

ADDITIONAL DIET INFORMATION FOR *CERROPHIDION GODMANI* (GÜNTHER, 1863) AND A DIETARY SYNOPSIS OF THE GENUS *CERROPHIDION* CAMPBELL AND LAMAR, 1992

INFORMACIÓN ADICIONAL DE LA DIETA DE *CERROPHIDION GODMANI* (GÜNTHER, 1863) Y UNA
SINOPSIS DIETÉTICA DEL GÉNERO *CERROPHIDION* CAMPBELL Y LAMAR, 1992

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Abstract.— The montane pitvipers (*Cerrophidion* spp.) consist of five recognized species that disjunctly occupy high elevational habitats from southern Mexico to western Panama. However, two of these species were recently delineated, leaving previously published natural history data on *Cerrophidion* outdated and in need of re-examination. To gain more information, we investigated the stomach contents of *Cerrophidion* specimens housed in the University of Illinois Museum of Natural History Herpetology Collection (UIMNH) and report our findings. We also compiled lists of all known prey items and present a comprehensive dietary synopsis for each species of *Cerrophidion* according to recent taxonomic changes. These efforts identified eleven previously undocumented prey items for three of the species.

Keywords.— diet, ecology, feeding, natural history, montane pitviper.

Resumen.— Las nauyacac (*Cerrophidion* spp.) consisten de cinco especies reconocidas que ocupan hábitats aislados de alta elevación desde el sur de México hasta el oeste de Panamá. Recientemente, dos de estas especies fueron delineadas, y sin embargo, los datos previamente publicados de la historia natural de *Cerrophidion* son obsoletos y necesitan una nueva revisión. Para obtener más información, investigamos los contenidos estomacales de los especímenes de *Cerrophidion* en la Colección de Herpetología del Museo de Historia Natural de la Universidad de Illinois (UIMNH) y declaramos nuestros descubrimientos. También compilamos listas de todas las presas conocidas y presentamos una sinopsis completa de la dieta para cada especie de *Cerrophidion* de acuerdo con los cambios taxonómicos recientes. Estos esfuerzos descubrieron once artículos de presas previamente indocumentados para tres de las especies. de su biodiversidad.

Palabras clave.— alimentación, dieta, ecología, historia natural, nauyaca.

INTRODUCTION

The montane pitvipers (*Cerrophidion* spp.) extend from Veracruz, Mexico into western Panama, comprising five species: *Cerrophidion godmani*, *C. petlalcalensis*, *C. sasai*, *C. tzotzilorum*, and *C. wilsoni*. Two species, *C. wilsoni* and *C. sasai*, were recently

delineated from *Cerrophidion godmani* (Jadin et al., 2012), but specific aspects of their natural histories have yet to be delimited accordingly. To date, Campbell and Solórzano (1992) present the only extensive dietary investigation of *Cerrophidion*, focusing

on the former characterization of *C. godmani* (*sensu lato*). This included specimens taken from Nuclear Central America (Mexico, Guatemala, El Salvador, and Honduras) and Lower Central America (Costa Rica and Panama). Herein, we present new information regarding the diet of *C. godmani* (*sensu stricto*) from museum specimens at the University of Illinois Museum of Natural History Herpetology Collection (UIMNH) and provide a comprehensive synopsis of all the known prey items for each species of *Cerrophidion*, in accordance with recent taxonomic changes.

Contributions from the UIMNH Herpetology Collection

To gain additional insights into the diet of *Cerrophidion*, we examined the stomach contents from all *Cerrophidion* specimens ($n = 7$) within the University of Illinois Museum of Natural History Herpetology Collection. Specimen identifications were confirmed following Campbell and Lamar (2004) and Jadin et al. (2012). Four specimens (UIMNH 27841; 53097–98; 56846) belong to *C. godmani* (*sensu stricto*) and three to *C. tzotzilorum* (UIMNH 48710; 93940–41).

UIMNH 27841 (♀; SVL = 239 mm; TBL = 267 mm) was collected on 14 January 1950 by Thomas B. MacDougall from the Sierra Madre near La Gloria, Juchitán District, Oaxaca, México (see Wylie & Grünwald, 2016 for locality interpretation). Unidentifiable fragments of an orthopteran as well as numerous nematodes were discovered in its gastrointestinal tract. Small nematodes (2–15 mm) are apparently common in the gastrointestinal tracts of this species (Campbell & Solórzano, 1992), but it is unclear if this has been observed in Oaxacan specimens before.

UIMNH 53097 (♀; SVL = 281 mm; TBL = 312 mm) was collected during April of 1963 again by Thomas B. MacDougall from the Sierra Madre north of [Santo Domingo] Zanatepec, Juchitán District, Oaxaca, México (see Lynch & Smith 1965). Ingested head-first was a shrew *Cryptotis parva pueblensis* (Fig. 1; length = 80 mm; width = 14 mm) identified based on its red-tipped teeth (= *Cryptotis*), medium brown dorsal pelage coloration, short claws and tail, and skull and dentary measurements (Carraway, 2007). This identification is also reaffirmed by the species distribution modeling of Guevara et al. (2015).

Both collection localities are from the Chimalapas region of Oaxaca (Mendelson, 1997; Peterson et al., 2003), a northwesterly isolate of the Sierra Madre de Chiapas that consist of a wide variety of habitats ranging from tropical rainforest to cloud and pine-oak forest (Peterson et al., 2003). The rainy season spans May through October (Campbell & Solórzano, 1992; Mata-Silva



Figure 1. Dorsal view of *Cerrophidion godmani* UIMNH 53097 and the prey item (*Cryptotis parva pueblensis*) removed from its stomach.

Figura 1. Vista dorsal de *Cerrophidion godmani* UIMNH 53097 y la presa (*Cryptotis parva pueblensis*) extraída de su estómago.

et al., 2015). Unfortunately, without more specific locality or elevational data, pinpointing the exact type of habitat is difficult to do with certainty, particularly for UIMNH 27841.

Nonetheless, UIMNH 53097 was probably collected from the southern versant of the Sierra Madre de Chiapas, in which case pine-oak forest is the predominant ecosystem (Campbell & Solórzano, 1992; Peterson et al., 2003). Campbell and Solórzano (1992) found mammals to be a slightly more important dietary component of pine-oak forest-inhabiting *Cerrophidion godmani* in Guatemala. Moreover, their investigation documented greater incidences of mammalian prey (as opposed to orthopterans) during the dry season (Campbell & Solórzano, 1992). These could be commonalities shared between Oaxacan and Guatemalan populations, but larger sample sizes are needed for definitive conclusions.

Dietary Synopsis of *Cerrophidion* spp.

Godman's montane pitviper—*Cerrophidion godmani* s. s. (Günther, 1863)—disjunctly occupies portions of the Sierra Madre de Chiapas in Oaxaca and Chiapas, the northern periphery of the Meseta Central of Chiapas, and the highlands of southern Guatemala at elevations exceeding 1400 meters (Campbell & Lamar, 2004; Jadin et al., 2012; Johnson et al., 2015; Mata-Silva et al., 2015; Fig. 2). Campbell and Solórzano (1992) examined the gastrointestinal tracts of 355 *C. godmani* specimens collected in Nuclear Central America. Most of the inspected specimens were from San Jorge Muxbal, Depto. de Guatemala, Guatemala, and the vicinity of La Unión Barrios, Depto. de Baja Verapaz, Guatemala (n = 199 and n = 71, respectively) (Campbell & Solórzano, 1992). The locations of the remaining specimens (n = 85) were not stated, but most were from other Guatemalan localities (J. A. Campbell *pers. comm.*) within a 300 km radius of San Jorge Muxbal (Campbell & Solórzano 1992). Arthropods (specifically orthopterans) and mammals represent the largest portion of prey items consumed by *C. godmani* (Campbell and Solórzano, 1992).

Only one prey item (*Abronia* sp.) from Oaxaca is specifically referenced by Campbell and Solórzano (1992), who examined a

total of 36 Oaxacan specimens during their entire investigation (some of which may not have been examined for stomach contents). The prey items from UIMNH 27841 and 53097 described in this study provide valuable insight into the most isolated and least understood populations of *C. godmani* in Oaxaca and represent novel taxa among the known prey items recorded in *C. godmani* (Table 1).

The Petlalcala montane pitviper—*Cerrophidion petlalcalensis* López-Luna, Vogt & Torre-Loranca, 1999—was originally only known from Cerro de Petlalcala in Veracruz (López-Luna et al., 1999; Campbell & Lamar 2004; Heimes 2016), but populations have been recently discovered in other locations within the Sierra de Zongolica (Sierra Madre de Oaxaca) at elevations between 1354 and 2500 meters in both Veracruz and Oaxaca (de la Torre-Loranca *in press*; Fig. 3). The species has yet to be recorded from Puebla, but targeted surveys will likely reveal its presence there as well. López-Luna et al. (1999) even speculated its possible occurrence within the Sierra Juárez (Sierra Madre de Oaxaca). Until now, the only dietary information available for the species was published in López-Luna et al. (1999) and Campbell and Lamar (2004). In Table 2, we present a summary of all the known prey items recorded in *C. petlalcalensis*, including nine new contributions.



Figure 2. *Cerrophidion godmani* from Chiapas, Mexico. Photograph by Scott Trageser.

Figura 2. *Cerrophidion godmani* de Chiapas, México. Fotografía de Scott Trageser.



Figure 3. *Cerrophidion petlalcalensis* from Veracruz, Mexico. Photograph by Miguel A. De La Torre-Loranca.

Figura 3. *Cerrophidion petlalcalensis* de Veracruz, México. Fotografía de Miguel A. De La Torre-Loranca.

The Costa Rica montane pitviper—*Cerrophidion sasai* Jadin, Townsend, Castoe & Campbell, 2012—occupies portions of the Cordillera Central and the Cordillera de Talamanca in Costa Rica and Panama at elevations exceeding 1400 meters (Campbell & Solórzano, 1992; Campbell & Lamar, 2004; Jadin et al., 2012). Campbell and Solórzano (1992) examined the gastrointestinal tracts of 246 *C. sasai* specimens collected from Las Nubes de Coronado, Costa Rica. The only other mention of this species' diet is from Clark (1942), who reported a lizard and rodent as prey items. Despite sympatry with a diverse amphibian fauna, only one instance of amphibian predation has been documented in this species, constituting <1% of the recorded diet (Campbell & Solórzano, 1992). Mammals and reptiles comprise the largest component of its diet (Campbell & Solórzano, 1992). A summary of these data is presented in Table 3.

The Tzotzil montane pitviper—*Cerrophidion tzotzilorum* (Campbell, 1985)—is endemic to the high elevations (2050–2500 meters) of the Central Plateau of Chiapas, Mexico (Campbell & Lamar, 2004; Jadin et al., 2012; Johnson et al., 2015; Heimes, 2016). Only four distinct prey items have been recorded in the diet of *C. tzotzilorum*, consisting of orthopterans and lizards (Campbell and Lamar 2004; Jadin 2007; Schramer et al., *in review*; Table 4). Two Jerusalem crickets (*Stenopelmatus* sp.) were discovered in

the stomachs of two preserved specimens by Schramer et al. (*in review*). *Stenopelmatus* sp. comprised half of the total orthopteran prey ingested by *C. godmani* in Campbell and Solórzano (1992) and may be an equally important food source for *C. tzotzilorum*.

The Honduras montane pitviper—*Cerrophidion wilsoni* Jadin, Townsend, Castoe & Campbell, 2012—is found in the highlands of El Salvador, Honduras, Nicaragua, and possibly Guatemala at elevations between 1400 and 3500 meters (Campbell & Solórzano, 1992; Campbell & Lamar, 2004; Jadin et al., 2012; Fernández et al., 2017; Sunyer et al., 2017). This is the least understood of all the *Cerrophidion* species, with only one prey item, “a large rodent,” being reported from Honduras (Hahn 1971). It is possible that some *C. wilsoni* data could be circumscribed in the 85 unclarified Nuclear Central American specimens examined by Campbell and Solórzano (1992) during their diet investigation; however, the vast majority of snakes examined came from Guatemala (J. A. Campbell *pers. comm.*). On 24 July 2017 at 09:25 h, a *C. wilsoni* was observed preying on an *Aspidoscelis motaguae* during the rain in premontane oak forest on Cerro Mogotón (13.746806° N, -86.394917° W; WGS84; 1783 m elev.) by M. Salazar-Saavedra. It took 35 minutes for the snake to completely engulf the prey head-first. Accordingly, we provide one new prey item to the diet of *C. wilsoni* from Nicaragua (Table 5).

Table 1. All known prey items of *Cerrophidion godmani* with taxonomic updates.

Tabla 1. Tipos de presa conocidos para *Cerrophidion godmani* con actualizaciones taxonómicas.

Higher Classification	Taxon	Ref(s)
ARTHROPODA		
Arachnida		3
Chilopoda		3
Orthoptera*		3, 11
	Stenopelmatidae	3
	<i>Stenopelmatus</i> sp.	3
AMPHIBIA		
Anura		3
	Craugastoridae	3
	<i>Craugastor</i> sp.	3
	Hylidae	3
	<i>Hyla</i> sp. s.l.	3
Caudata		3
	Plethodontidae	3
	<i>Bolitoglossa helmrichi</i>	3
	<i>Bolitoglossa morio</i>	3
	<i>Cryptotriton veraepacis</i>	3
REPTILIA		
Squamata: Lacertilia	Anguidae	3
	<i>Abronia</i> sp.*	3
	<i>Mesaspis moreletii</i>	3
	Dactyloidae	3
	<i>Anolis</i> sp.	3
	Phrynosomatidae	3
	<i>Sceloperus taeniocnemis</i>	3
	<i>Sceloperus</i> sp.	3
	Scincidae	3
	<i>Scincella incertum</i>	3
Squamata: Serpentes	Colubridae	3

Higher Classification	Taxon	Ref(s)
	<i>Geophis rhodogaster</i>	3
	<i>Rhadinaea kinkelini</i>	3
	<i>Tropidodipsas fischeri</i>	3
	Viperidae	3
	<i>Bothriechis aurifer</i>	3
	<i>Cerrophidion godmani</i>	3
AVES		
Passeriformes		3
	Passerellidae	3
	<i>Chlorospingus ophthalmicus</i>	3
MAMMALIA		
Insectivora		3
	Soricidae	3
	<i>Cryptotis micrura</i>	3
	<i>Cryptotis parva pueblensis</i> *	11
Rodentia		3
	Cricetidae	3
	<i>Peromyscus boylii</i>	3
	<i>Peromyscus guatemalensis</i>	3
	<i>Reithrodontomys sumichrasti</i>	3
	Heteromyidae	3
	<i>Heteromys desmarestianus</i>	3
	Muridae	3
	<i>Mus musculus</i>	3

(1) Clark (1942); (2) Hahn (1971); (3) Campbell & Solórzano (1992); (4) López-Luna et al. (1999); (5) Campbell & Lamar (2004); (6) López-Luna *pers. comm.* as cited in Campbell & Lamar (2004); (7) Jadin (2007); (8) Schramer et al. (*in review*); (9) Salazar-Saavedra *pers. obs.*; (10) de la Torre-Loranca *pers. obs.*; (11) this investigation.

*Asterisks denote prey items recorded from Oaxaca, México.



Figure 4. *Cerrophidion tzotzilorum* from Chiapas, Mexico. Photograph by Iván T. Ahumada-Carrillo.

Figura 4. *Cerrophidion tzotzilorum* de Chiapas, México. Fotografía de Iván T. Ahumada-Carrillo.



Figure 5. *Cerrophidion wilsoni* from Nueva Segovia, Nicaragua. Photograph by José G. Martínez-Fonseca.

Figura 5. *Cerrophidion wilsoni* de Nueva Segovia, Nicaragua. Fotografía de José G. Martínez-Fonseca.

Table 2. All known prey items of *Cerrophidion petlalcalensis* with taxonomic updates.

Tabla 2. Tipos de presa conocidos para *Cerrophidion petlalcalensis* con actualizaciones taxonómicas.

Higher Classification	Taxon	Ref(s)
AMPHIBIA		
Anura		6, 10
	Craugastoridae	6, 10
	<i>Craugastor decorates*</i>	10
	<i>Craugastor rhodopis*</i>	10
	<i>Craugastor spatulatus*</i>	10
	<i>Craugastor</i> sp.	6
Caudata		6, 10
	Plethodontidae	6, 10
	<i>Aquiloerycea cephalica</i>	10
	<i>Aquiloerycea cafetalera</i>	10
	<i>Isthmura gigantea</i>	10
	<i>Pseudoerycea</i> sp. s.l.	6
MAMMALIA		
Insectivora		6
	Soricidae	6
	<i>Cryptotis mexicana</i>	10
	<i>Cryptotis</i> sp.	6
Rodentia		10
	Cricetidae	10
	<i>Microtus mexicanus*</i>	10
	<i>Microtus quasiater</i>	10

(1) Clark (1942); (2) Hahn (1971); (3) Campbell & Solórzano (1992); (4) López-Luna et al. (1999); (5) Campbell & Lamar (2004); (6) López-Luna *pers. comm.* as cited in Campbell & Lamar (2004); (7) Jadin (2007); (8) Schramer et al. (*in review*); (9) Salazar-Saavedra *pers. obs.*; (10) de la Torre-Loranca *pers. obs.*; (11) this investigation.

*Asterisks denote prey items recorded from Oaxaca, México.

Table 3. All known prey items of *Cerrophidion sasai* with taxonomic updates.

Tabla 3. Tipos de presa conocidos para *Cerrophidion sasai* con actualizaciones taxonómicas.

Higher Classification	Taxon	Ref(s)
ARTHROPODA		
Orthoptera		3
	Gryllidae	3
	Locustidae	3
	Tethygonidae	3
AMPHIBIA		
Anura		3
	Craugastoridae	3
	<i>Craugastor</i> sp.	3
REPTILIA		
Squamata: Lacertilia		1, 3
	Anguidae	3
	<i>Mesaspis monticola</i>	3
	Dactyloidae	3
	<i>Anolis</i> sp.	3
	Phrynosomatidae	3
	<i>Sceloperus malachiticus</i>	3
	Scincidae	3
	<i>Scincella incertum</i>	3
Squamata: Serpentes		3
	Colubridae	3
	<i>Geophis brachycephalus</i>	3
	<i>Geophis godmani</i>	3
	<i>Ninia maculata</i>	3
AVES		
Passeriformes		3
	Troglodytidae	
	<i>Cantorchilus modestus</i>	3
	<i>Troglodytes aedon</i>	3

Higher Classification	Taxon	Ref(s)
MAMMALIA		
Insectivora		3
	Soricidae	3
	<i>Cryptotis nigrescens</i>	3
Rodentia		1, 3
	Cricetidae	3
	<i>Oryzomys</i> sp.	3
	<i>Reithrodontomys</i> sp.	3
	Muridae	3
	<i>Mus</i> sp.	3

(1) Clark (1942); (2) Hahn (1971); (3) Campbell & Solórzano (1992); (4) López-Luna et al. (1999); (5) Campbell & Lamar (2004); (6) López-Luna *pers. comm.* as cited in Campbell & Lamar (2004); (7) Jadin (2007); (8) Schramer et al. (*in review*); (9) Salazar-Saavedra *pers. obs.*; (10) de la Torre-Loranca *pers. obs.*; (11) this investigation.

*Asterisks denote prey items recorded from Oaxaca, México

Table 4. All known prey items of *Cerrophidion tzotzilorum* with taxonomic updates.

Tabla 4. Tipos de presa conocidos para *Cerrophidion tzotzilorum* con actualizaciones taxonómicas.

Higher Classification	Taxon	Ref(s)	Ref(s)
ARTHROPODA			
Orthoptera			7, 8
	Acrididae		7
	Stenopelmatidae		8
	<i>Stenopelmatus</i> sp.		8
REPTILIA			
Squamata: Lacertilia			5, 7
	Phrynosomatidae		5
	<i>Sceloporus variabilis</i>		5
	Scincidae		7
	<i>Scincella incerta</i>		7

Table 5. All known prey items of *Cerrophidion wilsoni* with taxonomic updates.

Tabla 5. Tipos de presa conocidos para *Cerrophidion wilsoni* con actualizaciones taxonómicas.

Higher Classification	Taxon	Ref(s)
REPTILIA		
Squamata: Lacertilia		9
	Teiidae	9
	<i>Aspidocelis motaguae</i>	9
MAMMALIA		
Rodentia		2

(1) Clark (1942); (2) Hahn (1971); (3) Campbell & Solórzano (1992); (4) López-Luna et al. (1999); (5) Campbell & Lamar (2004); (6) López-Luna *pers. comm.* as cited in Campbell & Lamar (2004); (7) Jadin (2007); (8) Schramer et al. (*in review*); (9) Salazar-Saavedra *pers. obs.*; (10) de la Torre-Loranca *pers. obs.*; (11) this investigation.

All *Cerrophidion* spp. are likely generalist predators, but each species may possess a nuanced affinity to certain prey types in their respective ranges. For example, *C. godmani* and *C. sasai* are both generally considered euryphagous (Campbell & Solórzano, 1992), but upon a more detailed inspection, they differ in the relative percentages of prey types consumed (i.e. mostly orthopterans and mammals versus mammals and reptiles). Based on these preliminary data, it also appears that *C. petlalcalensis* consumes the most amphibians of any *Cerrophidion* congener. Certainly, habitat type plays a role in intraspecific and interspecific dietary variation (i.e. Campbell & Solórzano, 1992). Future studies should delve deeper into the diets of *C. petlalcalensis*, *C. tzotzilorum*, and *C. wilsoni*—perhaps morphological variations are correlated to divergences in ecological traits within the genus.

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contributions to the life history of these pitvipers. Without their work, this investigation would have been greatly restricted.

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