



On the Critically Endangered Cofre de Perote Salamander (*Isthmura naucampatepetl*): discovery of a new population in Puebla, Mexico, and update of its known distribution

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Abstract.—The presence of the Cofre de Perote Salamander, *Isthmura naucampatepetl*, in the state of Puebla, Mexico, is confirmed based on a population found during recent forestland surveys. The new population is the largest known for the species, including at least 26 individuals. Information about the size, weight, and color pattern variations is provided for this rarely seen species, and its distribution and conservation needs are briefly discussed.

Keywords. Amphibia, Caudata, confirmation, color pattern, lost species, Plethodontidae

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Introduction

Amphibians are one of the vertebrate groups in which the current mass extinction episode is most evident (Bishop et al. 2012). The Zoological Society of London identified 100 priority amphibian species as Evolutionarily Distinct and Globally Endangered (i.e., “EDGE species”), and the Amphibian Survival Alliance lists 34 Lost Species of amphibians (ZSL 2008; García-Bañuelos et al. 2017). Among salamanders, the IUCN lists 57 Mexican species as Critically Endangered (IUCN 2020), one of which is the Cofre de Perote Salamander (*Isthmura naucampatepetl*).

A member of the *Isthmura belli* complex (Parra-Olea et al. 2005), *I. naucampatepetl* was described based on five specimens, all of which were collected in 1981 on a narrow ridge extending east from Cofre de Perote and terminating in a small peak (Cerro Volcancillo) in the Sierra Madre Oriental of central Veracruz, México. The collecting locality was Cerro Las Lajas on the slopes of Cofre de Perote, and Cerro Volcancillo (Parra-Olea and Wake 2001; Parra-Olea et al. 2005; IUCN 2020). Recently, *I. naucampatepetl* was recorded at two localities in Puebla State, and those records were uploaded into the Naturalista, CONABIO portal ([https://www.naturalista.](https://www.naturalista.mx/)

[mx/search?q=Isthmura%20naucampatepetl](https://www.naturalista.mx/search?q=Isthmura%20naucampatepetl); Accessed: 1 September 2019). The photographs were taken on 6 October 2015 in the Municipality of Teziutlán, near the localities of San Juan Acateno and Atoluca, and published in the Naturalista website without precise locality information. Therefore, this vague record was not included in the most recent cataloging of the herpetofauna of Puebla (Woolrich et al. 2017).

Only very limited information on this species has been available thus far, based on only seven specimens from four localities. This article provides data from the largest known population of the species (26 individuals) which was found in a new locality in Puebla, Mexico, confirming the presence of *I. naucampatepetl* in this state. Herein we provide novel data on the size, weight, and color pattern variations of this enigmatic species, and briefly comment on relevant conservation implications.

Materials and Methods

Surveys were conducted on 20 forested lands of the Unidad de Manejo Forestal (UMAFOR 2103-Teziutlán) in the Sierra Norte of Puebla, including the zone Bienes Comunes San Mateo Chignautla, in the Municipality

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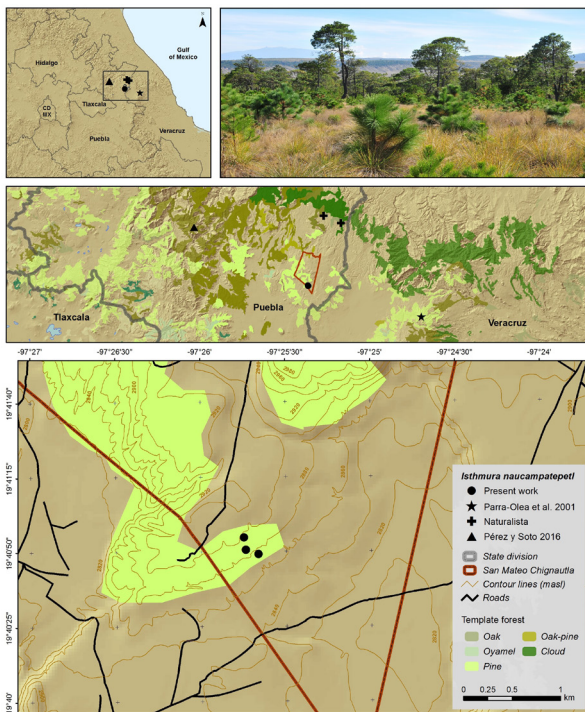


Fig. 1. Distribution maps of *Isthmura naucampatepetl*. Black circles represent published records, star represents the new population in the Municipality of Chignautla, Puebla, Mexico. The photograph shows the habitat at the new population. Photo by L. Fernández-Badillo.

of Chignautla, state of Puebla, México (Fig. 1). The zone Bienes Comunales has an area of 5,740.2 ha, of which 969.33 ha are earmarked for wood harvesting. The work presented here formed part of the project *Estudio regional de fauna en bosques de producción de la UMAFOR 2103 Teziutlán, Puebla, México* (WFC and ARST 2018). Field work was authorized by SEMARNAT permit SGPA/DGVS/07199/17.

All captured *I. naucampatepetl* individuals were measured, weighed, and photographed in the field, and subsequently released at the original collection site. Measurements of length were taken using a digital caliper, and weights were obtained using an electronic pocket scale (max. 500 g, min. 0.1 g). Length measurement abbreviations are as follows: SVL = snout-vent length; TL = tail length; and T = total length. A photograph of one salamander was deposited in the photographic collection of the Herpetological Collection of the Biological Research Centre of the Autonomous University of Hidalgo (CH-CIB).

A bibliographic review of the available information on this species was also performed. This review includes information from a record provided by Pérez y Soto (2016), who presented a photograph and data for some specimens identified as *I. gigantea*, but they actually correspond to *I. naucampatepetl*. Additional records in the Naturalista database (Naturalista CONABIO 2020) are also included. This information serves to comprehensively update the known distribution of this species.

Results

Field records. The first salamander was observed on 6 July 2017 (CH-CIB 117; Figs. 1,2a) under a rock in grassland habitat at ca. 1100 h (19.70668°N, -97.43773°W; WGS 84), elevation 2,879 m. On 16 September 2017, 25 additional salamanders were found in a grassland habitat with some reforested pine trees at around 1700 h (19.680720°N, -97.428987°W; WGS 84), elevation 2,918 m (Fig. 1). Ten of these salamanders were found under bunch grass, another six were found ca. 30 m away under a dry *Yuca*, seven more were found ca. 15 m away under another dry *Yuca*, and two additional salamanders were found under a rock.

Morphological description. Among the 26 captured *I. naucampatepetl*, SVL spanned 23–83.2 mm (mean \pm SD: 77.86 ± 10.75), TL varied from 0–73.4 mm (67.47 ± 10.18), T ranged from 23–156.6 mm (145.33 ± 20.93), and weight varied from 0.1–23 g (10.86 ± 2.83 ; Table 1). One individual with no tail had the smallest SVL value. Four of the 26 animals (with SVL ranging from 62.4–85 mm; Table 1) had clearly visible rounded mentonian glands and prominent nasolabial protuberances, suggesting they were sexually mature males. Another six animals were greater than 62.4 mm in SVL (range: 69.5–83.2 mm; Table 1), but lacked both mentonian glands and prominent nasolabial protuberances, so we concluded that they were adult females. The remaining salamanders were smaller than the smallest sexually mature male, so we considered them to be juveniles of undetermined sex.

Color pattern variation. All 26 captured *I. naucampatepetl* display a solid black body color with pale marks; these marks are orange in smaller individuals and pink or pinkish cream in larger individuals (Fig. 2). In all animals, the pale marks are arranged in a consistent pattern as follows: a pair of spots on the back of the head that vary in size, but are usually about the diameter of the orbit; a pair of inverted, rather elongated triangular marks on the shoulders; one to 11 pairs of small spots positioned dorsolaterally on the intercostal areas of the trunk; and a large, conspicuous mark on the caudosacral region that resembles a pelvis bone, ranging from a rounded to more quadrangular U-shape, and always with two small, rounded black marks. In addition, some individuals show one or two rounded orange, pink, or pinkish-cream spots in the nuchal region. The venter is pale to dark gray, and the mentonian gland in adult males is pale gray (Fig. 2).

Literature records. The work of Pérez y Soto (2016) reported some records and a photograph of a salamander found in Tetela de Ocampo, Puebla, Mexico, which was misidentified as *I. gigantea* but actually corresponds to *I. naucampatepetl*. Two of those specimens were deposited in the Herpetological Collection of the Zoological Museum Alfonso L. Herrera (MZFC 28819–20). That

Isthmura naucampatepetl in Puebla, Mexico

Table 1. Morphological measurements of *Isthmura naucampatepetl* from the Municipality of Chignautla, Puebla, Mexico. Snout-vent length = SVL, tail length = TL, total length = T, all measurements in mm. Note: Specimen numbers match the numbers of photographs in Fig. 1.

Specimen number	Sex	SVL (mm)	TL (mm)	T (mm)	Weight (g)
1	Female	83.8	69	152.8	3
2	Female	83.2	73.4	156.6	23
3	Female	78.2	73	151.2	14
4	Female	78.1	69.8	147.9	11
5	Male	66.9	60.1	127	9
6	Male	85	70.7	155.7	10
7	Female	69.8	56.3	126.1	6
8	-	52.3	46.7	99	5
9	-	59.7	45.3	105	5
10	-	54.4	33.5	87.9	4
11	-	48.6	34.7	83.3	3
12	-	59.7	45	104.7	4
13	Female	69.5	56.7	126.2	9
14	-	47.9	26	73.9	4
15	-	60.9	42.5	103.4	6
16	Male	63.7	44.9	108.6	6
17	-	34	22.3	56.3	1.5
18	Female	73.8	54.7	128.5	5
19	Male	62.4	43.2	105.6	3
20	-	38.2	23.2	61.4	1
21	-	37.3	21.5	58.8	0.5
22	-	40.5	21.4	61.9	1
23	-	22.3	11	33.3	0.2
24	-	23	0	23	0.1
25	-	61.9	46.7	108.6	4.5
26	-	56.1	38.8	94.9	3
Mean		77.86	67.47	145.33	10.86
SD		10.75	10.18	20.93	2.83

author did not include the precise number of the observed individuals, but she described it as a “common species,” a category assigned in that work to the species with an abundance of 12–22 individuals.

Naturalista records. As mentioned above, this review includes the two records for *I. naucampatepetl* that were uploaded into the portal Naturalista, CONABIO (<https://www.naturalista.mx/search?q=Isthmura%20naucampatepetl>; Accessed: 1 September 2019). These photographs were taken on 6 October 2015 in the Municipality of Teziutlán, near the localities of San Juan Acateno and Atoluca, and they were published in Naturalista without precise locality information (Fig. 1, plus signs).

Habitat description. The site where the new population of *I. naucampatepetl* was found is (currently) under forest

management, which includes various activities such as fire protection, reforestation, soil conservation and restoration, and wood harvesting. All the forest management in the area is performed according to the standard methodologies in México as specified in *Método Mexicano de Ordenación de Bosques Irregulares* and the *Método de Desarrollo Silvícola*. In the specific site of specimen collection, the landscape is dominated by trees of the genera *Pinus*, *Quercus*, *Abies*, and *Alnus*, that vary in size and age, within ranges of 1.5–38 m high and 1–60 years old.

Discussion

Isthmura naucampatepetl was recently rediscovered in the state of Puebla, with two photographs uploaded in the Naturalista portal and cited by Aguilar-López et al. (2019). The work reported here confirms the presence of the species in another population in Puebla for the first time (García-

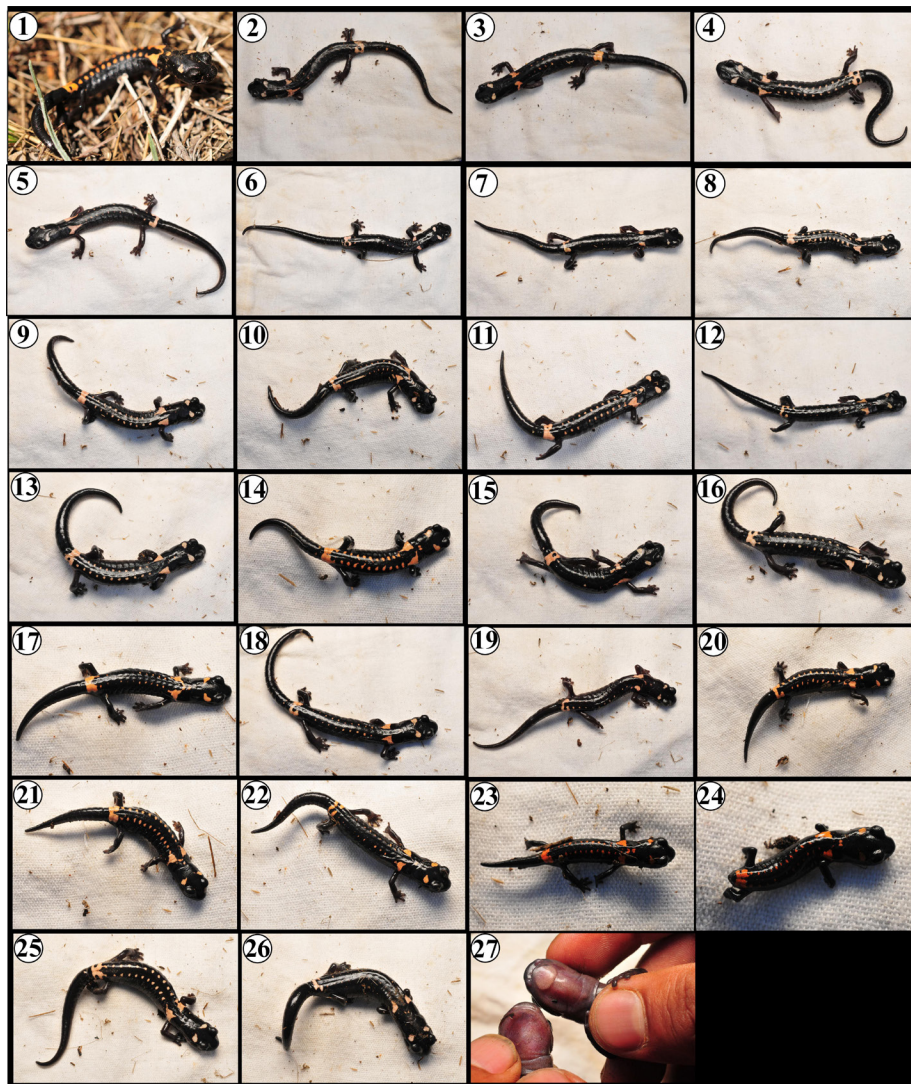


Fig. 2. Color patterns of each captured *Isthmura naucampatepetl* individual. Photo numbers correspond to the specimen numbers given in Table 1. Photo 27 is a ventral view of the chins of an adult female (left) and an adult male (right), showing the male mentonian gland. Photos by L. Fernández-Badillo.

Vázquez et al. 2009; Woolrich-Piña et al. 2017) and records the highest number of individuals reported for any known population. These records extend the geographic distribution of the species by 75.43 km from the report of Pérez y Soto (2016), 38 km from the reports of Naturalista, and 36.9 km (field records) from the type locality (Parra-Olea and Wake 2001; Parra-Olea et al. 2005). These records show this species has a wider distribution in the Sierra Norte of Puebla than was previously known, so additional search efforts in other regions of this area, with similar environmental and microhabitat conditions, could potentially reveal other populations and provide valuable data on the natural history of this rarely-encountered species.

During the field work for this study, many individuals of *I. naucampatepetl* were found grouped together, but we are currently unable to explain the reason for this behavior. However, local residents mentioned that in the previous year they unearthed a congregation of ca. 50 individuals

of the species while extracting soil near the area where our *I. naucampatepetl* were encountered, suggesting that this behavior may be a regular occurrence.

The color pattern of the 26 individuals found generally agrees with the description available in Parra-Olea and Wake (2001), but some variations are described above and clearly evident in Fig. 2. The data from this population modestly increase the maximum known SVL of adult females from 82.9 mm (Parra-Olea and Wake 2001) to 83.2 mm. For males, Parra-Olea and Wake (2001) reported that sexually mature individuals vary from 67.6–82.1 mm SVL, a range that our data broadens (62.4–85 mm SVL).

This contribution increases our knowledge of the species regarding its conservation. The IUCN (2020) indicates a decreasing current population trend for *I. naucampatepetl*. In contrast, we recorded a strong signal of demographic variability in the newly discovered population, including two individuals of less than 50 mm T, nine of 56.3–99

mm T, and 15 of 103.4–156.6 mm T. This size variation distribution suggests that the population is actively reproducing, but more observations and long-term study are necessary to rigorously assess the population size and trends in this species.

The IUCN (2016) identifies extensive logging, farming (especially for potatoes), and expanding human settlements as the major threats to *I. naucampatepetl* at the type locality in Veracruz. At the new locality (Bienes Comunales San Mateo Chignautla, Puebla), the land owners have a legal permit to sell wood from the forest, but we also detected some other disturbances (like cattle, feral and domestic dogs, some threats inherent to the forest management, and also wildfires) which can pose risks for this species.

Adequate protection of this species would benefit from the inclusion of management actions specifically related to *I. naucampatepetl* in an updated forest management plan, and perhaps the establishment of conservation areas where timber extraction can be limited. To better inform decisions on how to preserve this newly discovered population, there is an urgent need to acquire basic natural history and population data. It is also imperative to educate the local inhabitants about the global importance of this salamander and the need to conserve it. Grassroots buy-in is necessary for any successful conservation strategy, as is involvement by governmental and non-governmental stakeholders. If coordinated in alliance with local residents and landowners, and linked with forest management strategies, we can show that the conservation of *I. naucampatepetl* and the sustainable use of the forest go hand in hand.

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