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Distribution extension and first verified records for Narrow-bridged Musk Turtle, *Claudius angustatus* Cope, 1865 (Testudines, Kinosternidae) in the Selva Lacandona, Mexico

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Abstract

We document the first verifiable records of *Claudius angustatus* Cope, 1865 in the Selva Lacandona, Chiapas, Mexico. Three individuals were observed in different types of anthropic land covers. These records are the most recent observations of *C. angustatus* in the southeastern zone of its range in more than 20 years, thus representing the southernmost known occurrences of this species. With these records we confirm the long-suspected presence of *C. angustatus* in the region, increasing the number of reptile species in the Selva Lacandona to 91.

Keywords

Distribution extent, Kinosternoidea, Mesoamerica, reptiles, southern Mexico, tropical rainforest

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Introduction

Claudius angustatus (Cope, 1865), Narrow-bridged Musk Turtle, is one of the 18 species of the family Kinosternidae recorded in Mexico (Legler and Vogt 2013). *Claudius angustatus* is the only representative of its genus (Uetz et al. 2020), and one of the three species of the subfamily Staurotypinae (Iverson et al. 2013). Its distribution encompasses hot and humid lowland areas of Mexico, Belize, and Guatemala (Lee 1996; Vogt 1997; Campbell 1998; Legler and Vogt 2013), although it also occurs in semi-arid and dry tropical climates (Calderón-Mandujano 2002). In Mexico, this species is mainly distributed around the coastal plain of the Gulf of Mexico, from Veracruz to the Yucatan Peninsula (Cázares 2015; Reynoso et al. 2016) at elevations below 300 m. In

Guatemala and Belize, this species is rare, and the last verified records date from the mid-1990s according to published sources (Lee 1996; Campbell 1998; Platt and Rainwater 1998).

Claudius angustatus is a freshwater turtle that can reach a shell length of 120–170 mm and a weight of 350–600 g (Campbell 1998; Lee 2000; Legler and Vogt 2013). It inhabits streams, swamps, and temporary or permanent ponds with muddy bottoms (Campbell 1998; Lee 2000; Legler and Vogt 2013). This species presents sexual dimorphism, and males are larger, have bigger heads, longer and thicker tails than females, and fastening organs on the rear appendages, particularly on the tail (Campbell 1998; Lee 2000; Legler and Vogt 2013). During the dry season from March to May, *C. angustatus* estivates, remaining hidden underground or in the mud, and during the rainy season from June to November, individuals emerge and start the courtship and the reproduction period (Flores-Villela and Zug 1995; Legler and Vogt 2013). Females usually have one or two clutches per season and lay from one to six eggs in each clutch, which they deposit underground in sites with vegetal covering (Flores-Villela and Zug 1995; Campbell 1998). This species feeds on a wide diversity of arthropods, mollusks, frogs, aquatic vegetation (Vogt 1997; Lee 2000), and even on other turtle species (Vásquez-Cruz and Reynoso-Martínez 2020). At the same time, *C. angustatus* is part of the diet of mammals (e.g., raccoons), reptiles (e.g., crocodiles), and birds (e.g., *Caracara cheriway*; Lee 2000; Legler and Vogt 2013; Reynoso et al. 2016).

Habitat loss and degradation are major threats to populations of *C. angustatus* (Cázares 2015; Reynoso et al. 2016), but it is also threatened by illegal hunting for meat consumption and by the capture of specimens for sale as pets (Flores-Villela and Zug 1995; Calderón-Mandujano 2002; Legler and Vogt 2013; Cázares 2015; Reynoso et al. 2016). Furthermore, freshwater turtle populations are negatively impacted by road mortality (Gibbs and Shriver 2002; Aresco 2005). Due to population declines and local extinctions of *C. angustatus* in Mexico, it is classified as Endangered by the Mexican government (SEMARNAT 2010) and is assessed as Near Threatened in the IUCN Red List (IUCN 2020).

The Selva Lacandona is an important biodiversity hotspot (Medellín 1994; Myers et al. 2000) and is one of the Mexican regions with highest diversity of reptiles, with at least 90 species according to the most recent checklist (Hernández-Ordóñez et al. 2014, 2015). Seven of these reptiles are turtles, belonging to the families Kinosternidae (*Kinosternon acutum*, *K. leucostomum*, *Staurotypus triporcatus*), Chelydridae (*Chelydra rossignoii*), Dermatemidae (*Dermatemis mawii*), Geomydae (*Rhinoclemmys areolata*), and Emydidade (*Trachemys scripta*). However, the region has been poorly studied, and the reptile inventory remains incomplete (Lazcano-Barrero et al. 1992; Hernández-Ordóñez et al. 2014). Previous publications suggest the presence of *C. angustatus* in the Selva Lacandona (e.g., Lazcano-Barrero et al. 1992; Lee 1996; Hernández-Ordoñez et al. 2015). Legler and Vogt (2013) included the Selva Lacandona within the distribution range of *C. angustatus*, and Ramírez et al. (2015) reported the presence of the species in the Montes Azules Biosphere Reserve, which is located in the same region. However, no study to date has provided voucher specimens to confirm this species' presence. Here, we provide the first verifiable records of *C. angustatus* from the Lacandona region. Our new records were documented in the municipality of Marqués de Comillas, an unprotected part of the Selva Lacandona.

Methods

The Selva Lacandona is located in the southeastern part of the Mexican state of Chiapas (Fig. 1). The southernmost portion of the Selva Lacandona borders Guatemala and is occupied by the municipality of Marqués de Comillas (16°15′51″N, 090°37′16″W – 16°04′26″N, 090°57′36″W). The predominant vegetation is tropical rainforest, and the matrix surrounding the forest patches is highly heterogeneous, as it is composed of old-growth forests fragments, secondary forests, annual crops, cattle pastures, human settlements, and rubber, cocoa, and oil palm plantations (San José et al. 2019). According to the Köppen climatic classification, Marqués de Comillas is located within the Tropical Equatorial Climate, with a mean annual temperature of 24–26 °C and a mean rainfall of 2500–3500 mm (INE 2000). Although rain occurs throughout the year, the region has a marked dry season between January and May.

We recorded three individuals of *Claudius angustatus* while monitoring the herpetofauna community in various land covers (i.e., old-growth forest patches, secondary forests, oil palm plantations, and cattle pastures). The sampling method consisted of visual encounter surveys, carried out both during the day (9:00–13:00 h) and at night (18:00–22:00 h). Only one individual was captured, and it was photographed using a Cannon PowerShot SX510 HS. Its carapace length (CL) was measured using dial calipers. The images of the captured individual were deposited in the photographic records database of the Colección Nacional de Anfibios y Reptiles, from the Instituto de Biología, at the Universidad Nacional Autónoma de México (CNAR-IBH-RF).

We used information from previous records available on the GBIF platform (GBIF 2021) to delineate the current distribution of *C. angustatus* in Mexico, Belize, and Guatemala. We also added information from scientific collections (e.g., El Colegio de la Frontera Sur, Instituto de Historia Natural y Ecología) and the scientific literature (e.g., Lee 1996; Ravell-Ley et al. 2017; Vásquez-Cruz and Reynoso-Martínez 2020). Only reliable information and accurate coordinates coming from scientific institutions and published articles were considered; these data are summarized in Appendix Table A1 and in Figure 1A. This map was prepared with ArcGis v. 10.5.

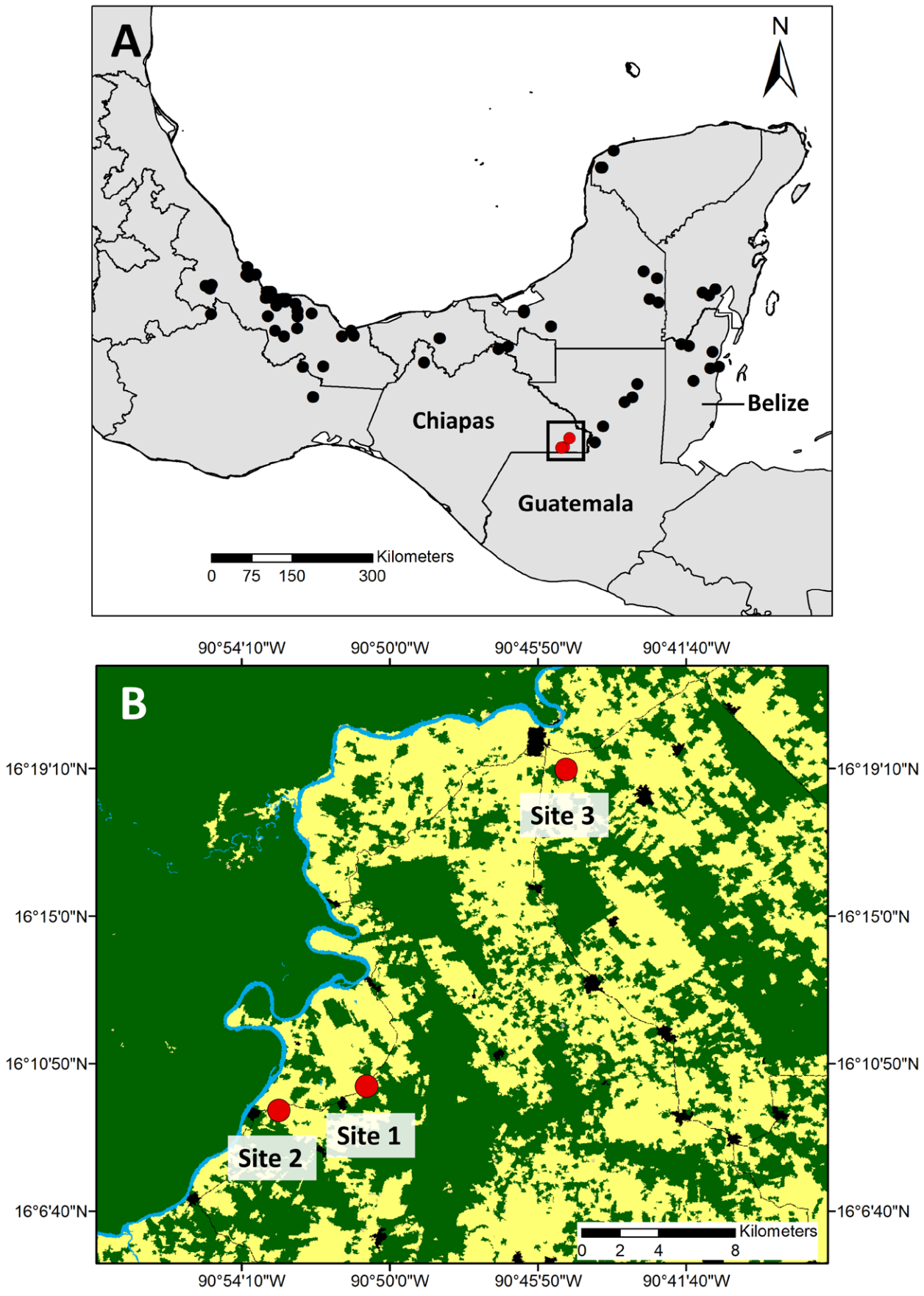

Figure 1. Distribution of *Claudius angustatus* in Mexico, Belize and Guatemala. **A.** Geographic distribution of the species based on literature records. **B.** New records of *C. angustatus* in the Selva Lacandona, Chiapas. Green coverage = mature forest; light yellow = anthropic matrix; black = human settlements; black dots = literature records; red dots = new records.

Results

New record. MEXICO – **Chiapas** • municipality of Marqués de Comillas, Galacia; 16°19′08″N, 090°45′02″W; 150 m elev.; 20.VIII.2018; Cervantes-López M.J., Soriano López A. obs.; found on an asphalt road in the morning (09:33 h); 1 adult ♂, CNAR-IBH-RF 631.

Identification. This turtle species is characterized by the following diagnostic characters: upper jaw with a pair of sharp maxillary cusps; head large, with strong hooked jaws; chin with a pair of barbels; carapace oval, with three evident dorsal keels; plastron reduced in size (Fig. 2D), cruciform, with narrow bridge, and without movable hinges; eight paired plastral scutes; feeth with webbed digits; tail long, ending in a keratinized spine; shell dark brown; plastron with yellow hue; head dark gray, with several light spots; jaws yellow, with black stippling; skin of the neck pale gray and cream; and iris brown (Fig. 2A–D). The specimen was an adult male 107 mm CL (Fig. 2A–D). The specimen was identified following the keys by Legler and Vogt (2013), and our identification was later corroborated by Adriana González-Hernández from the CNAR-IBH-RF.

Our review revealed 84 records of *Claudius angustatus* (Fig. 1A, Appendix Table A1), of which 88% are from Mexico, 6% from Belize, and the remaining 6% from Guatemala. Our new records (Fig. 1B) increase the distribution of the species in Chiapas 200 km to the southeast and are also the southernmost records of this species (Fig. 1A). Our new records are located approximately 60 km southeast from the closest previously known record in Chinajá, El Petén, Guatemala. An adult male was observed over a road near an old-growth rainforest fragment close to the Galacia village (Marqués de Comillas, Site 1 in Fig. 1B). Two other specimens were observed near the villages of Playón de la Gloria and Pico de Oro, both located in the Marqués de Comillas municipality (Sites 2 and 3 in Fig. 1B) in two different land covers (oil palm plantations and secondary forests), but they could not be captured or photographed.

Discussion

Our new records of *Claudius angustatus* in Marqués de Comillas municipality represent the southernmost records of this species, increasing its southern geographic distribution by approximately 12 km in a straight line from the previous southernmost record in Chinajá, El Petén, Guatemala, which is approximately 60 km northeast from the individual captured in Galacia (Lee 1996). The new records also extend the distribution of the species in the state of Chiapas by 200 km southeast from the nearest location in Catazajá, Chiapas (Lee 1996). With presence of this species now confirmed in the municipality of Marqués de Comillas, a large distributional gap is filled between the reported populations of the Gulf of Mexico and northern Chiapas and those of El Petén, northern Guatemala (Lee 1996; Campbell 1998). Given the current knowledge of this species' distribution, we expect its presence in eastern Chiapas, especially within the basin of the Usumacinta River and within the Montes Azules Biosphere Reserve.

The distribution of *C. angustatus* is mainly concentrated in the southern part of the Gulf of Mexico, and most of the known records are from coastal locations. Thus, our new records represent the furthest records

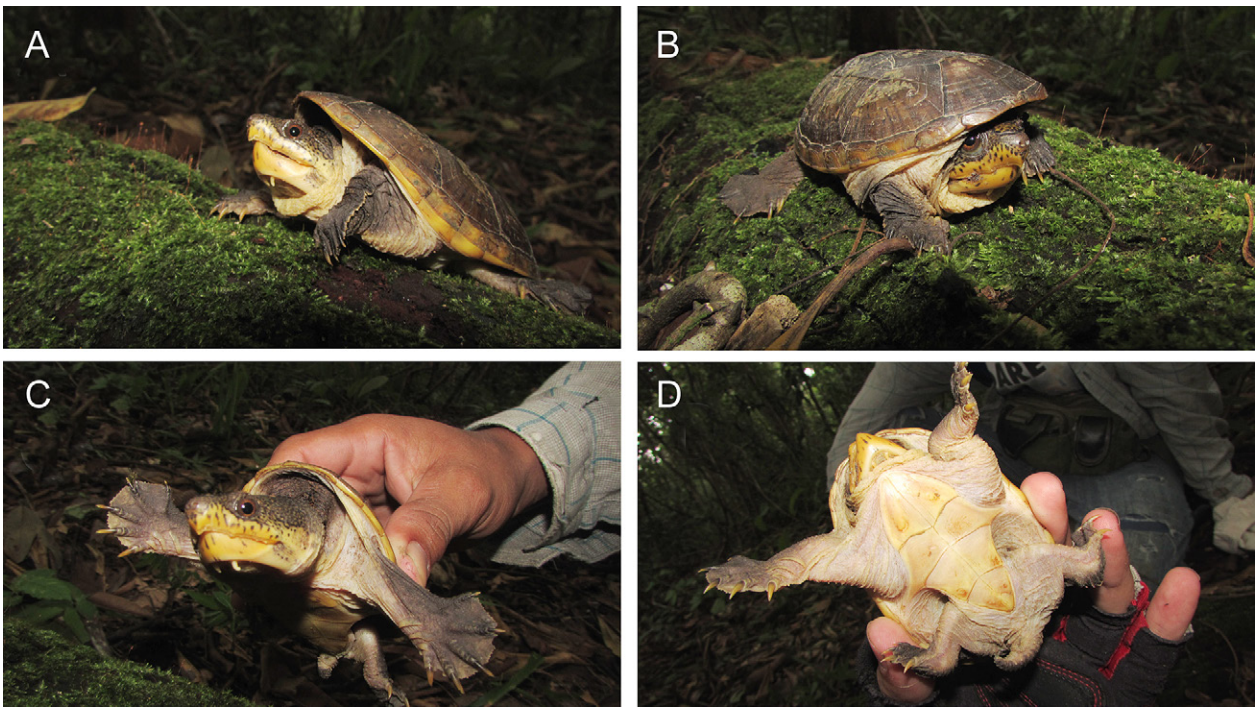

Figure 2. *Claudius angustatus.* **A.** Dorsal view of the body. **B.** Frontal view of body. **C.** View of the head and webbed feet. **D.** Ventral view of the body.

from the coast, approximately 200 km from the Bay of Honduras, in the Pacific Ocean. Additionally, our records are the most recent verified observations of *C. angustatus* in the southeastern zone of its range in more than 20 years, since the records reported for Guatemala and Belize in the mid-1990s (see Lee 1996; Campbell 1998). Although the species has been historically rare far from the Gulf of Mexico (Lee 1996; Campbell 1998), the fact that the species has not been documented in the southeastern part of its range in the last 20 years is surprising. The main causes could be the fewer herpetological expeditions in this region compared to on the coastal plain of the Gulf of Mexico (e.g., Cázares 2015; Vásquez-Cruz and Reynoso-Martínez 2020) and a significant increase in deforestation in some of the places where Lee (1996) and Campbell (1998) reported high densities of *C. angustatus* in the mid-1990s, such as El Petén and northern Belize (Shriar 2002; Chicas et al. 2016). Therefore, more expeditions in the southeastern range of *C. angustatus* are urgently needed to verify the status of populations in that area.

Our records of *C. angustatus* are the first verifiable ones from the Selva Lacandona and increase the number of species of turtles from seven to eight and the number of reptile species to 91 (Hernández-Ordóñez et al. 2014, 2015). The presence of *C. angustatus* in the Selva Lacandona region has been long-suspected in previous studies (Legler and Vogt 2013; Ramírez et al. 2015). Nevertheless, these studies did not document any voucher specimens nor provide a detailed description or geographic coordinates to validate the information. Here, we corroborate the presence of the species using a photo-record, a technique that has been recognized as an important tool for documenting the presence of reptiles in a given location (Nguyen et al. 2020). However, to be accepted by the scientific community, photographic records must be verified by an expert and deposited in a repository together with data such as geographic coordinates and habitat characteristics (Casper et al. 2015).

Major land-use changes such as forest loss and degradation can cause the decline and local extinctions of *C. angustatus* populations (Calderón-Mandujano 2002; Reynoso et al. 2016), in line with recent reports for other reptile species in the region (Russildi et al. 2016). Also, forest fragmentation caused by road construction represents an increasing threat that could jeopardize their persistence. For example, Reynoso et al. (2016) observed high mortality of *C. angustatus* attempting to cross roads, and Cedeño-Vázquez and Beutelspacher-García (2016) similarly reported an adult male dead on the road. As some of the new records of *C. angustatus* consist on individuals crossing roads (e.g., Ravell-Ley et al. 2017; our data), we hypothesize that road-kill could be an important threat for the species. However, the presence of *C. angustatus* in human-modified tropical landscapes, such as where we recorded individuals, suggests that some anthropogenic matrices may be suitable for this species. Additionally, this species has been reported in floodplains and semi-permanent water bodies surrounded by cattle pastures (Reynoso et al. 2016), in pastures (Aguilar-López et al. 2020), or in sugarcane fields (Vásquez-Cruz and Reynoso-Martínez 2020). This is not surprising, as some aquatic turtles can inhabit several aquatic environments (e.g., rivulets or temporary ponds) located inside anthropic matrices, such as tree plantations and cattle pastures (Legler and Vogt 2013; Petrozzi et al. 2021). However, the anthropic matrix can also represent a threat to this species, suggested by the reports of several death specimens found in burned plantations (Cedeño-Vázquez and Beutelspacher-García 2016; Reynoso et al. 2016). Furthermore, the capture of *C. angustatus* for meat consumption by humans increases in anthropic landscapes (Reynoso et al. 2016). Therefore, more research is needed on the adverse effects on turtles in human-dominated landscapes.

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Authors' Contributions

Conceptualization: MJCL. Data curation: OHO. Methodology: RAG. Project administration: MJCL. Resources: MJCL. Supervision: VAR. Visualization: RAG. Writing – original draft: MJCL, RAG, OHO. Writing – review and editing: VAR.

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Appendix

Table A1. Locality records of *Claudius angustatus* from Mexico and Central America, derived from literature records, official institutions and from the present study. Only specimens including coordinates and localities from reliable sources are shown. Abbreviations: MX = Mexico; BZ = Belize; GT = Guatemala. Institutional abbreviations: Ecosur = El Colegio de la Frontera Sur; UMMZ = University of Michigan; IHNE = Instituto de Historia Natural y Ecología; AMNH = American Museum of Natural History; MCZ-HU = Museum of Comparative Zoology, Harvard; FC-UNAM = Instituto de Biología, Universidad Nacional Autónoma de México; IBUNAM = Instituto de Biología, Universidad Nacional Autónoma de México; CNAR = Colección Nacional de Anfibios y Reptiles; CMNH = Cleveland Museum of Natural History; KUNHM = Natural History Museum University of Kansas; UIUC = University of Illinois Urbana-Champaign; FLMNHU-UF = National Museum of Natural History, Smithsonian Institution; MVZ-UCB = Museum of Vertebrate Zoology = University of California, Berkeley; MSU = Michigan State University.

Locality	Country	Latitude	Longitude	Reference
Xkan-ha, Campeche	MX	19.1131	−089.5036	ECOSUR
X-Pujil, Campeche	MX	19.0017	−089.2800	ECOSUR
Aguada, Campeche	MX	18.6506	−089.4089	ECOSUR
Nuevo Becal, Campeche	MX	18.5911	−089.2578	ECOSUR
Balchacaj, Campeche	MX	18.4250	−091.5083	UMMZ
Balchacaj, Campeche	MX	18.4583	−091.5083	UMMZ
Candelaria, Campeche	MX	18.1916	−091.0583	UMMZ
Playón de la Gloria, Chiapas	MX	16.1583	−090.8853	This study
Pico de Oro, Chiapas	MX	16.3189	−090.7508	This study
Galacia, Chiapas	MX	16.1697	−090.8441	This study
Rancho Alejandría, Chiapas	MX	17.5867	−093.1819	IHNE
Catazajá, Chiapas	MX	17.8074	−091.9397	Lee (1996)
Río Malatengo, Oaxaca	MX	17.0083	−095.0417	AMNH
Río Malatengo, Oaxaca	MX	17.0083	−095.0417	MCZ-HU
La Unión, Quintana Roo	MX	17.8964	−088.8761	ECOSUR/Cedeño-Vazquez et al. 2003
Road Bacalar-Reforma, Quintana Roo	MX	18.7132	−088.4120	ECOSUR/Cedeño-Vazquez & Beutelsácher-García 2016
Road Bacalar-Reforma, Quintana Roo	MX	18.7612	−088.5128	ECOSUR
San Felipe Bacalar, Quintana Roo	MX	18.8187	−088.3010	Chávez-León and Lemos-Espinal 1987
Villahermosa, Tabasco	MX	17.9906	−092.9281	FC-UNAM
Villahermosa, Tabasco	MX	17.9917	−092.9250	FC-UNAM
Chabé, Tabasco	MX	17.8567	−091.7800	IBUNAM
Lerdo de Tejada, Veracruz	MX	18.6583	−095.5497	IBUNAM
Lerdo de Tejada, Veracruz	MX	18.6583	−095.5497	CMNH
Lerdo de Tejada, Veracruz	MX	18.6031	−095.5100	IBUNAM
Lerdo de Tejada, Veracruz	MX	18.6283	−095.5217	IBUNAM
Lerdo de Tejada, Veracruz	MX	18.6583	−095.4979	IBUNAM
Lerdo de Tejada, Veracruz	MX	18.3600	−095.3000	CNAR
Alvarado, Veracruz	MX	18.7703	−095.7606	CMNH
Alvarado, Veracruz	MX	18.7703	−095.7606	IBUNAM
Alvarado, Veracruz	MX	18.6750	−095.7750	FC-UNAM
Alvarado, Veracruz	MX	18.7700	−095.7500	CNAR
Río San Agustín, Veracruz	MX	18.6575	−095.5483	IBUNAM
Río Tecolapan, Veracruz	MX	18.5721	−095.3424	CMNH
Santiago Tuxtla, Veracruz	MX	18.4511	−095.3019	IBUNAM
Ciudad de Alvarado, Veracruz	MX	18.7703	−095.7606	FC-UNAM
Ciudad de Alvarado, Veracruz	MX	18.7700	−095.7550	FC-UNAM
Boca del Río, Veracruz	MX	19.0250	−096.1250	UMMZ
Boca del Río, Veracruz	MX	19.0583	−096.0083	KUNHM
Boca del Río, Veracruz	MX	19.0658	−096.0797	UMMZ
Boca del Río, Veracruz	MX	19.0750	−096.1417	UMMZ
Boca del Río, Veracruz	MX	19.0607	−096.0000	KUNHM
Tlacotalpan, Veracruz	MX	18.5417	−095.6583	FC-UNAM
Tlacotalpan, Veracruz	MX	18.6100	−095.6600	IBUNAM
Tlacotalpan, Veracruz	MX	18.6136	−095.6583	IBUNAM
Yanga, Veracruz	MX	18.8239	−096.7693	Vásquez-Cruz and Reynoso-Martínez 2020
El Potrero, Veracruz	MX	18.8917	−096.7417	UIUC
Potrero Viejo, Veracruz	MX	18.8750	−096.8417	UIUC
Potrero Viejo, Veracruz	MX	18.8750	−096.8417	KUNHM
Potrero Viejo, Veracruz	MX	18.8757	−096.8417	KUNHM
Potrero Viejo, Veracruz	MX	18.8750	−096.8433	UIUC
Potrero Viejo, Veracruz	MX	18.8750	−096.8433	KUNHM
Minatitlán, Veracruz	MX	18.0250	−094.5583	AMNH

Locality	Country	Latitude	Longitude	Reference
Jesus Carranza, Veracruz	MX	17.5250	−094.8750	KUNHM
Laguna de Alvarado, Veracruz	MX	18.7733	−095.8167	FLMNH-UF
Laguna de Alvarado, Veracruz	MX	18.7733	−095.8167	IBUNAM
Laguna de Alvarado, Veracruz	MX	18.6667	−095.8333	IBUNAM
Medellín, Veracruz	MX	19.0583	−096.1583	NMNH-SI
Cuatotolapan, Veracruz	MX	18.1583	−095.3083	UMMZ
Cerca de Isla, Veracruz	MX	18.0283	−095.5283	UMMZ
Lago de Catemaco, Veracruz	MX	18.4083	−095.0667	UMMZ
Tlacotalpan, Veracruz	MX	18.6136	−095.6583	IBUNAM
Tesechoacan, Veracruz	MX	18.1214	−095.6797	CMNH
Mercado de Alvarado, Veracruz	MX	18.7700	−095.7550	MVZ-UCB
Veracruz, Veracruz	MX	19.1883	−096.1400	MSU
Cosamalopan, Veracruz	MX	18.3669	−095.7967	NMNH-SI
Río Coatzacoalcos, Veracruz	MX	18.1200	−094.4064	CMNH
Ciudad de Alvarado, Veracruz	MX	18.7700	−095.7550	FC-UNAM
Tecolapan, Veracruz	MX	18.5683	−095.3350	CMNH
Ixhuatlán, Veracruz	MX	18.0414	−094.3560	Aguilar-López et al. 2020
Jesús Carranza, Veracruz	MX	17.5137	−095.2157	KU
Tlacotepec de Díaz, Puebla	MX	18.3998	−096.7548	De La Torre-Loranca et al. 2020
Hunucmá, Yucatán	MX	21.1364	−090.0096	Ravell-Ley et al. 2017
Celestún, Yucatán	MX	20.8562	−090.2226	ECOSUR
Celestún, Yucatán	MX	20.8600	−090.1944	ECOSUR/Calderón-Mandujano et al. 2001
San Felipe, Orange Walk	BZ	17.8666	−088.7500	Platt and Rainwater 1998
Belize City, Belize	BZ	17.5205	−088.2465	Lee 1996
Hattieville, Belize	BZ	17.4910	−088.3913	Lee 1996
Beaver Dam Camp, Cayo	BZ	17.2783	−088.6719	Lee 1996
Altún Ha, Belize	BZ	17.7645	−088.3474	Lee 1996
Chinajá, Petén	GT	16.2490	−090.3226	Lee 1996
Sayaxché, Petén	GT	16.5197	−090.1855	Lee 1996
Lago de Petén, Petén	GT	16.9215	−089.8249	Campbell 1998
El Remate, Petén	GT	17.0027	−089.6910	Campbell 1998
Tikal, Petén	GT	17.2250	−089.6133	Lee 1996