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## A new species of treefrog of the genus *Ptychohyla* (Anura: Hylidae) from Southern Mexico

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### Abstract

We describe a new species of treefrog of the genus *Ptychohyla* from southern Mexico occurring to the east of the Isthmus of Tehuantepec. This new species can be distinguished from Mexican congeners by a combination of a pale pink iris and the presence of nuptial excrescences in breeding males. Including this new taxon, the number of species of *Ptychohyla* increases to 14, with seven of these occurring in Mexico. The new species is relatively common in pristine tropical forests, but appears to be sensitive to habitat degradation and has not been found in human modified habitats, suggesting that habitat modification is a threat for this hylid frog.

**Key words:** Amphibian, *Ptychohyla*, new species, description, frog, evergreen tropical forest, advertisement call, Veracruz, Oaxaca, Mesoamerica

### Resumen

Se describe una especie nueva del género *Ptychohyla* para el sur de México que se distribuye al este del Istmo de Tehuantepec. Esta especie nueva se puede distinguir de sus congéneres mexicanos por la combinación de un iris rosa pálido y la presencia de excrescencias nupciales en machos en estado reproductivo. Incluyendo este taxón nuevo, el número de especies de *Ptychohyla* asciende a 14, siete de las cuales se distribuyen en México. La especie nueva es relativamente común en bosques tropicales bien conservados y parece ser sensible a la transformación del hábitat, pues no ha sido registrada en hábitats modificados por el ser humano, lo cual sugiere que la modificación del hábitat es una amenaza para esta especie.

**Palabras clave:** Anfibio, *Ptychohyla*, especie nueva, descripción, rana, selva alta perennifolia, canto de advertencia, Veracruz, Oaxaca, Mesoamérica

### Introduction

The region known as Selva Zoque-La Sepultura harbors one of the best preserved and largest regions of tropical forest in Mexico. Located in southern Mexico, it includes the Chimalapas in eastern Oaxaca, the Uxpanapa region in southern Veracruz, and the western portion of Chiapas that encompasses two protected areas: La Sepultura and El Ocote (Arriaga *et al.* 2000). This region is considered a Priority Conservation Area (Arriaga-Cabrera *et al.* 2009) primarily because it harbors a great species diversity of birds and mammals (Peterson *et al.* 2003; Lira-Torres *et al.*

2012). However, our understanding of the herpetofauna distributed along the different zones within the La Selva Zoque-La Sepultura region is incomplete. Although species inventories for El Ocote and La Sepultura are reviewed periodically (see Reynoso *et al.* 2011), only a few localities in the Uxpanapa-Chimalapas have been explored, most of them are located near the periphery of the region (Aguilar-López *et al.* 2016).

Duellman (1960) described the distribution for 36 species of amphibians from the Isthmus of Tehuantepec, but cited few localities from the Uxpanapa and Chimalapas areas. Navarro *et al.* (2008) documented 35 species of amphibians and 105 reptiles from the Chimalapas in Oaxaca. Recently, Aguilar-López *et al.* (2016) provided an updated list of 51 amphibian species from the Uxpanapa-Chimalapas region, but the knowledge of amphibian diversity remains incomplete because there are many areas that have not been explored.

In 1993, as part of a vertebrate survey and inventory of the evergreen tropical forest of the Chimalapas region in eastern Oaxaca, LCM collected a single enigmatic female hylid frog that remained unidentified in the collection of Museo de Zoología, UNAM (MZFC). It possessed morphological characteristics not agreeing with the diagnoses of any known hylid species from the region. Subsequently, from 2008 to 2014, as part of ecological research to evaluate amphibian species diversity in evergreen tropical forests and human modified habitats in Uxpanapa, Veracruz, eight additional specimens of this frog were collected. Based on all of the material now available to us, we describe a new hylid frog that we assign to the genus *Ptychohyla*.

## Materials and methods

Measurements and terminology follow Duellman (2001). Measurements were made with calipers under a stereo microscope and rounded to the nearest 0.1 mm; those from bilateral structures were taken on the right side of each specimen. Sex was determined by the presence of nuptial excrescences in adult males. Webbing formulae for hands and feet follow Myers & Duellman (1982). Descriptions of coloration were noted from photographs of living individuals.

Advertisement calls of one male (not collected) were recorded with a SONY PCM-M10 digital recorder, with the microphone held at 1 m distance from the frog. Recordings were digitized at 44.1 kHz, 24-bit signed. After a preliminary view of the original spectrograms, we applied a filter band-pass between 900 and 3200 Hz to reduce stream noise and maximize accuracy of measured acoustic parameters (Ortega-Andrade *et al.* 2013). Oscillograms and spectrograms were generated and analyzed with Raven Lite 2.0 and SoundRuler 0.9.6.0. Five acoustic parameters were measured to describe the call structure, following the terminology of Cocroft & Ryan (1995): number of pulses, pulse duration, interpulse interval, dominant frequency, and note duration.

Specimens used in the description are in the following collections: Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México (UNAM-MZFC); University of Texas at Arlington (UTA) and the Colección de Anfibios y Reptiles del Instituto de Ecología, A. C. (CARIE).

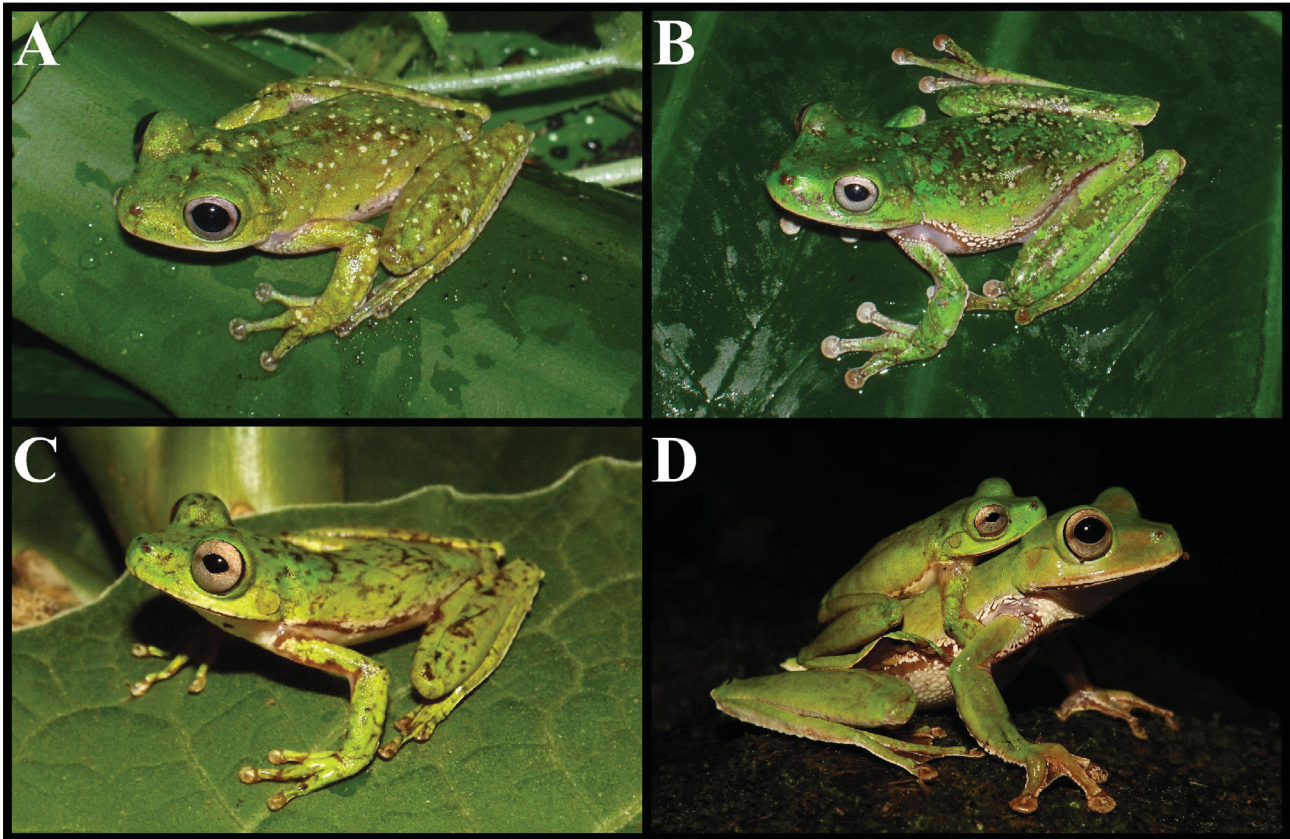
### *Ptychohyla zoque* sp. nov.

Zoque Treefrog, *Rana arborícola zoque*  
(Figures 1–2)

*Ptychohyla* sp. nov.—Aguilar-López, Pineda, Luría-Manzano, and Canseco-Márquez (2016).

**Holotype.** UNAM-MZFC 24004 (original field number RLM 062), an adult male (Fig. 1A) from 6.5 km SSE Paso del Moral, Uxpanapa, Veracruz, Mexico (17° 10.84' N, 94° 35.13' W; 76 m elevation) collected on 6 July 2008 by Ricardo Luría-Manzano and José Luis Aguilar-López.

**Paratypes.** Eight specimens. UNAM-MZFC 18667 (adult female) from Chalchijapa (Chimalapas region), Oaxaca (17° 3.25' N, 94° 39.23' W; 600 m elevation), collected on 9 May 1993; three females MZFC 24005-06 and UTA A 59271 (Fig. 1B) from Paso del Moral, Veracruz (17° 10.8' N, 94° 35.39' W; 230 m elevation), collected 5–6 March 2009 (Fig. 1B); CARIE 1135 (adult male, Fig. 1C) same locality as the holotype, 10 April 2013; CARIE 1138 (adult male) 16 May 2013 and CARIE 1215–16 (one adult male and one adult female, Fig. 1D) 12 June 2013, from Arroyo Zarco, Uxpanapa, Veracruz (17° 11.34' N, 94° 29.2' W; 246 m elevation).



**FIGURE 1.** Specimens in life of *Ptychohyla zoque*. A: Male holotype (MZFC 24004, 36.4 mm SVL); B: Female paratype (UTA-A 59271, 55.65 SVL); C: male paratype (CARIE 1135); D: Female and male paratypes in amplexus (CARIE 1215 and 1216).

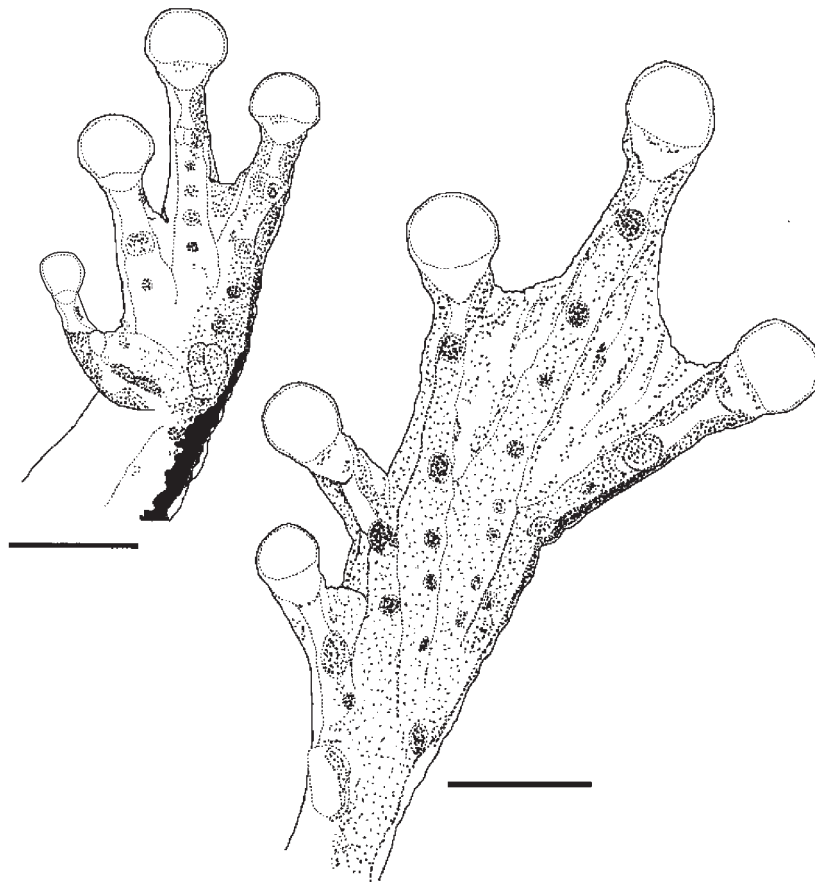
**TABLE 1.** Morphometric variation in type-series of *Ptychohyla zoque*: range (in millimeters) followed by mean in parentheses.

Measurement	Males ( <i>n</i> = 4)	Females ( <i>n</i> = 5)
SVL	35.0–36.4 (35.8)	46.2–57.8 (54.3)
Tibia length	20.3–22.0 (20.9)	28.9–35.6 (32.9)
Foot length	14.2–16.7 (15.4)	20.9–26.3 (24.2)
Head length	12.0–12.9 (12.5)	17.2–20.7 (19.3)
Head width	12.1–13.5 (12.9)	17.4–21.7 (20.3)
Diameter of eye	4.0–4.8 (4.4)	5.2–5.6 (5.5)
Diameter of tympanum	1.9–2.3 (2.1)	2.4–3.0 (2.7)

**Diagnosis.** *Ptychohyla zoque* is placed into the genus *Ptychohyla* because of characteristics described below. It has a green dorsal coloration with brown blotches and numerous irregular white spots, and the iris is pale pink with brown reticulations. There is a marked sexual size dimorphism, with males attaining 36.4 mm in SVL, and females 57.8 mm. Breeding males have small nonspinous nuptial excrescences, and lack glands on the venter (either ventrolateral or chest). *Ptychohyla zoque* may be distinguished from all other species in the genus *Ptychohyla* by its green dorsal coloration and iris pale pink. Although it superficially resembles *P. acrochorda*, *P. erythromma*, and *P. sanctaecrucis* in regard to dorsal coloration, *P. zoque* may be distinguished by its iris of pale pink with brown reticulations (whitish or silver in *P. acrochorda*, red in *P. erythromma*, and pale tan in *P. sanctaecrucis*). *Ptychohyla zoque* can also be distinguished by the presence of small nonspinous nuptial excrescences (dark nuptial excrescences composed of spines in *P. acrochorda* and *P. sanctaecrucis*, unknown in *P. erythromma*). Additionally, the new species is distinguished from *P. acrochorda* and *P. sanctaecrucis* by the absence of a chest gland in breeding males (present in the latter two species). *Ptychohyla zoque* and *Duellmanohyla ignicolor* have similar

dorsal color patterns of brown blotches and numerous irregular white spots, and both share a pinkish iris. However, *P. zoque* can be distinguished from *D. ignicolor* by having nuptial excrescences and lacking noticeably thickened and extended ventrolateral gland.

**Description of the holotype.** An adult male, SVL 36.4 mm, tibia length 20.9 mm; tibia length/SVL 0.57; foot length 15.4 mm; foot length/SVL 0.42; head length 12.7 mm; head length/SVL 0.34; head width 12.8 mm; head width/SVL 0.35; eye diameter 4.8 mm; tympanum diameter 1.9 mm; tympanum/eye 0.39. Snout in lateral view truncate, slightly rounded in dorsal view; canthus distinct and slightly angular; loreal region concave; lips moderately thick, not flared; nostrils protuberant; internarial distance 2.2 mm; top of head flat; interorbital distance 4.3 mm. Supratympanic fold well developed, extending from posterior corner of eye above tympanum to point above insertion of forearm, covering upper edge of tympanum; tympanum distinct, rounded. Forearm moderately robust; ulnar tubercles unequally elevated. Prepollex ossified, large and blunt. Nuptial excrescences small and nonspinous, located on prepollical protrusion, inner and outer surface of Finger I, and dorsal surface of webbing between Fingers I and II; subarticular tubercles rounded, distal one on Fingers III and IV bifid; discs on fingers large, disc of the third finger slightly smaller than diameter of the tympanum; webbing formula **II** 1½—3 **III** 2½—2 **IV** (Fig. 2). Heels overlapping when hind limbs addressed at right angle to body; tibiotarsal articulation extending slightly beyond nostril; row of tubercles forming dermal ridge on the tarsus, extending from heel to disc of fifth toe; heel tubercle present; subarticular tubercles rounded; length of toes from shortest to longest 1-2-3-5-4; webbing formula **I** 1—2 **II** 1½—2 **III** 1—2 **IV** 2—1 **V** (Fig. 2). Toes moderately long; discs of toes about same size as those on fingers (Fig. 2). Cloacal opening directed posteroventrally at midlevel of thighs with several curved folds below cloacal opening; cloacal sheath short; a few white tubercles below and lateral to vent. Skin on dorsum smooth; that of throat, chest, belly and ventral surface of thighs granular. Ventrolateral glands absent. Tongue cordiform with posterior notch; vomerine teeth five on right side, six on left, situated on small, elliptical elevations between ovoid internal nares. Vocal slits present on both sides.



**FIGURE 2.** Ventral aspect of hand and foot of *Ptychohyla zoque*, holotype (MZFC 24004). Scale bar = 3 mm.

**Table 2.** Selected characteristics of all species of the genus *Psychohyla*. Data of *P.acrochorda* were obtained from Campbell and Duellman (2000), and the data of other species were obtained from Duellman (1963, 2001).

	<i>P.acrochorda</i>	<i>P.dendrophasma</i>	<i>P.erythroma</i>	<i>P.euthysanota</i>	<i>P.hypomykter</i>	<i>P.legleri</i>	<i>P.leonhardtschulzei</i>
<b>Maximum SVL in males (mm)</b>	36.6	84.1	----	37.3	35.4	36.7	35.1
<b>Maximum SVL in females (mm)</b>	57.6	Unknown	26.2	53.3	39.6	37	43.4
<b>Iris coloration</b>	Whitish or silver with reddish brown reticulations	Gold with black reticulations	Red	Reddish-bronze	Dull grayish bronze	Red	Reddish bronze with fine black flecks or reticulations
<b>Ventrolateral glands</b>	Absent	Absent	-----	Well developed	Well developed	Well developed	Well developed
<b>Chest gland</b>	Present	Absent	Absent	Absent	Absent	Absent	Absent
<b>Nuptial excrescences</b>	Dark keratinized nuptial excrescence of several hundred tiny spines	Unknown	-----	Cluster of about 44 to 143 small spines	35 to 66 sharply pointed spines	Enlarged	Cluster of 24 to 80 spines
<b>Dorsal coloration</b>	Lime-green with a small amount of indistinct pale brown mottling	Reddish brown with indistinct dark brown smudging of mottlings	Olive green to gray with irregular darker green blotches	Reddish brown with small indistinct darker brown markings	Yellowish tan with small irregular brown markings	Reddish brown or dull olive-green	Pale tan, yellowish-brown, or pale reddish-brown with irregular, darker brown blotches
<b>Labial stripe</b>	White fine on upper lip	Absent	Narrow discontinuous with line	White line along the edge of the upper lip	Fine on upper lip	White stripe on upper lip	Absent
<b>Flanks</b>	Reticulate pattern	Whitish with brown markings	Large white spots more or less confluent, bordered by irregular blackish spots	White lateral stripe	Marked by dark brown spots	Creamy yellow stripe extend the length of the flank	Creamy tan with irregular brown spots or mottling
<b>Tarsal fold</b>	Narrow, low, extending full length of tarsus	Dermal fold extends from the heel along the ventrolateral edge of the tarsus	Faint present	A low rounded extends the full length	Distinct, low and rounded extend the full length of tarsus	Low on the distal half of the tarsus	Row of tubercles forms a indistinct fold
<b>Forearm</b>	Distinctly raised dermal ridge punctuated with enlarged tubercles	Poorly developed dermal fold	Inconspicuous dermal fold, but not enlarged tubercles	A row of small tubercles	Row of low tubercles	Row of tubercles fused in some specimens into a low, thick dermal fold	Low and rounded extends the full length of tarsus
<b>Distribution and elevation</b>	Atlantic slopes of Sierra Juárez, Oaxaca, México at 594–900 m elev.	Northwestern edge of the Sierra de los Cuchumatanes, Huehuetenango, Guatemala at 1270 m elev.	Pacific slopes of the Sierra Madre del Sur of Guerrero at 700–950 m elev.	Pacific slopes from southeastern México (Chiapas and extreme Oaxaca) and pacific slopes of Guatemala, Honduras and El Salvador at 600–1200 m elev.	West central Guatemala to north-central Nicaragua at 340–2070 m elev.	Pacific slopes of the Sierra de Talamanca, eastern Costa Rica and western Panamá at 700–1600 m elev.	Pacific slopes of the Sierra Madre del Sur in Oaxaca and Guerrero, México at 700–2000 m elev.

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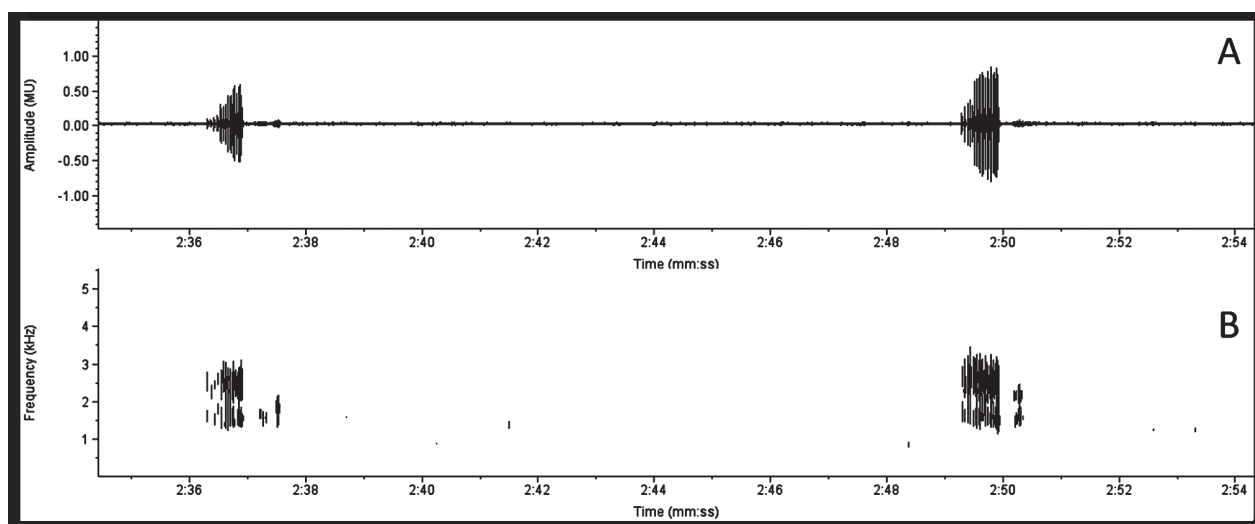
Table 2. Continued

	<i>P. macrotypanum</i>	<i>P. panchoi</i>	<i>P. savadorensis</i>	<i>P. sanctaerucis</i>	<i>P. spinipollex</i>	<i>P. zophodes</i>	<i>P. zoque</i>
Maximum SVL in males (mm)	38.8	34.2	34.9	32.5	39.1	37.4	36.4
Maximum SVL in females (mm)	44.8	37.3	41.8	50.7	46.1	43.6	57.8
Iris coloration	Reddish-bronze	Deep reddish orange	Copper color with fine black flecks	Pale tan, almost white with fine brown markings	Cooper in male, and chocolate in female	Reddish brown to cooper with fine black reticulations	Pale pink with brown reticulations
Ventrolateral glands	Well developed	Barely evident	Absent	Absent	Absent	Well developed	Absent
Chest gland	Absent	Absent	Absent	Present	Absent	Absent	Absent
Nuptial excrescences	Small horn spines (94-100)	Moderately large, pointed, keratinous spines	Large, pointed, keratinous spines	A patch of minutes pointed, keratinous spines	Large, pointed, keratinous spines	More than 50 keratinized spines	Small, nonspinous
Dorsal coloration	Pale tan with dark flecks	Grayish tan to dark brown with darker gray or darker brown mottling on dorsum	Mottled green (male) and brown (female)	Lime green with scattered pale green dots or olive-green dots to brown with a lichenous pattern of dark brown	Mottled shades of olive green in males and brown dorsum with darker brown mottling with or without white flecks	Dark brown to dull greenish brown with or without irregular dark brown to black mottling	Green with brown blotches and numerous irregular white spots concentrated on posterior part of dorsum
Labial stripe	A thin white line extends the length of upper lip	Present	Narrow white stripe on upper lip	Thin pale	Absent	-----	White fine line on upper lip
Flanks	No lateral stripe	White ventrolateral stripe	Mottled silvery white and dark brown	Purplish band with flecks	A stripe with diffuse edges along the flank is cream anteriorly and yellow posteriorly	White with black mottling or brown	Mottled with irregular white spots on pale brown background
Tarsal fold	Weak on distal two thirds of tarsus	Distinct, no row of tubercles	Weak present distally on tarsus	Weakly developed	Weak	Wide, low and extends about three-fourths of the length of the tarsum	Row of tubercles forming a dermal ridge
Forearm	Dermal fold, but no row of tubercles	A row of elevated tubercles	A row of low tubercles fused into a nearly continuous fold	Low of elevated tubercles forming a distinct ridge	Row of elevated tubercles along the ventrolateral edge of the forearm forms a distinct ridges	A distinct dermal ridge punctuated with enlarged tubercles on the ventrolateral edge	Ulnar tubercles unequally elevated
Distribution and elevation	Northern slopes of the Chiapan highlands in Mexico and the Sierra de los Cuchumatanes in Guatemala. Also in the upper Grijalva Basin in Chiapas, Mexico and Guatemala at 700–1700 m elev.	Northern slopes of the Sierra de las Minas and Montañas del Mico in eastern Guatemala at 100–895 m elev.	Pacific versant from northwestern El Salvador to south central Honduras and southeastern Guatemala. Also along the Atlantic versant near the Continental divide in southwestern Honduras at 1440–2050 m elev.	Sierra Santa Cruz in eastern Guatemala at 366–1150 m elev.	Cordillera Nombre de Dios in north-central Honduras at 160–1580 m elev.	Atlantic slopes of northern Oaxaca and southern Puebla at 400–1500 m elev.	Southern Mexico in Oaxaca and Veracruz at 76–600 m elev.

In life, dorsum of head, body, forelimbs, and hind limbs green with brown blotches and numerous irregular white spots concentrated on posterior part of dorsum; well-defined white stripe along upper jaw; flanks mottled with irregular white spots on pale brown background; narrow white stripe on ventrolateral edge of forearm and hand, and on ventrolateral edge of tarsus and foot; brown stripe parallel to white stripe on forearm, extending onto Finger IV; similar brown stripe on tarsus. White stripe above cloacal opening; brown patch with a few small white spots below cloacal opening. Belly, chin, chest, and ventral surfaces of limbs white. Ventral surface of Finger IV, and webbing between Fingers III and IV, dark brown; and all ventral surface of foot, including webbing, dark brown. Iris pale pink with brown reticulations.

**Variation.** Marked sexual size dimorphism is evident, with a ratio of sexual dimorphism of 1.52, and females attaining the greater SVL (Table 1). Variation in body measurements among four males and five females is summarized in Table 1. Two males (CARIE 1138, 1216) and three females (MZFC, 18667, 24005; CARIE 1215) lack the scattered white spots on dorsum; additionally, one male (CARIE 1135) and two females (MZFC 24006; CARIE 1215) have a concentration of black spots along the edge of the lower lip, and UTA A 59271 have concentrated brown spots on the chin and chest that are absent in the other specimens. Variation in vomerine teeth is as follows: 5/7 (MZFC 18667); 5/4 (MZFC 24005); 6/5 (MZFC 24006); 6/6 (UTA-A 59271); 4/5 (CARIE 1135); 5/7 (CARIE 1138); 4/5 (CARIE 1215) and 4/5 (CARIE 1216).

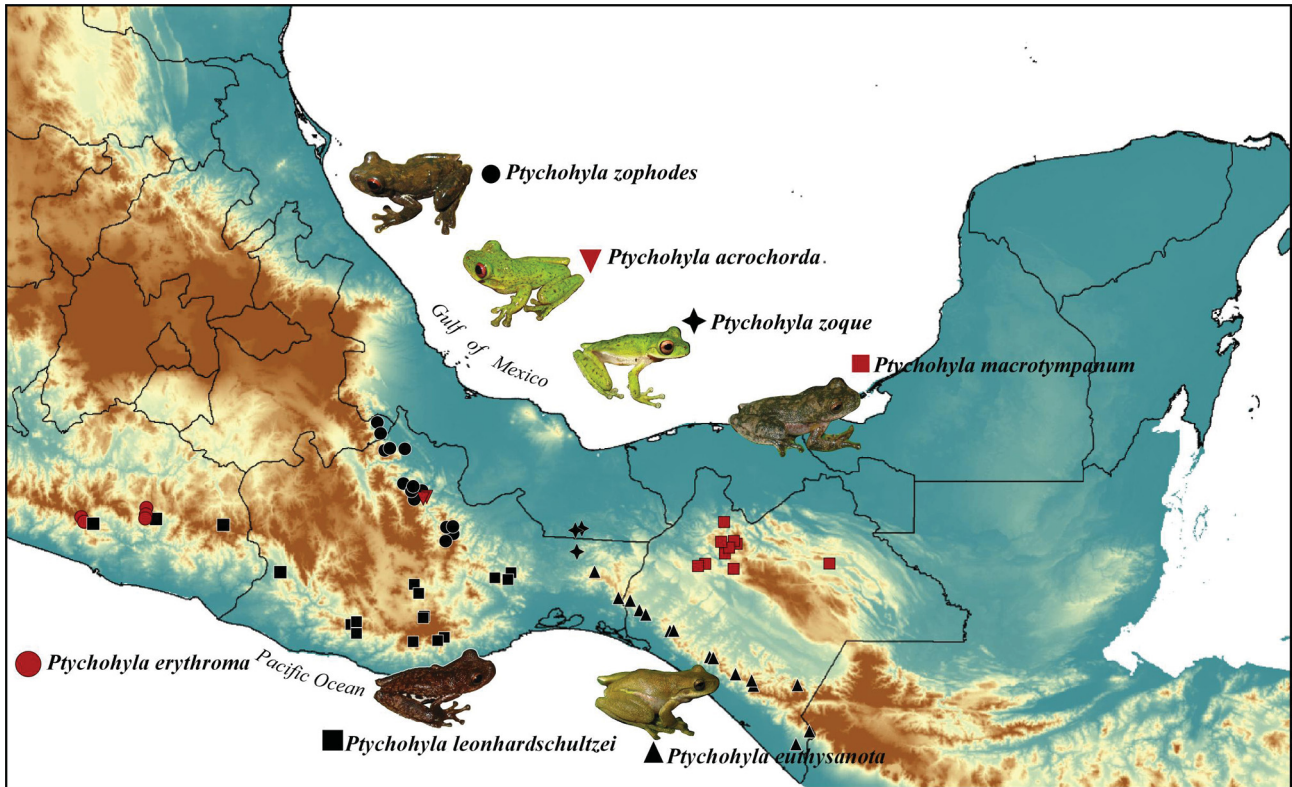
**Advertisement call.** The description of the advertisement call is based on one male (SVL = 36.1 mm) recorded at 0140 h on 4 May 2014, when it was calling on a leaf at 92 cm above ground, over a quiet pool next to a stream, in the locality of Arroyo Zarco, Uxpanapa, Veracruz (17° 11.46' N, 94° 29.30' W; 216 m elevation). The advertisement call of *P. zoque* is very soft and difficult to hear because of noise produced by other species of frogs (mainly *Exerodonta bivocata*), insects, and the stream. It consists of two notes with different structure (Fig. 3); in some cases the first note is immediately followed by the second, but in some instances the notes seem to be emitted independently. The first is a short, pulsed note ( $n = 9$ ), with a mean number of pulses of  $9.6 \pm 4$  (range 3–14), mean pulse duration  $0.008 \pm 0.003$  s (range 0.005–0.011), mean interpulse interval  $0.015 \pm .007$  s (range 0.005–0.027), mean dominant frequency  $2516.9 \pm 103.5$  Hz (range 2325.6–2670.1), and mean note duration  $0.249 \pm 0.136$  s (range 0.043–0.395). The second note is shorter than the first, and is not pulsed ( $n = 8$ ), it has a mean dominant frequency  $2024.1 \pm 220.8$  Hz (range 1808.8–2497.8), and a mean note duration  $0.01 \pm 0.003$  s (range 0.005–0.013).



**FIGURE 3.** Advertisement call of *Ptychohyla zoque*, recorded in the locality of Arroyo Zarco, municipality of Uxpanapa, Veracruz. Oscillogram (A), and audio spectrogram (B) of two calls composed by two notes with different structure.

**Distribution and ecology.** *Ptychohyla zoque* occurs in evergreen tropical forest, and is known from three localities in southern Mexico in the Selva Zoque, two in southern Veracruz (Paso del Moral and Arroyo Zarco) and one in northeastern Oaxaca (Chalchijapa) (Fig. 4). Known elevational range is 76–600 m asl. Seven of the nine specimens that comprise the type series plus 20 additional specimens not collected (18 adult males, one adult female, and one juvenile) were observed at night, on branches or leaves at 20–228 cm above ground, and close to streams. Exceptions from this pattern were the female from Chalchijapa (MZFC 18667), which was sleeping on a leaf at 0830 h near a stream, a male from Paso del Moral (CARIE 1135), which was found on the ground at 1504 h near a stream, and a juvenile of undetermined sex (not collected), which was on a leaf at 1730 h, approximately 30

m away from the nearest stream. Twenty-five of the 29 frogs were found in the dry season (March-May), whereas only four were observed in the beginning of the rainy season (June-July). All males had well developed nuptial excrescences regardless of month collected. An amplexing pair (CARIE 1215 and 1216) was collected in Arroyo Zarco, and was held overnight in a plastic bag, where 341 eggs were deposited a few hours later. Although all males appeared to be in breeding condition, only two observed on 11 March and 4 May 2014 in Arroyo Zarco, were calling from perches on leaves 228 and 92 cm above the ground, respectively.

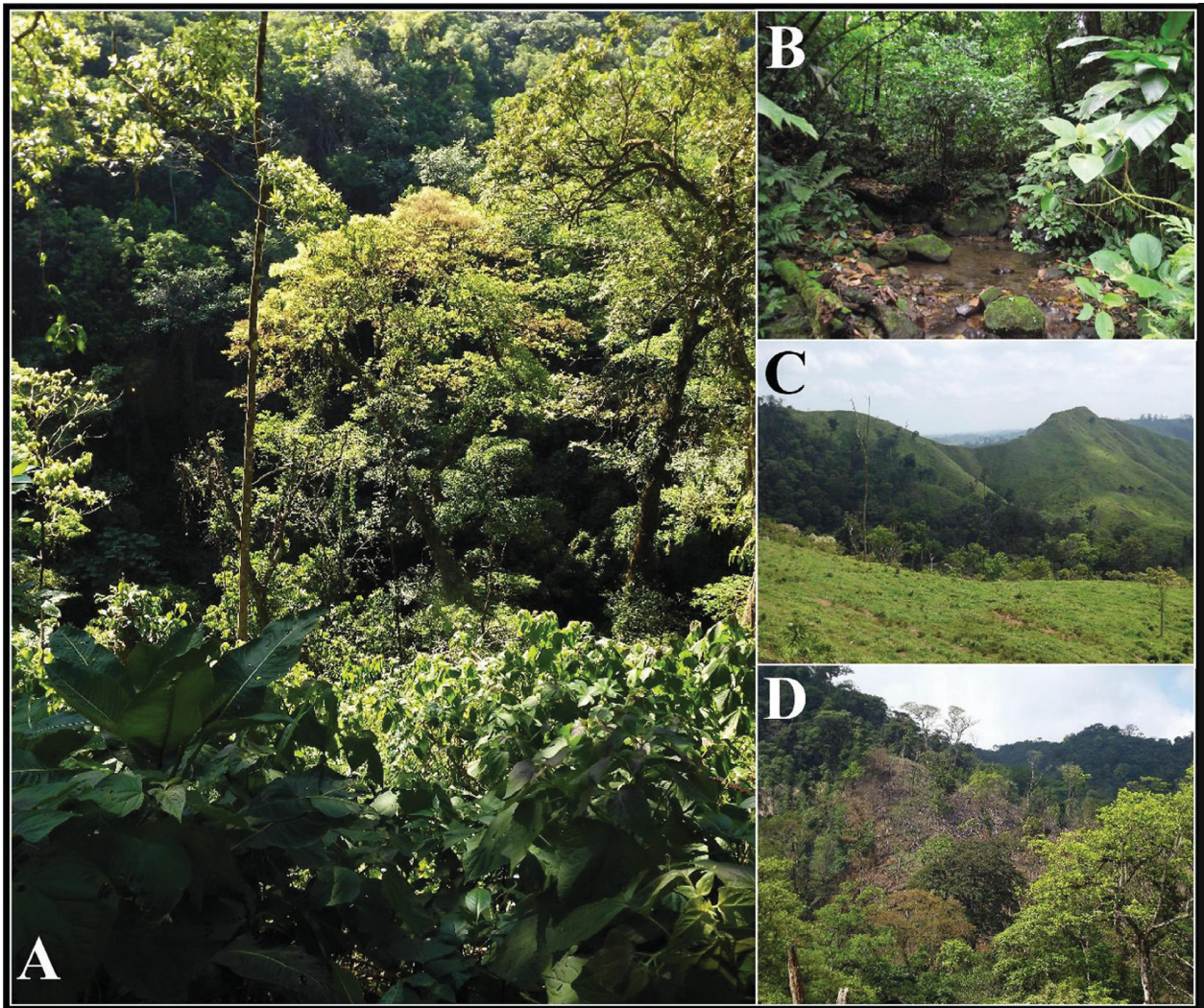


**FIGURE 4.** Geographic distribution of the species of *Ptychohyla* in Mexico.

*Ptychohyla zoque* is sympatric with other species of amphibians including *Agalychnis moreletii*, *Anotheca spinosa*, *Incilius macrocristatus*, *I. valliceps*, *Hyalinobatrachium fleischmanni*, *Craugastor alfredi*, *C. berkenbuschii*, *C. loki*, *Eleutherodactylus leprus*, *Duellmanohyla chamulae*, *Exerodonta bivocata*, *Hypopachus ustus*, *Rhinella horribilis*, *Smilisca baudinii*, *S. cyanosticta*, *Lithobates vaillanti*, *Bolitoglossa alberchi*, *B. rufescens* and *B. veracruzis*. The new species is relatively common in the evergreen tropical forests, being more abundant than other members of the family Hylidae such as *Duellmanohyla chamulae*, *Agalychnis moreletii* and *Anotheca spinosa*, but less abundant than *Exerodonta bivocata* and anurans in other families represented by *Craugastor berkenbuschii* and *Incilius macrocristatus*. This species appears to be sensitive to anthropogenic forest degradation, since it has been observed only in undisturbed evergreen tropical forest sites (Fig. 5 A and B), but not in altered environments (Fig 5 C and D) such as cattle pastures, rubber plantations and secondary forests (Aguilar-López, 2010).

**Etymology.** The species epithet, *zoque*, is an indeclinable word and refers to the Selva Zoque, a region comprised of tropical forest and covering the areas about Uxpanapa (Veracruz), Chimalapas (Oaxaca) and El Ocote (Chiapas). This region includes part of the historical range of Zoque culture, an ethnic group that has inhabited this region since pre-Columbian times.





**FIGURE 5.** General habitat at Arroyo Zarco (A); Section of a stream at the same locality (B); modified habitat near the type locality (C, D).

## Discussion

Including the species described here (Table 2), the Middle American genus *Ptychohyla* is composed of 14 species (Duellman, 2001), of which seven occur in Mexico: *P. acrochorda*, *P. erythromma*, *P. euthysanota*, *P. leonhardschultzei*, *P. macrotympanum*, *P. zophodes*, and *P. zoque* (Fig. 4). The genus was represented in Mexico previously only from Guerrero, Puebla, Chiapas, and Oaxaca (Duellman, 2001; García-Vázquez *et al.* 2009); hence *P. zoque* adds a new genus for the amphibian fauna of Veracruz and an additional amphibian species for Veracruz and Oaxaca. Because of habitat similarities, it is possible that *P. zoque* also occurs in Chiapas.

Campbell & Smith (1992) proposed a phylogeny of the related genera *Ptychohyla* and *Duellmanohyla* on the basis of larval morphology and sexually dimorphic features. In their analysis, two clades are defined: *Ptychohyla* and *Duellmanohyla*. However they mentioned that there is no evidence for the monophyly of both genera. Later Pyron & Wiens (2011) using molecular data, demonstrated that *Ptychohyla* is paraphyletic with respect to *Duellmanohyla* and *Bromeliohyla*. The same conclusions were obtained by Duellman *et al.* (2016). However, previous analyses only include about half of *Ptychohyla* species, and inconsistencies among phylogenies based on morphology and molecular data corroborate that future research is necessary to clarify the relationships among these three genera.

Duellman (2001) proposed a hypothesis of the phylogenetic relationships within *Ptychohyla*, based on morphological characters of adults and larvae. In his cladogram, *P. acrochorda*, *P. sanctaecrucis*, and *P.*

*erythromma* comprised a clade, in which the position of the last species assumes the presence of a chest gland in breeding males, which was in fact the unique synapomorphy of this clade. Although breeding males of *P. zoque* lack a chest gland, this species shares three characters (not considered in Duellman's analysis) with the clade proposed by Duellman (*P. acrochorda*, *P. sanctaecrucis*, and *P. erythromma*). First, dorsal coloration is relatively similar in the four species mentioned, that is, green with dark (brown or green) blotches. Second, although a slight sexual size dimorphism is apparent in all species of *Ptychohyala*, with females being larger than males (Duellman, 2001), this feature is much more marked in *P. acrochorda*, *P. sanctaecrucis*, and *P. zoque* (unknown in *P. erythromma* for lack of enough material), with a ratio of sexual dimorphism of 1.52 in all of them (for ratios of the other species of *Ptychohyala*, see Duellman, 2001). Finally, the advertisement call of *P. acrochorda* has a similar dominant frequency as that of *P. zoque* (2266 and 2516.9 Hz, respectively), which are the lowest-pitched calls within the genus (Duellman, 2001). Lack of quantitative descriptions of the advertisement calls of *P. erythromma* and *P. sanctaecrucis* precludes additional comparisons. Hylid frogs have a high rate of morphological convergences and cryptic species are common, therefore inferences based only on morphological data need to be considered carefully.

Regarding detailed descriptions of advertisement calls among members of *Ptychohyala*, it is important to note that these exist for only six of the 14 known species (Campbell *et al.* 2000; Duellman, 2001). Therefore, comparisons made above are limited to few species. In fact, the advertisement call of *P. zoque* is lower-pitched than those of *P. euthysanota*, *P. hypomykter*, *P. macrotympanum*, and *P. zophodes*. Despite these differences, the call of the new species is very soft, as has been described for *P. acrochorda*, *P. euthysanota*, *P. macrotympanum*, and *P. sanctaecrucis* (Campbell & Smith, 1992; Duellman, 2001).

Although the advertisement call of *P. zoque* shows some similarities with those of other species of *Ptychohyala* (especially *P. acrochorda*), it is unique within the genus in that it is composed by two structurally different notes, instead of one, similar to all other species for which there is an advertisement call description (Duellman, 2001). We did not observe any frog close to the male we recorded, so our observations are too limited to know if the two notes convey separate messages to males and females, as has been shown for other species of frogs (Littlejohn & Harrison, 1985). The ecological observations of *P. zoque* suggest that reproduction occurs during the dry season and early rainy season, when streams are not subject to torrential fluctuations. Other species in the genus appear to breed throughout the rainy season (Campbell & Smith, 1992; Campbell & Duellman, 2000).

Given the restricted distribution of *P. zoque* and its presumed sensitivity to habitat disturbance, in combination with the high rate of deforestation and habitat transformation in the region where it inhabits (Ewell & Polleman, 1980; Asbjornsen *et al.* 2005), it would be worthwhile to implement a conservation strategy for this species which includes the protection of the portion of tropical forests that remains intact, including riparian areas where this species congregates for reproduction.

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## References

- Aguilar-López, J.L. (2010) *Transformación del hábitat y diversidad de anfibios en un paisaje tropical del sur de México*. Master of Science Thesis. Instituto de Ecología A.C. Xalapa, México, 60 pp.
- Aguilar-López, J.L., Pineda, E., Luría-Manzano, R. & Canseco-Márquez, L. (2016) Species Diversity, Distribution, and Conservation Status in a Mesoamerican Region: Amphibians of the Uxpanapa-Chimalapas Region, Mexico. *Tropical Conservation Science*, 9 (4), 1–16.  
<http://doi.org/10.1177/1940082916670003>
- Asbjornsen, H., Velázquez-Rosas, N., García-Soriano, R. & Gallardo-Hernández, C. (2005) Deep ground fires cause massive above- and below-ground biomass losses in tropical montane cloud forests in Oaxaca, Mexico. *Journal of Tropical Ecology*, 21, 427–434.  
<http://doi.org/10.1017/S0266467405002373>
- Arriaga, L., Espinoza, J.M., Aguilar, C., Martínez, E., Gómez, L. & Loa, E. (Coordinadores). (2000) Mapa de regiones terrestres prioritarias de México. Escala de trabajo 1:1 000 000. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad. México.
- Arriaga-Cabrera, L., Aguilar, V. & Espinoza, J.M. (2009) Regiones prioritarias y planeación para la conservación de la biodiversidad. In: Sarukhán, J. (Ed.), *Capital natural de México, vol. II: Estado de conservación y tendencias de cambio*. CONABIO, México, pp. 433–457.
- Campbell, J.A. & Duellman, W.E. (2000) New Species of Stream-breeding Hylid Frogs from the Northern Versant of the Highlands of Oaxaca, Mexico. *Scientific Papers Natural History Museum The University of Kansas*, 16, 1–28.
- Campbell, J.A. & Smith, E.N. (1992) A new frog of the genus *Ptychohyala* (Hylidae) from the Sierra de Santa Cruz, Guatemala, and description of a new genus of Middle American stream-breeding treefrogs. *Herpetologica*, 48, 153–167.
- Campbell, J.A., Smith, E.N. & Acevedo, M.E. (2000) A new species of fringe-limbed treefrog (Hylidae) from the Sierra Los Cuchumatanes of northwestern Guatemala. *Herpetologica*, 56 (2), 250–256.
- Cocroft, R.B. & Ryan, M.J. (1995) Patterns of advertisement call evolution in toads and chorus frogs. *Animal Behaviour*, 49, 283–303.  
<http://doi.org/10.1006/anbe.1995.0043>
- Duellman, W.E. (1960) A Distributional Study of the Amphibians of the Isthmus of Tehuantepec, México. *University of Kansas Publications*, 13 (2), 19–72.
- Duellman, W.E. (1963) A review of the Middle American tree frogs of the genus *Ptychohyala*. *University of Kansas Publications, Museum of Natural History*, 15 (7), 297–349.  
<http://doi.org/10.5962/bhl.part.7290>
- Duellman, W.E. (2001) *Hylid Frogs of Middle America*. 2 volumes. Society for the Study of Amphibians and Reptiles. 1–1158 pp.
- Duellman, W.E., Marion, A.B. & Hedges, B. (2016) Phylogenetics, classification, and biogeography of the treefrogs (Amphibia: Anura: Arboranae). *Zootaxa*, 4104 (1), 1–109.  
<http://doi.org/10.11646/zootaxa.4104.1.1>
- Ewell, P.T. & Polleman, T.T. (1980) *Uxpanapa: Agricultural development in the Mexican tropics*. NY: Pergamon Press, New York, 282 pp.
- Faivovich, J., Haddad, C.F.B., García, P.C.A., Frost, D.R., Campbell, J.A. & Wheeler, W.C. (2005) Systematic review of the frog Hylidae, with special reference to Hyliinae: Phylogenetic analysis and taxonomic revision. *Bulletin of the American Museum of Natural History*, 294, 1–240.
- García-Vázquez, U.O., Canseco-Márquez, L., Aguilar-López, J.L., Solano-Zavaleta, I. & Maceda-Cruz, R.J. (2009) Noteworthy records of amphibians and reptiles from Puebla, México. *Herpetological Review*, 40 (4), 467–470.
- Klepeis, P. & Vance, C. (2003) Neoliberal policy and deforestation in Southeastern Mexico: an assessment of the PROCAMPO program. *Economic Geography*, 79 (3), 221–240.  
<http://doi.org/10.1111/j.1944-8287.2003.tb00210.x>
- Littlejohn, M.J. & Harrison, P.A. (1985) The functional significance of the diphasic advertisement call of *Geocrinia victoriana* (Anura: Leptodactylidae). *Behavioral Ecology and Sociobiology*, 16, 363–373.  
<http://doi.org/10.1007/bf00295550>
- Lira-Torres, I., Galindo-Leal, C. & Briones-Salas, M. (2012) Mamíferos de la Selva Zoque, México: riqueza, uso y conservación. *Revista de Biología Tropical*, 60 (2), 781–797.  
<http://doi.org/10.15517/rbt.v60i2.3999>
- Muñoz-Alonso, A., Martínez-Castellanos, R. & Hernández-Martínez, P. (1996) Anfibios y reptiles de la reserva El Ocote. In: Vázquez-Sánchez, M.A. & March-Mifsut, I. (Eds.), *Conservación y desarrollo sustentable en la reserva El Ocote*. El Colegio de la Frontera Sur. México, pp. 87–108.
- Myers, C.W. & Duellman, W.E. (1982) A new species of *Hyla* from Cerro Colorado, and other tree frog records and geographical notes from western Panama. *American Museum Novitates*, 2652, 1–32.
- Navarro-Sigüenza, A., Canseco-Márquez, L. & Monrroy, H.O. (2008) Vertebrados terrestres de los Chimapalas: Una prioridad de conservación. *Biodiversitas*, 77, 10–15.
- Ortega-Andrade, H.M., Rojas-Soto, O. & Paucar, C. (2013) Novel Data on the Ecology of *Cochranella mache* (Anura:

- Centrolenidae) and the Importance of Protected Areas for this Critically Endangered Glassfrog in the Neotropics. *PlosOne*, 8 (12), 1–13.  
<http://doi.org/10.1371/annotation/3afad533-ccf9-4d29-83ea-e4eeae57203c>
- Peterson, A.T., Navarro-Sigüenza, A., Hernández-Baños, B.E., Escalona-Segura, G., Rebón-Gallardo, F., Rodríguez-Ayala, E., Figueroa-Esquível, E. & Cabrera-García, L. (2003) The Chimalapas region, Oaxaca, Mexico: A high-priority region for bird conservation in Mesoamerica. *Bird Conservation International*, 13, 227–253.  
<http://doi.org/10.1017/s0959270903003186>
- Pyron, R.A. & Wiens, J.J. (2011) A large-scale phylogeny of Amphibia including over 2800 species, and a revised classification of extant frogs, salamanders, and caecilians. *Molecular Phylogenetics and Evolution*, 61 (2), 543–583.  
<http://doi.org/10.1016/j.ympev.2011.06.012>
- Reynoso, V.H., Paredes-León, R. & González-Hernández, A. (2011) Anfibios y reptiles del estado de Chiapas con algunos comentarios sobre los reportes y estudios de diversidad herpetofaunística en la región. In: Álvarez, F. (Ed.), *Chiapas: Estudios sobre su diversidad biológica*. Universidad Nacional Autónoma de México, México, pp. 459–509.
- Salas-Morales, S.H., Schibli, L. & Torres-Bahena, E. (2001) La importancia Ecológica y Biológica. In: *Chimalapas: La última oportunidad*. World Wildlife Found Program México, Secretaría del Medio Ambiente, Recursos Naturales y Pesca, México, pp. 27–47.
- Wiens, J.J., Kuczynski, C.A., Hua, X. & Moen, D.S. (2010) An expanded phylogeny of treefrogs (Hylidae) based on nuclear and mitochondrial sequence data. *Molecular Phylogenetics and Evolution*, 55, 871–882.  
<http://doi.org/10.1016/j.ympev.2010.03.013>