

Comparison of Preliminary Herpetofaunas of the Sierras la Madera (Oposura) and Bacadéhuachi with the Mainland Sierra Madre Occidental in Sonora, Mexico

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***Abstract**—Amphibians and reptiles were observed in the Sierra La Madera (59 species), an isolated Sky Island mountain range, and the Sierra Bacadéhuachi (30 species), the westernmost mountain range in the Sierra Madre Occidental (SMO) range in east-central Sonora. These preliminary herpetofaunas were compared with the herpetofauna of the Yécora area in eastern Sonora in the main SMO, where 92 species are known from the Río Yaqui to the Chihuahua border. The Yécora area, as we have defined it, extends from the Río Yaqui to the Chihuahua border along Mexico Federal Highway 16 and other areas accessible from it. Seven species in the Sierra la Madera are exclusive of the SMO fauna. Sky Island faunas are dominated by Madrean species, but also include species with tropical, desert, and northern temperate biotic affinities. Although the herpetofaunas of many Sky Island ranges in Sonora are not well documented, it is clear that the SMO fauna is much more diverse than any of them.*

Introduction

The fauna of the southwestern United States is famous for its diversity of amphibians and reptiles. The Madrean Archipelago is the area of isolated Sky Island (SI) mountain ranges between the northern Sierra Madre Occidental (SMO) in Sonora and Chihuahua and the southern edge of the Colorado Plateau (Mogollon Mountains and escarpment of the Mogollon Rim) in New Mexico and Arizona. High species richness in the region and each Sky Island is related to the convergence of five biotic provinces with diverse topography and habitats that converge in the area: tropical temperate SMO, temperate

Rocky Mountains, Great Plains-Chihuahuan Desert, Sonoran Desert, and the western Mexico low-lands tropics. The transition between the New World tropics and the northern temperate zone is at about 29°N in east-central Sonora.

In this paper, we summarize the amphibian and reptile faunas of the Sierra La Madera (SI) and the Sierra Bacadéhuachi (SMO) and compare them with the extensive herpetofauna of the Yécora area in east-central Sonora in the main Sierra Madre Occidental (Enderson and Bezy, unpubl. data).

Study Areas

The three study areas are all in east-central Sonora and are either in the Río Yaqui Basin or the adjacent Río Mayo Basin. Vegetation in all three areas ranges from lowland tropical skirts of foothills thornscrub (FTS) to oak woodland and pine-oak forest at higher elevations. The Sierra Bacadéhuachi is unique due to the occurrence of desert grassland between FTS and oak woodland in some areas. The Yécora area is substantially more tropical than the other two areas with tropical

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deciduous forest (TDF) between FTS and oak woodland. We follow the classification used in Martin et al. (1998) for vegetation names.

Sierra la Madera

Sierra la Madera (= Oposura) is a Sky Island mountain range located (ca. 29°51'N to 30°10'N, 109°25'W to 109°42'W; fig. 1) between Óputo (= Villa Hidalgo) and Huásabas on the Río Bavispe to the east and between Cumpas and Moctezuma on the Río Moctezuma to the west (Yanes-Arvalo et al. 2011). Portions of the range are in the Municipios of Cumpas, Granados, Huásabas, Moctezuma, and Villa Hidalgo. Elevations range from 615 m at Huásabas and 660 m at Moctezuma to over 2300 m on the highest peak, an elevational range of about 1685 meters; Sierra la Madera is one of the higher ranges in Sonora. Most of the area is privately owned; the higher elevations are in Fracción V of the Área Natural Protegida Ajos-Bavispe. Cottonwood-willow forest occurs along the Ríos Bavispe and Moctezuma.

Sierra Bacadéhuachi

Sierra Bacadéhuachi, the westernmost mountain range in the Sierra Madre Occidental, is located east of Bacadéhuachi, Municipio Bacadéhuachi, 34 km east of the Chihuahua border, and 165 km south of the Arizona border (fig. 1). The southern portion of the Bacadéhuachi is in the Ríos Nácori Chico and Ríto drainages, with the Río Bacadéhuachi to the west. Elevations range from 700 m at Bacadéhuachi to about 2400 m on the highest peak, an elevational range of 1700 meters.

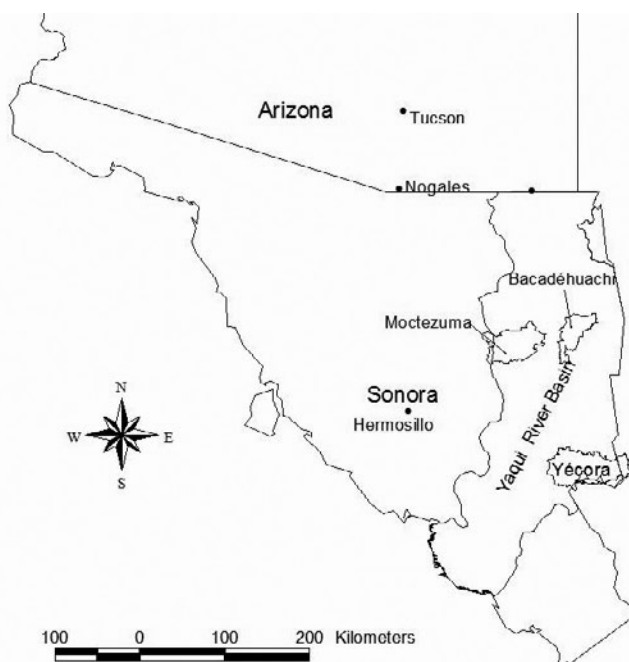


Figure 1—Sierra Bacadéhuachi, the westernmost mountain range in the Sierra Madre Occidental

Yécora Area

Yécora is a town in the SMO in east-central Sonora 42 km east of the Chihuahua border (fig. 1). Mexican Federal Highway 16 (MEX 16), one of the few highways that crosses the SMO, provides a west-to-east elevational transect from Río Yaqui (180 m) east to the Chihuahua border east of Yécora. The herpetofauna observations were in the Municipios de Yécora, Ónavas, and Soyopa. The vegetation gradient along MEX 16 is foothills thornscrub (180-550 m elevation), tropical deciduous forest (500-1,160 m), oak woodland (1,050-1,700 m), and pine-oak forest (1,220-2,140 m). Grassland occurs in high valleys (1,200-1,700 m) within oak woodland or pine-oak forest. Mixed-conifer forest (1,900-2,100 m) is present in Barranca El Salto on Mesa del Campanero. The elevational range is 1960 m, with 1660 m in the Municipio de Yécora.

Inventories

Sierra La Madera

Early collections in Sonora were made along two routes from the Arizona border that reach different sides of the Sierra la Madera; 1) Agua Prieta to Fronteras and Esqueda, south through Nacoziari de García and Cumpas to Moctezuma, mostly along the Río Moctezuma, and 2) Agua Prieta to Esqueda, southeast to the Sierra El Tigre, south along the Río Bavispe through Angostura and Óputo to Huásabas. Specimens of *Aspidoscelis exsanguis* from near Moctezuma were collected by S. B. Benson in March 1936 and J. E. Simpson in May 1938 (Museum of Comparative Zoology, MCZ, Harvard University). In the early 1950s, Paul S. Martin, University of Michigan, collected *Bufo alvarius* from west of Huásabas and *Crotalus atrox* and *Phrynosoma solare* from south of Óputo. Lowe and Woodin (1954) described *Masticophis flagellum* ssp. *cingulum* based on a specimen from Moctezuma. Michael D. Robinson collected in the Huásabas area for the University of Arizona Herpetological Collection (UAZ) in July 1969. As part of his study of the systematics of *Aspidoscelis*, John W. Wright collected in the Óputo-Huásabas area for UAZ, and the Los Angeles County Museum of Natural History (LACM) in July 1963, April 1966, July 1969, July 1974, July 1975, June 1980, and August 1982. Tod W. Reeder, San Diego State University, collected in the area for the Museo de Zoología "Alfonso L. Herrera" Facultad de Ciencias (MZFC, Universidad Autónoma Nacional de México). Arthur H. Harris and T. Paul Maslin, collected for the University of Colorado in the area in July 1970. Charles J. Cole collected in the area for the American Museum of Natural History in June 1988.

The other observations and collections in this study were made by the authors. Hale visited Arroyo la Saucedá in search of *Rana tarahumaræ* on November 1981 and October 1982, the latter trip with Cecil R. Schwalbe (Hale and Jarchow 1988), and in May 1998 with Ferguson, Peter A. Holm, and Elizabeth B. Wirt (Hale et al. 1998). Enderson, Turner, Hale, and Bezy visited the Sierra la Madera in September 2003 and Enderson and Bezy returned in July 2009. Areas visited included the microwave towers east-northeast of Cumpas and Rancho Mesa Quemada west of Huásabas. Van Devender, Turner, Villa, and Hedgcock visited the Sierra la Madera on a Madrean Archipelago Biodiversity Assessment (MABA) Expedition in June and July-August 2010, when a group of 38 scientists, researchers, students, volunteers, and agency biologists visited Ranchos Las Bateas, la Cieneguita, San Francisco, and Mesa Quemada, and the antenna area. Additional herpetologists in the group were R. Wayne Van Devender, Stephen L. Minter, Matt Nordgren, and Scott J. Trageser.

Sierra Bacadéhuachi

John W. Wright and James L. Patton in July 1967, Michael D. Robinson in July 1969, and Hale and Schwalbe in October 1982 collected specimens in the Bacadéhuachi area for UAZ. Later Wright collected in the area for LACM (July 1974) and with Allen E. Greer for MCZ (July 1975). Van Devender visited the Bacadéhuachi area in July 2008 and on MABA Expedition trips in June, August, and September 2011, and March 2012. Turner, Villa, Hale, Ferguson, and Hedgcock (also March 2012) were on the main expedition of 45 participants in August 2011, along with Will Lattea, Nordgren, Martín Villa, and Eric Wallace. Robert Villa and David J. Bygott were on the September trip. Our recent field activities in the Sierra Bacadéhuachi were centered on Rincón de Guadalupe in Arroyo Campo los Padres (29°50'40"N 108°58'37"W, 1680 m elevation).

Yécora Area

Between 1953 and 2005, amphibians and reptiles were collected in the Yécora area for UAZ on 33 trips involving 26 people. Primary collectors were Charles H. Lowe, Hale, Peter A. Holm, Darryl R. Frost, Julia V. Salmon, Brent E. Martin, and Cecil R. Schwalbe. Van Devender and Ana L. Reina-Guerrero made observations on 36 trips to the area from 1995 to 2008. Enderson and Bezy spent 40 field days investigating the Yécora area herpetofauna from 2004 to 2008.

Methods

Amphibians and reptiles were encountered during field searches and driving roads at night. Most areas were visited at different times of the day and in different seasons, but most effort was in the summer rainy season in July-September. Additional museum records were found in online databases such as VertNet (<http://vertnet.org/index.php>) and scientific publications, especially Rorabaugh (2008) and Enderson et al. (2009, 2010). Most historical records and our new observations and images are available in the MABA database (Madrean.org). Photovouchers of selected taxa were deposited into UAZ. Due to permit restrictions, animals were photographed but not collected.

Nomenclature follows Enderson et al. (2010) with a few exceptions. We follow Pauly et al. (2009) in the use of the traditional genera *Bufo* and *Rana*, rather than *Anaxyrus*, *Incilius*, or *Lithobates*. We use *Sonora aemula* rather than *Procinura aemula*.

Results

A total of 59 species of amphibians (11) and reptiles (48) are known from Sierra la Madera (table 1). A total of 30 species of amphibians (9) and reptiles (21) are known from Sierra Bacadéhuachi. In contrast, 92 species of amphibians (21) and reptiles (71) are known from along MEX 16 from the Río Yaquí at Tónichi through the Municipio de Yécora to the Chihuahua border. None of the species observed in the study areas are non-native.

Discussion and Conclusions

Biogeography

Several species observed in the Sierra Bacadéhuachi were range extensions of central SMO animals, notably *Bufo occidentalis*,

Craugastor tarahumaraensis (Ferguson et al. in press), and *Geophis dugesi* (Lemos-Espinal and Smith 2007; Villa et al. in press). Our observation of *Trimorphodon lambda* in pine-oak forest at Rincón de Guadalupe was the first record in the SMO; *T. tau* is common in various habitats in the Yécora area. A suite of typical SMO species, including *Crotalus lepidus*, *C. willardi*, *Elgaria kingii*, *Plestiodon callicephalus*, *Lampropeltis pyromelana*, *Sceloporus jarrovii*, *S. virgatus*, and *Senticolis triaspis*, are widespread in oak woodland and pine-oak woodland in Sky Island ranges in Sonora (Rorabaugh 2008; Enderson et al. 2010) and Arizona (Brennan and Holycross 2006).

A specimen from the Sierra la Madera was a typical *L. p. ssp. pyromelana*, but two specimens seen in the Sierra Bacadéhuachi appeared to be *L. p. ssp. knoblochi* X *L. p. ssp. pyromelana* intergrades (images with observations in the MABA database). Intermediate specimens in this intermediate site challenge recognition of *L. knoblochi* as suggested by Lemos-Espinal et al. (2003). A recent molecular study of *L. pyromelana* by Burbrink et al. (2011) not only concluded that they were separate species, but restricted the range of *L. pyromelana* to north of the Mogollon Rim in Arizona. Basing species and geographic distributions on non-selective molecular characters does not reflect the existing evolutionary hypotheses (subspecies) in any meaningful way. Extending the range of *L. knoblochi* into central Arizona would mean that most individuals in Sky Island populations half of its geographic distribution would not have the pattern characters typical of this subspecies.

Disjunct populations of a number of SMO amphibians and reptiles are known in Sky Island mountain ranges in Sonora (table 2). Hale collected *Salvadora bairdi* in Arroyo el Nogalito on the west side of the Sierra la Madera (UAZ 53743) in November 1981. This is a remarkable range extension of ca. 320 km north-northwest of Milpillas in the SMO on the Sonora-Chihuahua border (AMNH 102194). *Salvadora grahamiae* would have been expected instead.

A few species in Sierra la Madera are not known from the SMO (table 2). *Aspidoscelis opatae*, which is endemic to the Río Bavispe Valley (Enderson et al. 2010), occurs just south of Óputo. *Craugastor augusti* and *Oxybelis aeneus* are expected to occur in the Sierra la Madera. *Bufo woodhousii* and *Thamnophis marcianus* have been collected along the Río Bavispe just north of Óputo, and may be found farther south. *Aspidoscelis exsanguis* A. *tigris*, *Cophosaurus texanus*, *Crotalus atrox*, and *Heloderma suspectum* are desertscrub/desert grassland species reaching their western/southern limits in foothills thornscrub in central Sonora. *Plestiodon obsoletus* is a grassland species that is widespread in the Great Plains from Wyoming south to Texas and west to southeastern Arizona. Cliff (1953) reported it in Sonora from west of Huásabas. We observed one in the same area at Mesa Quemada in FTS in the southern Sierra la Madera. Quijada-M. et al. (2007) reported it from 34 km east of Hermosillo in foothills thornscrub/Sonoran desertscrub. In July 1975, Allan E. Greer collected one from near el Coyote (MVZ 137664), only 19 km north of Bacadéhuachi and just west of the Sierra Bacadéhuachi, almost in the SMO.

A few notably tropical animals reach their northern limits in the Sierra la Madera. *Leptophis diplotropis* is a colorful snake found in tropical western Mexico from Oaxaca north (Lemos-Espinal and Smith 2009). Most Sonoran records of this showy, aggressive snake are in TDF in the Álamos area, but McCoy (1964) reported it from along the Río Moctezuma south of Cumpas. This is a substantial record of a tropical species evidently using a river corridor to disperse northward. The nearest locality to Cumpas is Santa Rosa in the Municipio de Yécora, ca. 170 km to the south-southeast.

Until recently, *Sonora aemula* was known in Sonora only as a TDF species with most records from around Álamos, and a single locality

Table 1-Amphibians and reptiles in the Sierras la Madera (SM) and Bacadéhuachi (SB), and the Yécora area (YEC), Sonora, Mexico.

Taxon	SM	SB	YEC	Taxon	SM	SB	YEC
CAUDATA				TESTUDINATA			
Ambystomatidae				Emydidae			
<i>Ambystoma rosaceum</i>	x	x	x	<i>Terrapene nelsoni</i>		x	x
Plethodontidae				<i>Trachemys yaquia</i>	x		x
<i>Pseudoeurycea bellii</i>			x	Kinosternidae			
ANURA				<i>Kinosternon arizonense</i>			x
Brachycephalidae				<i>Kinosternon integrum</i>			x
<i>Craugastor augusti</i>	?		x	<i>Kinosternon sonoriense</i>	x	x	x
<i>Craugastor tarahumaraensis</i>		x	x	Testudinidae			
Bufo				<i>Gopherus morafkai</i>	x	x	x
<i>Bufo alvarius</i>	x	x	x	SAURIA			
<i>Bufo mazatlanensis</i>	x	x	x	Anguidae			
<i>Bufo mexicanus</i>			x	<i>Elgaria kingii</i>	x	x	x
<i>Bufo occidentalis</i>		x	x	Crotaphytidae			
<i>Bufo punctatus</i>	x	x	x	<i>Crotaphytus collaris</i>	x		
<i>Bufo woodhousii</i>	?			<i>Crotaphytis nebrius</i>	x		x
Hylidae				Eublepharidae			
<i>Hyla arenicolor</i>	x	x	x	<i>Coleonyx fasciatus</i>	?		x
<i>Hyla wrightorum</i>			x	Helodermatidae			
<i>Pachymedusa dacnicolor</i>			x	<i>Heloderma horridum</i>			x
<i>Smilisca baudinii</i>			x	<i>Heloderma suspectum</i>	x		
<i>Smilisca fodiens</i>	x	x	x	Iguanidae			
Leptodactylidae				<i>Ctenosaura macrolopha</i>	x		x
<i>Leptodactylus melanonotus</i>			x	Phrynosomatidae			
<i>Syrhophus interorbitalis</i>			x	<i>Callisaurus draconoides</i>	x		x
Microhylidae				<i>Cophosaurus texanus</i>	x		
<i>Gastrophryne olivacea</i>	x		x	<i>Holbrookia elegans</i>	x	x	x
Pelobatidae				<i>Phrynosoma ditmarsii</i>			x
<i>Scaphiopus couchii</i>	x		x	<i>Phrynosoma hernandesi</i>	x		x
Ranidae				<i>Phrynosoma orbiculare</i>			x
<i>Rana magnaocularis</i>	x		x	<i>Phrynosoma solare</i>	x		x
<i>Rana tarahumarae</i>	x		x	<i>Sceloporus albiventris</i>			?
<i>Rana yavapaiensis</i>	x	x	x	<i>Sceloporus clarkii</i>	x	x	x
				<i>Sceloporus jarrovi</i>	x	x	x
				<i>Sceloporus lemosespinalis</i>		x	x
				<i>Sceloporus poinsetti</i>			x
Taxon	SM	SB	YEC	Taxon	SM	SB	YEC
Phrynosomatidae (cont'd)				Colubridae (cont'd)			
<i>Sceloporus slevini</i>			x	<i>Leptodeira splendida</i>			x
<i>Sceloporus virgatus</i>	x	x	x	<i>Leptophis diplotropis</i>	x		x
<i>Urosaurus ornatus</i>	x	x	x	<i>Oxybelis aeneus</i>	?		x
Polychrotidae				<i>Pituophis catenifer</i>	x		x
<i>Anolis nebulosus</i>			x	<i>Pituophis deppei</i>			x
Scincidae				<i>Rhinocheilus lecontei</i>	x		x
<i>Plestiodon callicephalus</i>	x	x	x	<i>Salvadora bairdi</i>	x		x
<i>Plestiodon obsoletus</i>	x			<i>Salvadora deserticola</i>	x		x
<i>Plestiodon parviauriculatus</i>			x	<i>Senticolis triaspis</i>	x	x	x
Teiidae				<i>Sonora aemula</i>	x		x
<i>Aspidoscelis burti</i>	x		x	<i>Storeria storerioides</i>			x
<i>Aspidoscelis costata</i>		x	x	<i>Tantilla hobartsmithi</i>	x		

Table 1-Cont.

Taxon	SM	SB	YEC	Taxon	SM	SB	YEC
<i>Aspidoscelis exanguis</i>	x		?	<i>Tantilla wilcoxi</i>		x	x
<i>Aspidoscelis opatae</i>	x			<i>Tantilla yaquia</i>	x		x
<i>Aspidoscelis sonora</i>	x		x	<i>Thamnophis cyrtopsis</i>	x	x	x
<i>Aspidoscelis tigris</i>	x			<i>Thamnophis eques</i>	x		x
Boidae				<i>Thamnophis marcianus</i>	?		
<i>Boa constrictor</i>	x		x	<i>Thamnophis melanogaster</i>			x
Colubridae				<i>Thamnophis rufipunctatus</i>			x
<i>Coluber bilineatus</i>	x	x	x	<i>Trimorphodon lambda</i>	x	x	x
<i>Coluber flagellum</i>	x		x	<i>Trimorphodon tau</i>			x
<i>Coluber mentovarius</i>	?		x	<i>Tropidodipsas repleta</i>			x
<i>Diadophis punctatus</i>			x	Elapidae			
<i>Drymarchon melanurus</i>	?		x	<i>Micruroides euryxanthus</i>	x		x
<i>Geophis dugesii</i>		x	x	<i>Micrurus distans</i>			x
<i>Gyalopion canum</i>			x	Viperidae			
<i>Gyalopion quadrangulare</i>			x	<i>Crotalus atrox</i>	x		x
<i>Hypsiglena chlorophaea</i>	x		x	<i>Crotalus basiliscus</i>			x
<i>Imantodes gemmistratus</i>			x	<i>Crotalus lepidus</i>	x		x
<i>Lampropeltis getula</i>	x		x	<i>Crotalus molossus</i>	x	x	x
<i>Lampropeltis pyromelana</i>	x	x	x	<i>Crotalus tigris</i>	x		x
<i>Lampropeltis triangulum</i>			x	<i>Crotalus willardi</i>	x	x	x

Table 2-Herpetofauna summaries and comparisons.

Site	Effort	Elevation		Elevation	
		Low	High	Range	
Sierra la Madera (SM)	Moderate	615	2300	1685	
Sierra Bacadéhuachi (SB)	Moderate	700	2400	1700	
Yécora (YEC)	High	180	2140	1960	
Herpetofauna	Amphibians	Reptiles	Total		
SM	11	47	58		
SB	9	21	30		
YEC	21	71	92		
Shared	SM	SB	YEC		
SM	---	22	50		
SB	22	---	30		
YEC	50	30	---		
Amphibians					
Shared	SM	SB	YEC	Unique	
SM	---	7	11	SM	0
SB	7	---	9	SB	0
YEC	11	9	---	YEC	7
Reptiles					
Shared	SM	SB	YEC	Unique	
SM	---	15	39	SM	7
SB	15	---	21	SB	0
YEC	39	21	---	YEC	20

east-northeast of Ónavas (28°29'N; UAZ45675). Julio Lemos-Espinal found one at Tónichi on the Río Yaqui (28°36'N; CONABIO record). In 2012 Van Devender photographed another one east of San Pedro de la Cueva in the Sierra Agua Verde (29°16'N), extending the known distribution ca. 100 km north-northwest of the Ónavas locality and ca. 80 km north-northwest of Tónichi. Finally Roberto Hernández-Jimenez photographed *S. aemula* at Tonibabi Spring in the Sierra la Madera (29°51'N; Hugo Silva- Kurumiya, pers. comm., 2012), 150 km north of the Ónavas locality (new records and images in MABA database).

Biodiversity

Several factors influence biodiversity. Within a Sky Island, species richness is influenced by local factors such as area, elevational range, vegetation diversity, habitats, bedrock types, and land use history. Geographic location is important because, in general, species richness in many groups' biodiversity increases southward to more tropical habitats. Although the northernmost tropical deciduous forest is in the Sierra San Javier (28°35'N; 100 km south-southwest of Sierra La Madera, 120 km southwest of Sierra Bacadéhuachi), foothills thornscrub and its tropical elements occur in a wide transition between Sonoran desertscrub and oak woodlands in the Sky Island ranges and the mainland Sierra Madre Occidental. Also the nearness to the SMO is important because biodiversity in general is higher in the SMO than any Sky Island (see Reina-G. and Van Devender, 2005 for floristic comparison).

The documentation of biodiversity is strongly influenced by access (roads), nearness of research centers, and the inventory effort (number of trips, field time, etc.) and the number and skills of observers. Herpetofaunas are difficult to study for a variety of reasons. Many species only emerge from underground retreats to feed and breed during a short part of the warm season and especially during the summer rainy season. Nocturnal, secretive species are rarely encountered.

The herpetofauna of the Sky Island Sierra la Madera with 59 taxa is moderately well known. Its affinities are strongly Madrean with 88.1% of the fauna shared with the SMO. Except for the Río Bavispe Valley endemic *Aspidoscelis opatae*, the species not known from the SMO are desertscrub/desert grassland species that are Sky Island faunas that are widespread in the Sonoran Desert to the west and/or desert grassland to the north. Old records of several additional taxa from the Cumpas-Moctezuma area, including *Aspidoscelis uniparens*, *Phrynosoma cornutum*, *P. modestum*, *Sceloporus cowlesi*, and *Terrapene ornata*, are desert grassland taxa not known from the SMO. These would be significant southern range extensions, but are not included in the present study until validated.

The Sierra Bacadéhuachi is in the SMO, but the known herpetofauna is small despite four visits by many observers. Moreover, the numbers of individuals, especially of typically common, easily-observed species (*Hyla arenicolor*, *Sceloporus jarrovii*, *Thamnophis cyrtopsis*, etc.) seen in our 2011-2012 fieldwork were low, suggesting the possibility that some recent catastrophe might have impacted their populations— perhaps the severe freeze of February 2-3, 2011. All of the Bacadéhuachi taxa occur in the Yécora area.

The Yécora herpetofauna is much richer than the Sierra la Madera fauna (table 2), and likely any Sky Island in Sonora. One species, the snail-eating snake *Tropidodipsas repleta*, is endemic to the Yécora area (Smith et al. 2005). Additional species known from the SMO may be added to the Yécora area. *Plestiodon brevirostris* (Rorabaugh, 2008) and *Salvadora bairdi* (AMNH 102194) are known in the SMO from near Milpillas on the Chihuahua-Sonora border, 120 km south of the Yécora area. Several species, including *Coluber taeniatus*, *Crotalus*

scutulatus, *Spea multiplicata*, *Thamnophis elegans*, and *T. sirtalis* occur in the Yécora area in Chihuahua to the east (Van Devender and Lowe 1977). *Sceloporus albiventris* is known from the Álamos and as far north as Zetasora on the Northern Jaguar Reserve north of Sahuaripa in TDF Rorabaugh et al. 2011), but not yet in the Yécora area. Another two amphibians and 12 reptiles (10 snakes) occur in TDF near Álamos, but have not yet been found near Yécora. We estimate the potential SMO herpetofauna in eastern Sonora at 113 species of amphibians (24) and reptiles (89). Colubrid snakes are especially diverse with 45 species, which contrasts with 187 species for Sonora as a whole, including 35 amphibian and 152 reptile species (Enderson et al. 2009).

With the exception of the Northern Jaguar Reserve north of Sahuaripa in FTS (Rorabaugh et al. 2011), there are no published herpetofaunas for eastern and northeastern Sonora. The two local herpetofaunas presented here and comparisons with the mainland SMO herpetofauna in the Yécora area help understand the regional biodiversity, but additional studies are needed in individual Sky Island ranges and other areas in the SMO. The fauna of the Tres Ríos area, the wettest highlands on the Sonora-Chihuahua border in the northernmost SMO, would be especially interesting.

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References

- Brennan, Thomas C.; and Holycross, Andrew T. 2006. *A field guide to amphibians and reptiles in Arizona*. Phoenix: Arizona Game and Fish Department. 152 p.
- Burbrink, F. T.; Yao, H.; Ingrasci, M.; Bryson, Jr., R. W.; Guiher, T. J.; and Ruane, S. 2011. Speciation at the Mogollon Rim in the Arizona Mountain Kingsnake (*Lampropeltis pyromelana*). *Molecular Phylogenetics and Evolution*. 60: 445-454.
- Cliff, F.S. 1953. Selected records of lizards from Sonora. *Copeia*. 1953(3):186-187.
- Enderson, Erik F.; Quijada-M., Adrián; Turner, Dale S.; Rosen, Philip C.; and Bezy, Robert L. 2009. The herpetofauna of Sonora, Mexico, with comparisons to adjoining states. *Check List*. 5: 632-672.
- Enderson, Erik F.; Quijada-M., Adrián; Turner, Dale S.; Bezy, Robert L.; and Rosen, Philip C. 2010. Una synopsis de la herpetofauna con comentarios sobre las prioridades en investigación y conservación. Pg. 357-383 in Molina-Freaner, Francisco and Van Devender, Thomas R. eds., *Diversidad Biológica de Sonora*, Universidad Nacional Autónoma de México, Hermosillo, Sonora.
- Ferguson, George M.; Turner, Dale; Hale, Stephen F.; Villa, Robert; Hedgcock, Chip; Enderson, Erik F. In press. *Craugastor tarahumaraensis* (Tarahumara Barking Frog). Geographic Distribution. *Herpetological Review*
- Hale, Stephen F.; and Jarchow, James L. 1988. The Status of the Tarahumara Frog (*Rana tarahumarae*) in the United States and Mexico; Part 2. Schwalbe, Cecil R. and Johnson, Terry B. eds. Report to Arizona Game and Fish Department, Phoenix, and Office of Endangered Species, U.S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Hale, Stephen F.; Ferguson, George M.; Holm, Peter A.; and Elizabeth B. Wirt. 1998. Re-survey of selected Tarahumara frog (*Rana tarahumarae*) localities in northern Sonora, Mexico, in May 1998. Report submitted to The Arizona Zoological Society and The Tarahumara Frog Conservation Team. 24 p.
- Lemos-Espinal, Julio A.; and Smith, Hobart M. 2007. Anfibios y Reptiles del Estado de Chihuahua. CONABIO, México. 613 p.

- Lemos-Espinal, Julio A.; Chisar, David; and Smith, Hobart M. 2003. Knobloch's kingsnake (*Lampropeltis knoblochi*) of México a species. Bulletin of the Maryland Herpetological Society. 39: 53-58.
- Lowe, Charles H.; and Woodin, William H. 1954. A new racer (genus *Masticophis*) from Arizona and Sonora, Mexico. Proceedings of the Biological Society of Washington, 67: 247-250.
- Martin, Paul S.; Yetman, David A.; Fishbein, Mark; Jenkins, Philip; Van Devender, Thomas R.; and Wilson, Rebecca K. (eds.). 1998. Gentry's Río Mayo Plants. The tropical deciduous forest and environs of Northwest Mexico. University of Arizona Press, Tucson. 558 p.
- McCoy, Clarence J., Jr. 1964. Notes on snakes from northern Mexico. The Southwestern Naturalist, 9: 46-48.
- Pauly, Gregory B.; Hillis, David M.; and Cannatella, David C. 2009. Taxonomic freedom and the role of official lists of species names. Herpetologia, 65: 115-128.
- Quijada-M., Adrián; Enderson, Erik F.; Parra-S., Iván, and Bezy, Robert L. 2007. *Plestiodon obsoletus* (Great Plains Skink). Sonora, México. Herpetological Review, 38: 353.
- Reina-G., Ana L.; and Van Devender, Thomas R. 2005. Floristic comparison of an Arizona 'sky island' and the Sierra Madre Occidental in eastern Sonora: the Huachuca Mountains and the Yécora area. Pp. 154-157 in Gottfried, Gerald J.; Gebow, Brooke S.; Eskew, Lane G.; and Edminster, C.B. (compilers). connecting mountain islands and desert seas: Biodiversity and management of the Madrean Archipelago II. Proc. RMRS-P-36, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.
- Rorabaugh, J.C. 2008. An introduction to the herpetofauna of mainland Sonora, México, with comments on conservation and management. Journal of the Arizona-Nevada Academy of Science. 40: 20-65.
- Rorabaugh, James C.; Gómez-Ramírez, Miguel A.; Gutiérrez-González, Carmina E.; Wallace, J. Eric; and Van Devender Thomas R. 2011. Amphibians and reptiles of the Northern Jaguar Reserve and vicinity, Sonora, Mexico: A preliminary evaluation. Sonoran Herpetologist. 24: 123-131.
- Smith, Hobart M.; Lemos-Espinal, Julio A.; Hartman, D.; and Chisar, David. 2005. A new species of *Tropidodipsas* (Serpentes: Colubridae) from Sonora, Mexico. Bulletin of the Maryland Herpetological Society. 41: 39-41.
- Yanes-Arvalo, Gertrudis; Montañez-Armenta, María de la Paz; Silva-Kurumiya, Hugo; and Gil-Montañón, Enrique. 2011. Catálogo de Fauna de Sierra La Madera. Fracción V de la Reserva Ajos Bavispe. Universidad de la Sierra, Hermosillo, Sonora.
- Van Devender, Thomas R., and Charles H. Lowe. 1977. Amphibians and reptiles of Yepómera, Chihuahua, Mexico. Journal of Herpetology. 11: 41-50.
- Villa, Robert; Van Devender, Thomas R.; and Bygott, David G. In press. *Geophis dugesi aquilonaris* (Chihuahuan Earth Snake). Sonora, México. Herpetological Review,