

Captive husbandry and breeding of the banded knob-tailed gecko (*Nephrurus wheeleri cinctus*) at Perth Zoo

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ABSTRACT - This paper describes the captive husbandry and breeding information gained from 11 wild-born banded knob-tailed geckos, *Nephrurus wheeleri cinctus*, held at Perth Zoo from May 2009 to June 2014. Geckos bred from late October through to late May. Females produced 2-4 clutches per season initially, with older females producing 5-6 clutches per season. Incubation lasted 51-60 days, with 33-63 day intervals between clutches, shortening to 23-46 days in the more fecund females. Regardless of the number of clutches produced each breeding season, the inter-season interval remained similar, at 225-268 days. Egg weights and dimensions are described, along with hatchling birth weights. Hatchling growth rates are provided for seven individuals, from hatching through to 300 days of age.

INTRODUCTION

The banded knob-tail gecko is found in the mid-west of Western Australia and has two sub-species; *Nephrurus wheeleri wheeleri* which is found in the Murchison and Goldfields regions and *N. w. cinctus* which is found in the Pilbara region and inhabits rocky outcrops and ranges supporting spinifex vegetation. Both sub-species are of similar appearance and can appear pink to reddish brown to sandy brown and ghostly grey. Their body and limbs are covered in rosettes; they have a broad dorso-ventrally compressed tail and broad dark brown bands on the body and tail (Storr & Johnstone, 1990; Wilson & Swan, 2003). The main difference in appearance between the two sub-species is that *N. w. wheeleri* has four bands across the neck, shoulder, rump and tail base while *N.w.cinctus* has five bands with the neck/shoulder band being broken in two, although this character has been noted to be quite variable (Swan, 2008).

N. w. cinctus is a relatively common species in the Pilbara region of Western Australia. Perth Zoo acquired 11 geckos in May 2009 from Department of Parks and Wildlife (DPaW) after these animals were taken from the wild illegally and subsequently confiscated by the regulating authority. It was determined by DPaW that these animals were unable to be returned to the wild. Of the 11 geckos, there were 10 adults and one juvenile (5 females and 6 males). This paper describes the husbandry methods used for successful care and breeding of this species at Perth Zoo.

MATERIALS AND METHODS

Husbandry Conditions

Adult *N. w. cinctus* were housed in 880 mm long x 550 mm wide x 600 mm high enclosures off-display. Due to

availability of space these animals were kept in a room that also housed other lizard and dragon species and as such they were kept on the normal day/night cycle. The enclosures were made of ply wood and had a perspex front/door and thin wire mesh on top. The enclosure was furnished with sand substrate to a depth of 30-50 mm; both red sand and brown coarse river sand have been used. This species burrows and excavates shallow depressions and if provided with deeper areas of sand (50-100 mm) they create their own tunnels and burrows. This however, can make it difficult to visually inspect and perform daily health checks as the animals bury themselves and have to be dug out on occasions. A 3 L clear/opaque plastic container with a small hole cut in the front filled with slightly moist sand was provided for them as a nest box and for them to burrow in. Other furnishings included flat rock pieces positioned on top of each other as well as bark and branches to create hides. Ply wood cut and fashioned to make tiered ledges were also used. This species seemed to prefer digging out small depressions in the sand under pieces of flat rock. A small shallow water dish was also provided in each enclosure (although no drinking from this was observed). All enclosures had Reptistar® 36w UV fluorescent lights during daylight hours and 60-80W heat lamps (Red® for night cycle) positioned at one end of the enclosure. Ambient room temperatures in summer range from absolute minima of 19-20° C to a maximum of 26° C with enclosure hot spots of 31°-35° C provided. Winter ambient temperatures recorded an absolute minimum of 15° C and maxima of 21°-22° C with hot spots of 24°-28° C.

Servicing these enclosures consisted of removing any faecal matter (this species tends to defecate in the same area on most occasions), providing fresh water, lightly misting down half or one side of enclosure every three days, checking the nest box if necessary, checking and recording temperature using min/max thermometers and Raytek® temperature reader.

All geckos were fed three times a week in spring-autumn (Sept-May) and twice a week in winter (June-August) on a staple diet of live crickets (Family: Gryllidae), with live mealworms (*Tenebrio molitor*) offered as a variation. Some individuals took dead wood roaches offered from tongs occasionally, although most refused. All insects offered were dusted in Repti-vite® vitamin supplement once a week and calcium powder twice a week. Each individual gecko was offered 2-3 medium-large crickets, and female geckos that had just laid eggs were offered more food for a short period to support good body condition. Live insects were scattered throughout the enclosures for the animals to catch themselves.

Four enclosures were set up for the geckos with a different sex ratio in each. This was done to determine if there would be any differences in breeding success or housing complications. Enclosure 1 had two males, enclosure 2 one male one female, enclosure 3 had two males one female and enclosure 4 had one male and two females.

RESULTS

Husbandry

Geckos settled into a captive environment quite well and took insects offered on tongs or long tweezers and this helped to ensure all animals received an adequate amount of food. *Nephrurus* spp. geckos are nocturnal or crepuscular in their activity, but since we kept our geckos on a normal day/night cycle, food was offered between 12-3 pm for ease of husbandry. It was noted in our collection that the females seemed to be more active feeders and when insects

were offered either live, or from tweezers, they would emerge from their hides and start hunting the insects almost immediately, regardless of time of day. All geckos were lightly misted with a fine mist of water every three days for hydration, with individuals observed licking water droplets off their eyes and lips.

Sloughing occurred quite regularly and the geckos would turn a ghostly grey colour 1-3 days before they sloughed. Care should be taken to check that all the slough comes off, especially around their toes. No problems have been noted at Perth Zoo with all geckos sloughing well.

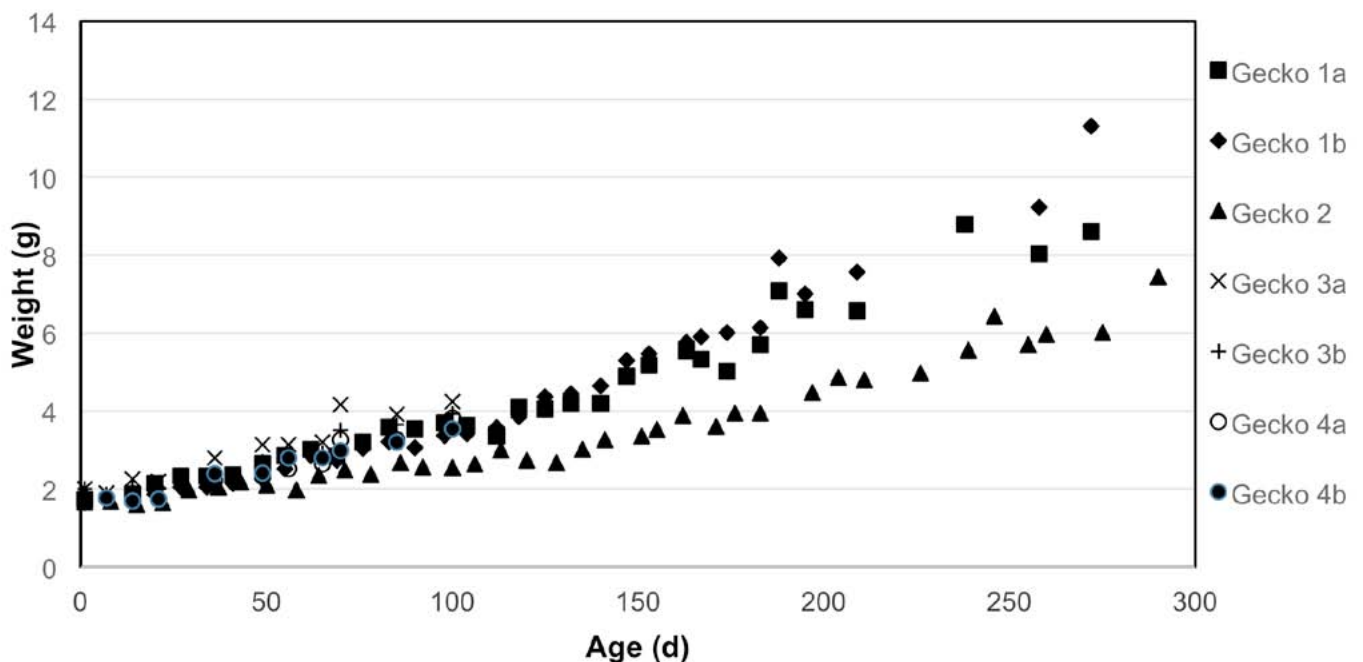
All geckos maintained a very good level of health and no issues arose. Only one adult animal has been lost with the cause of death unknown (wild caught animal, so age at acquisition was unknown). All individuals were weighed regularly and visual checks were performed daily.

Each housing set-up provided no complications, with breeding success recorded from all females and no fighting observed between males. Animals were observed sharing the same hide regularly and nesting together, and all fed very well and all animals maintained a healthy weight.

Captive Breeding

The breeding season for this species has been reported as commencing in early spring and extending into late summer/early autumn with females laying on average 3-5 clutches per season (Swan, 2008). The geckos at Perth Zoo arrived in May 2009 and no breeding occurred until mid-late autumn the following year (May-June 2010), with the late start to breeding presumably due to settling in to the captive environment. The first successful breeding resulted in one female laying two eggs in a shallow depression

Figure 1. Growth rate for seven *N. w. cinctus* hatched at Perth Zoo from July 2010-May 2011. Animal identification is as given in Table 3.



in the sand, and the following month a second female laid two eggs on top of the sand, one of which was not viable. The second egg appeared to be normal and was placed in the incubator along with the other clutch. The first two clutches were the only occasions where eggs have not been laid in the nest box provided. The clear/opaque containers used as a nest box are a reliable way of seeing where and when the eggs are deposited without disturbing the female prior to laying. The females all concealed their digging very carefully and in most cases it was difficult to determine if they had laid at all when viewed from the top of the container, so the ability to see through the nest box was a distinct advantage.

At the end of the winter cooling period the temperature in the enclosures was gradually increased over a few weeks and the food supply offered was also increased. Females started digging and test holing around mid-October to late-November, both in the nest boxes and surrounding areas. Females were also visually checked and confirmed to be gravid by gently holding a female and looking at her abdomen to see if developing eggs could be clearly seen through the ventral abdominal wall. Over the second breeding season all four females laid a second clutch within 52-66 days after laying their first clutch, with one female laying the very same day her first clutch hatched. From December-April three females laid two clutches and one female laid three clutches (Table 1).

After the first breeding season, eggs were laid between late-October and late-May, with the number of clutches per female increasing with each year. One female laid six clutches in a seven-month period. When 2-4 clutches were laid in a season the interval between clutches usually ranged from 33-63 days, when 5-6 clutches were laid the interval shortened to around 23-46 days (Table 1). This is within the inter-clutch interval reported for *N. wheeleri* by Brown (2012).

Incubation temperature of *N. w. cinctus* eggs at Perth Zoo has been 29°-30° C with 29.5° C used on most occasions. Incubation medium was perlite (vermiculite was used on one occasion) and both ratios of 2:1 and 1:1 of perlite/water w/w were used, with the dryer 2:1 ratio the most successful. Incubation lasted between 51-60 days (Table 2), which matches the 50-61 days reported by Treseder (2008), but generally shorter than that reported by Brown (2012). One clutch of eggs developed a fungal growth over the eggs halfway through incubation, this did not affect the eggs and both hatched and produced healthy individuals. On only one occasion has an egg failed to hatch, when a fully formed embryo was found dead inside the egg when it was manually opened after 58 days incubation. Despite some adult females producing more clutches in successive breeding seasons, the duration of each season remained fairly constant, with the interval between clutches being reduced (Table 1 and 2).

Eggs were ca. 22 x 11-12 mm in size and weighed 2.3-2.7 g when freshly laid. Hatchlings weighed 1.65-2.01 g at birth and had a snout-vent length of 42-45 mm (Table 3) which is larger (contra: 35 mm) than that reported by Brown (2012).

		2010/11	2011/12	2012/13	2013/14
Female 1	No. clutches	3	4	4	6
	Inter-clutch interval (d)	56.5±3.5, 54-59	51.5±4.9, 45-55	44.7±16.1, 33-63	39.8±14.7, 30-63
Female 2	No. clutches	3	3	4	5
	Inter-clutch interval (d)	57	54.0±9.9, 47-61	36.0±9.1, 26-44	35.5±9.0, 23-44
Female 3	No. clutches	2	2	-	-
	Inter-clutch interval (d)	66	54		
Female 4	No. clutches	2	2		
	Inter-clutch interval (d)	52	52		

Table 1. Number of clutches produced each season and inter-clutch interval (in days) (mean±s.d. and range) for *N. w. cinctus* at Perth Zoo during 2010/11-2013/14.

	Incubation period (d)			Interval between successive breeding seasons (d)	
	Mean±s.d.	Range	n	Mean±s.d.	n
Female 1	57.1±1.7	55-60	8	225.0±12.5	3
Female 2	51	-	2	233.5±26.1	2
Female 3	55.5±2.1	53-59	8	234.7±43.7	4
Female 4	52	-	2	268	1

Table 2. Incubation period (in days) (mean±s.d., range and sample size) and duration of the interval between successive breeding seasons for *N. w. cinctus* at Perth Zoo. Identification of breeding females matches that used in Table 1.

Clutch No.	Egg Wt	Egg dimensions (mm) L/W	Hatchling Wt (g)	Hatchling S-V Length (mm)
	(g)			
1a	2.73	-	1.72	-
1b	2.56	-	1.65	-
2	2.34	-	1.67	-
3a	2.50	22.5 x 11.5	2.01	42.0
3b	2.49	22.0 x 11.0	2.00	42.0
4a	2.41	22.0 x 11.0	1.78	45.0
4b	2.50	23.0 x 12.0	1.78	44.0

Table 3. Egg weight (g) and dimensions (mm), and hatchling weight (g) and snout-vent length (mm) for *N. w. cinctus* at Perth Zoo during 2010/2011.

Hatchling Growth

Hatchlings were housed in small holding enclosures (600 mm L, 400 mm W, 400 mm H) made from the same materials as used for adult enclosures. The set-up was virtually identical to that for adults, just on a smaller scale with small hides made of flat rock and bark, sand substrate to a depth of 10-20 mm, a small shallow dish of water and heat lamp positioned at one end of enclosure. All hatchlings started eating within 4-7 days of hatching and small crickets were the preferred food. Two individuals began taking food offered from tongs within seven days of hatching, others within two months. To stimulate a drinking response, hatchlings were lightly misted with water every 3-4 days the same as adults, young geckos were observed

licking droplets of water off their eyes and lips and from the surface of rocks. All hatchlings sloughed 4-7 days after hatching.

Hatchling growth rates were steady and consistent during the first year, but the minor differences in body weight apparent at hatching increased with age, until there was up to 4 g difference in body weight between some individuals (Fig. 1). At 300 days of age young geckos were about 67 percent of adult body weight (mean 14.5 g; ISIS, 2014)

DISCUSSION

The only records of keeping *N. w. cinctus* in zoo collections other than those from Perth Zoo, or institutions that received animals from this collection, are from Nakhorn Ratchasima Zoo in Khorat, Thailand. The four animals in that collection all died in 2008 and 2009, and there is no evidence of them having bred, and their origins are not given in the ISIS data set. Keeping *N. w. cinctus* in captivity has been relatively easy with few complications and minimal stimulation required to start breeding. Some of the more important points were to ensure they had an adequate area to dig and to lay their eggs, as well as a cooling period through winter. Ensuring the females stay in good condition and have plenty of food leading up to, and after egg deposition is also essential, especially since they lay multiple clutches in a season.

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