



## INTRODUCED SPECIES

# Notes on the Striped Keelback (*Xenochrophis vittatus*) in Puerto Rico: A Recently Reported Non-native Snake in the Western Hemisphere

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Photographs by the author.

The Striped Keelback (*Xenochrophis vittatus*; Fig. 1) is a semi-aquatic snake (Pauwels et al. 2008) in a genus with a historically confused taxonomy (Vogel and David 2012) that includes either 12 (Dubey et al. 2012) or 13 (Uetz and Hošek 2015) species. The Striped Keelback occurs naturally in Indonesia (Banga, Java, Sumatra, and Sulawesi [Celebes]; Inger and Voris 2001; de Lang and Vogel 2006; Raharjo and Hakim 2015) and an introduced population is established in Singapore (Uetz and Hošek 2015). The presence of *X. vittatus* in Puerto Rico is the first record of the species in the Western Hemisphere (Herrera-Montes et al. 2015) and is the thirteenth introduced herpetofaunal species on the island

(six anurans and six reptiles have been previously recorded). Of the introduced reptiles, to date only one snake species, the Boa Constrictor (*Boa constrictor* spp.) is considered established. However, five additional snake species have been documented, although they are not known to have established breeding populations (Mayer 2012). The new record of *X. vittatus* in Puerto Rico increases the total number of snake species in the island to twelve.

In Puerto Rico, observations of *X. vittatus* have been recorded since 2011 in the northeastern lowlands (Herrera-Montes 2014; Herrera-Montes et al. 2015). Individuals observed include adults and juveniles detected in pastures



**Fig. 1.** Juvenile Striped Keelback (*Xenochrophis vittatus*) captured in an urban pasture in Carolina Pueblo on 24 February 2012. Photograph deposited as voucher (MZUPRRP-PA-05) in the Museum of Zoology at the University of Puerto Rico, Río Piedras Campus.



**Fig. 2.** Striped Keelback (*Xenochrophis vittatus*) habitat: Urban pasture in Carolina Pueblo (30 m elev.). Photograph deposited as voucher (MZUPRRP-PA-06) in the Museum of Zoology at the University of Puerto Rico, Río Piedras Campus.

with shorter grasses (<1.5 m height; Fig. 2) and along the edges of mature secondary forest (Fig. 3) near wet, swampy areas at elevations of 27–144 m asl. In its natural range, the species occurs from coastal plains to elevations of 1,200 m and frequently is associated with terrestrial to semi-aquatic habitats, such as wetlands, ponds, rice paddies, grasslands, scrublands, and suburban areas (Bergman 1950; Raharjo and Hakim 2015). The Striped Keelback is diurnal, oviparous (clutches averaging five eggs), breeds year-round (Bergman 1950), and feeds primarily on fishes and frogs (Bergman 1950; Hampton 2011; Guo et al. 2012). However, some Puerto Rican observations document individuals moving through sampling sites at night, apparently searching actively for food.

In pastures where *X. vittatus* was observed, ten additional species comprise the herpetofaunal assemblage (Table 1), and two common species, the White-lipped Frog (*Leptodactylus albilabris* Cochran) and the Common Grass Anole (*Anolis pulchellus* Duméril and Bibron), were dominant species (Herrera-Montes 2014). The White-lipped Frog is a common and adaptable frog endemic to the Puerto Rican Bank (Mayer 2012). This frog is mainly active in the evening and usually is associated with humid, swampy, and disturbed habitats around the island (Rivero 2006). The Common Grass Anole is a diurnal grass-bush ecomorph (Williams 1983) that is widely distributed in Puerto Rico (Gorman and Harwood 1977). It is common in grassy and open habitats (Rand 1964), where it is found in extremely high population densities (to 20,000 individuals/ha; Gorman and Harwood 1977). In the secondary forest parcel where I observed *X. vittatus*, 17 species including *X. vittatus* comprised the herpetofaunal

assemblage. The Common Coqui (*Eleutherodactylus coqui* Thomas) was the dominant species (Herrera-Montes 2014; Table 1). *Anolis pulchellus*, *L. albilabris*, *E. coqui*, and other common or threatened native species could be potential prey or competitors of *X. vittatus* in Puerto Rico (Table 1).

The time of introduction of *X. vittatus* in Puerto Rico is unknown, but anecdotal accounts of “Garter Snake” sightings in Carolina Municipality can be traced to around 1994 and refer to an accidental escape of snakes, presumably for the pet trade, from containers at the Luis Muñoz Marín International Airport (Herrera-Montes et al. 2015). *Xenochrophis vittatus* is currently not listed in CITES, but evidence indicates its presence in the international trade of live animals in the U.S. Between 2004 and the first few months of 2015, over 19,000 Striped Keelbacks have been imported (C. Romagosa, pers. comm.). The Striped Keelback is an attractive snake and is in Indonesia commonly kept as a pet. It is harmless, easy to catch, and does not bite; it lives around 10 years, and is easily maintained in captivity (Bergman 1950). All of these characteristics foster its popularity in the exotic animal trade, which increases the risk of new introductions and translocations of individuals to other localities around Puerto Rico, the Antilles, and the Western Hemisphere.

With the exception of the Puerto Rican Slider (*Trachemys s. stejnegeri* Schmidt), Puerto Rico lacks native species of semi-aquatic reptiles (Joglar et al. 2007; Mayer 2012), and non-saline aquatic environments represent an unexploited resource for other introduced reptiles and amphibians. Since observations of *X. vittatus* in Puerto Rico are indicative of a well-established population (Herrera-Montes et al. 2015), studies that contribute to the knowledge of its spatial distribution on

**Table 1.** Species comprising the herpetofaunal assemblages in sympatry with the Striped Keelback (*Xenochrophis vittatus*) in Puerto Rico. Relative abundance of each species in the assemblage is presented. Classification as endemic to Puerto Rico/Puerto Rican Bank (E), native (N), or introduced (I) is based on Rivero (2006), Joglar and Longo (2011), and Mayer (2012).

Species	Distribution	Suburban Mature forest	Suburban Pasture	Urban Pasture
<i>Rhinella marina</i>	I	0.45	0.00	0.31
<i>Eleutherodactylus antillensis</i>	E	0.06	0.61	4.70
<i>Eleutherodactylus brittoni</i>	E	0.19	0.00	0.00
<i>Eleutherodactylus cochranae</i>	E	0.52	0.00	0.00
<i>Eleutherodactylus coqui</i>	E	58.12	2.44	2.19
<i>Leptodactylus albilabris</i>	E	1.29	24.59	3.76
<i>Anolis cristatellus</i>	E	25.76	0.61	0.31
<i>Anolis krugi</i>	E	7.96	0.61	0.00
<i>Anolis pulchellus</i>	E	1.49	70.33	85.89
<i>Anolis stratulus</i>	E	2.14	0.00	0.00
<i>Ameiva exsul</i>	E	0.26	0.00	1.25
<i>Iguana iguana</i>	I	0.45	0.00	0.00
<i>Sphaerodactylus klauberi</i>	E	0.39	0.00	0.00
<i>Sphaerodactylus macrolepis</i>	E	0.71	0.00	0.00
<i>Borikenophis portoricensis</i>	N	0.00	0.00	0.94
<i>Chilabothrus inornatus</i>	E	0.06	0.00	0.00
<i>Typhlops platycephalus</i>	E	0.00	0.20	0.00
<i>Typhlops rostellatus</i>	E	0.06	0.00	0.00
<i>Xenochrophis vittatus</i>	I	0.06	0.61	0.63

the island, habitat use and selection, diet, and interactions with other species are needed. I strongly recommend additional research, monitoring, and implementation of eradication programs of *X. vittatus* in Puerto Rico.

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### Literature Cited

- Bergman, R.A.M. 1950. The life of *Natrix vittata* (L.). *Zoologische Mededelingen* 31:1–11.
- de Lang, R. and G. Vogel. 2006. The snakes of Sulawesi, pp. 35–38. In: M. Vences, J. Köhler, T. Ziegler, and W. Böhme (eds.), *Herpetologia Bonnensis II*. Proceedings of the 13th Congress of the Societas Europaea Herpetologica, Bonn, Germany.
- Dubey, B., P.R. Meganathan, N. Vidal, and I.H. Dubey. 2012. Molecular evidence for the nonmonophyly of the Asian natricid genus *Xenochrophis* (Serpentes, Colubroidea) as inferred from mitochondrial and nuclear genes. *Journal of Herpetology* 46:263–268.
- Gorman, G.C. and R. Harwood. 1977. Notes on population density, vagility, and activity patterns of the Puerto Rican Grass Lizard, *Anolis pulchellus* (Reptilia, Lacertilia, Iguanidae). *Journal of Herpetology* 11:363–368.
- Guo, P., Q. Liu, Y. Xu, K. Jiang, M. Hou, L. Ding, R.A. Pyron, and F.T. Burbrink. 2012. Out of Asia: Natricine snakes support the Cenozoic Beringian Dispersal Hypothesis. *Molecular Phylogenetics and Evolution* 63:825–833.
- Hampton, P.M. 2011. Comparison of cranial form and function in association with diet in natricine snakes. *Journal of Morphology* 272:1435–1443.
- Herrera-Montes, A. 2014. Maintaining herpetofaunal diversity in urban landscape: Implications for conservation. Ph.D. Dissertation. University of Puerto Rico-Río Piedras, San Juan.
- Herrera-Montes, A., B. Ríos-Dróz, A.R. Puente-Rolón, D. Dávila-Casanova, and N. Ríos-López. 2015. Geographic distribution: *Xenochrophis vittatus* (Striped Keelback). *Herpetological Review* 46:64.
- Inger, R.F. and H.K. Voris. 2001. The biogeographical relations of the frogs and snakes of Sundaland. *Journal of Biogeography* 28:863–891.



**Fig. 3.** Striped Keelback (*Xenochrophis vittatus*) habitat: Forest edge in suburban mature secondary forest (approximately 40 years of succession; 144 m elev.). Photograph deposited as voucher (MZUPRRP-PA-03) in the Museum of Zoology at the University of Puerto Rico, Río Piedras Campus.

- Joglar, R.L. and A.V. Longo (eds.). 2011. Guía de biodiversidad urbana: Especies en ciudades y bosques urbanos de Puerto Rico. Proyecto Coqui, University of Puerto Rico-Río Piedras, San Juan.
- Joglar R.L., A.O. Álvarez, T.M. Aide, D. Barber, P.A. Burrowes, M.A. García, A. León-Cardona, A.V. Longo, N. Pérez-Buitrago, A. Puente, N. Rios-López, and P.J. Tolson. 2007. Conserving the Puerto Rican herpetofauna. *Applied Herpetology* 4:327–345.
- Mayer, G.C. 2012. Puerto Rico and the Virgin Islands, pp. 136–147. In: R. Powell and R.W. Henderson (eds.), *Island lists of West Indian amphibians and reptiles*. *Bulletin of the Florida Museum of Natural History* 51:85–166.
- Pauwels, O.S.G., V. Wallach, and P. David. 2008. Global diversity of snakes (Serpentes: Reptilia) in freshwater. *Hydrobiologia* 595:599–605.
- Raharjo, A.D. and L. Hakim. 2015. Diversity of snakes in Rajegwesi Tourism Area, Meru Betiri National Park. *Journal of Indonesian Tourism and Development Studies* 3:37–40.
- Rand, S.A. 1964. Ecological distribution in anoline lizards of Puerto Rico. *Ecology* 45:745–752.
- Rivero, J.A. 2006. *Guía para la Identificación de Lagartos y Culebras de Puerto Rico*. La Editorial Universidad de Puerto Rico, San Juan.
- Uetz, P. and J. Hošek (eds.). 2015. The Reptile Database. <<http://www.reptile-database.org>>.
- UNEP-WCMC. 2009. Review of non-CITES reptiles that are known or likely to be in international trade. A Report to the European Commission, UNEPWCMC, Cambridge.
- Vogel, G. and P. David. 2012. A revision of the species group of *Xenochrophis piscator* (Schneider, 1799) (Squamata: Natricidae). *Zootaxa* 3473:1–60.
- Williams, E.E. 1983. Ecomorph, faunas, island size, and diverse end points in island radiation of *Anolis*, pp. 326–370. In: R.B. Huey, E.R. Pianka, and T.W. Schoener (eds.), *Lizard Ecology: Studies of a Model Organism*. Harvard University Press, Cambridge, Massachusetts.