



Until the umbilicus is healed, which usually occurs within a few days, hatchling Guatemalan Beaded Lizards (*Heloderma horridum charlesbogerti*) are kept on damp towels in a Rubbermaid™ shoebox.

H U S B A N D R Y

Ex-Situ: Notes on Reproduction and Captive Husbandry of the Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*)

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Photographs by the author except where noted.

As conservation strategies are developed for the Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*), understanding all aspects of the life history of this species has become essential. Unfortunately, this elusive and very rare lizard has not yet presented researchers with an opportunity to observe many aspects of its reproduction and characteristics related to hatchlings (e.g., size, weight, and coloration). Beginning in 1986, after observing the moribund situation in the endangered ecosystem of the Motagua Valley, Dr. Jonathon Campbell brought eleven animals into captivity as an assurance colony. This colony was eventually divided between the San Diego Zoo

and Zoo Atlanta. These eleven animals have served as a paradigm of the animals in nature, provided us with data on reproduction, and have helped to elucidate elements of the Guatemalan Beaded Lizard's life history.

Enclosure

Since their arrival at the San Diego Zoo (SDZ), the adult Beaded Lizards (2:3) have been housed in a variety of enclosures and conditions in an attempt to determine the optimum environmental conditions needed for reproduction. Upon arrival at SDZ, the group of *H. h. charlesbogerti* was housed together in a 2.3 x 3.6 m room in a quarantine facility. This room had floor heat, basking spots, and large hollow logs that served both as visual barriers and refugia. Following the quarantine period, the lizards were moved to 1.3 x 0.6 x 0.6 m glass terraria. These enclosures utilized pine-bark substrate, 1–1.5 m cork-bark tubes (hollow), and a heavy dish for water. The latter type of enclosure was in use when the first successful breeding occurred. Since not all females (n = 3) had nested, the group was moved to two 2.5 x 0.75 x 0.75 m Neodesha™ cages. These enclosures are plastic with screen mesh for ventilation and mesh-covered openings in the top for basking lamps and 4-ft. fluorescent fixtures. With access through the front, these cages also made it safer and easier to work with venomous lizards. The substrate was pine-bark mulch and the same cork-bark tubes were used. These enclosures, unlike earlier models, were equipped with nest boxes for the female Beaded Lizards. These were large Rubbermaid™ storage containers with lids attached and 2/3-filled with Supersoil™ potting soil. With circular holes cut in the side large enough for adult *H. h. charlesbogerti* to pass in and out of the container, they also served as refugia for individuals of both sexes.

Lighting/Photoperiod and Temperature

In all the vivaria described in this article, Beaded Lizards were subjected to Acrylite™ OP4 skylights that transmit Ultra-violet light. Consequently, the photoperiod varied seasonally, providing an abbreviated winter at 9:15 light-to-dark ratio and extended in the summer to 13:11. In addition, fluorescent fix-



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Adult Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*) at Zoo Atlanta, one of eleven founders of an assurance colony that has served as a paradigm of the species in nature.



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tures utilizing a Sylvania™ 350 Blacklight bulb and a Philips™ 40w Colortone bulb in tandem supplied artificial light. Basking lights consisted of 75-watt spotlight bulbs for 9 hours daily. The ambient temperature varied with season and time of day. The daytime temperatures during the summer range from 25–29 °C and at night can drop to 23 °C. The winter daytime temperatures are slightly milder, rarely getting much higher than 26 °C and dropping as low as 20 °C. Basking spots are situated so that animals may choose to bask directly on the substrate or elevated on cage furniture (e.g. log, nest box). The basking temperatures ranged from 33 °C directly on the substrate to 46 °C at the highest basking spot.

Feeding

When the group of adult *H. b. charlesbogerti* arrived at the San Diego Zoo, they did not feed readily on adult mice. If hatchlings have a large abdomen, yolk storage may be sufficient so that food will not be accepted or needed until the yolk is depleted (Burghardt and Layne 1995). Some individual animals were reluctant to feed even after the yolk mass was spent. For the adult Beaded Lizards that would not eat, our initial feeding strategy involved forcing the nose of an adult mouse into the lizard's mouth until the lizard began to swallow the prey on its own. At this time, subsequent mice could be fed by putting the head of another mouse into the mouth of the Beaded Lizard as it finished the prior mouse. This process took place weekly until all animals in the group began to feed on their own. Adult *H. b. charlesbogerti* are fed three 21–35 g adult mice weekly. This diet is offered with the same frequency throughout the year. Juveniles are fed 1–2 adult mice once per week. Hatchlings are started on 2–4 g newborn mice and are quickly moved to 8–15 g mice. Sometimes, as with other *Heloderma*, some individuals are very difficult to feed for the first few meals after hatching. Even reluctant feeders can usually be induced to feed by placing a pre-killed newborn mouse at the end of forceps and touching it to the base of tail of the hatchling Beaded Lizard. The animal will spin around defensively. This procedure is

repeated until the lizard bites the newborn mouse defensively and then begins to swallow.

Breeding

Since the 1970s, with helodermatid lizards reproducing infrequently in captivity, the reproductive habits of Beaded Lizards have been slowly revealed, but difficult to assimilate into a successful breeding program. Sexing *H. b. charlesbogerti* using previously described ultrasound sexing techniques (Morris and Alberts 1996, Morris and Henderson 1998) was problematic due to enlarged preanal plates and thick scalation. The population of *H. b. charlesbogerti* housed at SDZ is comprised of two males and three females. Since the time that they were housed together as a group in quarantine, many combinations of total numbers and sexes were utilized in an attempt to stimulate breeding. Attempted combinations included one male and one female, one male and two females, and isolating males from females entirely until the breeding season, when they are reintroduced. Two females have produced eggs and only one male has been observed breeding. The sizes of the two reproductive females are 43.2 cm snout-vent length (SVL), 72.4 cm total length (TL), 1.8 kg and 40.9 cm SVL, 74.3 cm TL, 1.5 kg, respectively. The nonreproductive female is smaller. The size of the reproductive male is 47.9 cm SVL, 81.0 cm TL, and 2.1 kg. The other male is smaller. Breeding has been observed on many occasions during July and August. At SDZ, we have never observed combat behavior between males either in situations where two males are living together or where they are introduced just prior to being paired with a female. Zoo Atlanta has reported seeing very intense male combat behavior on multiple occasions (B. Lock, pers. comm.) At SDZ, males will sometimes refuse prey for 2–3 weeks during the breeding season.



Hatchling Guatemalan Beaded Lizards (*Heloderma horridum charlesbogerti*) have 4–5 broad yellow tail bands separated by black bands. After some experimentation, clutches are incubated on mixtures that are slightly drier than a 1:1 water-to-vermiculite ratio.

Eggs and Incubation

While eggs were yielded in all the enclosure types described above, viable eggs were obtained only in the latter two. Reports indicate that egg-laying for *H. b. charlesbogerti* in the wild begins in late October and early November (Campbell and Vannini 1988, Ariano 2003, Beck 2005). At SDZ, we have had eggs produced from the end of September until the beginning of January. Clutch size for adult females ($n = 2$) has ranged from 5–10 eggs with a mean clutch size of 8 ($n = 8$). In all three types of enclosures provided at SDZ, nesting has been problematic. Although females have laid in a nest box, they seem to scatter the eggs on the substrate, and will lay in or behind the hollow logs even when provided with deep soil in a variety of nest boxes. The first four clutches were set up in a 1:1 water-to-vermiculite mixture. The fourth clutch of 10 eggs, was incubated at 30 °C (86 °F), and four eggs hatched after an incubation period of 145–148 days (Owens et al. 2003). At a one-month interval, this clutch of eggs was candled and vascularization was well developed. Embryos approximately 2 cm in length were observed in five of the eggs. About two months into incubation, one egg with an embryo ruptured and failed to hatch. Incubation media were modified to a 1:2 water-to-vermiculite mixture for the next two clutches. Both of these clutches began to dehydrate after only two months of incubation. So, clutches seven and eight were set-up just slightly drier than a 1:1 water-to-vermiculite ratio. Due to infertility, one of these clutches deteriorated immediately. The last clutch of six eggs was incubated at 28 °C (82 °F). Two of the eggs successfully hatched after 163 and 164 day incubation periods. This incubation period is considerably shorter than that reported for other subspecies of Beaded Lizards (Ramirez-Bautista 1994).

Hatching

Hatching success has occurred in two different clutches. The first event occurred in May 2003 and the second in March 2006. Once slitting the egg, each hatchling took anywhere from 1–2 days to fully emerge. Little to no yolk was visible externally at time of emergence. Until the umbilicus is healed, which is usually within a few days, the hatchlings are kept on damp tow-



Once eggs are slit, hatchlings take anywhere from 1–2 days to fully emerge.



Hatchling Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*).

els in a Rubbermaid™ shoebox. All hatchlings ($n = 6$), from two different females, ranged in SVL from 119–124.9 mm (197–208 mm TL) and weighed 33.5–37.0 g. Coloration of the young is much like that of other forms of *Heloderma horridum*. Instead of 4–5 pairs of distinct yellow tail rings separated by black bands, the hatchlings have 4–5 broad yellow bands separated by black bands.

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