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A New Species of Toad of the Genus *Incilius* from the Sierra Madre Occidental of Chihuahua, Mexico (Anura: Bufonidae)

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ABSTRACT.—In this paper we describe a new species of toad of the genus *Incilius*. This species was originally recorded as *Bufo simus*, a synonym of *I. occidentalis*. It differs from *I. occidentalis* by having the following combination of characters: a pale brown dorsal ground color with numerous dark brown spots and lacking a vertebral stripe and a high density of granules on the dorsum producing a rugose skin texture. The most developed of the cranial crests is the supraorbital, while the parietal is poorly developed. *Incilius mccoysi* inhabits pine and pine-oak forests of the southwestern Sierra Madre Occidental in Chihuahua, Mexico.

The complex physiography of the state of Chihuahua, Mexico, has given rise to an array of habitats supporting a herpetofaunal diversity reaching 186 species and subspecies (Lemos et al., 2004). Few studies of the herpetofauna of Chihuahua have been published (e.g., Domínguez et al., 1974; Tanner 1985, 1987, 1989), and recently Lemos-Espinal and Smith (2007) published a checklist and keys for the herpetofauna of the state. Concerning amphibians, nine species of bufonid toads have been recorded from Chihuahua (Tanner, 1989; Lemos-Espinal et al., 2004): *Anaxyrus cognatus*, *Anaxyrus debilis*, *Anaxyrus punctatus*, *Anaxyrus speciosus* and *Anaxyrus woodhousii* in the northern and eastern part of the state; *Incilius occidentalis* in the southern Sierra Madre Occidental; *Anaxyrus mexicanus* in the northwest; and *Rhinella marina* and *Incilius mazatlanensis* at the southwestern part of the state.

Incilius occidentalis is an endemic species of toad in Mexico that has been recorded from >200 localities (Santos-Barrera, 1995). These populations inhabit several kinds of habitats including pine-oak forest, tropical deciduous forest, scrub forest, and arid lands. As part of a project reviewing the taxonomy of *I. occidentalis* (Santos-Barrera, 1995), we identified several features that distinguish the populations of these toads inhabiting west central Chihuahua, Mexico, from those of the High Plateau and southern Mexico; we propose this taxon as a new species, and it is described below.

MATERIALS AND METHODS

We examined 57 adult and 37 young and recently-metamorphosed specimens of toads catalogued as *Bufo simus* and/or *I. occidentalis* recorded along western Chihuahua housed at the Herpetological Collections of BYU, KU, UMMZ, MVZ, and MZFC (abbreviations are according to Leviton et al., 1985; Flores Villela and Hernández-Gómez, 1992). In addition, we examined the syntypes of *Bufo occidentalis* held at the Torino Museum, Italy. Eight morphometric variables often used in taxonomy of bufonid anurans (Mendelson, 1997; Mendelson et al., 2005) were measured: snout–vent length (SVL), head length (HL), head width (HW), tibia length (TL), longest diameter of the tympanum (TYMP), eye diameter, and parotoid width and parotoid length (PAROT). In addition, the following measures were taken from the head: interorbital distance (IOD, the distance between the inner edge among both eyes), snout–nostril distance (SND, from tip of the snout to the anterior edge of the nostril), and nostril–eye distance (NED, from the anterior border of the eye to the posterior edge of the nostril). The variables were measured using an electronic caliper, with resolution of 0.01 mm. Additional morphological characters

evaluated included development and arrangement of the cranial crests, dorsal and ventral color pattern, texture of the skin, and tympanum development. Color numbers in parentheses describing specimens correspond to those of Smithe (1974). Sexual dimorphism was identified by the presence of vocal slits and nuptial excrescences in males. Absence of these characters; size, rotund aspect of the body, reflecting egg content; and direct examination of gonads, when possible, were interpreted to representing females. In a previous work in which the morphometric variables mentioned above were analyzed, Santos-Barrera (1995) demonstrated that sexual dimorphism exists in populations formerly known as *I. occidentalis*. Foot webbing formulae follow Savage and Heyer (1967) as modified by Savage and Heyer (1997).

Incilius mccoysi, sp. nov.

Figure 1

Bufo simus: Taylor and Knobloch, 1940: 125 Mojaráchic, Tanner, 1989: 64, Cerocahui, 25.5 miles S Creel; SW Chihuahua, Río San Miguel.

Bufo occidentalis: Riemer, 1955: 21, Río Gavilán, 11 km SW Pacheco; Van Devender and Lowe, 1977: 43, 23.8 km SE Madera; 17.1 km NW Yepómera; Van Devender et al., 1989: 48, 6 km WNW Ocampo; all localities in Chihuahua, Mexico.

Holotype.—MZFC 9935, an adult female from 42.5 km S of Creel, on the Creel–Huachochi road Chihuahua, Mexico. Type locality is located at 27°38'35"N, 107°48'21"W, in pine-oak forest, 1,400-m elevation. Obtained on 20 August 1996 by Georgina Santos-Barrera.

Paratypes.—MZFC 9932, 9933 from 42.4 km S of Creel, on the Creel–Huachochi road, two juveniles. Collected on 20 August by Georgina Santos-Barrera.

Referred Specimens.—Mexico, Chihuahua: BYU 14542, Cerocahui; BYU 17049, 17134–37 from 40.8 km S of Creel, on the road to La Bufa, Chihuahua, Mexico (an adult female and three juveniles); BYU 39373, Río San Miguel; KU 44432, 37 km S and 2.4 km E Creel, Barranca del Cobre; KU 47233, 8 km S Riito; KU 47234, 3.5 km S Riito; KU 52058–61, 52064–75, 5 km NW Temoris; KU 52062–63, 13 km SW Cuiteco; KU 56168, Urique; KU 63659–62, 4 km N Urique; KU 63663, Yosachique; UMMZ 111513 (a series of 10 specimens), UMMZ 117778 (a series of two specimens) and UMMZ 117779 (series of four specimens), Maguarichic; UMMZ 111515 (series of four specimens), Mojarachic; UMMZ 111114, La Polvosa; MVZ 46639–40, Río Gavilán, 11 km SW Pacheco.

Diagnosis.—This is a large- to medium-sized species of toad (SVL of females, 56.52–86.53; males, 50.61–67.47). The species can be distinguished from other species by the following arrangement of characters: 1) skin rugose, with abundant, small conical granules uniformly distributed on the dorsum,

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FIG. 1. Holotype of *Incilius mccoyi* (MZFC 9935), an adult female from 42.5 km S of Creel, on the Creel-Huachochi road, Chihuahua, Mexico. Photo by Adrián Nieto Montes de Oca.

becoming more densely distributed on the limbs; 2) each granule bearing one dark, keratinized spine on the tip, multiple spines per granule sometimes present in adults; 3) three cranial crests present, supraocular crest being most developed, parietal and postocular crests reduced, with postocular crest often absent and parietal crest slightly reduced; 4) parotoid glands medium sized (approximately 47% of HL), elliptical, bearing same color as dorsum; 5) tibia short (approximately 38% of the SVL); 6) dorsum with numerous small and nearly rounded sepia colored blotches (119) that never form a middorsal stripe; 7) ventral surfaces uniform cream (54); 8) tympanum indistinct, and when present, it is small and ovoid; 9) juveniles with small dark gray spots on the throat and belly; and 10) vocal slit unilateral in males.

Comparisons with Other Populations Referred to *I. occidentalis*.—*Incilius mccoyi* differs from other known populations of *I. occidentalis* in several aspects. In comparison to populations of *I. occidentalis* from the Mexican plateau, *I. mccoyi* can be distinguished by the presence of numerous dorsal granules with conical tip, making texture of the skin highly rugose in *I. mccoyi*, whereas the skin is relatively smooth in *I. occidentalis*. Concerning color pattern, all populations of *I. occidentalis* examined have a pattern consisting of dark brown dorsal bands that result in the formation of a pale middorsal line; sometimes this line is interrupted at mid- or posterior dorsum by the coincidence of two or more spots forming a larger blotch; the color pattern of spots in *I. mccoyi* never shows this middorsal line; instead, several small- to medium-sized blotches can be seen and in some individuals, these blotches can suffuse to form bigger blotches but never producing a middorsal line. Populations of *I. occidentalis* in the Sierra Madre del Sur in Guerrero are quite different from *I. mccoyi* by having conspicuous, large, rounded granules on the dorsum; also the dorsal color pattern in *I. occidentalis* from Guerrero consists of dark gray dorsolateral bands running parallel from behind the eye and reaching the flanks; a conspicuous pale middorsal line is present; in addition, *I. occidentalis* from Guerrero has a lateral line of sharp granules never present in *I. mccoyi*, and lateral surfaces are of the same texture of the rest of body. By comparing *I. mccoyi* to the population of *I. occidentalis* in northern Puebla, it is easy to distinguish a pale middorsal line in the latter population; in addition, there are numerous irregular black blotches on the venter of individuals from northern Puebla, whereas *I. mccoyi* lacks a vertebral line and has immaculate ventral surfaces. Dorsal surfaces are considerably more rugose in *I. mccoyi* than in *I. occidentalis* (Santos-Barrera, 1995).

Comparisons with Other Species of *Incilius* and *Anaxyrus*.—*Incilius mccoyi* is sympatric only with *Anaxyrus mexicanus* in the forested pine-oak area of the Sierra Madre in southern and west central Chihuahua (Gergus, 1998) and probably with *I. mazatlanensis* in the area near the border between Chihuahua and Sinaloa. It differs from *A. mexicanus* in the development of the cranial crests, with the supraocular and postocular crests being less developed in *A. mexicanus* and being short and wide in *I. mccoyi*. Parotoid glands are small and nearly rounded in *A. mexicanus* and elliptical in *I. mccoyi*. Granules on the dorsal surfaces are conical and uniformly distributed in *I. mccoyi* and scarce and rounded in *A. mexicanus*. The color pattern of the dorsum consists of several small dark blotches in *I. mccoyi*, not forming a middorsal line, in contrast to the reddish to brown medium-sized spots on a light brown ground in *A. mexicanus*. Comparing *I. mccoyi* with *I. mazatlanensis*, the latter species has a greater development of the cranial crests, including the presence of the pretympanic and supratympanic crests. *Incilius mazatlanensis* has a color pattern in the dorsum consisting of a clear middorsal line with two dark brown paravertebral blotches that are absent in *I. mccoyi*.

Description of Holotype.—An adult female; body robust. Measurements: SVL, 77.51; HL, 23.34; HW, 28.85; TL, 30.39; foot length, 33.07; parotoid length, 10.99; parotoid width, 7.44; eye diameter, 8.83; ratio parotoid length/eye diameter, 1.24; head length, 30.1% SVL; and width of head, 37.2% of SVL. Head triangular in dorsal view and snout laterally truncate, nostrils directed dorsally. Supraocular crests well developed; interorbital area slightly concave, postocular crest slightly reduced, parietal crests poorly developed, preocular crest distinct, canthal crest absent, canthus rostralis smooth, not forming an angle between dorsal and lateral surfaces of head, loreal region slightly concave, supralabial crest absent. Parotoid glands elliptical, separated from eye by row of granules. Tympanum indistinct, small, oval, annulus inconspicuous and incomplete on the left side. Webbing on hands absent. Relative length of the Fingers 3, 1, 4, 2 (left hand) and 3, 1, 2, 4 (right hand); thenar tubercle smaller than palmar, and round-shaped, palmar tubercle slightly elongate, subarticular tubercles bifid except basal tubercle on the Finger IV. Tips of the fingers not enlarged. Tibia 39% of the SVL, foot 42.6% of the SVL. Relative length of toes is 4, 3, 5, 2, 1; webbing on feet toes in the following formula: right I 1–2 II 1–2 III 1½–3 IV 3–1 V, left I 1–2 II 1–2 III 1½–3 IV 3–1 V; unwebbed sections of toes bearing conspicuous lateral fringe; subarticular tubercles bifid on fourth toe; inner metatarsal tubercle slightly longer than metatarsal tubercle, tips of toes not enlarged. Skin on the dorsum, including limbs, with abundant small conical granules, some granules with more than one keratinized tip, granules becoming more densely concentrated on the arms such that arms are conspicuously rugose. Granules on ventral surfaces mostly concentrated on the gular and anterior ventral surfaces, each bearing only one keratinized spine.

Coloration of Holotype in Life.—In life, dorsal surfaces olive gray (42), with dark sepia blotches (119, 219), and some other marks of walnut color (221 B); these marks are lighter and more conspicuous on the sides of body and on the parotoid glands. Flanks of light olive gray (43) with sparse sepia mottling. Fore and hind limbs with the same pattern of the dorsum. Ventral surfaces uniform cream (56).

Coloration of Holotype in Preservative.—Dorsal coloration is from grayish olive (43) on the dorsum to smoke gray (44) on the lateral surfaces with many irregular sepia blotches (119), parotoids grayish olive; a series of dark brown dots are present on the upper lip; arms and feet olive gray (42) with incomplete transverse sepia bands; there is a longitudinal sepia band in the fore arm, running from the palmar tubercles to the elbow; legs with incomplete transverse sepia bands. Ventral surfaces

TABLE 1. Morphometric data for males and females of *Incilius mccoyi* from Chihuahua, Mexico. Measurements in millimeters (0.01 precision). For each sex, values presented as Min-Max (average/SD). SVL, snout-vent length; HL, head length; HW, head width; TL, tibia length; TYMP, tympanum diameter; EYELID LENGTH, eyelid diameter; PAROT, parotoid length; IOD, interorbital distance; SND, snout-nostril distance; NED, nostril-eye distance. See text for description of the variables.

Variable	Interval measurement	
	Males	Females
SVL	50.61–67.47 (57.48/5.28)	56.52–86.53 (74.05/8.21)
HL	15.78–20.04 (17.88/1.54)	20.02–25.87 (22.73/1.80)
HW	17.35–22.48 (20.20/2.25)	23.06–32.23 (27.25/2.46)
TL	10.19–26.66 (21.68/4.33)	23.45–33.49 (28.32/3.01)
TYMP	2.38–2.85 (2.77/0.45)	2.67–4.55 (3.40/0.43)
EYELID LENGTH	6.25–7.93 (6.98/0.48)	6.51–9.25 (8.42/0.91)
PAROT	6.58–10.63 (8.40/1.12)	8.15–13.27 (10.52/1.53)
IOD	8.38–11.69 (10.01/0.99)	10.4–15.04 (12.76/1.31)
SND	4.11–5.07 (4.56/0.28)	4.87–6.64 (5.57/0.59)
NED	4.13–5.35 (4.76/0.43)	4.84–6.65 (5.74/0.58)

including limbs are straw yellow (56) with several scattered sepia dots, especially on chest and lateral surfaces of belly.

Variation.—Morphometric data for females and males is summarized in Table 1. A clear sexual dimorphism exists in this species, with females being larger than males (Fig. 2). Size and number of granules on the dorsum are variable according to age and size of specimen; younger specimens have more and smaller granules, making all dorsal surfaces more rugose than adults; spines on the granules are small and without the dark colored point in younger specimens. The development of cranial crests is distinguishable only in subadult and adult individuals. The tympanum is generally indistinct in young specimens and when present it is round to oval. Parotoid glands generally lighter than dorsum. Dorsal coloration brown olive to dark brown in some specimens. The dorsal blotches sometimes may fuse, producing the appearance of a single large blotch. Ventral surfaces may be highly mottled with pale gray in young and subadult individuals.

Distribution and Natural History.—*Incilius mccoyi* occurs in west central Chihuahua, Mexico, through to the northern Sierra Madre Occidental (Fig. 3). It has been recorded from north

central Chihuahua (Colonia Juárez), south to Batopilas, and reaches the extreme southwestern Chihuahua (Río San Miguel). This species inhabits pine and pine-oak forests, at elevations from 1,200 to 1,500 m. This species dwells well in moderate and low streams with abundant rocks and logs that can provide suitable microhabitats in the heat of the day. Calls of males have been recorded by Gergus (pers. comm.), yet neither the call nor the tadpoles have been described. We found several juveniles and recently metamorphosed individuals in late August and mid-September, suggesting that mating season occurs at the beginning of the rainy season, from July to September as in other species of *Incilius* in other parts of northern Mexico.

Discussion.—*Incilius occidentalis* is now recognized as a complex of species. Besides *I. mccoyi*, at least two species remain undescribed within the group (Santos-Barrera, unpubl. data). The lack of a precise definition of characters is the main cause of misidentification of specimens in this group, that even involves South American species such as *B. simus* (Schmidt, 1857), which was reported by Tanner (1989) when he studied part of the Chihuahuan herpetofauna. The history starts when Camerano (1879) made a brief description of three toads



FIG. 2. Male (BYU 39373) and female holotype (MZFC 9935) of *Incilius mccoyi* from Chihuahua, Mexico.

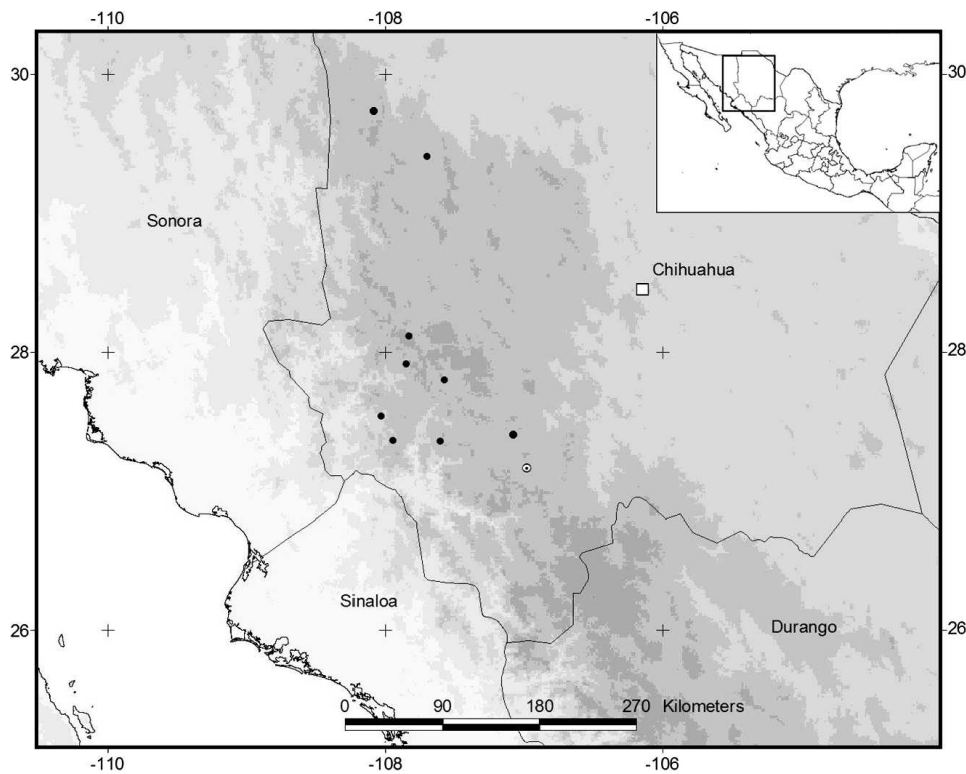


FIG. 3. Geographic distribution of *Incilius mccoysi* in Chihuahua, Mexico. Open circle represent type locality at north Guachochi, Chihuahua. Black circles represent collection localities.

collected by Cravieri in Mexico and housed at the Torino Museum; the specimens were named by him as *Bufo occidentalis*. Ignoring the publication of Camerano, the subsequent records from Mexico were erroneously assigned to *Bufo intermedius* Günther 1859 (e.g., Dugès, 1869). Later, Kellogg (1932) considered *B. intermedius* as a junior synonym of *B. simus*, and as a consequence, *B. occidentalis* became a synonym of *B. simus*. Savage (1972) revising the syntypes of *B. simus* demonstrated that there was no morphological relationship between the specimens collected in Central America and those recorded in Mexico, suggesting the probability that the syntypes of *B. simus* should be the juvenile form of an unidentified South American species. Recently, De la Riva (2004) concluded that *B. simus* is a synonym of *B. spinulosus* (*Rhinella spinulosa*; Frost et al., 2006). Therefore, at present, the only synonym for *I. mccoysi* should be *I. occidentalis*, which is the synonym included herein. A revision of the *I. occidentalis* nomenclatural historical will be presented in another article (Santos-Barrera, unpubl. data).

Recent molecular evidence based on mitochondrial and nuclear DNA provided new insight about the phylogeny of numerous bufonid species (Frost et al., 2006). However, relationships into the *I. occidentalis* group are still unclear; this is a highly important issue to define the phylogenetic allocation of *I. mccoysi*, too. In the phylogeny proposed by Pauly et al. (2004), *I. occidentalis* is the sister taxon of the Sonoran Desert Toad *Incilius alvarius*; however, it should be noted that the *I. occidentalis* samples used by them were from Oaxaca in southern Mexico. Other nearly complete phylogenies (e.g., Graybeal, 1997) did not include *I. occidentalis* specimens in the analysis. A new phylogeny that contents this new species as well as the other undescribed species will be of great help in the understanding of the taxonomy of the *I. occidentalis* group.

Etymology.—This species is dedicated to the late Dr. C. Jack McCoy, our friend and mentor.

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