

Cave-Dwelling Populations of the Monstrous Rainfrog (*Craugastor pelorus*) from Mexico

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Abstract: Amphibians are known cave dwellers, and a few anurans have shown to make exploratory or opportunistic use of subterranean environments. We report on the use of karst ecosystems and cavernicolous environments by the monstrous rainfrog *Craugastor pelorus* in Chiapas and Tabasco (Mexico). Individuals were found in crevices and wall depressions within the twilight zone of the cave, both during the day and at night. Although threatened by human activities and often severely understudied, caves are the last refugia for some endangered species. This report allows us to extend the known distribution of the species, increase our knowledge on a threatened species, and better understand the biodiversity and ecology of cave environments.

Keywords: amphibians; Anura; karst ecosystem; subterranean habitat; twilight zone; underground



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Amphibians are known to make use of caves and subterranean environments; however, most cases involve salamanders [1,2], with the presence of anurans in those environments often considered accidental [1]. More recently, reports on anurans with cavernicolous habits have been increasing, with studies suggesting that the species might benefit and/or have environmental preferences that allow them to occupy these habitats [3–5].

Caves are differentiated from surface habitats, not only by their limited light availability, but also by microclimatic features, such as higher relative humidity and a stable air temperature [6–8]. This allows for species that are sensitive to temperature changes to have a stable niche [1].

Complex cave systems are well known in the Sierra Norte de Chiapas (Chiapas and Tabasco states), particularly at Selva El Ocote Biosphere Reserve (REBISCO; Tuxtla Gutiérrez) [9,10]. “El Encanto” is a karstic calcium carbonate cave, located in the protected area, characterized by having a thick but irregularly bedded and porous limestone [11]. The climate at REBISCO is warm (with a mean annual temperature over 22 °C) and humid, and the rainfall is abundant throughout the year (with mean annual precipitation between 1500 and 2500 mm) [12–14]. The vertebrate diversity in REBISCO is extremely high (>600 species), including over 20 amphibian species [15,16]. El Encanto is no exception, holding a high diversity of species that are susceptible to environmental changes, such as bats [17].

With a similar climate, the Agua Blanca State Park (PEAB; Macucspana, southern Tabasco) is a 2025 ha tropical rainforest fragment with an important system of underground rivers and caves measuring 5200 m in length [18]. Despite a rich bat community [19], its amphibiofauna has been largely understudied [20]. Here, we report on two populations

of the Monstrous rainfrog *Craugastor pelorus* (Campbell and Savage, 2000), a species with little awareness of its distribution and natural history, making use of karst ecosystems and cavernicolous environments.

Craugastor pelorus is a direct-developing stream-dwelling anuran with a patchy distribution limited to the Chiapas and Tabasco states of Mexico [21–26]. The species is strongly associated with streams from the upper tributaries that flow into the Grijalva and Usumacinta rivers [10,16], and are often limited to premontane and lower montane wet forests [23–25].

In December 2006, an opportunistic survey resulted in the observation of an individual dwelling next to the underground river born out of the Iztac-Ha cave at PEAB (Figure 1; 17.62055° N, −92.47027° W; 300 m a.s.l.). The close proximity to the karst cavernicolous habitat raised the possibility of the species occasionally using, and even sometimes preferring, this kind of ecosystem. Four additional individuals (CNAR-IBH 24471, 24477, 24482, and 24998) were collected by Ernesto Zavala in October 2006 within PEAB, extending the species' known distribution 41.8 km northwest from the Tumbalá municipality in Chiapas [21].



Figure 1. Adult individual of *Craugastor pelorus* (A) (CNAR-RF 763 a-b) found dwelling next to the underground river Iztac-Ha (B) (PEAB, Tabasco, Mexico). Photos by Omar Hernández Ordóñez.

On 1 February 2018 at about 20:30, we found individuals of *Craugastor pelorus* inside the El Encanto cave (REBISCO; 16.75724° N, −93.52513° W, 634 m a.s.l.). This karstic cave has an opening with a width of approximately 5 m, a height of 4 m, and a total area of about 100 m². An underground river flows through the cave and it was possible to see that bats also inhabit the cave. GMR and MMM surveyed the whole entrance of the cave for ca. 45 min using headlamps. The temperature (ca. 25 °C) and humidity recorded (ca. 98%) were much higher relative to those above ground at that time of the year.

During this visit, we were able to record five adult *C. pelorus* in the twilight zone (Figure 2), found approximately 15 m deep inside the cave, resting on depressions and cavities on the rock walls, ranging from 1 to 2.5 m above the ground level. When disturbed, a frog hopped away but then later returned to its original location, suggesting some level of site fidelity in the species. When visiting the cave the following morning, the individuals were hiding in areas of the cave entrance not illuminated by daylight.

This population from El Encanto extends the range 75.7 km west from the Tapilula municipality at “Cascada El Salvador” in Chiapas [21]. Both observations add to an old record from Huimanguillo (Tabasco; 17.396783° N, −93.661617° W; 136 m a.s.l.): the single individual (CNAR-IBH 31683) was collected by Víctor H. Reynoso and Carlos A. Madrazo on 25 March 1998, 65.4 km west from the type locality in the Tenejapa municipality in Chiapas [21], becoming the northernmost record for this species. All collected vouchers were deposited at Colección Nacional de Anfibios y Reptiles (CNAR), Universidad Nacional Autónoma de México.

Little is known about the biology and ecology of *C. pelorus*, and our observations are the first records of cavernicolous habits for this species. Nevertheless, this may also represent

the opportunistic use of subterranean environments, as other frog species were found to inhabit caves for their microclimate conditions and abundance of prey [4]. Therefore, this population needs to be monitored to understand its relation to any variation outside climatic conditions, shedding light on the critical importance of the cave habitat. The use of cave habitats is not novel among the large *Craugastor* Cope 1862 genus [27–29]. *Craugastor psephosypharus*, which belongs to the same taxonomic group (*C. rugulosus* group), unlike most species in that group, inhabits karstic zones with old-growth tropical rain forests inside cavities but far from streams [30,31]. Thus, in conjunction with this observation, the behaviour might be more widespread than previously thought.

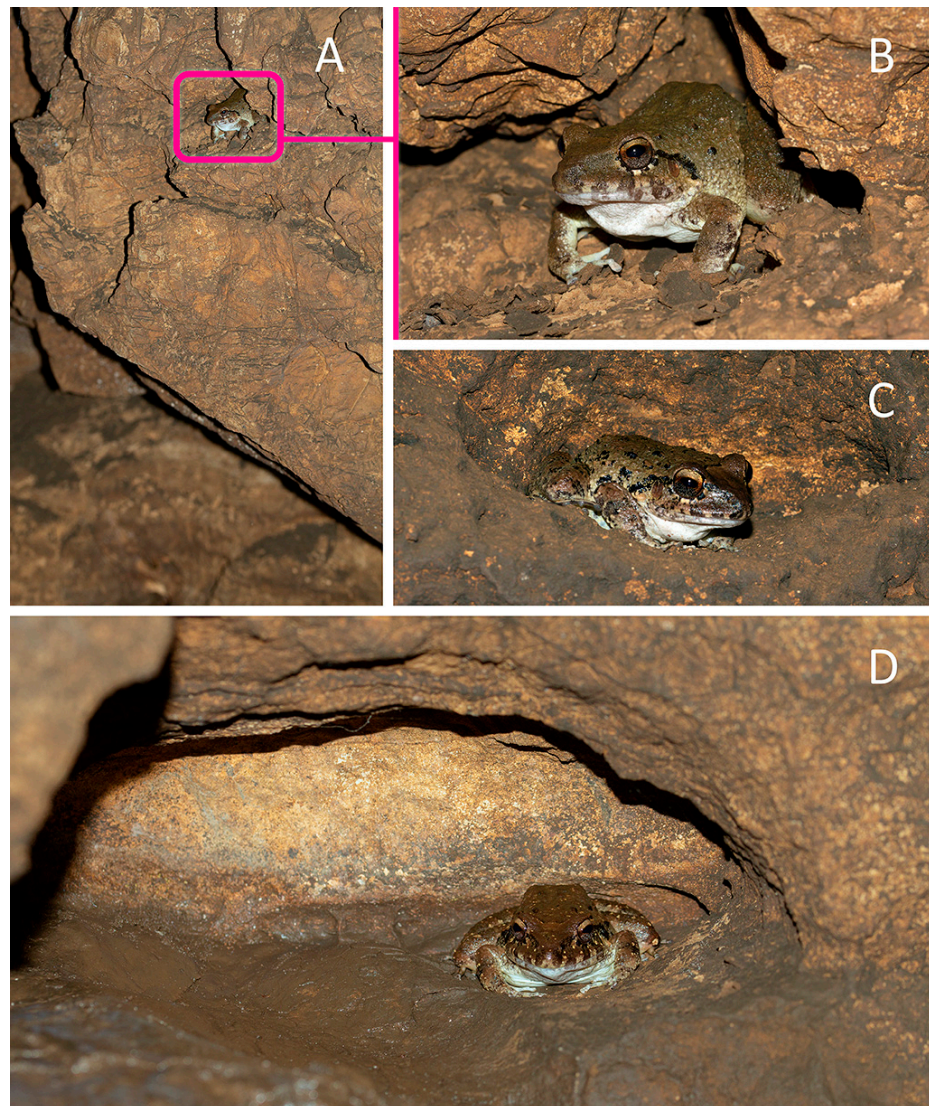


Figure 2. Adult individuals of *Craugastor pelorus* found inhabiting El Encanto cave (REBISCO, Tuxtla Gutiérrez, Chiapas, Mexico). (A,B). Male hiding in a cavity on the rock wall at about 2 m above the ground (CNAR-RF 764a and 764e). (C). Individual resting on a pocket on the wall (CNAR-RF 766e). (D). Individual resting in a cavity on the rock wall (CNAR-RF 767d). Photos by Gonçalo M. Rosa.

Lastly, *Craugastor pelorus* is a vulnerable species mostly threatened by habitat fragmentation and destruction [22]. Caves can act as the last refugia for some threatened species, yet decline in amphibian cave-dwelling populations, have also been reported in Mexico, and have been linked to threats such as the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) [32]. Moreover, these habitats are also threatened by human activities, including deforestation, mining, or even tourism and climate change [6,33–39]. An increase in

the knowledge of subterranean biodiversity, as well as their ecology and use of the cave environment, is a fundamental asset to support the conservation of these fragile and unique habitats [6].

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Data Availability Statement: All available data is shared in the main text of this article.

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