiod, through the inclusion of the skylights in their enclosures, and hence the timing of mating in the captive colony is presumed to be similar to that in the wild. Lizards in the captive colony mated in the wet season. The first generation captive-bred monitors were also exposed to natural stimuli and their breeding behaviour also took place in the wet season.

The enclosures used for the breeding of the *V. semiremex* were of the same design that had been previously used at Australia Zoo to breed the Canopy Goanna *V. keithhornei* (Irwin, 1996).

The size and weights of eggs from clutches laid at Australia Zoo are in agreement with those previously published for *V.semiremex* (De Lisle, 1996). The gestation period was determined to be around four weeks, based on the time span between consecutive clutches laid by individual females. Clutch size for *V. semiremex* was previously recorded as up to 14 eggs (Horn in James *et al*., 1992); one clutch of 21 eggs at Australia Zoo increased the known clutch size by seven eggs. Further, at the subgenus level of *Odatria*, the only species known to have produced a larger clutch is Mitchells Water Monitor *V. mitchelli* with a clutch of 23 eggs (G. Gaikhorst, pers. comm.).

It was presumed that lizards too young to mate, but found in a copulatory position on another lizard, were adolescent males. However, female Ridge-tailed Monitors *V. acanthurus* have been observed to pseudo-copulate with other females, which is thought to be an assertion of dominance (J. Lemm, per. comm.). The captive-bred *V. semiremex* were observed tail-waving on several occasions. This behavior has been reported in captive *V. storri* and *V. gilleni*, and in wild *V. gilleni* (pers. obs.), and is thought to be a threat response to human observers (Vincent & Wilson, 1999).

The estimated snout-vent length for both sexes at sexual maturity has been reported as 150mm (James *et al*., 1992). The first captive-raised *V. semiremex* observed copulating measured 187 mm SVL for the male and 204 mm for the female. Once maturity is reached some individuals became more obviously territorial, with dominant males biting sub-ordinate males by the ribs and hanging on. This aggression has the potential for serious injury. Hence any display of aggression resulted in one of the lizards involved being moved to a separate enclosure.

A number of *Odatria* monitor species have spur-clusters near the vent, e.g. Black-Tailed Monitor *V. tristis* (Bennett, 1995; Vincent & Wilson, 1999). These can be used to determine sex as males have larger clusters. *Varanus semiremex* lack any enlarged scales near the vent and therefore cannot be sexed using this method. It is not known whether hemipenial bones are visible on radiographs and ultrasound was not tried as a sexing method.

The lizards used in this study were collected under a permit issued by Queensland Parks and Wildlife Service to Australia Zoo in order to gain further knowledge of the reproductive biology of Rusty Monitors through captive breeding. Once this objective had been achieved, following all relevant health checks, the founding animals and their offspring were released back to the wild at the collection site, as per permit requirements.

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REFERENCES

Bennett, D. 1995. A little book of monitor lizards. Viper Press, Aberdeen, Great Britian.

Cameron, E.E. & Cogger, H.G. 1992. The Herpetofauna of the Weipa Region, Cape York Peninsula. Technical Reports of the Australian Museum (7): 1-200.

Cogger, H.G. 2000. Reptiles and Amphibians of Australia. Reed Books, Port Melbourne.

Cogger, H.G., Cameron, E.E. & Cogger, H.M. 1983. Amphibia & Reptila. Vol.1. Zoological Catalogue of Australia. Australian Government Printing Service, Canberra.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. 1993. The Action Plan For Australian Reptiles. Australian Nature Conservation Agency, Canberra.

De Lisle, H.F. 1996. The Natural History of Monitor Lizards. Krieger Publishing Company, Malabar, Florida.

Dunson, W.A. 1974. Salt gland secretion in a mangrove monitor. Comparative Biochemistry and Physiology 47A: 1245-1255.

Ehmann, H. 1992. Encyclopedia of Australian Animals, Reptiles. Angus and Robertson, Sydney.

Ingram, G. & Raven, R. 1991. An Atlas of Queenslands Frogs, Reptiles, Birds & Mammals. Queensland Museum, Brisbane.

Irwin, S. 1996. Capture, field observations and husbandry of the rare canopy goanna. Thylacinus 21(2):12-19.

James, C.D., Losos, J.B. & King, D.R. 1992. Reproductive biology and diets of goannas (Reptilia:Varandidae). Journal of Herpetology 26(2):128-136.

Kinghorn, J.R. 1924. New *Varanus* from Coquet Island, Queensland. Records of the Australian Museum 14:135-137.

Mertens, R. 1961. *Varanus semiremex* in Western Australia. Western Australian Naturalist 7(8): 209.

Peters, U. 1969. Observations on a mangrove monitor *Varanus (Odatria) semiremex* Peters 1869. Aqua-Terra 6: 61-63.

Swanson, S. 1976. Lizards of Australia. Angus & Robertson, Sydney.

Wilson, S.K. & Knowles, D.G. 1988. Australia's Reptiles. A Photographic Reference to the Terrestrial Reptiles of Australia. William Collins, Sydney.

Vincent, M. & Wilson, S. 1999. Australian Goannas. New Holland Publishers (Australia), Sydney.