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Short Communication

New dietary records for three species in the *Crotalus molossus* species complex (Serpentes: Viperidae)

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Palavras-chave: *Crotalus basiliscus*, *Crotalus molossus*, *Crotalus totonacus*, Dieta, Roedores.

The Mexican West-coast Rattlesnake *Crotalus basiliscus* (Cope, 1864), the Black-tailed Rattlesnake *Crotalus molossus* Baird and Girard, 1853, and the Totonacan Rattlesnake *Crotalus totonacus* Gloyd and Kauffeld, 1940, are closely related species that are part of the *Crotalus molossus* species complex within the *Crotalus durissus* species group (Carbajal-Márquez *et al.* 2020a, Reyes-Velasco *et al.* 2022). *Crotalus basiliscus* is endemic to Mexico and occurs from southern Sonora and southwestern Chihuahua along the Pacific coastal plain, foothills, and valleys of the Sierra Madre Occidental, to the lower Río Balsas and Tepalcatepec valleys of western Michoacán. *Crotalus molossus* is currently composed of three subspecies: *C. molossus molossus* ranges from Arizona and southwestern New Mexico south through Sonora and adjacent northwestern Chihuahua; *C. molossus nigrescens* Gloyd, 1936 ranges from west-central Chihuahua and southern Coahuila widely over the Mexican Plateau to its southern edge; and *C. molossus oaxacus* Gloyd, 1948 is distributed in southeastern Puebla and the highlands of central Oaxaca. *Crotalus totonacus* is another Mexican endemic, distributed from central Nuevo León and central Tamaulipas to northern Veracruz, southeastern San Luis Potosi, northeastern Queretaro, and northwestern Hidalgo (Campbell and Lamar 2004, Heimes 2016).

Currently, *C. basiliscus* and *C. molossus* are included in the NOM-059-SEMARNAT-2010 by the Mexican government as subject to special

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protection (Pr; SEMARNAT 2010), whereas in the IUCN Red List of Threatened Species *C. basiliscus, C. molossus,* and *C. totonacus* are considered as Least Concern (LC; Hammerson *et al.* 2007, Ponce-Campos and García-Aguayo 2007, Marquez *et al.* 2021). In contrast, *C. basiliscus* and *C. totonacus* are in the high vulnerability category (16 and 17, respectively), and *C. molossus* is in the low vulnerability category (8) according to their Environmental Vulnerability Scores (Wilson *et al.* 2013, Johnson *et al.* 2017). Information regarding the natural history of *C. basiliscus* is scarce; regarding diet, it is known to feed on rodents (Klauber 1972, Cupul-Magaña *et al.* 2021). *Crotalus molossus* feeds mainly on rodents and to a lesser extent on lizards and birds (Klauber 1972, Hardy and Greene 1999, Balderas-Valdivia *et al.* 2009), whereas *C. totonacus* consumes mainly rodents, but marsupials and birds are also part of its diet (Klauber 1972, Campbell and Lamar 2004, Farr *et al.* 2015).

We conducted field surveys in Mexico between the years 2013–2014 and 2020–2022 at various locations in the states of Aguascalientes, Colima, Jalisco, Hidalgo, Puebla, Tamaulipas, and Zacatecas, in order to locate individuals of these three rattlesnake species to study their diet. The captured snakes were handled with tongs and herpetological tubes, and gently palpated in search of stomach contents or scats. We also examined museum specimens and road-killed individuals; in these cases, a mid-ventral incision was made to determine the presence of food remains in the gut.

The collected snakes were euthanized by injecting sodium pentobarbital, 60–100 mg/kg intracelomically, fixed with 10% formalin, and placed (along with their prey remains) in individual containers with 70% ethanol. Scats were also deposited in 70% ethanol. We measured the snout–vent length (SVL ± 1 mm) and tail length (TL ± 1 mm) with a measuring tape. We determined sex by cloacal probing or by everting hemipenes, and recorded date, locality, quantity, and identity of prey items. When possible, we calculated the weight ratio (WR) by dividing the mass of the prey by the mass of the snake. The collected snakes and their prey items were deposited in the herpetological collections of El Colegio de la Frontera Sur in Chetumal, Quintana Roo (ECO-CH-H), the herpetological collection of the Universidad Autónoma de Aguascalientes (UAA-REP), or in the herpetological collection of the Faculty of Biology at Universidad Juárez del Estado de Durango (CHFCB).

To identify mammal prey, dorsal guard hairs were compared with hairs of small mammals obtained from the Mammalogy Collection of Universidad Autónoma de Aguascalientes (UAA-MA), and with keys to the dorsal guard hairs (e.g., Baca-Ibarra and Sánchez-Cordero 2004). Sometimes bones, molars, nails, hind limbs, and tails were recovered and used as complementary diagnostics elements (see Whorley 2000). Additionally, we used the known distribution of prey species as a criterion to reach species-level identification. The data reported for both the snakes and their prey follow the suggestions of Maritz *et al.* (2021), including predator and prey ID, time and place, predator and prey characteristics, ingestion notes, and sample notes.

We examined five *Crotalus basiliscus,* three *C. molossus nigrescens,* four *C. molossus oaxacus,* and two *C. totonacus* (Table 1). An adult male *C. basiliscus* (UAA-REP 829) was found basking on 08 May, 2020 6 km east of Tapalpa, Municipality of Tapalpa, Jalisco. The scat obtained revealed the digested remains of a *Sigmodon* sp. (Cotton Rat; Table 1). The snake was released at point of capture and only the scat was collected. In July 2020 three individuals of *C. basiliscus* were found dead on the road and collected. A newborn female (UAA-REP 797) was found 0.7 km north La Becerrera, on the road to San José del Carmen, Municipality of Comala, Colima; the gut content obtained revealed the presence of hairs belonging to a *Sigmodon* sp. (Cotton Rat). A newborn female (UAA-REP 798) from 1.2 km northwest of

Montitlán, Municipality of Cuauhtémoc, Colima, had digested remains in the gut indicating it had consumed a *Sigmodon* sp. (Cotton Rat). An adult female (UAA-REP 800), found 200 m east of the La Becerrera-Carrizalillos turn off, Municipality of Comala, Colima, contained the remains of an unidentified rodent. We collected an additional newborn male *C. basiliscus* that was dead on the road on 07 September 2020 (UAA-REP 805) 2 km east of Pueblo Nuevo, Municipality of Villa de Álvarez, Colima, containing remains of a *Sigmodon* sp. (Cotton Rat) in the gut (Table 1).

An adult male *Crotalus molossus nigrescens* (ECO-CH-H 3856) was found dead on the road and collected on 10 September 2013, 11.8 km east of Jalpa, Municipality of Jalpa, Zacatecas. Examination of gut contents revealed the remains of a *Peromyscus* sp. (Deer Mouse). A newborn male *C. m. nigrescens* (ECO-CH-H 3848), found dead on road and collected on 07 September 2014, at 2 km northeast from Presa de los Serna, Municipality of Calvillo, Aguascalientes, contained remains of a *Perognathus flavus* Baird, 1855 (Silky Pocket Mouse) in the gut. An additional juvenile male *C. m. nigrescens* (ECO-CH-H 3849) was found dead on the road and collected on 27 September 2014 at 5.2 km north of Presa de los Serna, Municipality of Calvillo, Aguascalientes, and contained digested remains of a Cotton Rat (*Sigmodon* sp.; Table 1) in the gut.

On 22–23 August 2021, we found three specimens of *Crotalus molossus oaxacus* at 5.7 km southwest of Cacaloapan, Municipality of Tepanco de López, Puebla. A newborn female (UAA-REP 927) found basking next to a stone wall in xeric scrub at 11:35 h regurgitated a recently headfirst ingested *Baiomys taylori* (Thomas, 1887) (Northern Pigmy Mouse); the mass of the snake was 50 g and the mass of the prey was 19 g, yielding a WR = 0.38; the snake was released at point of capture and only the stomach content was collected. A juvenile male (UAA-REP 928) found basking next to a stone wall in xeric scrub at 13:45 h regurgitated a recently headfirst ingested *Heteromys irroratus* (Gray, 1868) (Mexican Spiny Pocket Mouse); the mass of the snake was 75 g and the mass of the prey was 28 g, yielding a WR = 0.37. We also obtained a scat from the same specimen that contained highly degraded remains of a *B. taylori*. The snake was released at point of capture after the stomach content and scat were collected. An adult male (CHFCB 0480) was found moving in xeric scrub at 14:25 and palpated in search of gut contents, but no contents were obtained. On 26 June 2022, we found a neonate male *C. m. oaxacus* (UAA-REP 983) under a rock at 4.7 km southwest of Cacaloapan, Municipality of Tepanco de López, Puebla; we obtained a scat that contained highly degraded remains of an unidentified rodent and remains of arthropods that were probably secondary ingestion; the specimen was collected (Table 1).

We found an adult male *Crotalus totonacus* (UAA-REP 876) crossing a dirt road in August 2020 at 12.7 km south of Ciudad Victoria, Municipality of Victoria, Tamaulipas. After palpation we obtained a scat that revealed remains of *Sigmodon toltecus* (Saussure, 1860) (Toltec Cotton Rat). The snake was released at point of capture and only the scat was collected. On 28 August 2021 we found and collected a road-killed adult male *C. totonacus* (UAA-REP 926) 3.2 km southeast of Rancho Nuevo Pacula, Municipality of Pacula, Hidalgo. After dissection, we obtained gut contents that consisted of the remains of a *Sigmodon leucotis* Bailey, 1902 (White-eared Cotton Rat; Table 1).

These are the first reported records of consumption of *Sigmodon* sp. by *Crotalus basiliscus.* Judging by the locality, these remains could be either *S. alleni* Bailey, 1902 or *S. mascotensis* Allen, 1897 (Shump and Baker 1978, Ceballos 2014, Martínez-Chapital *et al.* 2017). Previous diet records of *C. basiliscus* included those of Klauber (1972) in which seven specimens contained mammalian remains, and Cupul-Magaña *et al.* (2021), who reported a specimen that consumed a *Peromyscus spicilegus* Allen, 1897 (Gleaning Mouse). The ingestion of

Table 1. List of prey items, size, sex, and coordinates of individuals of *Crotalus basiliscus, C. molossus,* and *C. totonacus* analyzed in this study. Abbreviations: SVL, snout–vent length; TL, tail length; M, male; F, female.

Species	# Catalogue	SVL (mm)	TL (mm)	Sex	Latitude	Longitude	Prey
Crotalus basiliscus	UAA-REP 829	-	-	M	19.936451	-103.701927	*Sigmodon* sp.
Crotalus basiliscus	UAA-REP 797	360	23	F	19.460631	-103.714314	*Sigmodon* sp.
Crotalus basiliscus	UAAREP 798	403	26	F	19.410234	-103.627661	*Sigmodon* sp.
Crotalus basiliscus	UAA-REP 800	855	61	F	19.425911	-103.69788	Unidentified rodent
Crotalus basiliscus	UAA-REP 805	391	39	M	19.311618	-103.8996	*Sigmodon* sp.
Crotalus m. nigrescens	ECO-CH-H 3856	654	57	M	21.618481	-102.865826	*Peromyscus* sp.
Crotalus m. nigrescens	ECO-CH-H 3848	386	34	M	21.822979	-102.829208	*Perognathus flavus*
Crotalus m. nigrescens	ECO-CH-H 3849	462	35	M	21.854159	-102.835274	*Sigmodon* sp.
Crotalus m. oaxacus	UAA-REP 927	308	17	F	18.554098	-97.631309	*Baiomys taylori*
Crotalus m. oaxacus	UAA-REP 928	382	33	M	18.554098	-97.631309	*Heteromys irroratus / B. taylori*
Crotalus m. oaxacus	CHFCB 0480	894	79	M	18.554098	-97.631309	-
Crotalus m. oaxacus	UAA-REP 983	283	316	M	18.563326	-97.625502	Unidentified rodent
Crotalus totonacus	UAA-REP 876	908	67	M	23.625019	-99.130881	*Sigmodon toltecus*
Crotalus totonacus	UAA-REP926	1315	116	M	20.934132	-99.272788	*Sigmodon leucotis*

Baiomys taylori, Heteromys irroratus, Perognathus flavus, and *Sigmodon* sp. represent new diet records for *Crotalus molossus,* whereas the ingestion of *Peromyscus* sp. was previously reported (see Klauber 1972, Gehlbach 1956, Woolrich-Piña *et al.* 2005). The ingestion of *Sigmodon toltecus* by *Crotalus totonacus* represents a new prey item, whereas *S. leucotis* was reported previously (Carbajal-Márquez *et al.* 2017). The frequent consumption of rodents of the genus *Sigmodon* found in this study from specimens found in the field and dead on the road, as well as previously reported in species of the *C. durissus* group (see Carbajal-Márquez *et al.* 2017, 2020b, 2021, 2022), indicates that these rodents are probably abundant in the area where these rattlesnakes live, and they frequent the same microhabitats, which makes them an important food source. This result is expected since members of the genus *Sigmodon* are mainly terrestrial and inhabit areas with grassland, scrub, and forest in small numbers at sites with

natural vegetation and in higher numbers at cropland and disturbed sites (Shump and Baker 1978, Martínez-Chapital *et al.* 2017). These rodents are also frequently found when we turn over stones and logs in search of rattlesnakes.

Based on our sampling, we found that *Crotalus basiliscus, C. Crotalus molossus,* and *C. totonacus* feed mainly on mammals and can do so during all their life stages, which concurs with other species in the *C. durissus* group (Sant'Anna and Abe 2007, Carbajal-Márquez *et al.* 2020b, 2022). However, it has been reported that *C. molossus* can consume other types of prey, such as lizards and birds (Funk 1964, Klauber 1972, Balderas-Valdivia *et al.* 2009), and that *C. totonacus* preys on birds (Klauber 1972). Because of the low number of individuals analyzed, it is not possible presently to make definitive conclusions about the diet of these species. We recommend continuing to document the diets of *C. basiliscus, C. molossus,* and *C. totonacus* and to analyze them systematically because their wide distribution can mean a broader diet that can vary geographically. Additional systematic analysis could help determine if they specialize on a particular prey and whether a change in diet occurs for ontogenetic, sexual, or seasonal reasons. Having a better understanding of diets and natural history of these species can help generate better conservation strategies.

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