

# HERPETOCULTURE

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## Reproduction of *Lachesis stenophrys* (Central American Bushmaster) at ZSL London Zoo

*Lachesis stenophrys*, the Central American Bushmaster, is a species of pit viper native to Nicaragua, Costa Rica and Panama, inhabiting hilly forested environments from ca. 100–1000 m elevation (Ripa 2002; Campbell and Lamar 2004). It is among the longest species of vipers in the world, with adults averaging over 200 cm total length (TL; Solórzano 2004) and frequently over 4 kg in weight (Corrales et al. 2014). The genus *Lachesis* is unique among new world pit vipers (except possibly *Bothrocophias colombianus*) in that it lays eggs rather than giving birth to live young (Campbell and Lamar 2004; Solórzano 2004). In captivity, females may attain sexual maturity at around four years of age, or 160 cm TL (Ripa 1994; Solórzano 2004). Herein we present the first documented breeding of the species in the United Kingdom and provide additional insights into the successful husbandry and reproductive biology of this uncommon species.

### ORIGINS OF ANIMALS AND HUSBANDRY

The Zoological Society of London, London Zoo acquired three one-year-old, captive-bred *L. stenophrys* in June 2016 from a facility in France. These snakes were kept individually in off-exhibit naturalistic housing in a climate-controlled room set to 25.0°C during the day and 23.0°C overnight, with Arcadia 6% T5 exhibit lighting and fluorescent T8 room lighting on a 12:12 cycle creating a thermal and UVB gradient in each exhibit. From an initial weight of 230–265 g (mean: 248 g) in June 2016, the group reached 1263–1438 g (mean: 1348 g) by March 2019. At this time, a male and a female were moved to a display exhibit in the Reptile and Amphibian House.

The exhibit was an irregular pentagon in shape; three sides had large viewing windows and the other two were internal walls. The ground area measured approximately 4.5 m<sup>2</sup> and was themed in a natural way using a variety of substrates, plants, and pieces of wood to create structure and hiding places (Fig. 1). An

automatic misting system (MistKing Starter v5.0, Jungle Hobbies Ltd, Ontario N9E4R3, Canada) controlled precipitation and a hot air blower controlled by a digital thermostat with day and night set points controlled ambient temperature; both systems were adjusted throughout the year in accordance with natural seasonality. Diurnal and nocturnal ambient temperatures ranged from 21.0 and 20.0°C, respectively from January to March, to 24.0 and 22.0°C from April to September, to 22.0 and 21.0°C from October to December. Enclosures were sprayed with water throughout the year, usually for 1–2 min at a time several times per day between 0900 and 1700 h, but more heavily from November to March.

Ambient lighting consisted of twelve 1150 mm T5 lamps, comprising two 12% Arcadia T5 lamps and various brands of non UVb-emitting T5 lamps, as well as a clustered pair of Arcadia 160W mercury vapour lamps. Together, these created an ambient UV index (UVi) of 0.5 at ground level. While the exhibit did initially have a basking zone creating surface temperatures of 31.0°C with a UVi of 2.0, the mercury vapour and fluorescent lamps were often switched off to assist in maintaining appropriate ambient temperatures. The mercury vapour lamps were replaced with two single 18W LED lamps in April 2020 to limit heat input to the exhibit. These lights were maintained on an approximately 11:13 h photoperiod during the

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FIG. 1. *Lachesis stenophrys* exhibit at ZSL London Zoo: January 2021.

TABLE 1. Comparative reproductive data for *Lachesis stenophrys*. Snake weights reported from this study are from five individuals, length is from three individuals. All values are reported as mean (range). Mass is reported in g and lengths are reported in mm.

Female mass	Clutch size	Egg length	Egg width	Egg mass	Clutch mass	Incubation temp. (°C)	Incubation period (d)	Fertilization (%)	Hatchling weight	Hatchling length	Observation type	Reference
1600	7	87 (80–92)	41 (39–42)	–	526	24.5–26.0	77–79	71	67 (64–70)	467 (461–484)	Captive	This study
3300–3700	9 (7–13)	70	–	82	–	26.0–30.0	–	–	63.6 (45–70)	447.9 (380–480)	Captive	Corrales et al. 2014
3700	9	–	–	–	–	26.0–26.5	78	–	45	410	Captive	Camina et al. 2020
–	16	76	63	–	–	–	74–76	–	45	406	Captive	Ripa 1994
–	11	64.15 (60.3–70.9)	40.3 (40.1–40.5)	69.7–74.2	–	–	106.6 (105–108)	100	55.1 (52.6–59.3)	486.7 (480–490)	Recent captive	Chacón & Valverde 2004



FIG. 2. Illuminated egg of *Lachesis stenophrys* showing healthy vascularization at seven days post-oviposition.

'cool season' and 13:11 h during the 'warm season' cycle. Snakes were fed every 7 to 28 d exclusively on defrosted, pre-warmed commercially-bred rodents which comprised ca. 6–10% of the snake's body weight, never exceeding 16% (Ripa 2002).

#### REPRODUCTION

We did not observe any copulation and animals cohabited continuously for a period of 16 months prior to egg laying. The breeding female, which weighed around 1600 g when we suspect she mated, consumed a meal 26 days prior to laying eggs and was not offered a subsequent meal prior to laying eggs, so may have continued to eat as normal as reported in Camina et al. (2020). This snake sloughed her skin 37 days prior to laying and again 24 days post-lay.

During the weeks prior to egg laying, the female appeared restless and would become active around one hour before the lights turned off in the exhibit. At 1800 h on 21 July 2020, the female was observed beneath a cork tube that was partially buried in the substrate, coiled around four eggs; body contractions indicated that more eggs were due to be laid. The following morning the female was very alert while being removed from her eggs but did not strike. Seven eggs which adhered together were collected from the exhibit for artificial incubation: total clutch mass was 526 g. The eggs' dimensions were larger than previously reported records in the literature (Table 1). Pre- and post-laying body weights for the female were 2376 and 1770 g, respectively, representing a relative clutch mass of 26%.



FIG. 3. Hatching *Lachesis stenophrys* at ZSL London Zoo, October 2020.

Medium-grade vermiculite mixed with reverse osmosis water at a ratio of 1:1 by weight was used as the incubation media, and all eggs were placed in the same translucent plastic container within a SciQuip Incu-90C incubator (SciQuip Ltd, Shropshire, UK) set at a constant 26.0°C. Due to issues with space, the eggs were later transferred to another incubator set to 26.0°C that featured heat pads mounted on the walls and floor that were controlled by HabiStat thermostats (Ely, United Kingdom). However, night-time temperatures dropped as low as 24.5°C most nights due to the poor temperature control of this unit. Eggs were incubated together in a clump as they were laid, with those on the bottom being half-buried in the vermiculite. Shortly after incubation began, two eggs were discarded as they were not viable and started to discolour, whereas the remaining five eggs showed strong vascularization when illuminated with a torch and had a healthy off-white external coloration (Fig. 2). Incubation period ranged between 77 and 79 d (Fig. 3), with the time individual snakes took to pip and leave the egg varying from one to two days. Upon their removal from the incubation container, each hatchling was weighed with a digital balance (Salter 1160BKDR). Weights ranged between 64–70 g with a mean weight of 67 g; these are substantially heavier than values reported in the literature (Table 1).

Each hatchling was housed individually in a 45 cm<sup>3</sup> Exo-Terra vivarium furnished with a substrate of peat-free compost, a layer of mixed leaf litter with a hide, a small water bowl, live *Philodendron* or *Epipremnum* sp., and a cut *Ficus* sp. branch to provide shade. Enclosures were lit with a single Arcadia 6% T5 fluorescent lamp with reflector, creating an ambient UVi at ground level of 0.7. Enclosures were situated in a climate-controlled room set to 25°C in the day and 21°C at night. Hatchlings sloughed their skin between 17 and 22 d post-hatching and each juvenile accepted a first meal of defrosted and warmed day-old mouse with little encouragement between 29 and 31 d post-hatching. Husbandry was free of problems provided that the substrate where the snakes sat remained dry while ambient humidity was high; wet substrates rapidly led to erythema of ventral scales, which resolved quickly after substrate was changed or dried out.

## DISCUSSION

This reproductive event represents the second time *L. stenophrys* has reproduced in a European zoological institution. As with Camina et al. (2020), we experienced less than total fertilization (71%); however, all viable eggs hatched successfully. The clutch size of seven eggs falls within the normal parameters for this species (Table 1), albeit at the low end, and all neonate weights were toward the upper end of what was reported by Corrales et al. (2014) and above what was reported by Ripa (1994) and Camina et al. (2020). Maximum individual egg size was larger than what had previously been reported in the literature (Ripa 1994; Chacón and Valverde 2004). Incubation period fell between previously reported values of 74–108 days (Ripa 1994; Chacón and Valverde 2004). At the time of mating, the female weighed considerably less (ca. 1600 g) than what has been reported for breeding females (Corrales et al. 2014; Camina et al. 2020) despite producing a normal clutch size, large eggs and large neonates. Good nutrition was a potential factor influencing this. As noted in other reproductive accounts (Ripa 1994; Corrales et al. 2014; Camina et al. 2020), an increase in precipitation in the cooler part of the year seems to have encouraged mating activity.

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## LITERATURE CITED

- CAMINA, A., N. SALINAS, I. GARCIA-DELGADO, B. BAUTISTA, G. RODRIGUEZ, R. ARMENDARIZ, L. IENNO, A. ANGOSTO, R. HERRANZ, AND G. CORRALES. 2020. First report of reproduction in captivity of the Central American bushmaster (*Lachesis stenophrys*) in a European zoo. *Herpetol. Bull.* 151:24–27.
- CAMPBELL, J. A., AND W. W. LAMAR. 2004. *The Venomous Reptiles of the Western Hemisphere*. 2 vols. Cornell University Press, Ithaca, New York. 962 pp.
- CHACÓN, D., AND R. VALVERDE. 2004. *Lachesis stenophrys* (bushmaster) reproduction. *Herpetol. Rev.* 35:68.
- CORRALES, G., R. MEIDINGER, S. RODRÍGUEZ, D. CHACÓN, AND A. GÓMEZ. 2014. Reproduction in captivity of the Central American bushmaster (*Lachesis stenophrys*, Serpentes: Viperidae), in Costa Rica. *Cuad. Herpetol.* 28:137–139.
- RIPA, D. 1994. The reproduction of the Central American bushmaster (*Lachesis muta stenophrys*) and the blackheaded bushmasters (*Lachesis muta melanocephala*) for the first time in captivity. *Bull. Chicago Herpetol. Soc.* 29:165–183.
- . 2002. *The bushmasters (genus Lachesis Daudin, 1803): Morphology in evolution and behaviour*. Ripa Ecologica, Wilmington, North Carolina. 358 pp.
- SOLÓRZANO, A. 2004. *Serpientes de Costa Rica: Distribución, Taxonomía e Historia Natural*. Instituto Nacional de Biodiversidad, Editorial INBio. San José, Costa Rica. 791 pp.