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Distribution and Ecology of the Northernmost Mexican West Coast Boa Constrictor (*Boa sigma*)

The boa constrictor is a large New World serpent that was described as *Boa constrictor* by Linnaeus in 1758. The Central American and Mexican populations were described as *B. imperator* by Daudin in 1803. Based on genetic evidence, Card et al. (2016) recognized boa constrictors in northwestern Mexico as *B. sigma*, the Mexican West Coast Boa Constrictor. This taxon was first described as *Constrictor constrictor sigma* from the Tres Marias Islands by Smith (1943).

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The New World tropics reaches its northern limits in Sonora. The northernmost tropical deciduous forest (TDF) is in the Sierra San Javier (28.6°N; 300 km S of the Arizona border). Foothills thornscrub (FTS) is a transitional vegetation between TDF and Sonoran desertscrub (SDS) in southern Sonora, and between oak woodland (OW) and SDS in central Sonora (Van Devender et al. 2013). Tropical FTS extends northward in river valleys to ca. 30.4°N (104 km S of the Arizona border; Van Devender et al. 2013). In this area, FTS merges into desert grassland (DG) as winter temperatures decline. The distributions of a few tropical species are in mid-elevation DG-OW in southern Arizona, where they are limited by cold at higher elevations and aridity at lower elevations (Van Devender et al. 1994). Examples are the Brown Vinesnake (*Oxybelis aeneus*), Green Ratsnake (*Senticolis triaspis*), and Thornscrub Hook-nosed Snake (*Gyalopion quadrangulare*). To the west, FTS enters the Plains of Sonora subdivision of the Sonoran Desert on the tops of desert mountain ranges and hills.

Here we discuss the northernmost records of *B. sigma* in Sonora, Mexico. Records are from the Madrean Discovery

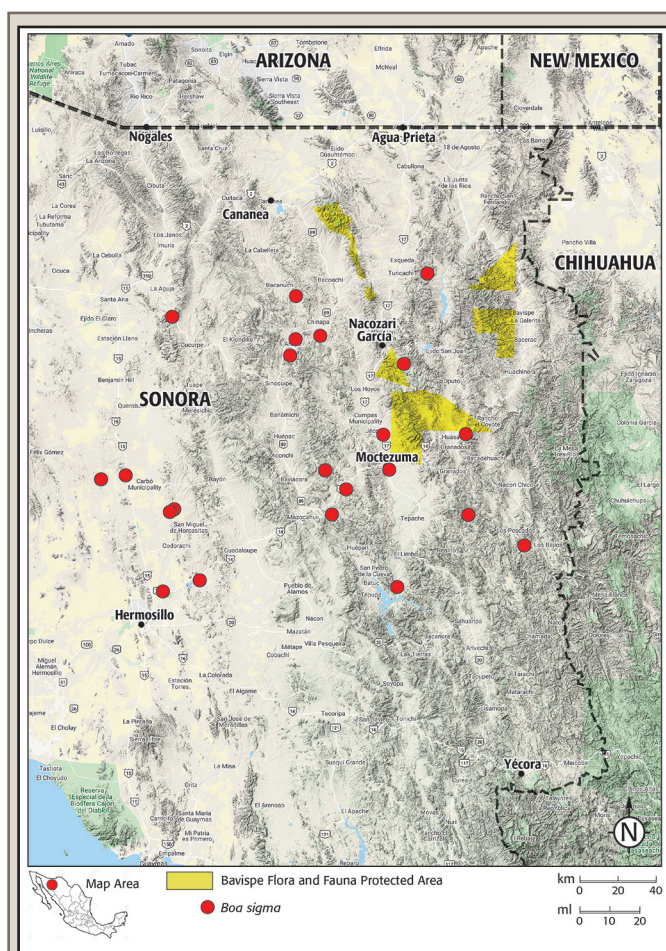


FIG. 1. Distribution of *Boa sigma* in northern Sonora.

PHOTOS BY T. R. VAN DEVENDER (A) AND ANA L. REINA-G. (B)

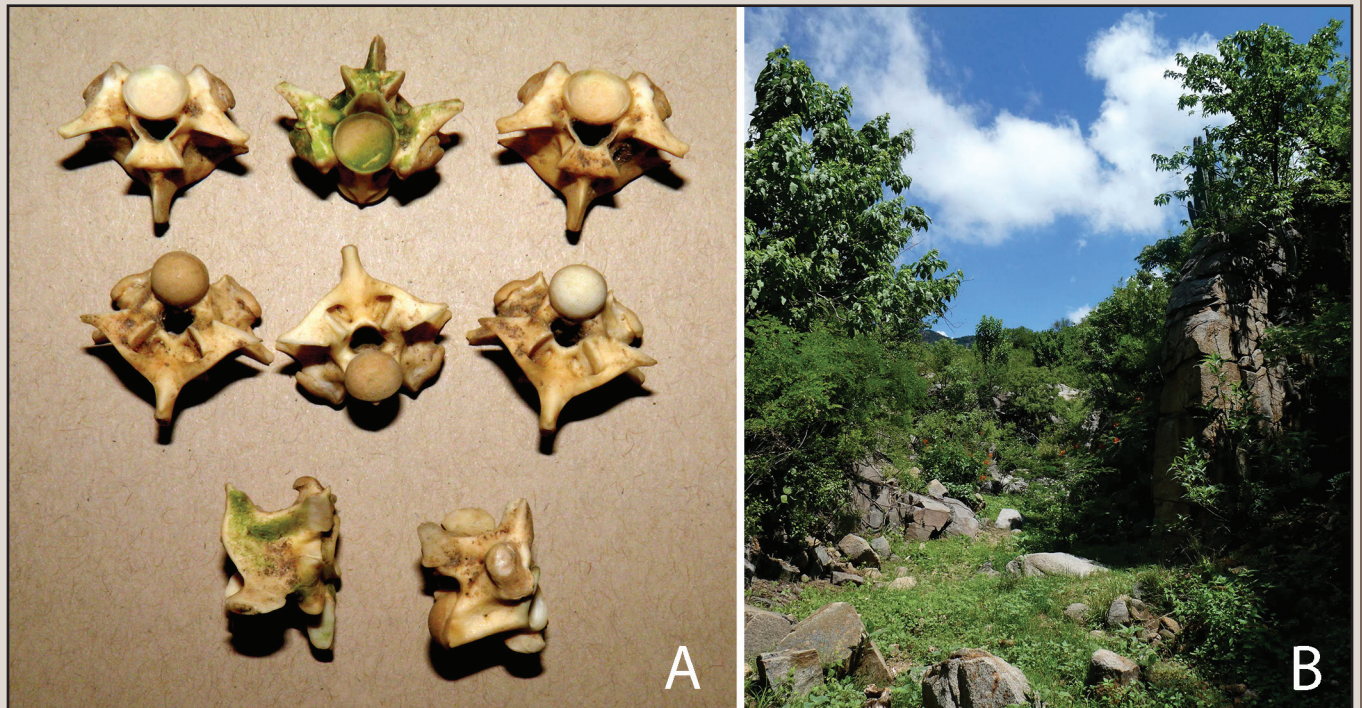


FIG. 2. A) *Boa sigma* vertebrae. Rancho El Buzón. B) Rocky canyon habitat in foothills thornscrub on Rancho La Palma.

PHOTOS BY T. R. VAN DEVENDER

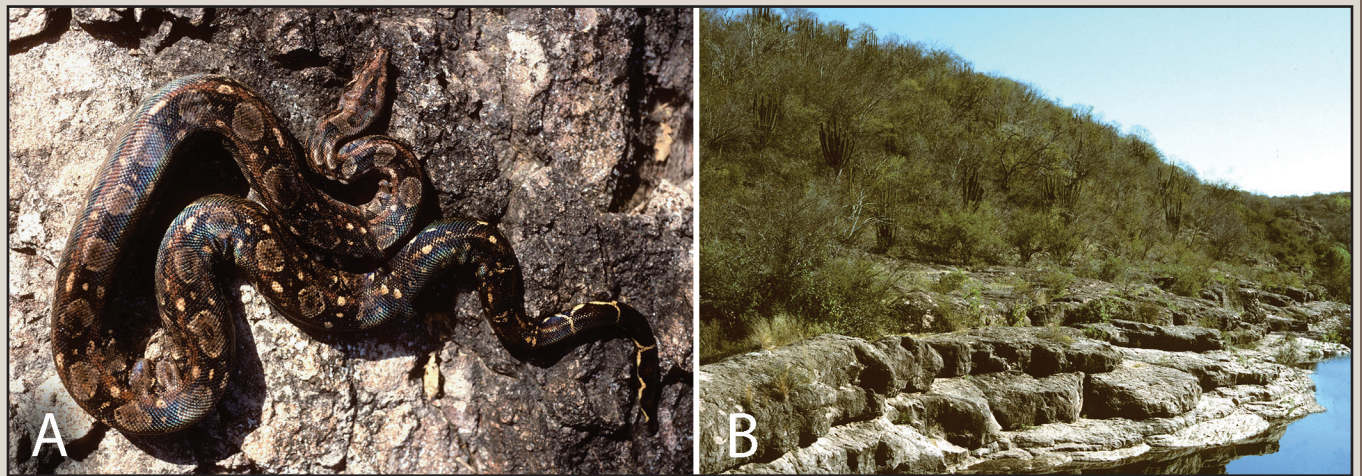


FIG. 3. A) *Boa sigma* and B) tropical deciduous forest habitat on Río Cuchujaqui.

Expeditions (MDE) program of GreaterGood.org in Tucson, Arizona, fieldwork by the authors, and specimens in the University of Arizona Herpetological Collection (UAZ) and the University of Texas at El Paso Biodiversity Collections (UTEPBC). Observations and images are available in the MDE database (madreandiscovery.org) and the Arizona State University Herpetological Collection photo vouchers (ASU HP).

SPECIMEN RECORDS

MEXICO: SONORA: MUNICIPALITY OF ARIZPE: El Corralito, Aguaje El Palmillalito, 9.4 km (by air) SE of Bacanuchi, Rancho El Peñascal. (30.5594°N, 110.15444°W; NAD 27), 1105 m elev. 13 September 2019. José Abel Salazar-Martínez. ASU HP00427 (photo voucher); Rancho Los Alisos, 3.1 km (by air) ESE of Buenavista, 6.2 km (by air) S of Chinapa (30.3849°N, 110.0301°W), 911 m elev. 15 September

2018. Ignacio Urías-Castro. ASU HP00432 (photo voucher); 3.8 km (by air) ENE of Arizpe, Río Sonora (30.3508°N, 110.1311°W), 841 m elev. 24 September 2005. Philip C. Rosen. ASU HP00430 (photo voucher); Bámori (30.2931°N, 110.1872°W), 800 m elev. 6 September 2019. Bere Montijo-Castillo. ASU HP00428 (photo voucher); ca. 2 mi SSW of Arizpe (Tahuichopa). (30.3681°N, 110.158°W), 841 m elev. 19 August 1958. Charles H. Lowe. UAZ 36084–36085. Correct locality: Tahuichopa, 3.5 km (by air) NNE of Arizpe, northern side tributary of the Río Sonora. Mistakenly in the Municipality of Santa Ana in Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (2016) record. MUNICIPALITY OF CARBÓ: 18 mi W of Carbó (ca. Arroyo Crisanto [NW tributary of the Río San Miguel]), 14.5 km (by air) WNW of El Oasis (29.725°N, 111.186393°W), 639 m elev. 2 May 1945. Arthur C. Twomey. Carnegie Museum of Natural History (CM 25233); 49 mi N of Hermosillo (ca. 11.6 km [by air]) NW of Carbó (29.7444°N,

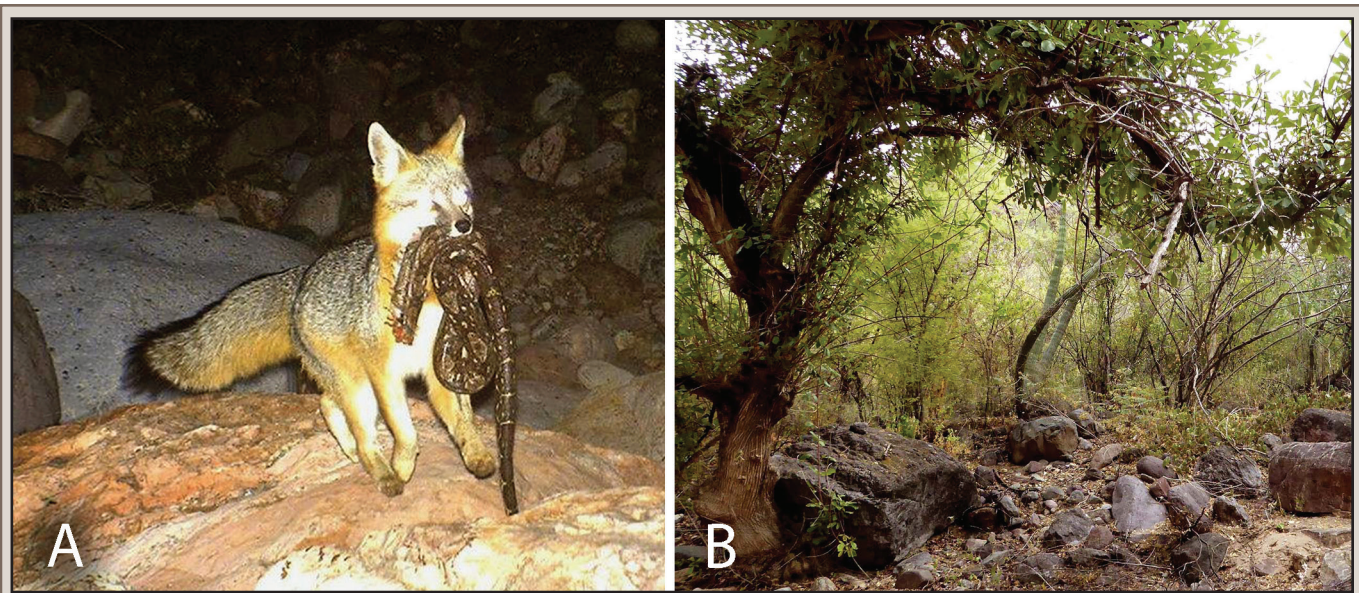


FIG. 4. Rancho Viejo. A) *Urocyon cinereoargenteus* eating *Boa sigma*. B) Foothills thornscrub habitat.



FIG. 5. Northernmost locality 12.6 km (by air) E of Turicachi. A. *Boa sigma*. B. Desert grassland habitat.

111.0553°W), 602 m elev. 28 October 1941. Seth B. Benson #7931 (MVZ 37799). MUNICIPALITY OF CUCURPE: Palm Canyon in Cerro de Plata, 17.7 mi SE of Magdalena on road to Cucurpe (Rancho la Lámina, Sierra Babiso) (30.4703°N, 110.8086°W), 1049 m elev. 5 September 1976. N. Nikiforou, Thomas R. Van Devender. UAZ 42356, UAZ-PSV-006 (photo voucher), ASU HP00431 (photo voucher). (Locality correction for previously published record for this municipality. Mistakenly in the Municipality of Santa Ana in Comisión Nacional para el Conocimiento y Uso de la Biodiversidad [2016] record). MUNICIPALITY OF CUMPAS: 10.4 km (by air) SE of Cumpas (29.925°N, 109.6956°W), 760 m elev. 6 October 2012. Thomas R. Van Devender, Ana L. Reina-Guerrero. ASU HP00434 (photo voucher). MUNICIPALITY OF DIVISADEROS: Rancho Pueblo Viejo, 22.4 km (by air) ESE of Divisaderos (29.5656°N, 109.2467°W; NAD 27), 513 m elev. 6 October 2011. José Manuel Galaz-Galaz. Primero Conservation.org wildlife camera image. ASU HP00441 (photo voucher). MUNICIPALITY OF HERMOSILLO: 2 km N of San Pedro on Real del Alamito road (29.2113°N, 110.8606°W), 269 m elev. 29 October 2014. Jorge H. Valdez-Villavicencio. ASU HP00457 (photo voucher). MUNICIPALITY OF HUÁSBABAS: 4.7 km (by

air) NE of Huásabas (29.9347°N, 109.2622°W), 800 m elev. 5 August 2018. Dale S. Turner, Charles Hedgcock, Sky Jacobs. ASU HP00237 (photo voucher); Rorabaugh et al. (2019). MUNICIPALITY OF MOCTEZUMA: Rancho La Palma, 16.9 km (by air) ENE of Baviácora (29.7631°N, 109.998°W; NAD 27), 1083 m elev. 9 August 2019. R. Wayne Van Devender, Thomas R. Van Devender. Skeleton. ASU HP00429 (photo voucher); Cañada la Carabina, Rancho la Montosa, 38.6 km SW of Moctezuma (29.5664°N, 109.9683°W; NAD 27), 1150 m elev. 22 September 2017. Hugo Silva-Kurumiya, Gertrudis Yanes-Arvayo. ASU HP00436 (photo voucher); 24.8 km (by air) SW of Moctezuma (29.6777°N, 109.8952°W), 952 m elev. 3 August 2019. Oscar Leonardo Chavez-Torres. ASU HP00442 (photo voucher); Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (2016. EncicloVida. CONABIO. México, 18 November 2019 de <http://www.encyclovida.mx>); 3 km S of Moctezuma-Huásabas highway on road to Sahuaripa, ca. 4 km (by air) S of Moctezuma (29.765°N, 109.6644°W), 626 m elev. 5 August 2010. Scott J. Trageser, Robert A. Villa, Matthew Nordgren. ASU HP 00433 (photo voucher). MUNICIPALITY OF NÁCORI CHICO: El Chunero, 30.1 km (by air) SSE of Nácori Chico (29.4187°N,

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FIG. 6. El Corralito, Aguaje El Palmillalito, Rancho El Peñascal. A) *Boa sigma*. B) Spring habitat in desert grassland.

PHOTOS BY CHARLES HEDGCOCK (A) AND SKY JACOBS (B)



FIG. 7. Rancho El Orégano Viejo, Sierra Juriquipa. A) *Boa sigma*. B) Sky Jacobs in front of massive *huérigo*. Note boa, yet unnoticed, under foot.

108.9467°W), 879 m elev. 29 September 2013. José Manuel Galaz-Galaz. Primero Conservation.org wildlife camera image. ASU HP00439 (photo voucher). MUNICIPALITY OF NACOZARI DE GARCÍA: 12.6 km (by air) E of Turicachi (30.6664°N, 109.4636°W), 1066 m elev., 29 July 2019. Brandon Dietrich, Yekaterina Pavlova. ASU HP00440 (photo voucher). Rancho el Orégano Viejo, 16.0 km (by air) SE of Nacozari de García, Sierra Juriquipa (30.2594°N, 109.5878°W), 1418 m elev. 14 August 2017. Sky Jacobs. UTEPBC (UTEP Obs: Herp: 124; photo voucher; Jacobs 2018). MUNICIPALITY OF SAN MIGUEL DE HORCASITAS: Cueva el Tigre, 12 km S, 13 km E of Carbó (29.575°N, 110.8208°W), 463 m elev. 7 November 1987. George M. Ferguson, Philip C. Rosen. SVL = 1582 mm, tail = 137 mm, 1032 g. ASU HP00437 (photo voucher). Cueva la Dorada, 10.5 km S, 14.5 km E of Carbó (29.5883°N, 110.800°W), 497 m elev. 7 November 1987. George M. Ferguson, Philip C. Rosen. ASU HP00438 (photo voucher). MUNICIPALITY OF SAN PEDRO DE LA CUEVA: El Bajío, 4.0 km (by air) S of Carrizal, 13.0 km (by air) SE of San Pedro de la Cueva (29.2305°N, 109.6193°W), 389 m elev. 19 June 2010. Gertrudis Yanes-Arwayo, Hugo Silva-Kurumiya ASU HP00435 (photo voucher). All coordinates in WGS 84 unless otherwise indicated.

RESULTS

The 23 records of *Boa sigma* from north of 29.2°N in Sonora include first records for the municipalities of Carbó, Cumpas, Divisaderos, Hermosillo, Moctezuma, Nacozari de García, San Miguel de Horcasitas, and San Pedro de la Cueva and previously published records from the Municipalities of Arizpe, Cucurpe, Huásabas, and Nacozari de García (Fig. 1). The northernmost *B. sigma* locality for 43 years was Palm Canyon 17.7 mi SE of Magdalena (Enderson et al. 2009; Rorabaugh and Lemos-Espinal 2016), until the 2019 El Corralito, Aguaje El Pamillalito and 12.6 km (by air) E of Turicachi observations reported here extended the *B. sigma* distribution closer to the Arizona border.

In southern and eastern Sonora, the distribution of *B. sigma* is centered in TDF and FTS. In northeastern Sonora, boas have been found in SDS (6), FTS (9; Fig. 2), FTS-DG transition (4), DG (1), FTS-OW transition (2), and OW (1; Jacobs 2018). In most of these localities, boas were in riparian habitats, including cottonwood-willow riparian forests along the Ríos Bacanuchi and Sonora; mesquite-dominated arroyos in FTS and DG, desert riparian scrub in SDS; rocky stream canyons in mountains; springs; and *milpas* (cultivated fields on floodplain).

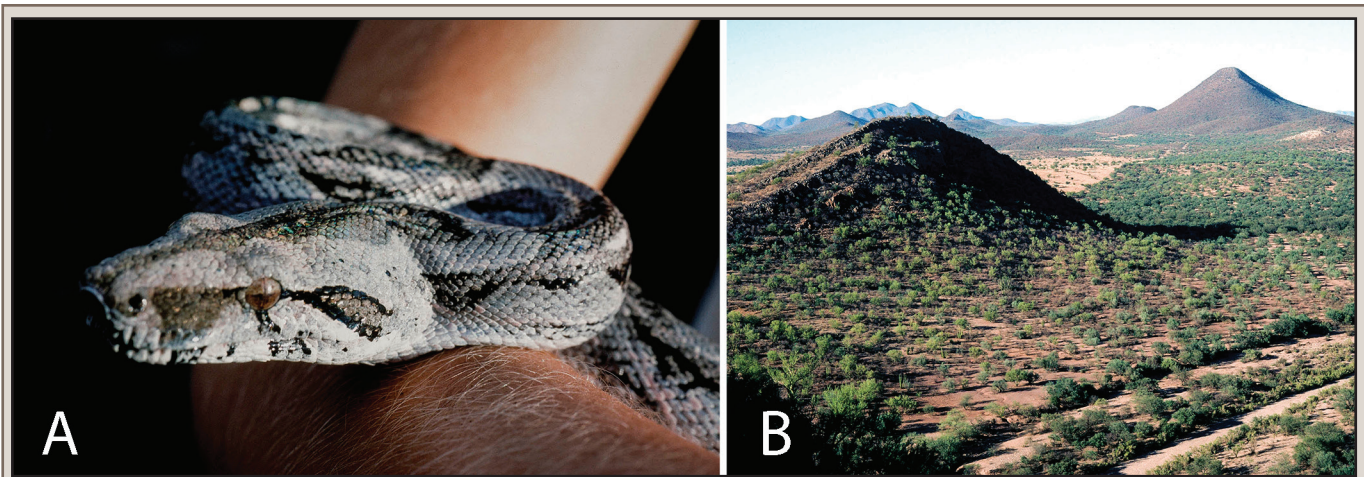


FIG. 8. Cueva El Tigre, 12 km S, 13 km E of Carbó. A) *Boa sigma*. B) Plains of Sonora desertscrub habitat.

PHOTOS BY GEORGE M. FERGUSON

In southern Sonora, boas have been found near sea level around San Carlos Bay and likely occur in coastal thornscrub along the Gulf of California south to Sinaloa. Near Álamos, boas occur as low as 200 m elevation in TDF along the Río Cuchujaqui (Fig. 3). Elevations in the northern Sonora boa localities range from 269–639 m (mean 463.3, $N = 6$) in Sonoran desertscrub, 389–1083 m (mean 742.9, $N = 9$) in FTS, 841–1066 m (mean 966.8, $N = 4$) in FTS-DG transition, 1105 m in DG ($N = 1$), 952–1150 m (mean = 1051, $N = 2$) in FTS-OW, and 1418 m ($N = 1$) in OW.

Northern Sonora boas were seen in the warm season in May (1), June (1), July (1), August (7), September (7), October (4), and early November (2). Peak activity appears to be in August–September during and immediately after the summer monsoon rainy season (*las aguas*).

Rorabaugh and Lemos-Espinal (2016) reported the size of *B. sigma* as up to 2000 mm long. The Bátori individual was estimated to be ca. 2300 mm long (Steven L. Minter, pers. comm.).

A wildlife camera image of a *B. sigma* being eaten by a Gray Fox (*Urocyon cinereoargenteus*) on Rancho Pueblo Viejo near the Río Bavispe east-southeast of Divisaderos (Fig. 4) is an interesting predation record.

DISCUSSION

Mythology.—In several Sonoran indigenous tribes (e.g., Mayo, Ópata), boas are called *corúa*, *corúga*, or *corúva*. In Spanish in Sonora, they are called *las guardianas del agua*, guardians of the water. Unlike most *víboras* (vipers, but used for most snakes), *corúas* are not killed on sight to prevent the springs from drying up. Sobarzo (1991) said that the name *corúa* was derived from the Cahita (the language of the Mayo and Yaqui tribes in southern Sonora) word *curúas*, meaning a big, fat snake. The name of the town Bacoachi (Municipio de Bacoachi, 20 km by air ENE of the El Corralito *B. sigma* locality) on the Río Sonora is derived from the Ópata language *baco* + *tzi* – the place of the water snake. Oral tradition says that this was a sanctuary dedicated to an enormous snake that lived near the river. Apparently, boas have been known in this area for a very long time.

Northern limits of *B. sigma* distribution.—The known northern distribution limit of *B. sigma* is in the transition between the New World tropics (FTS) and Northern Temperate biomes south of 31°N latitude. At the edges of FTS, boas are found in non-tropical vegetation.

The northernmost boa record 12.6 km (by air) E of Turicachi (30.67°N, 74 km S of the Arizona border; Fig. 5) is in an arroyo in a complex transition zone from FTS to the east and DG and Chihuahuan desertscrub to the north. The habitat at El Corralito 9.4 km (by air) SE of Bacanuchi, the second most northerly record (30.56°N, 86 km S of Arizona border; Fig. 6), is a permanent spring in an arroyo in DG with FTS species. Jacobs (2018) reported *B. sigma* in a stream canyon with Sonoran cottonwood/*huérigo* (*Populus monticola*) trees in OW at 1418 m elevation at Rancho el Orégano Viejo in the Sierra Juriquipa, southeast of Nacoari de García (30.26°N; Fig. 7). FTS is present just to the west along the Río Moctezuma.

In early November 1987, Ferguson and Rosen saw two *B. sigma* in Cuevas La Dorada and El Tigre east of Carbó in the Plains of Sonora subdivision of the Sonoran Desert at 463 and 497 m elev. (Fig. 8). Relict FTS is on top of the hills above the rocky hillside boa localities and a desert riparian wash occurs below them. The westernmost boa record (18 mi W of Carbó; 111.19°W) is also in the Plains of Sonora, but likely was in a *bajío* (dense mesquite thicket) along Arroyo Crisanto, a major northwestern tributary of the Río San Miguel.

Potential distribution in Sonora.—The distribution of *B. sigma* is potentially larger than currently documented by specimens and observations. In the east, FTS extends to the base of the Sierra Madre Occidental near Nácori Chico (108.8°W) and north to the Sierra Bacadéhuachi (29.8°N). The closest boa record to the area is northeast of Huásabas (29.93°N 109.26°W; Rorabaugh et al. 2019). Farther north, FTS extends along the Río Bavispe to the southern end of the Sierra El Tigre east of Angostura (30.4°N). The Turicachi locality reported here is 36 km to the north-northeast. The only boa record in the Río San Miguel drainage is 2 km N of San Pedro (29.21°N), but good riparian and FTS boa habitats occur along this major Río Sonora tributary as far north as Cucurpe and the Rancho Agua Fria area (30.41°N). Tucson hunting guide and naturalist Seymour Levy told TRVD about a large boa seen in Arroyo Babasac in Ímuris (30.79°N) by his taxidermy student in the 1980s, suggesting that *B. sigma* might occur farther north in the Río Magdalena Valley. The only possibility to reach Arizona might be in the Sycamore Canyon area (31.4°N) west of Nogales. But in general, hard freezes in winter likely set the northern distributional limits of *B. sigma*.

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Biodiversity of the Herpetofauna of the Muyunkum Desert, Kazakhstan

The Muyunkum Desert is situated in southern Kazakhstan. This sandy desert, with an area of 37,500 km², stretches from southeast to northwest for about 500 km. It is located in the middle of the North Turanian deserts. From the south and west, it is bounded by the Karatau Ridge, from the east by the Chu-Iliysky Mountains, and from the north by the Betpak-Dala Desert. Because of its location, this desert is the limit of northward distribution for a number of reptile species and is habitat for isolated populations of the psammophilous species.

The first references to the herpetofauna of the Muyunkum Desert date from the second half of the last century. Paraskiv (1956) listed a total of 16 species for the Muyunkum Desert and surrounding areas. However, most of the findings were mentioned without precise geographical attribution. In subsequent years, research studies have been fragmentary. In 1967, censuses of

Eremias grammica (Lichtenstein, 1823), *Eremias velox* (Pallas, 1771), and *Phrynocephalus mystaceus* (Pallas, 1776) were conducted on the southern periphery of the Muyunkum Desert (Vtorov and Pereshkolnik 1970). In 1978, data on new findings and abundance of five reptile species were obtained (Brushko 1995; Kubykin and Brushko 1998; Brushko and Kubykin 2000). In the late 1980s, *Eremias lineolata* (Nikolsky, 1896) was recorded for the first time on the eastern edge of the desert; and there were also findings of *Hemorrhois ravergeri* (Menetries, 1832) on the northern edge (Golubev 1990). In 1994, studies of *Teratoscincus scincus* (Schlegel, 1858) in the southeastern periphery of the desert were reported (Borkin et al. 2007). By the same authors, 10 reptile species were also recorded there. Two inventories of *Testudo horsfieldii* Gray, 1844 on the southern edge of the desert were conducted in 2003 and 2005 (Bondarenko et al. 2008). The localities of some species of lizards and snakes are given in the survey monographs by Sindaco and colleagues (Sindaco and Eremchenko 2008; Sindaco et al. 2013); however, due to the small scale of the maps used, it is difficult to estimate the distribution of species in this region. Thus, most of the available information on reptiles is fragmentary and refers to areas peripheral to the Muyunkum Desert. There is no complete list of reptiles of this area and the data on their distribution and population density are insufficient. In this regard, the aim of this work is to compile a list of the herpetofauna of the Muyunkum Desert and also to clarify the distribution and relative abundance of the reptiles.

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