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Short Communication

Neonatal growth of three species of *Xenosaurus* (Squamata: Xenosauridae) in captivity

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Lizards of the genus *Xenosaurus* W. Peters, 1861 are mostly crevice- or hole-dwellers, and found in cloud forest, tropical forest, pine-oak forest and xerophytic scrub in the mountains of eastern and southern Mexico (reviewed in Ballinger *et al.* 2000, Lemos-Espinal *et al.* 2012). Their conservation status is somewhat variable because of the six species of *Xenosaurus* evaluated in the IUCN Red List, two are endangered (*X. newmanorum* Taylor, 1949, *X. platyceps* King and Thompson, 1968), one is vulnerable [*X. grandis* (Gray, 1856)], two are Least Concern (*X. penai* Pérez Ramos, De la Riva and Campbell, 2000, and *X. rectocollaris* Smith and Iverson, 1993), and one data deficient (*X. phalaroanthereon* Nieto-Montes de Oca, Campbell and Flores-Villela, 2001) (IUCN 2019). The Mexican government lists three species of *Xenosaurus* as subject to special protection (Pr): *Xenosaurus grandis, X. newmanorum,* and *X. platyceps* (SEMARNAT 2010). Based on the Environmental Vulnerability Scores of Wilson *et al.* (2013), one of the nine taxa of *Xenosaurus* is at low vulnerability (*X. grandis*), two are at medium vulnerability (*X. agrenon* King and Thompson, 1968 and *X. rackhami* Stuart, 1941), and six are at high vulnerability (*X. newmanorum, X. penai, X. phalaroantereon, X. platyceps, X. rectocollaris,* and *X. tzacualtipantecus* Woolrich-Piña and Smith, 2012). However, Johnson *et al.* (2017) placed the 11 species of *Xenosaurus* that they evaluated in the high vulnerability category. Given the conservation status of these lizards, we need to explore possible ways to improve their population status and to obtain a better overall understanding of their biology and ecology.

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Relatively little is known about the growth of individuals in this genus, with only three studies having examined individual growth (Lemos-Espinal *et al.* 2003, Zúñiga-Vega *et al.* 2005, Zamora-Abrego *et al.* 2012). Two of these studies examined growth in non-adults (Zúñiga-Vega *et al.* 2005, Zamora-Abrego *et al.* 2012), and we know of none that have investigated individual growth of *Xenosaurus* in captivity. We examined the growth of captive-reared neonates of three species of *Xenosaurus* (*X. fractus* Nieto-Montes de Oca, Sánchéz-Vega and Durán-Fuentes, 2018, *X. grandis,* and *X. rectocollaris*) during the first 9–10 months of life. Such information may be useful in developing a head-start program in which gravid females are brought into a lab or facility, give birth, and the neonates raised for a period of time prior to release into nature. In particular, our study will help determine the feasibility of such a strategy by establishing if levels of mortality are acceptable and whether the growth rates of neonates raised in the lab are comparable to growth in natural populations. This study will also provide basic knowledge about the growth ecology and survival rates of the lizards, especially early in ontogeny.

In spring 2016, we collected two gravid *Xenosaurus grandis* from Cuautlapan, municipality of Ixtaczoquitlán, Veracruz, Mexico, and two gravid *X. rectocollaris* from the municipality of Zapotitlán Salinas, Tehuacan Valley, Puebla, Mexico (habitats described by Zúñiga-Vega *et al.* 2007, Woolrich-Piña *et al.* 2012). At the beginning of the summer of 2016, we collected two gravid *X. fractus* (Nieto-Montes de Oca *et al.* 2018) from a pine-oak forest, at an elevation of 1900 m a.s.l., between the municipalities of Zacapoaxtla and Tlatlauquitepec, Puebla, Mexico. We transported the lizards to the Laboratorio de Ecofisiología del ITS Zacapoaxtla where they were housed individually in plastic containers (45 × 20 × 10 cm) that contained small rocks to simulate the natural microhabitat. We provided the females with free access to water, fed them with moth larvae (*Galera* sp.) every third day, and kept them at a constant temperature of 20°C, because their body temperatures are similar to their microhabitat and typically range from 18–22°C (Lemos-Espinal *et al.* 2012). We checked containers daily in the morning and afternoon, and recorded the birth date of any neonates.

Neonates were housed individually in plastic containers (20 × 10 × 10 cm) during the study. We fed them with one moth larvae (*Galera* sp.) daily, and provided free access to water and a constant temperature of 20°C. We measured snout–vent length (SVL; to nearest mm), total length (TL; to nearest mm), and body mass (BM; to nearest g) monthly from July–August of 2016 (depending on the date of birth) to May 2017.

To analyze growth rates, we regressed measurements of SVL, BM, and TL on the age of the individual to obtain the slope of the relationship (i.e., growth rate) for each individual. We then averaged this for each species to obtain a mean growth rate (mm/d or g/d). Due to violations of the assumptions of parametric analyses (non-normal distribution and unequal variances), we used a non-parametric Kruskal-Wallis test to compare mean growth rates among species, followed by Wilcoxon pairwise comparisons.

There were differences in SVL growth rates among the three species, but they only approached statistical significance (Table 1; $H_2 = 5.75$, $p = 0.056$). *Xenosaurus grandis* grew slower than *X. fractus* ($p = 0.0452$) and *X. rectocollaris* ($p = 0.055$). The SVL growth rates of *X. fractus* and *X. rectocollaris* were not significantly different ($p = 0.71$). The three species did not differ in TL growth rate (Table 1; $H_2 = 1.65$, $p = 0.44$) or BM increase (Table 1; $H_2 = 0.182$, $p = 0.91$).

Growth rates for the captive-reared neonates of *X. fractus, X. grandis,* and *X. rectocollaris* were generally within the range of field-measured growth in yearling *Xenosaurus,* albeit at the lower end of the range. Field estimates of SVL growth rate in yearling *X. grandis* from Veracruz ranged from around 0.02–0.12 mm/d (estimated

Table 1. Mean ± 1 SE (range) of SVL growth rate, TL growth rate, and body mass (BM) increase for neonates of three species of *Xenosaurus*.

Species	*N*	SVL growth rate (mm/d)	TL growth rate (mm/d)	BM increase (g/d)
X. fractus	8	0.0291 ± 0.0026 (0.0165–0.0418)	0.0440 ± 0.0035 (0.0315–0.0589)	0.0037 ± 0.0017 (-0.00006–0.0128)
X. grandis	6	0.0235 ± 0.0012 (0.02–0.0266)	0.0408 ± 0.0068 (0.0251–0.0713)	0.0022 ± 0.0008 (-0.0006–0.0055)
X. rectocollaris	5	0.0296 ± 0.0026 (0.0205–0.0346)	0.0384 ± 0.0033 (0.029–0.048)	0.0036 ± 0.0019 (0.0013–0.0111)

from Figure 2 of Zúñiga-Vega *et al.* 2005). Field SVL growth rates in *X. mendozai* Nieto-Montes de Oca, García-Vázquez, Zúñiga-Vega, and Schmidt-Ballardo, 2013 from Sierra Gordo, Querétaro, Mexico, for yearlings ranged from 0.015 to 0.08 mm d^{-1} (estimated from Figure 2 of Zamora-Abrego *et al.* 2012).

Because the growth rates in captivity are at the lower end of the observed growth rates in the field, we think that a "head-start" program might be successful, if it were modified to increase growth rates (e.g., change feeding rates, food type, rearing temperature). It also would be useful to have more data on the growth rates of the lizards in nature—both for the neonates/yearlings and adults because of the limited number of studies that have examined individual growth rates in *Xenosaurus* (*X. grandis,* Zúñiga-Vega *et al.* 2005; *X. mendozae,* Zamora-Abrego *et al.* 2012; *X. newmanorum,* Lemos-Espinal *et al.* 2003). This is particularly important given that individual growth among size classes is key to the population growth rates of some *Xenosaurus* populations (Zúñiga-Vega *et al.* 2007).

Survival of neonates in our study was highly variable among species: *X. grandis* (100%; 6 of 6 survived duration of study), *X. rectocollaris* (80%; 4 of 5 survived), and *X. fractus* (50%; 4 of 8 survived). Previous field estimates of annual survivorship of yearling *Xenosaurus* range from 0.34 to > 0.95, with noticeable annual variation in the examined populations (Zúñiga-Vega *et al.* 2007, Rojas-González *et al.* 2008, Zamora-Abrego *et al.* 2010). Thus, our observed survivorship rates are on par with natural survivorship estimates, but higher in *X. grandis* than estimated rates of 0.34–0.81 in the population studies by Zúñiga-Vega *et al.* (2007). However, the variation in survivorship among species suggests that there is no single husbandry technique that will maximize survivorship in all species, and that each species might need to have a specific protocol developed for any lab-based rearing program.

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References

Ballinger, R. E., G. R. Smith, and J. A. Lemos-Espinal. 2000. *Xenosaurus. Catalogue of American Amphibians and Reptiles 712:* 1–3.

IUCN. 2019. The IUCN Red List of Threatened Species. Verison 2018-2. http://www. iucnredlist.org. Captured on 28 September 2019.

Johnson, J. D., L. D. Wilson, V. Mata-Silva, E. García-Padilla, and D. L. DeSantis. 2017. The endemic herpetofauna of Mexico: organisms of global significance in severe peril. *Mesoamerican Herpetology 4:* 544–620.

Lemos-Espinal, J. A., G. R. Smith, and R. E. Ballinger. 2003. Variation in growth and demography of a knob-scaled lizard (*Xenosaurus newmanorum*: Xenosauridae) from a seasonal tropical environment in México. *Biotropica 35:* 240–249.

Lemos-Espinal, J. A., G. R. Smith, and G. A. Woolrich-Piña. 2012. *The Family Xenosauridae in Mexico*. Rodeo. ECO Herpetological Publishing. 106 pp.

Nieto-Montes de Oca, A., H. Sánchez-Vega, and I. Durán-Fuentes. 2018. A new species of knob-scaled lizard (Xenosauridae, *Xenosaurus*) from the Sierra Madre Oriental of Puebla, Mexico. *ZooKeys 737:* 141–160.

Rojas-González, R. I., C. P. Jones, J. J. Zúñiga-Vega, and J. A. Lemos-Espinal. 2008. Demography of *Xenosaurus platyceps* (Squamata: Xenosauridae): a comparison between tropical and temperate populations. *Amphibia-Reptilia 29:* 245–256.

SEMARNAT (Secretara de Medio Ambiente y Recursos Naturales). 2010. Norma Oficial Mexicana NOM-059-Ecol-2010. Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especifaciones para su inclusion, exclusion o cambio-Lista de especies en riesgo. Diario official (Segunda Seccion, 30-dic).

Wilson, L. D., V. Mata-Silva, and J. D. Johnson. 2013. A conservation reassessment of the reptiles of Mexico based on the EVS measure. *Amphibian and Reptile Conservation 7:* 1–47.

Woolrich-Piña, G. A., J. A. Lemos-Espinal, L. Oliver-López, and G. R. Smith. 2012. Ecology of *Xenosaurus rectocollaris* in Tehuacan Valley, Puebla, Mexico. *Southwestern Naturalist 57:* 157–161.

Zamora-Abrego, J. G., J. J. Zúñiga-Vega, and A. M. Ortega-León. 2012. Ecología del crecimiento de una lagartija del género *Xenosaurus* Peters 1861 (Squamata: Xenosauridae) en la Reserva de la Biosfera, Sierra Gorda, Querétaro, México. *Revista Chilena de Historia Natural 85:* 321–333.

Zamora-Abrego, J. G., Y. -M. Chang, J. J. Züñiga-Vega, A. Nieto-Montes de Oca, and J. B. Johnson. 2010. Demography of a knob-scaled lizard in northeastern Querétaro, México. *Herpetologica 66:* 39–51.

Zúñiga-Vega, J. J., R. I. Rojas-González, J. A. Lemos-Espinal, and M. E. Pérez-Trejo. 2005. Growth ecology of the lizard *Xenosaurus grandis* in Veracruz, México. *Journal of Herpetology 39:* 433–443.

Zúñiga-Vega, J. J., T. Valverde, R. I. Rojas-González, and J. A. Lemos-Espinal. 2007. Analysis of the population dynamics of an endangered lizard (*Xenosaurus grandis*) through the use of projection matrices. *Copeia 2007:* 324–335.

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