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Short Communication

Ecological observations of *Chiropterotriton chiropterus* (Caudata: Plethodontidae), an endangered salamander from Mexico

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Chiropterotriton chiropterus (Cope, 1863) is a species of plethodontid salamander, endemic to Mexico, listed as Critically Endangered by the IUCN (Parra-Olea *et al.* 2008, 2020, IUCN 2021) and under special protection by national regulation NOM-059 (SEMARNAT 2010). Its known distribution extends from the municipality of Huatusco in northeast Veracruz, the type locality, southward to the northern part of the Sierra Madre de Oaxaca, with a reported elevational range of 1400 to 2170 m a.s.l. (Parra-Olea *et al.* 2020). In Oaxaca, there are currently 79 records of *C. chiropterus* observed between 1958 and 2020 (Parra-Olea *et al.* 2020, GBIF 2022) although available ecological information for the species is scarce. Habitat loss, emerging diseases, land use change, and the deterioration of its microhabitat due to the removal of bromeliads for cultural purposes have been proposed as its main threats (IUCN 2021).

We report ecological data for six new records of *C. chiropterus* from the community of "La Esperanza" in the municipality of Santiago Comaltepec (17°37'41.88" N, 96°22'5.88" W, Datum WGS84), in the physiographic subprovince of the Sierra Madre de Oaxaca (Ortiz-Pérez *et al.* 2004). This locality is within the cultural region of La Chinantla, considered to be one of the most complex in Mexico, mainly due to its orography, diversity of climates, and types of ecosystems including the montane cloud forest that stands out for its biodiversity and endemism (Gual-Díaz and Rendón-Correa 2014,

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Simón-Salvador *et al.* 2021, Tobar-Suárez *et al.* 2021). Temperatures at the site vary from 21.6°C to 28.2°C with an average rainfall of 10.5 mm to 211 mm per month during the dry season (December to May). During the wet season, temperatures vary from 11.9°C to 19.1°C with an average rainfall of 201 mm to 481 mm per month (June to November) (Prediction of Worldwide Energy Resources 2022). All reported organisms were found active at night during the dry season (Table 1). The sex and age were determined according to size and presence or absence of mental glands (Petranka 1998).

We observed the first specimen (Id1), an adult male (Figure 1A), near a permanent stream (17°35'25" N, 96°23'33" W; Datum WGS84). It was on a leaf of *Palicourea padifolia* (Humb. & Bonpl. ex Roem. and Schult.) C.M. Taylor and Lorence a native herbaceous plant at a height of 1 m from the ground and at a distance of 80 cm from the water. The stream had the following characteristics: riverbed, 70 m long and 1.76 m wide, obtained with a flexometer (Truper TFC-50), and speed of the water, 0.7 m/s, measured with a digital flowatch (JDC Electronics) (Figure 1B).

The second specimen, an active juvenile at the same stream (Id2), was observed moving on the leaf of a fern *Diplazium* sp. Sw. at a height of 40 cm from the ground (Figure 1C). It was found at 1.20 m from the highway (17°35'25" N, 96°23'33" W, Datum WGS84) (Figure 1D). At another stream (17°35'20" N, 96°23'45" W, Datum WGS84) we observed two more juvenile specimens (Id3 and Id4) and two adults (Id5 and Id6). The first juvenile (Id3) was on a native herbaceous plant, *Miconia* sp. Ruiz and Pav., at a height of 35 cm from the ground and 86 cm from the stream. The second juvenile (Id4) was on a leaf of a fern *Diplazium* sp. above the stream at 1 m from the water. The first adult was a female (Id5) positioned on a mossy log above the stream at a height of 35 cm from the water. Finally, the second adult was a male (Id6) found climbing the stem of a leaf of *Miconia* sp. above the stream at a height of 1.5 m from the water.

Table 1. Environmental and morphometric data for the six individuals of *Chiropterotriton chiropterus* found in La Esperanza. Relative Humidity (RH), Dew Point (DP), Barometric Pressure (BARO), and vapor pressure deficit (VPD) are listed along with other environmental variables.

Individual	Life stage/ Sex	Date	Time	Elevation (m a.s.l.)	Mass (g)	SVL (mm)	Tail length (mm)	Total length (mm)	Body temperature (°C)	Substrate temperature (°C)	Ambient temperature (°C)	RH (%)	DP (°C)	BARO (InHg)	Wind speed (m/s)	Canopy cover (%)	VPD (kPa)
Id1	Adult male	17 Feb 2022	20:50	1890	1.0	32.0	31.0	63.0	11.6	11.8	11.9	82.5	9.6	23.8	0.4	93.0	24.53
Id2	Juvenile	18 Feb 2022	22:15	1825	0.3	24.0	20.0	44.0	9.8	10.0	10.6	86.7	9.4	24.0	0.3	87.4	17.44
Id3	Juvenile	30 Apr 2022	23:36	1986	0.5	27.0	24.4	51.4	13.8	13.6	15.6	81.8	12.5	23.8	0.3	96.2	33.08
Id4	Juvenile	30 Apr 2022	23:46	1988	0.9	28.8	30.0	58.8	12.8	12.6	18.0	71.7	12.5	23.8	0	95.9	58.41
Id5	Adult female	01 May 2022	00:05	2027	1.9	32.8	40.0	72.8	12.6	12.5	18.8	71.7	12.5	23.8	0	97.0	39.67
Id6	Adult male	01 May 2022	01:20	2026	2.3	41.0	51.0	92.0	14.3	14.2	20.7	74.0	15.0	23.7	0.1	97.8	36.45

Figure 1. (**A**) Adult male of *Chiropterotriton chiropterus* perching on a plant (*Palicourea padifolia*) over a perennial stream. (**B**) Perennial stream in the community of La Esperanza, Oaxaca**.** (**C**) Juvenile of *Chiropterotriton chiropterus* climbing on a plant (*Miconia* sp.) near the highway. (**D**) Federal highway 175 that crosses through La Esperanza, Oaxaca. Photographs by Carlos A. Flores (A and B) and Medardo Arreortua (C and D).

The environmental characteristics recorded on the site at the time of each encounter were: environmental temperature (TEMP), relative humidity (RH), dew point (DP), barometric pressure (BARO), and wind speed. Measurements of these variables were taken using a portable meteorological meter (Kestrel 3500 Pocket weather meters). Canopy cover data were taken using a concave mirror densiometer (Lemmon 1956), and the vapor pressure deficit was calculated using the formula VPD = [(100 - HR).SVP] / 1000, where SVP is saturated vapor pressure (Ludwig 1945).

From these observations we conclude the following: (1) canopy cover plays an important role for this species. All individuals in this study were found at sites with 87% or greater canopy cover. Tree composition influences the presence of salamanders because it provides them with favorable microclimates to take refuge and feed (McEntire 2016, Aguilar-López *et al.* 2017). (2) As expected, as the dry season advances, the drying capacity of the air increases as reflected in the VPD measurements. This variable may influence the salamanders' use of microhabitat and thus periods of activity because plethodontid salamanders depend exclusively on moisture in their skin for gas exchange (Gatz *et al.* 1975, Feder and Londos 1984). We observed more salamanders near the water on the driest nights (high values of VPD). Despite the high values of VPD, resistance to dehydration of this species may increase in high-temperature conditions (Table 1), which has been observed in other species of plethodontids (Riddell and Sears 2015). (3) Although this species has been associated with bromeliads (McEntire 2016, Parra-Olea *et al.* 2020), we found all individuals on top of leaves, branches, or trunks not higher than 0.76 m above the ground. Only one individual (Id2) was away from water. However, this site had the highest percentage of humidity, the lowest temperature, and the lowest VPD values in relation to the sites where the other five individuals were found close to water (Table 1). These observations suggest that periods of activity of this species seem to correlate with low-temperature nights, when they are active for some hours before retreating to their shelters in the canopy and bromeliads to escape adverse conditions during the day (Ruano-Fajardo *et al.* 2014, Riddell and Sears 2015, McEntire 2016).

Currently, montane cloud forests are one of the most threatened ecosystems worldwide, mainly due to deforestation, climate change, and land use change (Toledo-Aceves *et al.* 2011). The physiographic subprovince of the Sierra Madre de Oaxaca has some of the best-preserved areas of montane cloud forest in Mexico, although logging for different purposes is still a frequent threat in some areas (Gual-Díaz and Rendón-Correa 2014). Communal efforts to protect montane cloud forests play a major role in the conservation of optimal habitat for native herpetofauna (Simón-Salvador *et al.* 2021, Tobar-Suárez *et al.* 2021). The community of La Esperanza conserves 4421 ha of mostly montane cloud forest by the Indigenous and Community Conservation Areas (ICCA's) modality (CONANP 2020). This conservation measure protects the existence of areas where many endemic amphibians find the necessary resources for their survival, such as perennial streams, connected habitats, forests with good canopy cover, and favorable undergrowth conditions. However, La Esperanza is crossed by a federal highway that runs from Oaxaca City to Tuxtepec (Figure 1D). We have observed people that use this highway extracting herbaceous plants from the roadside, dumping garbage in the forest and streams, and abandoning domestic animals like cats and dogs which become feral, threatening small vertebrates like the herpetofauna. These activities pose notable threats to the native amphibians of La Esperanza and must be addressed to support the admirable conservation efforts of the community.

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