



Maximum Size Records for Four Species of *Eleutherodactylus* (Anura: Eleutherodactylidae) from Western Cuba

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Size in amphibians is an important aspect of life history that often generates considerable interest among the public (Powell et al. 1982) and could be attractive to society in efforts to conserve species. About 70 species of amphibians inhabit Cuba, most of them in the genus *Eleutherodactylus* (Alonso Bosch and García-Padrón 2017; AmphibiaWeb 2022). Frogs in this genus occupy various habitats in the archipelago, from dry ecosystems to well-conserved evergreen forests and caves (Díaz and Cádiz 2008). In Cuba, several new size records have been recognized since the original descriptions of some anuran species (i.e., García 2012; García-Padrón et al. 2021). Herein I document new maximum size records for four species of *Eleutherodactylus*: the Cuban Giant Frog (*E. zeus*), Cuban Flat-headed Frog (*E.*

planirostris), Pinar del Río Bromeliad Frog (*E. varians olibrus*), and the Barred Rockfrog (*E. klinikowskii*), from western Cuba.

I encountered the four frogs during herpetological surveys from November 2018 to March 2022 in El Moncada, Viñales Municipality, Pinar del Río Province (22.32942°N, 83.50937°W; elev. 300 m asl), and Loma del Ganso, 5 km W of Pinar del Río Municipality, Pinar del Río Province (22.22921°N, 83.43158°W; elev. ~75 m asl). All of the frogs were found during nocturnal surveys (2100–2400 h), except for *E. varians olibrus*, which I encountered during the day (1000 h). I measured the SVL of all frogs with a caliper (0.02 mm) before releasing them at the site of capture. I followed the taxonomy in Díaz and Cádiz (2008).



Fig. 1. Two large female Cuban Giant Frogs (*Eleutherodactylus zeus*) encountered in the Lechuza Gallery, Santo Tomás Great Cavern, El Moncada, Viñales Municipality, Pinar del Río Province, Cuba. The frogs held by the author (left) and with a reference scale (caliper = 200 mm) (right). Photographs © Miguel Boligán Expósito.



Fig. 2. A female Cuban Giant Frog (*Eleutherodactylus zeus*) (132.36 mm SVL) encountered in the Puñales Gallery, Santo Tomás Great Cavern, El Moncada, Viñales Municipality, Pinar del Río Province, Cuba. This individual represents the maximum size record for the species. Reference scale (caliper = 200 mm). Photographs © L. Yusnaviel García-Padrón.

Eleutherodactylus zeus Schwartz 1958.—This species inhabits karstic areas and associated forests in the Cordillera de Guaniguanico (Henderson and Powell 2009), where it uses caves for reproduction and forages mostly in adjacent forests (Alonso Bosch et al. 2015; García-Padrón et al. 2021). García (2012) reported a maximum size of 127.4 mm SVL in a female from El Moncada Village, Viñales Municipality. I recently observed a female of similar size (127.7 mm SVL) at the same locality (García-Padrón et al. 2021). On 26 November 2018, I observed two large females (SVLs 132.25 mm and 131.7 mm) (Fig. 1) in the Lechuza Gallery, Santo Tomás Great Cavern, at El Moncada, Viñales, exceeding by 4.6 mm and 4.0 mm, respectively, the previous published record. I encountered both frogs at night 30 m inside the cave and both had eggs visible through the abdominal cavity. On 16 March 2022, I observed another large gravid female (SVL 132.36 mm) (Fig. 2) in total darkness 86 m from the nearest entrance in the Puñales Gallery, also in Santo Tomás Great Cavern. This female exceeded by 4.66 mm the previously published record. The first two frogs (Lechuza Gallery) were separated from the third individual (Puñales Gallery) by a 2 km-long labyrinth of galleries and forest, so these were obviously not the same individuals.

Recorded sizes of female *E. zeus* have increased during the last decades (García 2012; García-Padrón et al. 2021; this study). In the original description (Schwartz 1958), mean SVL for females was 77.9 ± 1.94 mm SVL (maximum 83 mm) (Schwartz 1958; Estrada et al. 1986), whereas in recent studies of the El Moncada population (García-Padrón et al. 2021), mean female SVL was to 90.5 ± 13.54 mm (maximum 127.7 mm). Whether frogs are actually larger, this is limited to the El Moncada population, or the size increase is merely an artifact of increased sampling is unknown.



Eleutherodactylus planirostris (Cope 1862).—In Cuba, this species occupies almost all habitats, including those dramatically altered by humans (Henderson and Powell 2009). In the highlands of the Cordillera de Guaniguanico, this species is almost exclusively associated with humans (L.Y. García-Padrón, pers. obs.), but in the lowlands, it occupies both forested (mostly secondary forest) and human-altered environments (Henderson and Powell 2009; L.Y. García-Padrón, pers. obs.). In Cuba, females of this species reach SVLs to 28 mm (Schwartz 1974), but a female in Hawaii had a SVL of 30.1 mm (Ferreira et al. 2015). On 6 June 2021, I encountered a gravid female in the twilight zone 15 m from the entrance of the Cueva del Infierno, Loma del Ganso, Pinar del Río Municipality, with a SVL of 32.8 mm SVL (Fig. 3), exceeding by 2.7 mm the previous maximum size recorded for the species and by 4.8 mm for

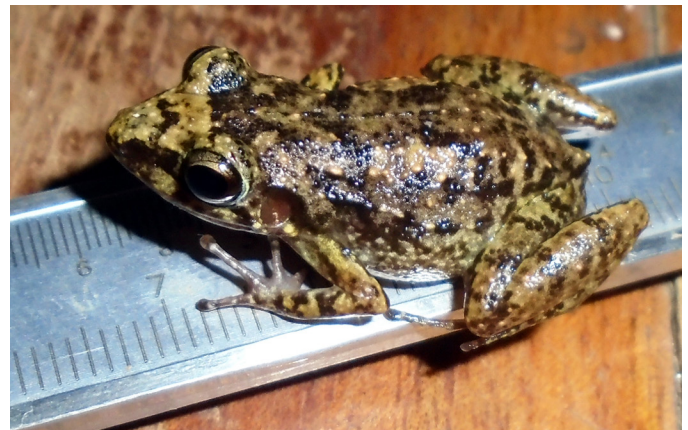


Fig. 3. The largest known female Cuban Flat-headed Frog (*Eleutherodactylus planirostris*) from Cueva del Infierno, Loma del Ganso, Pinar del Río Municipality, Pinar del Río Province, Cuba. Photographs © L. Yusnaviel García-Padrón.



Fig. 4. The largest known female Pinar del Río Bromeliad Frogs (*Eleutherodactylus varians olibrus*) from pine-forested hills in El Moncada, Viñales Municipality, Pinar del Río Province, Cuba; lateral view (left), the same individual with a reference scale (center), and the author holding it (on the palm) and another large female Pinar del Río Bromeliad Frog (right). Photographs © L. Yusnaviel García-Padrón.

Cuban populations. Note that Godwin (2014) mentioned a maximum female SVL of 32 mm, but provided no further data or references, thus I considered that size to be in need of confirmation.

Eleutherodactylus varians olibrus Schwartz 1958.—This Cordillera de Guaniguanico endemic subspecies (Díaz and Cádiz 2008) is a primarily arboreal frog that inhabits mesic forests where it seeks refuge in bromeliads or palm axils during the day (Henderson and Powell 2009). This subspecies reaches 31 mm SVL (Díaz and Cádiz 2008). At 1000 h on 6 March 2022, I found two large gravid females (SVLs 34.72 and 32.86 mm, 3.72 mm and 1.86 mm larger than the previous size record) (Fig. 4) in a Giant Airplant (*Tillandsia fasciculata*) in pine-forested hills at El Moncada Village, Viñales.

Eleutherodactylus klinikowskii Schwartz 1959.—This species lives in forest leaf litter and in terrestrial bromeliads in karstic hills (mogotes), including the entrances of caves in the Sierra de los Órganos (Henderson and Powell 2009). The largest body size recorded for the species was 27 mm SVL for females (Díaz and Cádiz 2008). On 16 March 2022, I encountered a large female (28.34 mm SVL, 1.34 mm larger than the previous maximum record) (Fig. 5) in El Moncada, Viñales Municipality, in leaf litter near the entrance of the Tapiada Gallery in Santo Tomás Great Cavern. No eggs were evident in the abdominal cavity of this frog.

Advantages of larger size are closely related to complex interactions between organisms and their environments that can affect ecology, behavior, and physiology (e.g., competition, vulnerability to predation, and access to more varied prey) (Smith 1976; Peters 1983; Hota 1994; Brown et al. 2004). Unfortunately, little is known about diets, inter- and intraspecific competition for food resources, predator-prey interactions, and relationships with the environment of these four species.

Several recent studies of *E. zeus* (García 2012; Alonso Bosch et al. 2015; García-Padrón and Alonso Bosch 2019; García-Padrón et al. 2021) have provided some insights into intra- and interspecific interactions. Also, recent work on *E. planirostris*, mostly based on non-Cuban populations (Olson et al. 2012; Iturriaga et al. 2014; Ferreira et al. 2015; Ramírez-Valverde et al. 2020), have led to a better understanding of the species' biology. Unfortunately, none explicitly addressed the role of body size.

Life-history traits in animals, such as longevity, are responsive to local abiotic and biotic factors (Ricklefs 2008). Little is known about biotic factors that could affect these frogs (e.g., diseases, predation, competition, human-induced habitat alterations) (Alonso Bosch et al. 2015; García-Padrón and Alonso Bosch 2019; García-Padrón and Borrego 2020; García-Padrón 2022). Evident problems that undoubtedly affect the studied populations are mostly extrinsic and all are human-mediated (e.g., habitat alterations and destruction, garbage and sewage disposal) (Alonso Bosch et al. 2015; García-Padrón and Borrego 2020). Detailed studies of population dynamics are needed to elucidate the future of these populations, and immediate conservation actions are critically important.

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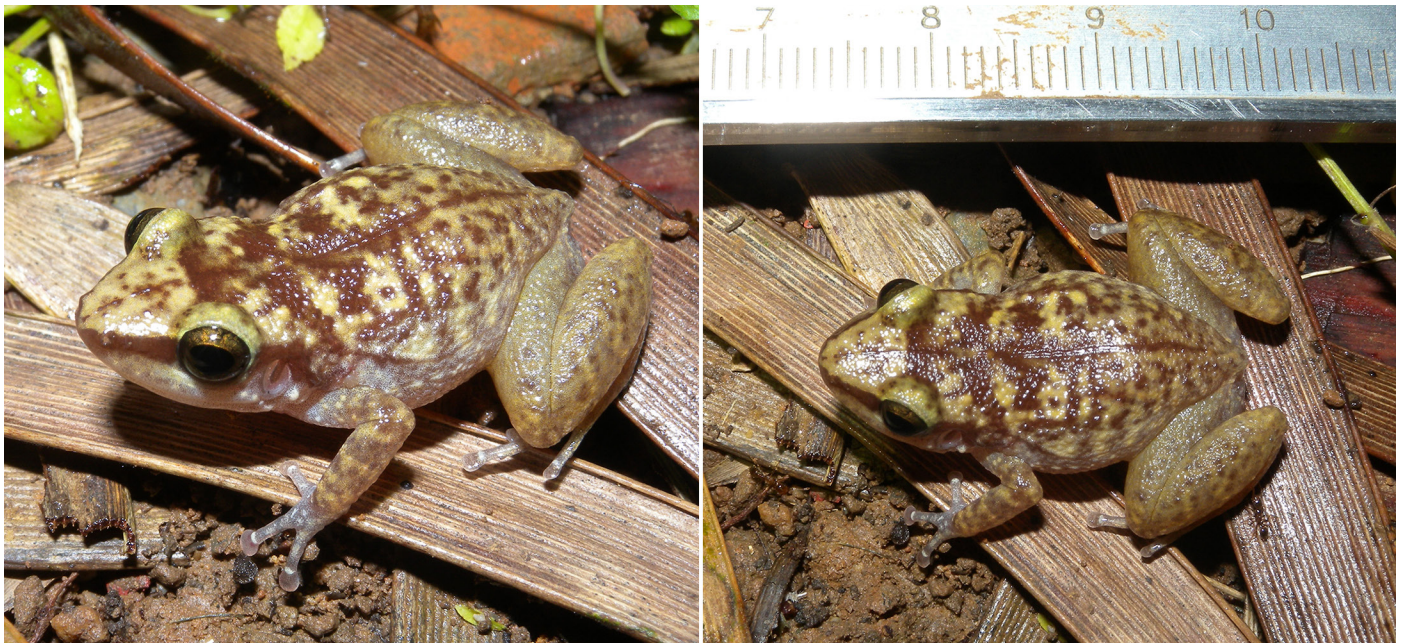


Fig. 5. The largest known female Barred Rockfrog (*Eleutherodactylus klinikowskii*) encountered in leaf litter near the entrance of the Tapiada Gallery, Santo Tomás Great Cavern, El Moncada, Viñales Municipality, Pinar del Río Province, Cuba (left) and with a reference scale (right). Photographs © L. Yusnaviel García-Padrón.

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Literature Cited

- Alonso Bosch, R. and L.Y. García Padrón. 2017. Anfíbios, pp. 248–275. In: C.A. Mancina and D.D. Cruz-Flores (eds.), *Diversidad Biológica de Cuba: Métodos de Inventarios, Monitoreo y Colecciones Biológicas*. Proyecto PNUD/GEF, Editorial AMA, La Habana, Cuba.
- Alonso Bosch, R., L.Y. García, S. del Castillo Domínguez, and E.L. Torres Martínez. 2015. Clutches, nest attendance, and hatching in a rock-cave-dwelling frog, *Eleutherodactylus (Syrrophus) zeus*, from Cuba. *Journal of Cave and Karst Studies* 77: 83–86. <https://doi.org/10.4311/2014LSC120>.
- AmphibiaWeb. 2022. Cuba. <https://amphibiaweb.org/cgi/amphib_query?relisocc=like&orderbyaw=Order&where=isocc=Cuba>.
- Brown, J.H., J.F. Gillooly, A.P. Allen, V.M. Savage, and G.B. West. 2004. Toward a metabolic theory of ecology. *Ecology* 85: 1771–1789. <https://doi.org/10.1890/03-9000>.
- Díaz, L.M. and A. Cádiz. 2008. *Guía Taxonómica de los Anfíbios de Cuba. Volume 4*. AbcTaxa, Brussels, Belgium.
- Estrada, A.R., J. Novo Rodríguez, and L.V. Moreno. 1986. Las ranas del grupo *symingtoni*, género *Eleutherodactylus* (Anura: Leptodactylidae) de Cuba. *Poeyana* 329: 1–14.
- Ferreira, R.B., K.H. Beard, R.T. Choi, and W.C. Pitt. 2015. Diet of the nonnative Greenhouse Frog (*Eleutherodactylus planirostris*) in Maui, Hawaii. *Journal of Herpetology* 49: 586–593. <https://doi.org/10.1670/14-103>.
- García, L.Y. 2012. *Eleutherodactylus zeus* (Cuban Giant Frog). Record size. *Herpetological Review* 43: 631.
- García-Padrón, L.Y. 2022. Maximum size and a new dietary record for the Broad-Banded Trope, *Tropidophis feicki* (Squamata: Tropidophiidae), in Cuba. *Reptiles & Amphibians* 29: 270–272. <https://doi.org/10.17161/randa.v29i1.17035>.
- García-Padrón, L.Y. and R. Alonso Bosch. 2019. Anomalous colour in a Cuban cave-dwelling frog: First record of piebaldism in *Eleutherodactylus zeus* (Anura: Eleutherodactylidae). *Herpetological Bulletin* 147: 1–3. <https://doi.org/10.33256/hb147.13>.
- García-Padrón, L.Y. and C.A. Borrego Quevedo. 2020. Dieta de *Eleutherodactylus atkinsi* (Anura: Eleutherodactylidae) en el occidente de Cuba. *Poeyana* 511: 53–58.
- García-Padrón, L.Y., M. Boligán, and H. Barrero Medel. 2021. Diet of the Cuban giant frog, *Eleutherodactylus zeus* (Anura: Eleutherodactylidae) in Viñales National Park, Cuba. *Cuadernos de Herpetología* 35: 43–51. [https://doi.org/10.31017/CdH.2021.\(2020-035\)](https://doi.org/10.31017/CdH.2021.(2020-035)).
- Godwin, C.D. 2014. *Eleutherodactylus planirostris* (Greenhouse Frog). *Herpetological Review* 45: 458.
- Henderson, R.W. and R. Powell. 2009. *Natural History of West Indian Reptiles and Amphibians*. University Press of Florida, Gainesville, Florida, USA.
- Hota, A.K. 1994. Growth in amphibians. *Gerontology* 40: 147–160. <https://doi.org/10.1159/000213584>.
- Iturriaga, M., A. Sanz, and R. Oliva. 2014. Seasonal reproduction of the Greenhouse Frog *Eleutherodactylus planirostris* (Anura: Eleutherodactylidae) in Havana, Cuba. *South American Journal of Herpetology* 9: 142–150. <http://dx.doi.org/10.2994/SAJH-D-13-00039.1>.
- Olson, C.A., K.H. Beard, and W.C. Pitt. 2012. Biology and impacts of Pacific Island invasive species. 8. *Eleutherodactylus planirostris*, the Greenhouse Frog (Anura: Eleutherodactylidae). *Pacific Science* 66: 255–270. <https://doi.org/10.2984/66.3.1>.
- Peters, R.H. 1983. *The Ecological Implications of Body Size*. Cambridge University Press, Cambridge, UK.
- Powell, R., K.P. Bromeier, N.A. Laposha, J.S. Parmerlee and B. Miller. 1982. Maximum sizes of amphibians and reptiles from Missouri. *Transactions of the Missouri Academy of Science* 16: 99–106.
- Ramírez-Valverde, T., D. González-Solís, J.R. Cedeño-Vázquez, and R. Luría-Manzano. 2020. Dieta de la rana de invernadero *Eleutherodactylus planirostris* (Amphibia: Eleutherodactylidae) en la península de Yucatán, México. *Revista Mexicana de Biodiversidad* 91: e912748. <https://doi.org/10.22201/ib.20078706e.2020.91.2748>.
- Ricklefs, R.E. 2008. The evolutionary ecology of senescence: the evolution of senescence from a comparative perspective. *Functional Ecology* 22: 379–392. <https://doi.org/10.1111/j.1365-2435.2008.01420.x>.
- Schwartz, A. 1958. Another new large *Eleutherodactylus* (Amphibia: Leptodactylidae) from western Cuba. *Proceedings of the Biological Society of Washington* 71: 37–42.
- Schwartz, A. 1974. *Eleutherodactylus planirostris*. *Catalogue of American Amphibians and Reptiles* 154: 1–4.
- Smith, G.C. 1976. Ecological energetics of three species of ectothermic vertebrates. *Ecology* 57: 252–264. <https://doi.org/10.2307/1934814>.