

# HERPETOCULTURE NOTES

---

## CAUDATA — SALAMANDERS

***EURYCEA SOSORUM* (Barton Springs Salamander). OOPHAGY.** The Edwards Aquifer (Texas, USA) and its associated springs are home to many species of plethodontid salamanders from the genus *Eurycea*. *Eurycea sosorum* is a species found in a group of hydrologically connected springs in the Barton Creek drainage within the city of Austin, Texas, and is also well-suited to living underground (Chippendale et al. 1993. *Herpetologica* 49:212–213). Published observational data are particularly sparse for this species, especially as it relates to brooding behavior and conspecific aggression. Here, a case of oophagy is reported in captive *E. sosorum* at the Dallas Zoo.

Oophagia has been noted in other plethodontid salamanders (Petranka 1998. *Salamanders of the United States and Canada*. Smithsonian Institution Press, Washington, D.C. 587 pp.) as an effective means of removing dead or infected eggs (Tilley 1972. *Copeia* 1972:532–540; Forester 1979. *Copeia* 1979:332–341) or due to conspecific aggression (Milanovich et al. 2007. *Herpetol. Rev.* 38:67; Miller et al. 2008. *Herpetol. Conserv. Biol.* 3:203–210). Kaplan and Sherman (1980. *J. Herpetol.* 14:183–185) indicated that intraspecific oophagy occurs mainly among salamander species that exhibit post-ovipositional egg attending, with the exception of *Ambystoma tigrinum nebulosum* (Hamilton 1948. *Copeia* 1948:212–213).

*Eurycea sosorum* at the Dallas Zoo can be historically traced back to a group of nine wild-caught individuals donated by the City of Austin's Environmental and Conservation Services Department on 12 April 1995. Since then, 35 individual egg-laying events have been recorded. However, raising *E. sosorum* larvae has proven difficult and ultimately culminated in a group of seven captive-bred individuals that survived from those 35 egg-laying events as of 26 September 2012. These animals were separated into three groups and placed into an Aquatic Habitats bench top system (AHBTRACK-4; Apopka, Florida, USA). The groups were composed of one male and two females, one male and one female, and one female and an individual of unknown gender. The enclosures were 10-L polycarbonate tanks measuring 30.5 × 23 × 20 cm (L × W × H) that came with the system. The

enclosures had no substrate and only contained a single karst limestone rock with plastic plants attached.

I have observed eight egg-laying events, with the first occurring on 25 December 2013 and the last observed on 24 November 2015. Eggs were left in the enclosure with the adults to hatch. On 26 June 2014, a fully-formed embryo within an egg was observed being consumed by an adult *E. sosorum* in the tank housing the trio of individuals. The animal held the egg in its mouth and eventually swallowed it. It is unclear if it was consumed by the female that laid the egg, the male, or the other female. Eggs have gone missing from enclosures in the past and are suspected to have been consumed by a conspecific. At the Dallas Zoo, the majority of *E. sosorum* eggs are laid as clutches on plastic plants and the occasional rock, with a few interspersed on the ground. At other breeding facilities, eggs have been laid singly on a variety of substrates and in different areas of enclosures including plastic plants, moss, gravel, and netting (Chamberlain and O'Donnell 2003. City of Austin's Captive Breeding Program for the Barton Springs and Austin Blind Salamanders [January 1–December 31, 2002]. City of Austin Watershed Protection and Development Review Department annual permit [PRT-839031] report. Unpublished report).

Only four *E. sosorum* eggs have been found in the wild, each representing separate incidences where a single egg was found near a spring orifice. (Chamberlain and O'Donnell 2003, *op. cit.*) Considering this, and that the eggs are brightly colored and conspicuous to predators, it has been suggested that the eggs are laid within the aquifer and receive no parental care, which is supported by observations in captivity (Chamberlain and O'Donnell 2003, *op. cit.*). Nevertheless, the consumption of a fertile egg with a developing neonate is a facultative behavior that remains unconfirmed in the wild. Documentation of this behavior from a conservation standpoint is valuable, as keeping and breeding this species in captivity may eventually be necessary to ensure its survival. Maximizing breeding efforts in the future may perhaps take oophagy into account when eggs are laid. Chamberlain and O'Donnell (2003, *op. cit.*) also noted an egg becoming stuck to the end of a female's snout while moving about the enclosure. They note that the female appeared to attempt to

shake it off first before consuming it. It is not clear whether the consumption of the egg in the present account was intentional or accidental. This appears to be the first documentation of oophagia in *E. sosorum*.

**JORGE CHAVEZ**, Department of Herpetology, Dallas Zoo Management, 650 S RL Thornton Freeway, Dallas, Texas 75203, USA; e-mail: Jorge.Chavez@dallaszoo.com.

#### ANURA — FROGS

**ELEUTHERODACTYLUS MONENSIS (Mona Coqui). BREEDING TO F2 GENERATION.** *Eleutherodactylus monensis* is a medium-sized (26.2 mm SVL for males; 34.4 mm SVL for females), terrestrial frog endemic to Mona Island, Puerto Rico (Joglar 1998. *Los Coquíes de Puerto Rico: Su Historia Natural y Conservación*. Editorial de la Universidad de Puerto Rico, San Juan, Puerto Rico. 232 pp.). The Mona Coqui is currently listed as Vulnerable by the IUCN due to its restricted range and effects of invasive predators on the island (Angula 2008. *The IUCN Red List of Threatened Species 2008*: e.T56774A11519092. Available online at: [www.iucnredlist.com](http://www.iucnredlist.com) [accessed 9 Sept 2017]). In addition to its small range, causes for decline include emerging amphibian disease, habitat alteration, and climate change (Stabile et al. 2014. *Herpetol. Rev.* 45:248–251). Having begun *ex situ* work with this frog in 2012, we have recently found success in breeding the captive-reared offspring. Here we document the first account of captive reproduction of this species to the second captive born generation, or F2 population.

An *ex situ* captive breeding program was started with *Eleutherodactylus monensis* to 1) establish a captive assurance population, and 2) learn about its reproductive biology. The reproductive study included five males and five females collected from Mona Island in 2012. Two pairs from this founder group produced a total of six fertile clutches (Stabile et al. 2014, *op. cit.*). Of the 98 offspring that were produced from these initial clutches, most survived to sub-adulthood (N = 86). The remaining F1 frogs were then divided between multiple 61 × 30 × 41-cm glass aquaria, housing 8–15 sub-adult frogs per aquarium. Enclosure setup, diet, and husbandry techniques closely matched those outlined in Stabile et al. (2014) with the exception of the substrate, which consisted of a mix of peat moss, organic soil, mulch, and charcoal at a depth of 7 cm. Pothos (*Epipremnum aureum*), tropical vines (*Piper* sp.), and dried Magnolia Tree leaves (*Magnolia grandiflora*) were placed on the substrate in each terrarium as refugia. Pill bugs added as food items colonized the aquaria, resulting in a self-sustaining food source for the frogs. As the frogs reached adulthood, they were further divided into groups of 4–6 per 61 × 30 × 41-cm glass aquarium, and provided with extra leaf litter for refuge at a depth of 12 cm.

The tanks were left untouched, and although an egg mass was not accounted for, on 2 October 2016, several baby coqui frogs were found in the tanks during routine feeding (Fig. 1). A total of 27 offspring from this F1 population was counted in one aquarium. No parental care has been observed to date with this species (Stabile et al. 2014, *op. cit.*). Due to the small size of the froglets, the tank lid was covered in perforated plastic wrap to prevent escape, but froglets were not immediately removed from the adult population. Once the offspring were removed, they were placed into a 61 × 30 × 41-cm glass aquarium, mimicking the plants, substrate, and rain schedule of the F1 adult tank they came from. Since hatching, offspring have been fed a diet of live pin-head crickets (*Acheta domesticus*), fruit flies (*Drosophila melanogaster*), and pill bugs (Isopoda) twice weekly. At 10 days post hatching,

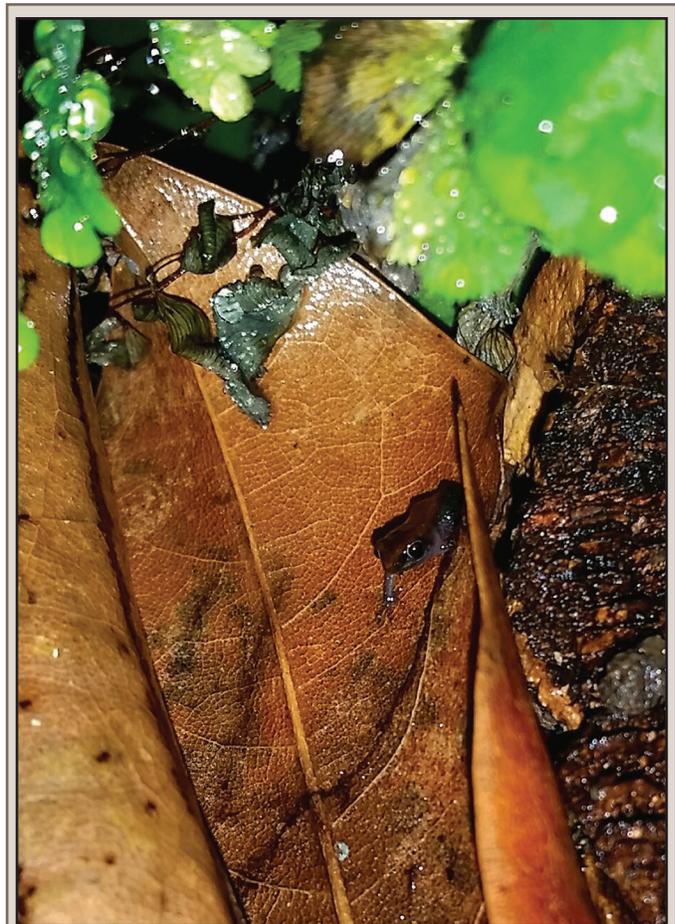


FIG. 1. Single specimen of an F2 generation Mona Coqui.

PHOTO BY JENNIFER L. STABILE

offspring were removed from the adults and placed in a separate 61 × 30 × 41-cm glass aquarium, featuring the same aforementioned substrate and refugia as the adult tanks. No froglet mortalities had yet been observed at the time of submission of this note (July 2017).

There are several potentially important observations we would like to attribute to the success of breeding this species to a healthy F2 generation. All live food items were fed a natural diet as opposed to a commercial purchased diet, i.e., crickets were fed a wide variety of fruits and vegetables. Fruits were also placed in the tank to aid in the nutrition of fruit flies and pill bugs. Natural UV light was utilized as opposed to commercial bulbs, and frogs were mostly left untouched and undisturbed in a natural substrate with live plants and an abundance of refuge sites.

We thank Louis Santiago and the Departamento de Recursos Naturales y Ambientales de Puerto Rico for their collaboration and permissions regarding this project.

**JENNIFER L. STABILE**, Proyecto Coqui, 120 La Sierra #132, Sierra del Monte, San Juan, Puerto Rico 00926, USA (e-mail: [jens@fieldprojects.org](mailto:jens@fieldprojects.org)); **RAFAEL L. JOGLAR**, Department of Biology, University of Puerto Rico-Río Piedras, Puerto Rico 00931-3360, USA.

#### SQUAMATA — LIZARDS

**XENOSAURUS (Knob-scaled Lizards). PREFERRED BODY TEMPERATURE.** Numerous terrestrial ectotherms behaviorally regulate their body temperature ( $T_b$ ) during periods of above-ground activity by exploiting spatial and temporal variation in

microclimates (Cowles and Bogert 1944. Bull. Am. Mus. Nat. Hist. 83:263–296). However, cryptic lizards of the genus *Xenosaurus* spend practically no time during the day outside their crevices (Lemos-Espinal et al. 2004. Amphibia-Reptilia 25:204–210). Depending on the thermal properties of their retreat site, these constrained ectotherms may have different opportunities for thermoregulation and thus may experience  $T_b$  very different from those associated with aboveground activity (Christian et al. 1984. Ecology 65:752–758; Peterson 1987. Ecology 68:160–169).

The preferred temperature ( $T_p$ ) that a lizard voluntarily selects in a laboratory thermal gradient provides a reasonable estimate of what a lizard would attain in the wild with a minimum of associate costs in absence of constraints (biotic and abiotic factors) for thermoregulation (Huey and Slatkin 1976. Q. Rev. Biol. 51:363–384; Pough and Gans 1982. In Gans and Pough [eds.], Biology of the Reptilia, Vol. 12, pp. 17–23. Academic Press, New York).

This viviparous genus of lizards ranges from southwestern Tamaulipas, Mexico, southward to central Guatemala. The distribution is disjunct with populations typically associated with specific mountain ranges at elevations from about 303–2121 m and exhibiting considerable variation in habitats occupied from xerophytic tropical scrub to tropical rainforest and cloud forest (Ballinger et al. 2000. Cat. Amer. Amphib. Rept. 712:1–3). There have been several reports detailing thermal ecology in *Xenosaurus* (García-Rico et al. 2015. West. N. Am. Nat. 75:209–217); nevertheless, preferred temperature data are known for only a single species (Woolrich-Piña et al. 2012. Southwest. Nat. 57:157–161). Here, we describe thermal preferences in three species of *Xenosaurus* under laboratory conditions.

We studied populations of three species of *Xenosaurus*. 1) *X. grandis* was obtained from Cuautlápan, Veracruz, Mexico (18.87°N, 97.02°W, WGS 84; 1100 m elev.). It is a large lizard (up to 120 mm SVL), occurring in dense tropical rain forest habitats (Zamora-Abrego et al. 2007. J. Herpetol. 41:630–637). 2) *Xenosaurus tzacualtipantecus* was collected from rainforest habitat in Zacualtipán, Hidalgo, Mexico (20.6413°N, 98.6017°W, WGS 84; 1900 m elev.). It is a medium-sized lizard (up to 104 mm SVL) (García-Rico et al., *op. cit.*). 3) *Xenosaurus rectocollaris* was collected in Tehuacán Valley, Puebla, Mexico (18.3057°N, 97.4820°W, WGS 84; 2300 m elev.). It is the smallest species in the genus; adults generally are  $\leq$  100 mm SVL (Lemos-Espinal et al. 2000. Cat. Amer. Amphib. Rept. 716:1), occurring in relatively open habitats of low shrubs (Lemos-Espinal et al. 1996. Herpetol. Nat. Hist. 4:151–154). Vegetation was a mixture of xerophilous plants (Woolrich-Piña et al., *op. cit.*).

Lizards of all three species were collected by hand during 2002–2006. For each lizard, we measured body temperature  $T_b$  (to nearest 0.2°C) with a quick-reading cloacal thermometer (Miller and Weber, Inc., Ridgewood, New York) immediately upon capture. To evaluate preferred body temperature  $T_p$ , we used 242 individuals of *X. rectocollaris* taken from the wild, 69 individuals of *X. tzacualtipantecus*, and 107 individuals of *X. grandis*. In this study we considered only an overall view of thermoregulation trends in these three species of *Xenosaurus*. Therefore, we do not separate samples of different age classes or sexes.

All lizards were transferred to the laboratory to record  $T_p$  of these samples measured on a thermal gradient (16–45 °C) (Lara-Reséndiz et al. 2015. J. Therm. Biol. 48:1–10; Woolrich-Piña et al.

2015. J. Therm. Biol. 52:84–89). The 25% and 75% quartiles of each species' thermal gradient  $T_p$  interquartile range ( $T_{p25}$  and  $T_{p75}$ ) were used as the lower and upper  $T_p$  (Hertz et al. 1993. Am. Nat. 142:796–818). Laboratory experiments were conducted two days after capture. After these, all lizards were released at their capture sites.

Assumptions of normality and homogeneity of variances were analyzed using the Kolmogorov-Smirnov and Levene's tests, respectively. Data satisfying requirements for parametric tests were compared via the Student's *t*-test or Analysis of Variance (ANOVA) and when differences existed at  $P < 0.05$ , post hoc Tukey pair-wise comparisons were used. We used Minitab version 17 Statistical Software (Minitab Inc., State College Pennsylvania) for statistical analyses. The significance value in all statistical tests was  $P < 0.05$  (Sokal and Rohlf 2000. Biometry. Freeman and Company, New York); mean  $\pm$  standard error (SE), (N) sample size, and temperature range.

Mean body temperature ( $T_b$ ) of *X. rectocollaris* was  $23.1 \pm 0.2^\circ\text{C}$  (range 11.8–33.6,  $N = 242$ , see Woolrich-Piña et al., *op. cit.*), and mean preferred temperature ( $T_p$ ) of this species was  $27.6 \pm 0.1^\circ\text{C}$  (range 18.8–33.4,  $N = 242$ ). These two temperature parameters were significantly different ( $t = -14.24$ , d.f. = 450,  $P < 0.0001$ ).

Mean body temperature ( $T_b$ ) of *X. tzacualtipantecus* was  $18.0 \pm 0.2^\circ\text{C}$  (range 14.6–26.8,  $N = 69$ , see García-Rico et al., *op. cit.*), and mean preferred temperature ( $T_p$ ) of this species was  $20.8 \pm 0.2^\circ\text{C}$  (range 18.4–28.0,  $N = 69$ ). These two temperature parameters were significantly different ( $t = -9.11$ , d.f. = 127,  $P < 0.0001$ ).

Mean body temperature ( $T_b$ ) of *X. grandis* was  $22.4 \pm 0.2^\circ\text{C}$  (range 16.2–28.6,  $N = 107$ ; see Ballinger et al. 1995. Biotropica 27:128–132), and mean preferred temperature ( $T_p$ ) of this species was  $25.6 \pm 0.1^\circ\text{C}$  (range 22.0–29.4,  $N = 107$ ). Likewise, these two temperature parameters were significantly different ( $t = -10.6$ , d.f. = 183,  $P < 0.0001$ ).

*Xenosaurus rectocollaris* and *X. grandis* were not significantly different in their  $T_b$ . However, these two species were significantly different in  $T_b$  than *X. tzacualtipantecus* ( $F_{2,415} = 64.17$ ,  $P < 0.0001$ ). Likewise, these three species were significantly different in  $T_p$  ( $F_{2,415} = 199.2$ ,  $P < 0.0001$ ).

A common denominator is that  $T_b$  was consistently lower than  $T_p$  in these three species and this suggests that thermoregulation capability is constrained in the wild, which may determinate the temperature that these lizards can actually attain in the field. Likewise,  $T_p$  was higher than  $T_b$  in these lizards at different elevations and in different vegetation types.

Future research should evaluate thermal efficiency by monitoring mean thermal requirements and microhabitat temperatures of these species across their ranges. Such information would be useful in understanding effects of global warming on these cryptic lizards.

Fieldwork was supported by CONACyT and ITSZ project No. PI.LB-16-05, and Tecnológico Nacional de México to GAWP.

**HÉCTOR GADSDEN**, Instituto de Ecología, A. C., Miguel de Cervantes No. 120, Complejo Industrial Chihuahua, C.P. 31109, Chihuahua, Chihuahua, México (e-mail: hector.gadsden@inecol.mx); **GUILLERMO A. WOOLRICH-PIÑA**, Instituto Tecnológico Superior de Zacapoaxtla, Carretera Acuaco Zacapoaxtla Km. 8, Col. Totoltepec Zacapoaxtla, Puebla, C.P. 73680, México (e-mail: gwoolrich@live.itsz.edu.mx).