Oophaga vicentei (Vicente´s Poison Frog): Color Change

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sylvaticus to produce cryoprotectants from blood glucose (reviewed in Dodd 2013. Frogs of the United States and Canada. Volume 2. John Hopkins, Baltimore, Maryland. 982 pp.) allow them to freeze (Storey and Storey 1987. Copeia 1987:720–726), and survive body temperatures as low as -5°C for two weeks (Layne 1995. J. Therm. Biol. 20:349–353). With this cold-tolerance and selection of sheltered locations, *L. sylvaticus* can survive even colder environments and occurs within the Arctic Circle, making this the most northerly ranging amphibian in North America (Martof 1970. Cat. Am. Amphib. Rept. 86:1–4). Surprisingly, few details of hibernation or hibernacula are published for *L. sylvaticus* (Dodd 2013, *op. cit.*).

At 1200 h on 17 September 2015, we accidently dug up a male *L. sylvaticus* (SVL = 5.0 cm) 18 cm deep among plant roots in loose, moist soil 0.5 m from the bank of a small garden pond (3 m diameter, 1 m deep) in the city of Thunder Bay, Ontario, Canada (48.4358°N, 89.2719°W, WGS 84; 228 m elev.) on the southern fringe of the boreal forest where winter low temperatures routinely drop into the -30 to -40°C range (Environment Canada Weather Information. https://weather.gc.ca; 01 May 2016). Although it was sunny and air temperature was 15°C when unearthed, the frog was in a curled upright position and torpid. Two hard frosts occurred in the previous week so it appeared that the individual had entered its hibernaculum. The frog began to make some sluggish movements after a minute of handling so we put him back in the depression and refilled the hole with soil. Snow cover began on 11 November 2015 and lasted until 15 April 2016 varying between 40–60 cm in depth through the coldest period in January and February. The winter of 2015–2016 was actually the mildest on record because of a strong El Niño event, but many nights of -20 to -31°C lows were recorded (Environment Canada Weather Information, *op cit.*). The ground above the hibernaculum remained undisturbed until 22 April 2016 when the male emerged, entered the pond, and began calling at 1600 h (sunny, air temperature = 8.5°C, water temperature = 16.6°C). The frog entered its hibernaculum just after the first cold events in fall and remained inside for at least 218 days. The pond skimmed over with ice on two cold nights in the week after emergence and occasional nights with frost occurred until the end of April but the individual survived and resumed calling on warmer days and evenings.

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OOPHAGA VICENTEI (Vicente's Poison Frog). **COLOR CHANGE.** In anurans, color change is controlled by the arrangement of two types of chromatic cells in the epidermis: chromatophores and melanophores (Hoffman and Blouin 2000. Biol. J. Linn. Soc. 70:633–665), and the concentration of pigments inside these cells and their distribution contributes to the final color and pattern perceived (Oshima 2001. Pigment Cell. Res. 14:312–319). Although some amphibians are known to change color in response to ontogenetic development (Hoffman and Blouin 2000, *op. cit.*), skin color change has never been reported in adults in the family Dendrobatidae. In dendrobatids, skin color is associated with the possession of secondary defenses, and functions as an aposematic signal, warning predators of their toxicity (Maan and Cummings 2012. Am. Nat. 179:E1–14). *Oophaga vicentei* exhibits skin color pattern polymorphism, with some populations having green, yellowish, and even red colors, sometimes with black stripes (Lötters et al. 2007. Poison Frogs. Biology, Species & Captive Husbandry. Edition Chimaira, Frankfurt am Main. 668 pp.). Our study populations at five locations are predominantly green to pale green with black stripes. At 1415 h on 9 April 2016, near the Santa Fe National Park headquarters (8.53343°N, 81.15074°W, WGS 84; 714 m elev.), Santa Fe, Veraguas, Republic of Panama, we captured a female *Oophaga vicentei* (SVL = 18.18 cm, 0.459 g) and, as part of a dietary study, flushed its stomach to collect contents. At the end of the flushing procedure, the frog changed color in less than 10 sec, its skin turned from green to yellow (Fig. 1). Quickly after the procedure, the frog was transferred to a 700-ml plastic container where its movements and behavior were normal. The frog was observed from 1800 h to 2000 h during which it continuously maintained the yellow color; at 0030 h the color had finally reverted to its original state.

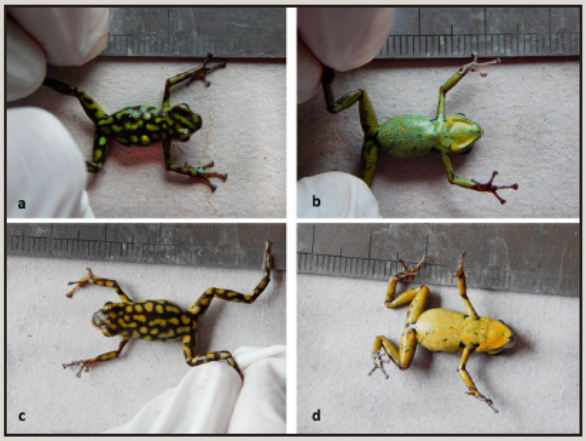

FIG. 1. Female *Oophaga vicentei* before and after color change: (A) dorsal view of normal skin pigmentation; (B) ventral view of normal skin pigmentation; (C) dorsal view after rapid color change; (D) ventral view after rapid color change.

The manipulation period may have triggered a rapid physiological color change (Nöel 1993. Bull. Zool. Soc. Fr. 108:169–185) resulting in the contraction of pigments inside the chromatic cells, in particular the melanophores, rendering the frog yellowish (Bagnara et al. 1968. J. Cell Biol. 38:67–79). For example, *Hyla arborea* transitions from olive green to lemon yellow as a result of pigment contraction inside the melanophores and dispersion of light reflecting pigments in chromatophores (Nielsen 1978. Cell Tissue Res. 194:405–408). One mechanism for this transition could be the lack of activity of melanophore-stimulating hormone in the pituitary gland which is known to regulate melanophore expansion in anurans (Hogben and Slome 1931. Proc. R. Soc. Lond. B Biol. Sci. 108:10–53). In *Oophaga pumilio*, a close relative to *O. vicentei*, skin coloration is subjected to sexual selection (Maan and Cummings 2008. Evolution 62:2334–2345; Maan and Cummings 2009. Proc. Natl. Acad. Sci. USA 106:19072–19077). Changes in this trait might have consequences for mating success; whether or not this also applies to *O. vicentei* remains unknown. To our knowledge, this is the first report of plastic change in skin color coupled with return to a normal state in any species of the Dendrobatidae. Further investigation is needed to understand the physiological mechanisms underlying this rapid color change, the natural conditions under which such color change could occur, and its consequences for fitness.

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the wild could improve the chances of survival for native wildlife and provide ecological benefits to Florida ecosystems.

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PELOPHYLAX PEREZI (Perez's Green Frog). **SCAVENGING.** *Pelophylax perezi* is endemic to the Iberian Peninsula and southern France (García-París 2007. *In* Gasc et al. [eds.], Atlas of Amphibians and Reptiles in Europe, pp. 152–153. Muséum National