

Craugastor escoces (Anura: Craugastoridae) reappears after 30 years: rediscovery of an “extinct” Neotropical frog

Randall Jiménez^{1,*}, Gilbert Alvarado^{2,3}

Abstract. We report the rediscovery of a declared extinct frog, *Craugastor escoces*, at the edge of a protected forest in the Juan Castro Blanco National Park, Alajuela, Costa Rica. This species, which is endemic to Costa Rica, had not been observed since 1986. The rediscovery of this species comes after 30 years without being seen and 12 years of being declared extinct. The site where we found the species is located in the west of the central mountain region of Costa Rica, which is >15 km away from its known distribution. Our finding adds another species to the list of the few rediscovered frogs declared extinct. Knowing that *C. escoces* can still be found triggers the need for conservation strategies to help the species survive.

Keywords: amphibian declines, Anura, conservation, extinction.

Around a third of amphibian species are threatened with extinction and many are believed already extinct, mostly because of a global phenomenon of amphibian population declines and disappearances that started to be noticed in the 1980's (Stuart et al., 2004). The International Union for Conservation of Nature (IUCN) declared extinct 35 species of frogs in 2004 and one in 2008. From the total number of extinct species of frogs, 28 were last observed before the 1980's (i.e., between 1853 and 1979), seven in the 1980's and one in the 1990's (IUCN, 2017). Notably, several of these extinct frogs have been rediscovered in recent years. For example, the first frog to be rediscovered was *Raorchestes travancoricus* in India (Last seen (Ls): 1891 – Rediscovery (R): 2004) (Biju and Bossuyt, 2009). Other rediscoveries of extinct frogs around the world have included *Craugastor milesi* in Honduras (Ls:

1983 – R: 2008) (Kolby and McCranie, 2009), *Incilius holdridgei* in Costa Rica (Ls: 1986 – R: 2010) (Abarca et al., 2010), *Discoglossus nigriverter* in Israel (Ls: 1955 – R: 2011) (Biton et al., 2013), and three species in Sri Lanka, namely *Adenomus kandianus* (Ls: 1872 – R: 2009), *Pseudophilautus hypomelas* (Ls: 1876 – R: 2010), and *Pseudophilautus stellatus* (Ls: 1853 – R: 2010) (Wickramasinghe et al., 2012, 2013a, 2013b).

Here, we report the rediscovery of another species declared extinct, *Craugastor escoces* (Savage, 1975), at the edge of a protected forest in the Juan Castro Blanco National Park, Alajuela, Costa Rica (1820 masl). On 18 September 2016 during a nocturnal survey for an ongoing research project with *Lithobates vibicarius*, we found one female individual (fig. 1) in a small boulder cave of a short stream. We do not provide the exact locality to discourage the visitation of people to the area because of the risk of illicit collecting, disturbance of the habitat and potential introduction of pathogens. This species is a stream-breeding frog that belongs to the Central American *C. punctariolus* group (Hedges et al., 2008). It is endemic to Costa Rica, and was distributed in the centre and east of the central mountain region of the country at elevations of 1100-2100 masl (Savage, 1975, 2002; Bolaños and Chavez, 2004).

1 - Institute of Evolutionary Ecology and Conservation Genomics, University of Ulm, Albert-Einstein Allee 11, D-89069 Ulm, Germany

2 - Laboratory of Comparative Wildlife Pathology, School of Veterinary Medicine and Animal Sciences, University of São Paulo, Av. Orlando Marques de Paiva 87, São Paulo, Brasil

3 - School of Biology, University of Costa Rica, Campus Rodrigo Facio, San Pedro de Montes de Oca, Costa Rica

*Corresponding author;

e-mail: randall.jimenez@uni-ulm.de



Figure 1. Female *Craugastor escoces* (SVL: 62 mm) found at the edge of a protected forest in the Juan Castro Blanco National Park, Alajuela, Costa Rica (1820 masl). The female has disks on fingers III and IV nearly twice as wide as digits, dorsum light to dark purplish and uniform, and venter tomato red confirming its identification as *C. escoces* and differing from the other members of the *C. punctariolus* group (Savage, 1975, 2002). Federico Bolaños from the University of Costa Rica confirmed the species. Photo by Gilbert Alvarado.

The locality where we found the female individual, west of the central mountain region, is >15 km away from its known distribution. We do not know if the species already occupied or recently colonized the Juan Castro Blanco National Park since there is no historical records of the herpetofauna in this location.

Craugastor escoces had not been observed since 1986 and the IUCN declared the species as extinct in 2004 after 18 years of no individuals being found (Bolaños and Chavez, 2004). The rediscovery of this species comes after 30 years without being observed and 12 years of being declared extinct. Interestingly, the last sighting of *C. escoces* preceded the last sighting of the symbolic golden toad (*Incilius periglenes*) in the nearby cloud forest of Monteverde, Costa Rica by only three years (IUCN, 2017). Furthermore, knowing that *C. escoces* can still be found, as well as four other species of the group of *C. punctariolus* that were recently found in Costa Rica after considered possibly extinct (e.g., *C. angelicus*, *C. fleischmanni*, *C. ranoides*, and *C. taurus*) suggests that the phylogenetic diversity of the group can still be preserved and further genetic studies are required (Puschendorf et al., 2005; Ryan et al., 2011; Chaves et al., 2014; Kubicki, 2016).

The rediscovery of *C. escoces* does not mean the species is recovered and likely to persist since it might remain on the brink of extinction. Therefore, we are monitoring the area to locate the population of *C. escoces* in the Juan Castro Blanco National Park to evaluate its status, population dynamics, health (e.g., skin microbiome) and susceptibility to sources of environmental change (e.g., habitat disturbance, infectious diseases, climate change and pesticides). This information will help conduct adequate conservation actions to better protect the species in its natural habitat. After careful conversations with experts and evaluating the relevance of this rediscovery we decided not to convert the female individual into a voucher specimen, which is a common practice in science to confirm a species' reappearance. Instead, we agreed to keep the animal in captivity under adequate conditions and to locate at least one mature male to obtain data on growth rate, reproductive behaviour and development, which will be critical for informing conservation actions. For instance, the information we get will help develop protocols for an ex situ conservation strategy, which will be necessary if in situ conservation cannot by itself ensure the species survival, and if there is a threat that requires the immediate action of collecting animals for

ex situ rescue (Gascon et al., 2007; Bolaños et al., 2008). The animals in captivity will be converted to voucher specimens when they die and deposited at the Zoology Museum of the University of Costa Rica. Knowing that *C. escoces* can still be found triggers the need for urgent conservation actions that help preserve a critically endangered species.

Acknowledgements. We thank S. Sommer, J.L. Catão-Dias, F. Bolaños, R. Puschendorf, J. Stynoski and S. Whitfield for earlier discussions about the topic. We thank the anonymous reviewers for their thoughtful comments that improved the manuscript. We are grateful to APANAJUCA, SINAC and D. Vargas for supporting field logistics. We would like to thank T. Jones for language corrections. R. Jimenez and G. Alvarado were both supported by Rufford Foundation, Auckland Zoo, Cleveland Metroparks Zoo and Cleveland Zoological Society. R. Jiménez was also supported by the National Council for Scientific and Technological Research of Costa Rica and Ministry of Science and Technology of Costa Rica. G. Alvarado was supported by Amphibian Ark and Laboratorio de Ensayos Biológicos (LEBI). The female *Craugastor escoces* mentioned in this article was collected and put in captivity under scientific permit SINAC-ACAHN-PI-R-008-2016.

References

- Abarca, J., Chaves, G., García-Rodríguez, A., Vargas, R. (2010): Reconsidering extinction: rediscovery of *Incilius holdridgei* (Anura: Bufonidae) in Costa Rica after 25 years. *Herpetol. Rev.* **41**: 150-152.
- Biju, S.D., Bossuyt, F. (2009): Systematics and phylogeny of *Philautus* Gistel, 1848 (Anura, Rhacophoridae) in the Western Ghats of India, with descriptions of 12 new species. *Zool. J. Linnean Soc.* **155**: 374-444.
- Biton, R., Geffen, E., Vences, M., Cohen, O., Bailon, S., Rabinovich, R., Malka, Y., Oron, T., Boistel, R., Brumfeld, V., Gafny, S. (2013): The rediscovered Hula painted frog is a living fossil. *Nat. Commun.* **4**: 1959.
- Bolaños, F., Chaves, G. (2004): *Craugastor escoces*. The IUCN Red List of Threatened Species 2004: e.T56588A11488977. Available at <http://dx.doi.org/10/2305/IUCN.UK.2004.RLTS.T56588A11488977.en>.
- Bolaños, F., Johnson, K., Rodríguez, J.E., Matamoros, Y. (2008): Taller de Priorización de Especies de Anfibios para Programas de Conservación Ex situ, San José, Costa Rica. 168 pp.
- Chaves, G., Zumbado-Ulate, H., García-Rodríguez, A., Gómez, E., Vredenburg, V.T., Ryan, M.J. (2014): Rediscovery of the critically endangered streamside frog, *Craugastor taurus* (Craugastoridae), in Costa Rica. *Trop. Conserv. Sci.* **7**: 628-638.
- Gascon, C., Collins, J.P., Moore, R.D., Church, D.R., McKay, J.E., Mendelson III, J.R. (2007): Amphibian Conservation Action Plan. IUCN/SSC Amphibian Specialist Group, Switzerland.
- Hedges, S.B., Duellman, W.E., Heinicke, M.P. (2008): New World direct developing frogs (Anura: Terrarana): molecular phylogeny, classification, biogeography, and conservation. *Zootaxa* **1737**: 1-182.
- IUCN (International Union for Conservation of Nature) (2017): The IUCN Red List of Threatened Species. Switzerland. Available at <http://www.iucnredlist.org/about/citing>.
- Kolby, J.E., McCranie, J.R. (2009): Discovery of a surviving population of the montane streamside frog *Craugastor milesi* (Schmidt). *Herpetol. Rev.* **40**: 282-283.
- Kubicki, B. (2016): Rediscovery of the critically endangered frog, *Craugastor angelicus*, in Costa Rica. *Mesoamerican Herpetology* **3**: 1070-1071.
- Puschendorf, R., Chaves, G., Crawford, A.J., Brooks, D.R. (2005): *Eleutherodactylus ranoides*. Dry forest population, refuge from decline? *Herpetol. Rev.* **36**: 53.
- Ryan, M.J., Bolaños, F., Chaves, G. (2011): Museums help prioritize conservation goals. *Science* **210**: 1272-1273.
- Savage, J.M. (2002): The Amphibians and Reptiles of Costa Rica: a Herpetofauna Between Two Continents, Between Two Seas. The University of Chicago Press, Chicago, USA.
- Savage, J.M. (1975): Systematics and distribution of the Mexican and Central American stream frogs related to *Eleutherodactylus rugulosus*. *Copeia* **1975**: 254-306.
- Stuart, S.N., Chanson, J.S., Cox, N.A., Young, B.E., Rodrigues, A.S.L., Fischman, D.L., Waller, R.W. (2004): Status and trends of amphibian declines and extinctions worldwide. *Science* **306**: 1783-1786.
- Wickramasinghe, L.J.M., Vidanapathirana, D.R., Airyathne, S., Rajeev, G., Chanaka, A., Pastorini, J., Chathuranga, G., Wickramasinghe, N. (2013a): Lost and found: one of the world's most elusive amphibians, *Pseudophilautus stellatus* (Kelaart 1853) rediscovered. *Zootaxa* **3620**: 112-128.
- Wickramasinghe, L.J.M., Vidanapathirana, D.R., Rajeev, M.D.G., Wickramasinghe, N. (2013b): Rediscovery of *Pseudophilautus hypomelas* (Günther, 1876) (Amphibia: Anura: Rhacophoridae) from the Peak Wilderness, Sri Lanka, a species thought to be extinct! *J. Threat. Taxa* **5**: 5181-5193.
- Wickramasinghe, L.J.M., Vidanapathirana, D.R., Wickramasinghe, N. (2012): Back from the dead: the world's rarest toad *Adenomus kandianus* rediscovered in Sri Lanka. *Zootaxa* **3347**: 63-68.
- Zumbado-Ulate, H., García-Rodríguez, A., Chaves, G., Alvarado, G. (2011): Searching for lost frogs of the *Craugastor rugulosus* group: understanding their disappearance and assessing their current population status. *FrogLog* **96**: 28.

Submitted: February 19, 2017. Final revision received: March 24, 2017. Accepted: April 17, 2017.
Associate Editor: Diogo Provete.