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BEYOND MYTHS: REDISCOVERY OF THE WESTERN DIAMONDBACK RATTLESNAKE *CROTALUS ATROX* (BAIRD & GIRARD, 1853) IN THE MEXICAN STATE OF OAXACA AFTER A SPAN OF 79 YEARS

MÁS ALLÁ DE LOS MITOS: REDESCUBRIMIENTO DE LA SERPIENTE DE CASCABEL DIAMANTADA DEL OESTE *CROTALUS ATROX* (BAIRD & GIRARD, 1853) EN EL ESTADO MEXICANO DE OAXACA DESPUÉS DE UN LAPSO DE 79 AÑOS

Iván Villalobos-Juárez[1], Elí García-Padilla[2*], Javier Ayala-Auyón[3], César Mayoral-Halla[4] & J. Carmen Aguilar-Terrazas[3]

[1]*Organización Los Hijos del Desierto, Aguascalientes 20427*
[2]*Biodiversidad Mesoamericana. Oaxaca de Juárez, Oaxaca 68016*
[3]*Base Aérea Militar No. 2 Gral. Div. P.A. Antonio Cárdenas Rodríguez. Ciudad Ixtepec, Oaxaca.*
[4]*Biodiversidad de Oaxaca A.C., Oaxaca de Juárez, Oaxaca, 68050*
**Correspondence: eligarciapadilla25@gmail.com*

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Resumen.– Redescubrimos y confirmamos, después de un lapso de 79 años, la presencia de la Víbora de cascabel diamantada del Oeste *Crotalus atrox* en el estado mexicano de Oaxaca. El registro es con base en seis ejemplares encontrados en un ambiente antropizado dentro de la Base Aérea Militar II ubicada en Ciudad Ixtepec, municipio de Asunción Ixtaltepec dentro de la región del Istmo de Tehuantepec.

Palabras claves.– Redescubrimiento, *Crotalus atrox*, Oaxaca, ambientes antropizados, Istmo de Tehuantepec.

Abstract.– We rediscovered and confirmed, after a span of 79 years, the presence of the Western Diamondback Rattlesnake *Crotalus atrox* in the Mexican state of Oaxaca. The record is based on six specimens found in an anthropized environment within the Base Aérea Militar II, located in Ciudad Ixtepec, in the municipality of Asunción Ixtaltepec within the Isthmus of Tehuantepec region.

Key words.– Rediscovery, *Crotalus atrox*, Oaxaca, anthropized environments, Isthmus of Tehuantepec.

The Mexican state of Oaxaca is considered the most biodiverse at the country level, being the entity with the greatest richness of terrestrial vertebrates (García-Mendoza et al., 2004; García-Padilla et al., 2022). In the case of reptiles, 322 species have been recorded to date, including 18 representatives of the Viperidae family. Rattlesnakes of the genus *Crotalus* are found in this family, where Oaxaca harbors a richness of five species: *Crotalus atrox, C. brunneus, C. ehecatl, C. intermedius and C. molossus* (Mata-Silva et al., 2015; Mata-Silva et al., 2021). However, a more recent study synonymized the recently described species known as *Crotalus ehecatl* (Carbajal-Márquez et al., 2020) with *Crotalus culminatus* (Reyes-Velasco et al., 2022), leaving Oaxaca with five species including *C. culminatus* instead of *C. ehecatl*.

The Western Diamondback Rattlesnake *Crotalus atrox* (Baird & Girard, 1853) is a large snake that can exceed 180 cm in total length (Campbell & Lamar, 2004). Dorsal coloration normally ranges from greyish to brown, but some organisms show greenish, yellowish, or reddish tones. The markings on the back it spots ranging from 23 to 45, which resemble diamonds with a white border, at in the front part of the body, and gradually towards the back, they alternate between white and black rings, which is characteristic of this species the number of rings is variable, between 2 and 8, but usually between 4 and 6. Species of pit viper has two internasal scales in contact with the rostral scale, two and three preocular scales, as well as 2–6 postocular and 2–4 subocular scales. Supralabial scales occur in the range

of 12 to 18 and infralabial 14 to 21. The mid-body transverse scales range from 23 to 29. Likewise, the species shows 168 to 193 ventral scales in males and 174 to 196 in females; finally, it can present 21 to 32 subcaudal scales in males and from 16 to 24 in females (Campbell & Lamar, 2004; Ernst & Ernst, 2012).

The distribution of *Crotalus atrox* is wide, covering much of the southwestern United States of America, from California to central and northern Texas, with a presence in Arkansas, Kansas, and Oklahoma. (Campbell & Lamar, 2004; Ernst & Ernst, 2012). In Mexico, the distribution covers the states of Aguascalientes, Baja California, Chihuahua, Coahuila, Durango, Guanajuato, Nuevo León, Querétaro, San Luis Potosí, Sonora, Tamaulipas, and Zacatecas, with isolated populations in Hidalgo, Jalisco, Veracruz, and Oaxaca (Campbell & Lamar, 2004; Quintero-Díaz & Carbajal-Márquez, 2017; Fernández-Badillo et al., 2011; Villalobos-Juárez & Sigala-Rodríguez, 2019). The species can also be found on some islands in the Gulf of California (García-Padilla et al., 2018).

In Oaxaca, *C. atrox* was recorded for the first time back in 1905 by the researcher Hans Gadow on the route from the municipality of Salina Cruz to the municipality of Magdalena Tequisistlán in the Isthmus of Tehuantepec; later in 1908, the same author published the same findings but with more specific data. However, he mistakenly identified the samples, because in the referred paper the snake is considered as *C. terrificus* (currently *C. culminatus*), but reviewing the description of the specimen, it seems more likely to be the morphological description and coloration of *C. atrox*. In fact, in the description of the organism it is mentioned that the specimen has an unusual length for *C. terrificus* and additionally the specimen exhibited a tail with black rings (Gadow, 1908).

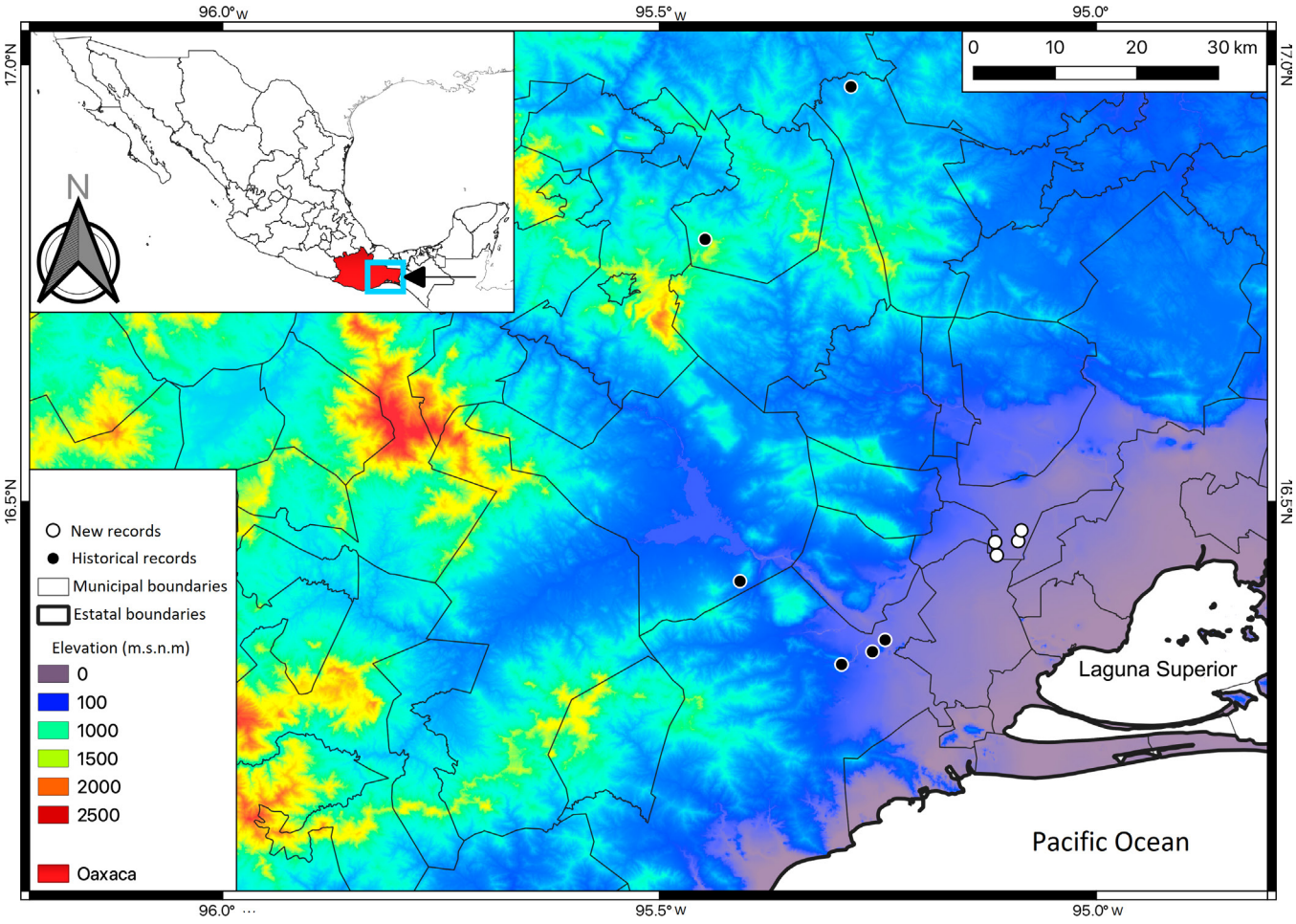

Figura 1. Mapa de distribución de *Crotalus atrox* en Oaxaca.

Figure 1. Distribution map of *Crotalus atrox* in Oaxaca.

Years later in 1936, Hartew & Oliver (1940) collected at least seven additional specimens of *C. atrox* in the locality mentioned as "Ranchero Pozo Río" in Tehuantepec. The collected specimens were sent to the current authority Laurence M. Klauber for a more detailed examination, who found no differences in morphology, color, and body pattern, except for the dark coloration on the first ventral scales and last gular scales.

Woodbury & Woodbury (1944) reviewed and listed the snake species by the researcher Wilbur Barker in Oaxaca, who sent the specimens to the herpetological collection of the University of Utah. Among the collected snakes is a female individual of *C. atrox;* unfortunately, that collection was the last officially published and was believed to be the last found specimen of this species in the state of Oaxaca (Campbell & Lamar, 2004). However, a search for additional specimens deposited in zoological collections in the Global Biodiversity Information Facility database showed two more specimens, one collected back in 1956 and deposited in the Museum of Zoology of the University of Michigan (UMMZ-114590), and the other one collected in 1971 and deposited in the University of Chicago Museum of Natural History (UCM-49256). Evidently, those museum individuals were not published.

In this paper, we present the formal rediscovery, after a span of 79 years of the Western Diamondback Rattlesnake *Crotalus atrox* in the Isthmus of Tehuantepec in the state of Oaxaca, based on the recent discovery of six specimens inside the Base Aérea Militar II General António Cárdenas Rodríguez, Ciudad Ixtepec in the municipality of Asunción Ixtaltepec within the physiographic region of Tehuantepec Coastal Plain (see Mata-Silva et al., 2015; Fig. 1). The first record was on the 8th of December of 2020 when a specimen accidentally fell into a pool inside the military air base (16.454786° N, 95.089384° W, WGS84, 27 m a.s.l.). Subsequently, due to a specific inspection for the species at the military airbase on June 29, 2021, a specimen was collected and released at coordinates 16.453653° N, 95.115749° W, WGS 84 (Fig. 2) In the same way, two other individuals were found, but only photographed and then released. The digital photographs were

Figura 2. Individuo juvenil de *Crotalus atrox* encontrado en la Base Aérea Miliar, municipio de Asunción Ixtepec, Oaxaca. Foto: César Mayoral-Halla.

Figure 2. A young individual of *Crotalus atrox* found at the Base Aérea Militar II, Ciudad Ixtepec in the municipality Asunción Ixtaltepec, Oaxaca. Photo: César Mayoral Halla.

deposited in the University of Texas at El Paso's digital collection under the catalog numbers UTEPObs: Herp: 204 and UTEPObs: Herp: 205. One more organism was found dead on August 2, 2022, in the BAM-II at coordinates 16.466070° N -95.086264° W, WGS84, and it was deposited in the Zoological Collection of the Autonomous University of Aguascalientes under the catalog number CZUAA-REP-985.

After the accidental finding of *Crotalus atrox* that fell into a pool inside the Base Aérea Militar II (BAM-II), we developed weekly samplings that were standardized for the nocturnal search for specimens on Saturdays and Sundays from 9:00 p.m. to 11:00 p.m. Likewise, sporadic transects were carried out outside the established sampling hours to locate snakes moving or laying waste within the military base BAM-II. The personnel were also notified to contact us in case organisms were accidentally found.

During the field surveys, a direct search for *C. atrox* was carried out in the in areas covered by native vegetation, we searched under logs and rocks, as it is suggested by Casas-Andreu, et al., (1991). Once the specimens were located, they were captured and placed in transparent plastic tubes with the help of herpetological supplies to safely handle the specimens, and to later perform the scale counts to identify the individuals. Each organism found was sexed using steel rods inserted posteriorly into the cloaca as described by Schaefer (1934). Once the specimens were processed, they were released to the exact site where they were found.

The snakes were measured in millimeters (mm) with a measurement tape to determine the total length (TL). In the same procedure, supralabials, infralabials, loreal, ventral, subcaudal scales, at mid-body dorsal scales were counted, in addition, dorsal spots and caudal dark rings were counted, and which are diagnostic characters for the correct identification of this rattlesnake species (Heimes, 2016).

Regarding morphology, we did not find any morphological differences from what is mentioned in the literature (Table 1). In fact, the specimens found in this study did not present the dark coloration in the last gular scales and first ventral scales, as mentioned by the researcher Laurence M. Klauber (Hartew & Oliver, 1940). However, a recently sacrificed specimen found in the BAM-II facilities (On October 26, 2022), had an aberrant coloration pattern although it was not only photographed because it was found by people outside this study (Fig. 3).

We present formal scientific evidence of the presence of the Western Diamondback Rattlesnake *C. atrox* after a span of 79 years of no formal records within the state of Oaxaca, Mexico, and 51 years since the last unpublished collected specimens. The area where the records were found is a private property with highly altered vegetation, surrounded by agricultural land. We assumed that the species had not been found or documented given the lack of formal and systematized sampling effort in the area, due to the current unsafe conditions in terms of the presence of the criminal organizations and the restrictions to the public due to the presence of the military air base in the zone.

We hypothesize that the distribution of *C. atrox* in the state of Oaxaca is restricted to the military air base due to the null access of the inhabitants and the vegetation found in that site because, although it is secondary growth, is denser than the surrounding crop fields where almost everything was converted into grasslands.

Tabla 1. Número de escamas y longitud de los individuos documentados en este estudio. TL = Longitud total (mm), Supra = Supralabiales, Infra = Infralabiales, Lor = Loreales, Vent = Ventrales, Sub = Subcaudales, MDS = Escamas dorsales a medio cuerpo, DB = Manchas dorsales, TR = Anillos de la cola.

Table 1. The number scales and total length of the individuals documented in this study / TL = Total length (mm), Supra = Supralabials, Infra = Infralabials, Vent = Ventrals, Sub = Subcaudals, MSD = Midbody dorsal scales, DB = Dorsal Blotches, and TR = Tail Rings.

Specimen	Sex	TL	Supra	Infra	Lor	Vent	Sub	MDS	DB	TR
Second snake	♂	*372*	14	16	2	171	28	24	34	6
CZUAA-985	♂	*359*	14	15	2	184	27	24	40	7
UTPObs-204	♀	*416*	15	17	2	170	18	25	34	6
UTPObs-205	♀	*389*	14	15	2	173	24	24	37	5

Figura 3. Individuo adulto de *Crotalus atrox* con patrón de coloración aberrante. Foto: Javier Ayala-Auyón.

Figure 3. An adult individual of *Crotalus atrox* with aberrant pattern coloration. Photo: Javier Ayala-Auyón.

We postulate this is one of the relict populations of this species of Nearctic affinity and typical of arid and semiarid ecosystems in North America (Campbell & Lamar, 2004). We know from the scarcely available literature that in the region this species is sympatric with *C. culminatus*, although since 1936 mentioned that it was more predominant than *C. atrox* as mentioned by Hartew and Oliver (1940). Unfortunately, this species suffers from human persecution as it is highly venomous and a species of medical importance. Although *C. atrox* is listed in the NOM 059 SEMARNAT (2019) as "Pr" (Species of Special Protection) it continues to be persecuted and killed. The conservation status of *C. atrox* was considered as Least Concern by the IUCN. The EVS (Environmental Vulnerability Score) provided a value of 9 placings at the higher level of the low vulnerability category (Wilson et al., 2013).

In the same way, one of the most important pressures that this species is facing in Oaxaca is the evident loss or transformation of its natural habitat due to land conversion for agricultural and livestock purposes. This species is also frequently killed while attempting to cross dirt and pavement roads. It is also persecuted due to the popular belief that its meat can cure and prevent cancer. More recently the Mexican government started the construction of the mega-development known as "Corredor Interoceánico" (Ceceña, 2021; García-Padilla, 2021) which will be a key factor in understanding the origin of subsequent even greater socio-environmental pressures and negative impacts to the habitat of *C. atrox* and the associated species within the once multicultural and mega biodiverse Isthmus of Tehuantepec region.

We propose to develop additional fieldwork to complete and consolidate the formal knowledge of this relict population of *C. atrox* in the Isthmus of Tehuantepec, likewise, we consider that carrying out environmental education campaigns and dialogues with the custodians and owners of these anthropized territories where *C. atrox* occurs is essential.

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