RESEARCH ARTICLE

Amphibians and Reptiles of the Sierra El Tigre Region, Sonora, Mexico

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Introduction

The northeastern corner of Sonora, Mexico, is lightly populated and contains some spectacular natural landscapes. Among its gems is Sierra El Tigre, a large and high mountain range surrounded on three sides by the Río Bavispe (Figs. 1, 2). The range is part of the Sky Islands, also known as the Madrean Archipelago for its relation to Mexico's Sierra Madre Occidental. The herpetofauna of Sierra El Tigre region has never been described previously but early collecting efforts there have played an important part in the understanding and conservation of amphibians and reptiles in Sonora and Arizona.

Fig. 1. View from Sierra El Tigre to the west. Presa Angostura on the Río Bavispe visible in center. Photo by Luis Gutiérrez of PhotoNorte.

The northeastern corner of Sonora, Mexico, is lightly populated and contains some spectacular natural landscapes. Among its gems is Sierra El Tigre, a large and high mountain range surrounded on three sides by the Río Bavispe (Figs. 1, 2).

Study Area

Our study area (Fig. 2) includes the Sierra El Tigre, reaches of the Río Bavispe that encircle the mountain range's western, northern, and eastern sides, and a short reach of the Río Batepito above its confluence with the Río Bavispe. To the east of the Bavispe, the study area includes the western bajadas and lower western slopes of, from north to south, the Sierras Pan Duro (a southern extension of the Sierra San Luis), Xitahueca, Huachita Hueca, and El Gato. The Sierra El Tigre, which is the second largest mountain range in the Madrean Archipelago, covers approximately 3,277 sq. km. (1,265 sq. mi.; Deyo et al. 2013). In our study area, it rises from about 638 m (2,093 ft) along the Río Bavispe upstream of Villa Hidalgo, Sonora, to approximately 2,440 m (8,005 ft) at the top of Cerro El Tigre. The range is a complex that includes the Sierra los Pilares de Teras on the northern end, the Sierra Las Iglesitas east of Presa La Angostura on the Río Bavispe, the Sierra San Diego on the east side, and the Sierra El Oso west of Bacerac. To the southeast of our study area, the headwaters of the Río Bavispe arise in the Sierra Madre Occidental. A nearly-continuous band of oak woodland at an elevation of 1,200 m (3,937 ft) or more connects the southern Sierra El Tigre with the Sierra Madre Occidental (Figs. 2, 3).

The Sierra El Tigre is a product of intense volcanic activity during the Tertiary Era with successive flows of rhyolite and rhyolite tuff that accumulated to a depth of 1,220 m (4,000 feet) over Mesozoic fluvial fans of eroded granite and limestone (Mishler 1920). The mountain range includes sheer cliffs due to a series of northwest/southeast geological faults. Those faults were responsible for two major earthquakes since 1880, including one in 1887 that leveled the town of Bavispe and caused significant damage across northern Sonora and southern Arizona (Mishler 1920, Suter 2008).

The climate of the Sierra el Tigre area is typical of the Sky Island Region, which is semi-arid with bi-seasonal precipitation. Winter precipitation is associated with frontal storms from the Pacific Ocean. Winter conditions generally last from November through March. From April until the beginning of the summer monsoon season in late June or early July, the climate is warm and dry. Monsoon storms are the result of tropical air flowing over heated mountain terrain, with frequent torrential rains and thunderstorms occurring during the afternoon and evening. Temperatures are elevation dependent. In the lowlands, near Presa La Angostura, summer temperatures can reach 50°C and winter temperatures can be as low 0°C. High in the Sierra El Tigre, summer temperatures rarely exceed 40°C but winter low temperatures can reach -15°C. The higher peaks of the Sierra El Tigre can be snow covered in winter (Brown 1982b, P&E Mining Consultants, Inc. 2024).

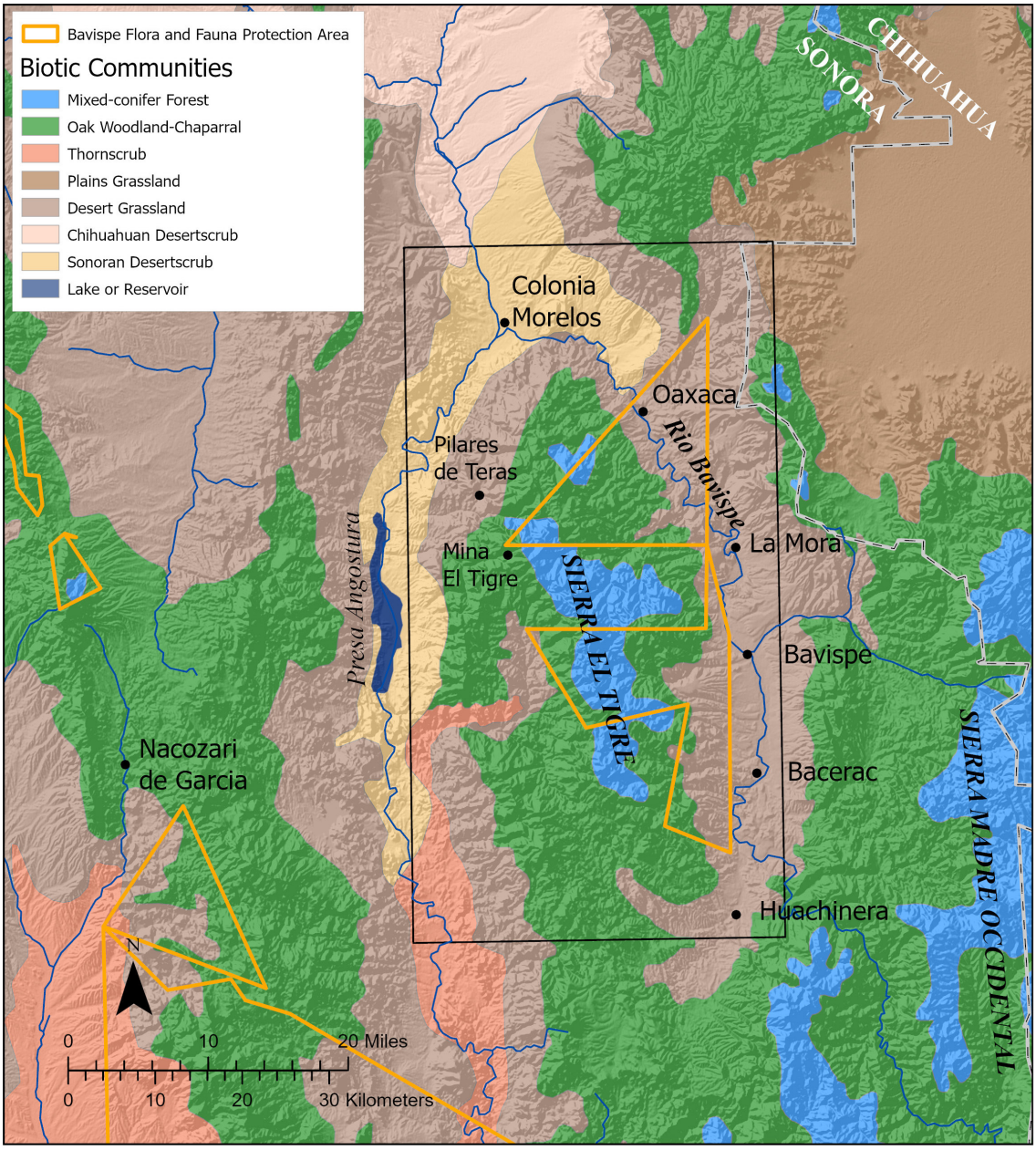

Fig. 2. Sierra El Tigre and surroundings. The black box defines the area of this study. Biotic communities modified from the map by Brown and Lowe (1980), with detailed descriptions in Brown (1982a). Orange polygons show areas managed as part of the Bavispe Flora and Fauna Protection Area. Map by Turner.

The area has a long history of mining, primarily for silver and gold, in the El Tigre Mining District at the northern end of the sierra. Important mines included the Mina El Tigre or "Lucky Tiger" (1,768 m or 5,800 ft elevation), along with the Cinco de Mayo, Roy, North Tigre, and Santa María mines (Mishler 1920). In the early 1900s, as many as 5,000 inhabitants lived in the former town of El Tigre (Avila and Jacobs 2008). Silver Tiger Metals, Inc. is currently exploring the feasibility of developing an open pit gold and silver mine in the El Tigre Mining District (P&E Mining Consultants, Inc. 2024). An all-weather road has been developed from Colonia Morelos and a base camp established on the El Tigre property. Since 2020, Silver Tiger has completed five exploratory drilling programs consisting of 475 drill holes totaling 118,975 m. The El Tigre property (21,775 ha) is entirely owned by Silver Tiger (P&E Mining Consultants, Inc. 2024).

About 611 sq km of Sierra El Tigre is part of the Área de Protección de Flora y Fauna (APFF) Bavispe (Fig. 2). First established in 1936 and expanded in 1939 to include the Tigres, the area has been administered by different Federal agencies during its history. Its initial goal was the protection and management of forests, fire, and regulation of timber harvests. It was known as the Reserva Forestal Nacional y Refugio de Fauna Silvestre Ajos-Bavispe until 2017, when it was redesignated an APFF.

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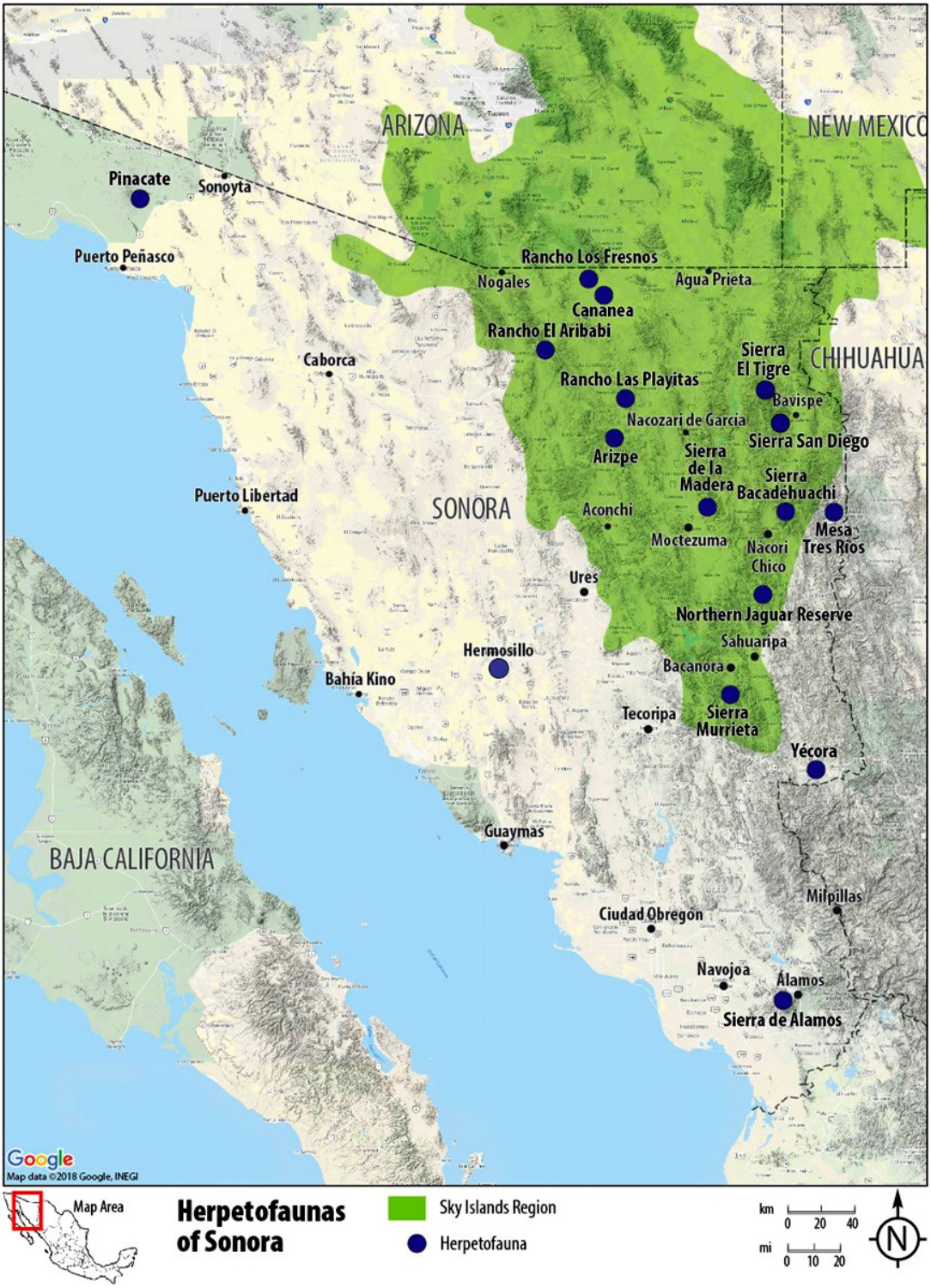

Fig. 3. Regional herpetofaunal studies. The Sierra El Tigre work adds to previous studies that summarized 15 regional herpetofaunas in Sonora. Modified from Van Devender and Turner (2023).

The higher elevations of the greater Sierra El Tigre have extensive pine-oak forest (Fig. 4A; Van Devender and Reina-Guerrero 2021) dominated by Apache (*Pinus engelmannii*) and Arizona (*P. arizonica*) pines, along with oaks (*Quercus durifolia*, *Q. gambelii*, *Q. hypoleucoides*, *Q. mcvaughii*, and *Q. rugosa*).

Vegetation

The higher elevations of the greater Sierra El Tigre have extensive pine-oak forest (Fig. 4A; Van Devender and Reina-Guerrero 2021) dominated by Apache (*Pinus engelmannii*) and Arizona (*P. arizonica*) pines, along with oaks (*Quercus durifolia*, *Q. gambelii*, *Q. hypoleucoides*, *Q. mcvaughii*, and *Q. rugosa*). In mesic canyons and on shady north slopes, trees typical of mixed-conifer forest, including Douglas fir (*Pseudotsuga menziesii*), southwestern white pine (*P. strobiformis*), white fir/*pinabete* (*Abies concolor*, White 1948), and Texas madrone/*madroño* (*Arbutus xalapensis*) are in the forest. The forests of Sierra

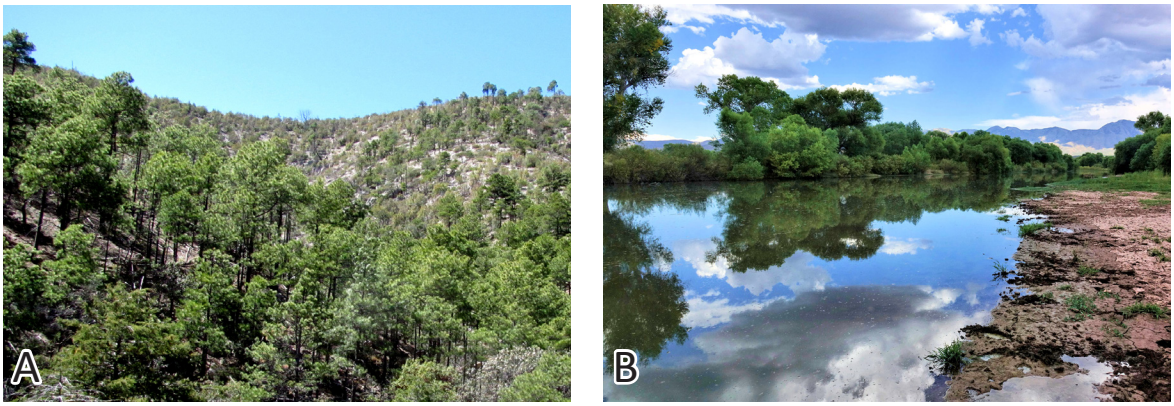

Fig. 4. A. Pine-oak forest in the Sierra El Tigre. Photo by Van Devender. **B.** Cottonwood-willow riparian forest along the Río Bavispe near Bavispe. Photo by Rorabaugh.

El Tigre have benefitted from the absence of fire suppression through most of the past century, with the natural fire regime supporting a forest composition that has been used as a reference for forest ecology in other sky islands of the region (Kaib 1998). Also, the forest has recovered with reduction in logging and access became difficult with the deterioration of mining exploration roads.

Oak woodland or chaparral is well-developed at middle elevations, especially in the Sierra San Diego on the east side. Arizona (*Q. arizonica*) and Mexican blue (*Q. oblongifolia*) are important oaks with other species (*Q. emoryi*, *Q. toumeyi*, and *Q. viminea*) less common, as well as Arizona madrone/*madroño* (*Arbutus arizonica*) and Arizona juniper/*táscate* (*Juniperus arizonica*). There are desert grassland breaks in the oak woodland in the Aribabi area between the southern Sierra El Tigre, the Sierra Bacadéhuachi, and the Sierra Madre Occidental (Brown and Lowe 1980).

At lower elevations on the east side between the Sierra San Diego and the Río Bavispe, overgrazed desert grassland is dominated by velvet mesquite (*Neltuma* [=*Prosopis*] *velutina*). On the north side of the range near Pilares de Teras and Colonia Morelos, desert grassland dominated by honey mesquite (*Neltuma odorata*) is mixed with Chihuahuan desertscrub species, including canyon senna (*Senna wislizenii*), *mariola* (*Parthenium incanum*), *oreja de ratón* (*Bernardia myricifolia*), sandpaper bush (*Mortonia scabrella*), tarbush (*Flourensia cernua*), and viscid acacia (*Vachellia vernicosa*).

On the west side of the study area between Presa Angostura and the Sierra Iglesitas, there is an area of desertscrub. Brittlebush/*rama blanca* (*Encelia farinosa*), *ocotillo* (*Fouquieria splendens*), and velvet mesquite are dominant. Brown and Lowe (1980) mapped the vegetation as an isolated patch of Arizona Upland Sonoran desertscrub that merges northward into Chihuahuan desertscrub near Colonia Morelos. Typical Chihuahuan desertscrub species, including creosotebush/*gobernadora* (*Larrea divaricata*), honey mesquite, *mariola*, and tarbush are not present in the Iglesitas desertscrub. Typical foothills thornscrub species that also occur in the Plains of Sonora subdivision of the Sonoran Desert are present, including *bacanora* (*Agave angustifolia*), *bebelama* (*Sideroxylon occidentale*), *gallinitas* (*Callaeum macropterum*), *mauto* (*Lysiloma divaricatum*), organ pipe cactus/*pitahaya* (*Stenocereus thurberi*), *tepeguaje* (*L. watsonii*), *teso* (*Senegalia occidentalis*), and *torotes* (*Bursera fagaroides*, *B. laxiflora*). The desertscrub in this area is most similar to Plains of Sonora desertscrub that also has strong thornscrub affinities.

Individual organ pipe cacti were seen in Cañada El Salto near Bavispe, Arroyo El Chinoso at Campo Bonito and Mina El Tigre, Arroyo Las Carabinas at Campo Apache, and at Pilares de Teras. The severe freeze of February 2-3, 2011, killed most organ pipes east of the Río Bavispe between Bavispe and Colonia Morelos, re-setting the eastern limit of the species in this portion of its distribution.

The New World tropics merge into the northern temperate zone at about 29°N in east-central Sonora (Van Devender and Reina-Guerrero 2021). Thornscrub is transitional between tropical deciduous forest and adjacent vegetation. On the coastal plain along the Gulf of California, coastal thornscrub merges northward into Plains of Sonora desertscrub near Guaymas. On inland rocky slopes in central Sonora, foothills thornscrub is between Sonoran desertscrub and oak woodland to the east. The northern limits of foothills thornscrub are in the Ríos Bavispe and Sonora Valleys at about 30.4°N. Foothills thornscrub occurs in the southwestern part of the study area near the town of Angostura (Van Devender and Reina-Guerrero 2021). In addition to the thornscrub plants mentioned above, *guasaraco* (*Parthenium tomentosum* var. *stramonium*), tree ocotillo/*ocotillo macho* (*Fouquieria macdougalii*), and *palo brea* (*Parkinsonia praecox*) are present. Exploration of the deep canyon in Arroyo Los Otates draining the southern Sierra El Tigre before turning west to join the Río Bavispe would yield many more records of tropical plants. *Otate* is the common name of native bamboo (*Otatea acuminata*). On Google Earth satellite images, a dense stand of palms is

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Fig. 5. A. *Rana tarahumarae* from Arroyo el Púlpito. Photo by Rorabaugh. **B.** *Thamnophis eques* on the Río Bavispe near Bavispe. Photo by Guillermo Molina-Padilla.

visible in the bottom of the canyon.

Riparian habitats are linear mesic vegetation communities that transect upland habitats. They harvest water, seeds, and nutrients from the entire local watersheds. These are high energy, unstable habitats with regular floods. Upland species are often found at low elevations in riparian habitats. The most extensive riparian habitat in the study area is along the Río Bavispe (Fig. 4B) that flows on three sides of the Sierra El Tigre. Riparian trees along the river at Bavispe are Fremont cottonwood/*álamo* (*Populus fremontii*), Goodding willow/*sauz* (*Salix gooddingii*), and netleaf hackberry/*cúmero* (*Celtis reticulata*). Additional species in Cañada El Salto, a boulder canyon near Bavispe, include Arizona sycamore/*aliso* (*Platanus wrightii*), Arizona walnut/*nogal* (*Juglans major*), Bonpland willow/*sauz* (*S. bonplandiana*), wingleaf soapberry/*chirrión* (*Sapindus drummondii*), *palo chino* (*Havardia mexicana*), Sonoran palmetto/*palma real* (*Sabal uresana*), Texas mulberry/*mora* (*Morus microphylla*), and wild cherry/*capulín* (*Prunus serotina*). High elevation species in the canyon are Arizona alder/*alamillo* (*Alnus oblongifolia*), Arizona cypress/*sabino* (*Hesperocyparis arizonica*), and bigtooth maple/*palo azúcar* (*Acer grandidentatum*). Many of these species are present in riparian areas in other parts of the greater Sierra El Tigre. Sonoran cottonwood/*huérigo* (*P. monticola*) is present in Arroyos El Chinoso and El Púlpito. Blue elderbery/*sáuco* (*Sambucus nigra* subsp. *cerulea*) is present at Campo Bonito and the El Tigre ruins but could be an old cultivar used medicinally.

Previous Research

While the Sierra El Tigre has not gotten the attention given many other Sky Islands, it has been the subject of assorted biological surveys over the past century. As a young biologist, Berry Campbell collected amphibians, reptiles, and small mammals during a trip to the area in 1935 (Burt 1938). He spent seven weeks there, collecting more than 200 specimens representing 35 amphibian and reptile species, many of them new records for the state of Sonora. His specimens are housed in the University of Michigan herpetology collection. He later became a noted neuroscientist and professor of anatomy.

During 1938-1941, Stephen S. White made extensive plant collections in and around the El Tigre for his doctoral research at the University of Michigan, listing some 1,200 species and varieties. He described it as "one of the least known regions of the north Mexican border" (White 1948). The area was visited by the ornithologist Joe Marshall in 1953 who noted widespread logging and burning of ponderosa pine forests (Marshall 1957). The biologists George Ferguson and Jim Malusa made a plant collecting trip there in 1996, with incidental observations of amphibians and reptiles (Ferguson pers. comm., 2025). Several canyons on the west side of Sierra El Tigre were visited repeatedly during 1981-2007 to study *Rana tarahumarae* (Tarahumara Frog, Hale et al. 2005, Rorabaugh pers. obs.; Fig. 5A).

In recent years, four large expeditions visited Sierra El Tigre to inventory its biodiversity. An initial trip by Sky Island Alliance in April-May 2008, led by Sky Jacobs and Sergio Avila, included 10 participants. A follow-up trip in March 2010 with 25 participants was part of Sky Island Alliance's Madrean Archipelago Biodiversity Assessment (MABA) program. Two more expeditions were part of the Greater Good Charities' Madrean Discovery Expeditions (MDE) program, including trips in August 2015 with 63 participants, and September 2024 with 24 participants. TRV led the three most recent trips, DST and SFH were part of two, and JCR was part of one. Observations and many images from these expeditions are publicly available in the MDE database (*madreandiscovery.org*).

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Methods

We searched for records of amphibians and reptiles in the Madrean Discovery Expeditions and linked databases in the SEINet network (*madreandiscovery.org*), as well as the VertNet and Global Biodiversity Information Facility (GBIF) databases for the greater Sierra El Tigre area, including the municipalities of Agua Prieta, Bacerac, Bavispe, Huachinera, Nacozari de García, and Villa Hidalgo in Sonora, Mexico. We examined records using a map search with a coordinate box of 30.908 to 30.187°N by 109.344 to 108.901°W (searched 12 February 2025). This area includes Sierra El Tigre, its northern and southern extensions, portions of the Río Bavispe Valley, a short reach of the Río Batepito, and portions of the mountains and bajadas to the east of the Río Bavispe. Additional records were found in *iNaturalist*.

Results and Discussion

We documented 56 herpetofaunal species from our study area, including 12 species of amphibians in 6 families and 44 species of reptiles in 13 families (Table 1).

Stephen Hale and colleagues observed the decline in *Rana tarahumarae* (Fig. 5A) populations in Arroyos La Carabina and El Tigre during the period 1981-1999. That was among the drivers for research on chytridiomycosis, a fungal skin disease caused by the pathogen *Batrachochytrium dendrobatidis*, and for conservation of the frog (Hale et al. 2005, Rorabaugh et al. 2020). In October 1999, Hale and Andres Villareal collected four adult *R. tarahumarae* and 30 small tadpoles from Arroyo El Tigre and brought them into captivity at the Arizona-Sonora Desert Museum (ASDM) to begin a captive population. The goal was subsequent reestablishment in Arizona, but all the frogs and tadpoles quickly died of chytridiomycosis (Rorabaugh et al. 2020). That was the last time *R. tarahumarae* were found in the Sierra El Tigre. In May 2007, a group of 8 biologists surveyed canyons on the western side of Sierra El Tigre for ranid frogs, with a particular interest in collecting more *R. tarahumarae* frog egg masses and/or tadpoles, but they found none (JCR, unpublished trip report). Observations by Rorabaugh and Hale in 2008 from Arroyo El Púlpito in Sierra Pan Duro are the most recent records from our study area.

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Table 1. Amphibians and reptiles of the greater Sierra El Tigre area, Municipios de Agua Prieta, Bacerac, Bavispe, Huachinera, Nacozari de García, and Villa Hidalgo, Sonora Mexico.

Family	Scientific Name	Common Name
Amphibians		
Ambystomatidae	*Ambystoma rosaceum*	Tarahumara Salamander
Bufonidae	*Anaxyrus mexicanus*	Mexican Madre Toad
	Anaxyrus punctatus	Red-Spotted Toad
	Anaxyrus woodhousii	Woodhouse's Toad
	Incilius alvarius	Sonoran Desert Toad
	Incilius mccoyi	McCoy's Pine Toad
Craugastoridae	*Craugastor augusti*	Barking Frog
Hylidae	*Hyla arenicolor*	Canyon Treefrog
Microhylidae	*Gastrophryne mazatlanensis*	Mazatlán Narrow-Mouthed Toad
Ranidae	*Rana tarahumarae*	Tarahumara Frog
	Rana yavapaiensis	Lowland Leopard Frog
Scaphiopodidae	*Scaphiopus couchii*	Couch's Spadefoot
Reptiles		
Emydidae	*Terrapene ornata*	Ornate Box Turtle
	Trachemys yaquia	Yaqui Slider
Kinosternidae	*Kinosternon sonoriense*	Sonora Mud Turtle
Testudinidae	*Gopherus morafkai*	Desert Tortoise
Anguidae	*Elgaria kingii*	Madrean Alligator Lizard
Crotaphytidae	*Crotaphytus collaris*	Eastern Collared Lizard
Helodermatidae	*Heloderma suspectum*	Gila Monster
Phrynosomatidae	*Cophosaurus texanus*	Greater Earless Lizard
	Holbrookia elegans	Elegant Earless Lizard

Table 1 (continued). Amphibians and reptiles of the greater Sierra El Tigre area, Municipios de Agua Prieta, Bacerac, Bavispe, Huachinera, Nacozari de García, and Villa Hidalgo, Sonora Mexico.

Family	Scientific Name	Common Name
	Phrynosoma ditmarsi	Rock Horned Lizard
	Phrynosoma orbiculare	Mountain Horned Lizard
	Phrynosoma solare	Regal Horned Lizard
	Sceloporus clarkii	Clark's Spiny Lizard
	Sceloporus jarrovii	Yarrow's Spiny Lizard
	Sceloporus lemosespinali	Lemos-Espinal's Spiny Lizard
	Sceloporus virgatus	Striped Plateau Lizard
	Urosaurus ornatus	Ornate Tree Lizard
Scincidae	*Plestiodon callicephalus*	Mountain Skink
Teiidae	*Aspidoscelis burti*	Canyon Spotted Whiptail
	Aspidoscelis opatae	Ópata Whiptail
	Aspidoscelis preopatae	Pre-Ópata Whiptail
	Aspidoscelis sonorae	Sonoran Spotted Whiptail
	Aspidoscelis uniparens	Desert Grassland Whiptail
Colubridae	*Diadophis punctatus*	Ring-necked Snake
	Hypsiglena chlorophaea	Desert Nightsnake
	Lampropeltis getula	Common Kingsnake
	Lampropeltis pyromelana	Mountain Kingsnake
	Masticophis flagellum	Coachwhip
	Pituophis catenifer	Gophersnake
	Rhinocheilus lecontei	Long-nosed Snake
	Salvadora deserticola	Big Bend Patch-nosed Snake
	Senticolis triaspis	Green Ratsnake
	Tantilla wilcoxi	Chihuahuan Black-headed Snake
	Tantilla yaquia	Yaqui Black-headed Snake
	Thamnophis cyrtopsis	Black-necked Gartersnake
	Thamnophis eques	Mexican Gartersnake
	Thamnophis marcianus	Checkered Gartersnake
Elapidae	*Micruroides euryxanthus*	Sonoran Coralsnake
Leptotyphlopidae	*Rena humilis*	Western Threadsnake
Viperidae	*Crotalus atrox*	Western Diamond-backed Rattlesnake
	Crotalus molossus	Black-tailed Rattlesnake
	Crotalus pricei	Twin-spotted Rattlesnake
	Crotalus tigris	Tiger Rattlesnake
	Crotalus willardi	Ridge-nosed Rattlesnake

Tarahumara Salamanders (*Ambystoma rosaceum*) were collected by Campbell in 1935 from two localities on the western side of Sierra El Tigre, and collected by others in 1974 and 1982. Hale and colleagues observed the species to be common in plunge pool habitat in upper Arroyo la Carabina from approximately 1,478 m elevation and higher between in the drainage as such habitat extended between June 1982 – July 1983 when several were collected for ASDM. They observed some large individuals, with Hale and Cecil Schwalbe recording one that exceeded 20 cm in total length. A 2020 iNaturalist record from Arroyo la Carabina suggests the species still persists in the area.

Tarahumara Salamanders (*Ambystoma rosaceum*) were collected by Campbell in 1935 from two localities on the western side of Sierra El Tigre, and collected by others in 1974 and 1982.

Similarly, three specimens of McCoy's Pine Toad (*Incilius mccoyi,* Fig. 6A) were collected by Campbell in 1935 from one locality in Sierra El Tigre. It has not been collected from our study area since, but we include it in the list while recognizing the need for confirmation. This is a disjunct and northernmost population of a Sierra Madre Occidental species, with the nearest known localities being in the Sierra Bacadéhuachi and the Mesa Tres Ríos area (Van Devender et al. 2022).

Sierra El Tigre represents unusual distributions for several horned lizard species. The upper elevations are occupied by the Mountain Horned Lizard

Fig. 6. Sierra El Tigre disjunct species. **A.** *Incilius mccoyi* from Mesa del Campanero west of Yécora. Photo by Robert L. Bellsey. **B. C. D.** *Phrynosoma orbiculare* in the Sierra El Tigre. **C.** Mated pair. Photos by R. Wayne Van Devender, Guillermo Molina-Padilla, and George M. Ferguson.

(*Phrynosoma orbiculare,* Figs. 6A, B, D), a disjunct and northernmost population of this species that extends southward from Mesa Tres Ríos along the length of the Sierra Madre to the mountains of central Mexico (Cabrera et al. 2018). Mountains to the north, west, and south have Greater Short-horned Lizard (*P. hernandesi*) instead at higher elevations (Sherbrooke 2003, Aguilar-Moreles and Van Devender 2018). There is some evidence that competition between the two species led to their separation (Montanucci 1981).

The Regal Horned Lizard (*Phrynosoma solare*) occupies the adjacent valley floors and bajadas to the east, north, and west of the Sierra El Tigre, but it has not been found to the south in our study area. Instead, there is a single low-elevation record of the Rock Horned Lizard (*P. ditmarsi*) to the southeast, from the vicinity of Bacerac (Turner et al. 2017).

The Striped Plateau Lizard (*Sceloporus virgatus*), a distinctive lizard that barely makes it into Arizona and New Mexico, was first collected in the Sierra El Tigre area by Berry Campbell in July 1935: "Above the Santa María Mines, El Tigre Mts., Sonora, Mex". That specimen became the holotype for a subspecies, *Sceloporus undulatus virgatus*, described by Smith (1938). It was elevated to full species by Cole (1963). The subspecies *Holbrookia* (now *Cophosaurus*) *texanus reticulatus* was described based on a specimen collected by Campbell in Pilares de Teras (Peters 1951).

Recent work in our study area described a diploid unisexual whiptail lizard, the Pre-Ópata Whiptail (*Aspidoscelis preopatae*). This new species was based on specimens collected along the Río Bavispe between Bavispe and Huachinera, and that is currently its full known distribution. *Aspidoscelis preopatae* is likely one of the ancestral species of the triploid Ópata Whiptail (*A. opatae*, Fig 7A), that is also found in the area (Barley et al. 2021, Van Devender et al. 2016).

Rattlesnakes in the middle to upper elevations of the Sierra El Tigre include the Black-tailed (*Crotalus molossus*), Twin-spotted (*C. pricei*), and Ridge-nosed (*C. willardi*). The subspecies *Crotalus willardi silus* was first collected in Sonora by Campbell "Above the Santa María Mines, El Tigre Mts" in July 1935, though the subspecies was described based on a 1948 specimen from the Río Gavilán in Chihuahua (Klauber 1949). Barker (1991) noted that specimens of *C. w. silus* from the El Tigre showed the greatest variation in facial pattern of mountain range samples he examined. Some had the typical *silus* pattern while others had a white line that passes from the corner of the mouth forward along the supralabials to the area beneath the eye, a pattern seen in some *C. w. obscurus*. Western Diamond-backed Rattlesnake (*Crotalus atrox*) and Tiger Rattlesnake (*C. tigris*) have been found at lower elevations around the mountains and in the adjacent valleys.

Amphibians along the Río Bavispe in our area include Mexican Madre Toad (*Anaxyrus mexicanus*), Woodhouse's Toad (*A. woodhousii,* Fig. 8A), Mazatlán Narrow-Mouthed Toad (*Gastrophryne mazatlanensis,* Fig. 8B), Canyon Treefrog (*Hyla arenicolor*), Sonoran Desert Toad (*Incilius alvarius*), Lowland Leopard Frog (*Rana yavapaiensis*), and Couch's Spadefoot (*Scaphiopus couchii*). Reptiles of the river include Sonora Mud Turtle (*Kinosternon sonoriense*), Black-necked Gartersnake (*Thamnophis cyrtopsis*), Mexican Gartersnake (*T. eques,* Fig. 5B), Checkered Gartersnake (*T. marcianus*) and Yaqui Slider (*Trachemys yaquia,*

The Regal Horned Lizard (*Phrynosoma solare*) occupies the adjacent valley floors and bajadas to the east, north, and west of the Sierra El Tigre, but it has not been found to the south in our study area. Instead, there is a single low-elevation record of the Rock Horned Lizard (*P. ditmarsi*) to the southeast, from the vicinity of Bacerac (Turner et al. 2017).

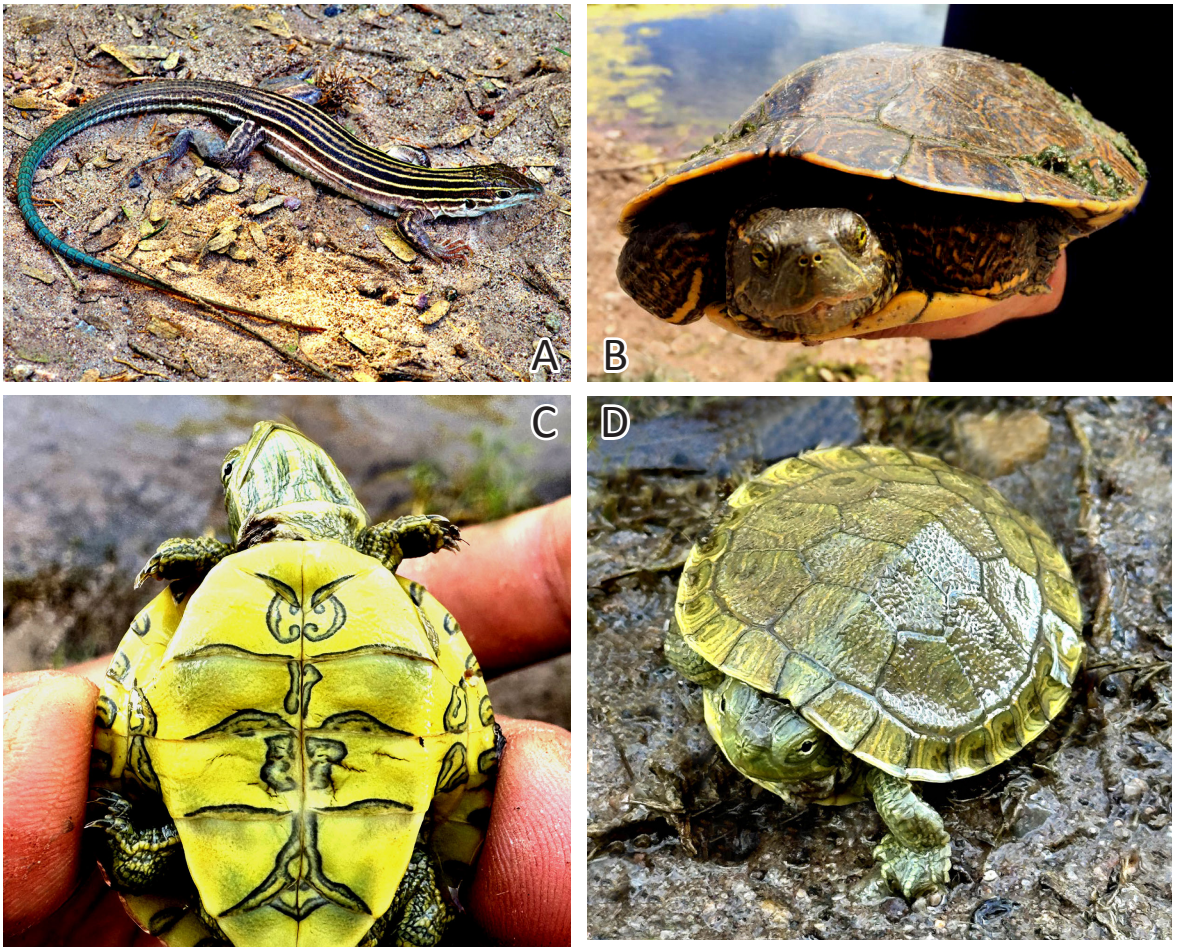

Fig. 7. Sonoran endemic reptiles in the greater Sierra el Tigre area. **A.** *Aspidoscelis opatae*. Photo by Erik K. Enderson. **B. C. D.** *Trachemys yaquia*. **B.** Adult from tributary of Río Bavispe near Colonia Morelos. Photo by Miguel Enríquez. **C. D.** Hatchling venter and dorsum from Río Sonora at Bacoachi. Photos by José Abel Salazar-Martinéz.

Figs. 7B, C, D). Unlike major river systems in Arizona that are dominated by non-native fishes (particularly centrarchids and ictalurids), crayfishes (particularly *Faxonius virilis*), American Bullfrogs (*Rana catesbeiana*), and in some cases non-native turtles, water snakes, and other frogs (Minckley and Marsh 2009, Holycross et al. 2022), the native assemblage of amphibians and reptiles in our study area is largely intact. No non-native amphibians, reptiles, or crayfishes have been reported from our study area.

At our Río Bavispe camp at Bavispe in September 2024, numerous *T. eques* were found, as well as several *R. yavapaiensis*. Both of those species have declined substantially in Arizona due to predation by non-native species as well as other factors (Sredl 2005, Jones et al. 2020). *Kinosternon sonoriense* and *Trachemys yaquia* were also found at our Río Bavispe camp. However, we also found non-native Largemouth Bass (*Micropterus salmoides*), Common Carp (*Cyprinus carpio*), Black Bullhead (*Ameiurus melas*), and presumed hybrid Yaqui/Channel Catfishes (*Ictalurus pricei* x *I. punctatus*), so invasion by non-natives is underway. *Rana catesbeiana* is present upstream (Río Cieneguita, about 38 km north of Colonia Morelos, MDE-56938) and downstream (mouth of the Río Yaqui and the Río Papigochi and other drainages in Chihuahua; Rorabaugh and Lemos-Espinal 2016, Rorabaugh et al. 2018, JCR pers. obs.). Crayfish have not been reported from the Río Yaqui drainage in Arizona (Inman et al. 1998) but *F. virilis* is present in the Río Papigochi in the Yaqui watershed in Chihuahua (JCR pers. obs.), so eventual invasion of our study area by both *Rana catesbeiana* and *F. virilis* is likely over time, with consequences similar to what has occurred in Arizona.

Our study area includes four of the six mainland reptile species endemic to Sonora, with *Aspidoscelis opatae* (Fig. 7A), *A. preopatae, Phrynosoma ditmarsi*, and *Trachemys yaquia* (Figs. 7B, C, D). The two not present here are Dickerson's Collared Lizard (*Crotaphytus dickersonae*) and Cole's Night Lizard (*Xantusia jaycolei*), known only from the Sonoran

Our study area includes four of the six mainland reptile species endemic to Sonora, with *Aspidoscelis opatae* (Fig. 7A), *A. preopatae, Phrynosoma ditmarsi*, and *Trachemys yaquia* (Figs. 7B, C, D).

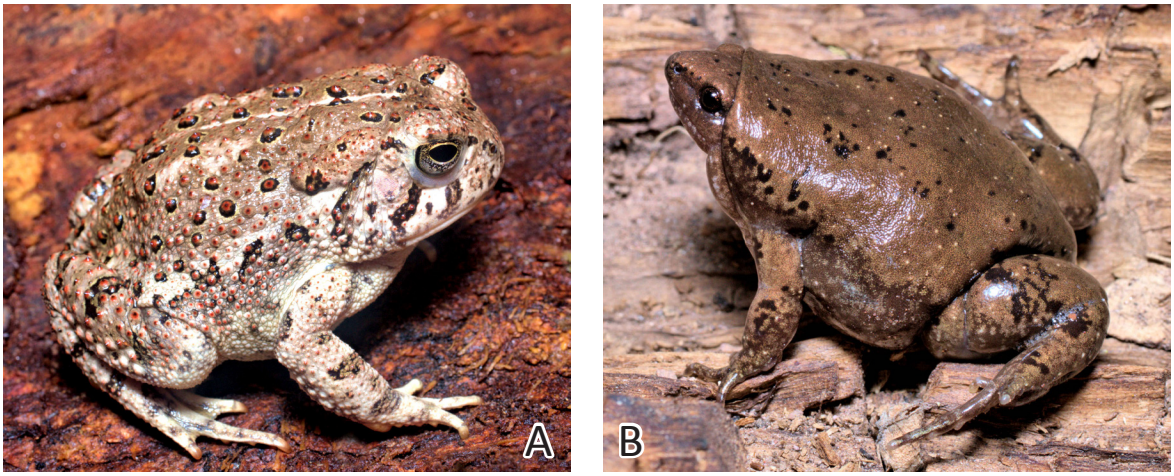

Fig. 8. Amphibians on the Río Bavispe near Bavispe. **A.** *Anaxyrus woodhousii*. **B.** *Gastrophryne mazatlanensis*. Photos by Rorabaugh.

Desert along the coast of the Gulf of California (Enderson et al. 2009). Other noteworthy reptiles in the study area are Lemos-Espinal's Spiny Lizard (*Sceloporus lemosespinali*; Fig. 9A, B) and Chihuahuan Black-headed Snake (*Tantilla wilcoxi*, Fig. 9C).

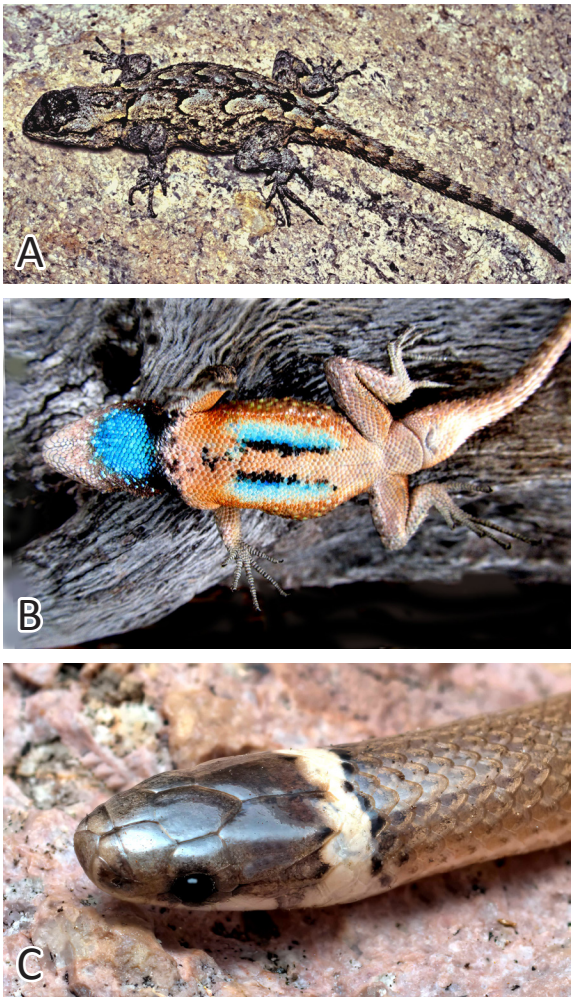

Fig. 9. Noteworthy Sierra El Tigre reptiles. **A. B.** *Sceloporus lemosespinali*. **C.** *Tantilla wilcoxi*. Photos by Rorabaugh and Turner.

The Sierra El Tigre/Río Bavispe area was identified by The Nature Conservancy as among the highest conservation priorities for the Sky Island region, based on species richness and rarity (Marshall et al. 2004). Despite much of the Sierra El Tigre being a part of the Bavispe APFF, our study area is at risk on multiple fronts. We discussed invasion by non-native predators on the Río Bavispe and potential consequences above. The montane woodland and forest species are especially at risk due to climate change, which in the Sky Island region is predicted to be characterized by higher temperatures, greater aridity, and a reduction in forested areas (Coe et al. 2012). Wildfire severity, size, and frequency have been increasing in forests of the southwestern United States, with changes to tree and shrub compositions (Fule and Falk 2023). Much of the land within the Sierra El Tigre portion of the Bavispe APFF is privately owned, so land protection depends on the cooperation of landowners. The proposed silver and gold open pit mine in the high country of Sierra El Tigre on properties owned by Silver Tiger Metals, Inc. is particularly concerning.

Undocumented, but Likely to Occur Species in the Study Area

The Sierra El Tigre area is at a crossroads of major biotic communities, with desert grasslands and Chihuahuan desertscrub to the north, foothills thornscrub entering from the south, the Sierra Madre Occidental close by to the southeast, as well as the riverine habitats of the Río Bavispe and montane woodlands of the Sierra El Tigre. None of these areas have been extensively explored, herpetologically, so the list of species that may occur in our study area but have not yet been documented is long. We will focus on a subset of those species most likely to be found there in the future.

The Mexican Spadefoot (*Spea multiplicata*) likely occurs in the desert grasslands and Chihuahuan desertscrub in the northern portion of our study area.

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Smith's Black-headed Snake (*Tantilla hobartsmithi*) has been collected just to the north of the study area boundary ("7.4 mi N Colonia Morelos", museum record UIMNH 28043) along the Río Batepito. Great Plains Toads (*Anaxyrus cognatus*) is in the Agua Prieta area and likely occurs southward along the Ríos Agua Prieta-Batepito.

A number of tropical and Sonoran Desert species are likely to extend into our study area from the south. Based on specimens or nearby observations, these include the Neotropical Vinesnake (*Oxybelis aeneus*, Río Bavispe at Presa Angostura - UAZ 25796), Lowland Burrowing Treefrog (*Smilisca fodiens*, Granados - ASUHEP000236), Sonoran Collared Lizard (*Crotaphytus nebrius*, "7.3 miles N Huásabas" - LACM 109951), Sonoran Spiny-tailed Iguana (*Ctensaura macrolopha*, Granados - MDE-28585), Western Banded Gecko (*Coleonyx variegatus*, "14.5 km (by air) SE of Nacozari de García" - iNaturalist), and Mexican West Coast Boa Constrictor (*Boa sigma*, "4.7 km (by air) NE of Huásabas" - MDE-28610). GBIF also lists *C. variegatus* specimens from "6 mi S of La Playa" that they plot near our study area, but we suspect "La Playa" is near Trincheras, about 100 km SW of Nogales.

Two specimens of Zebra-tailed Lizard (*Callisaurus draconoides,* CAS 15258 and 15259) plot within our study area according to GBIF, but the locality "4.7 mi SSE La Playa" is likely near Trincheras (see above). However, two other specimens of *C. draconoides* (CAS 15258 and 15259) are from "Óputo [now Villa Hidalgo] near Río de Bavispe", just south of our study area boundary. *Callisaurus draconoides* is expected to occur along the Río Bavispe in our study area.

Despite a lack of specimens or observations, the Banded Rock Rattlesnake (*Crotalus lepidus*) may have been overlooked in the Sierra El Tigre. There is one record of a *C. lepidus* from the "Sierra del Tigre" (NCSM Herps 71529) but additional information in the museum catalog says it was collected "5 miles W of Cananea" (= Sierra Elenita). GBIF plots another *C. lepidus* (MSB:Herp:32221) in our study area, but the locality that accompanies the specimen is "45 road miles southeast of Bacerac", which would put it outside of our study area, possibly in the Sierra El Gato, an outlier of the Sierra Madre Occidental. It is known to occur in the Sierras Pan Duro and San Luis to the northeast, Mesa Tres Río in the Sierra Madre Occidental to the east (Rorabaugh et al. 2019), and Sierra de la Madera.

The Sonoran Whipsnake (*Masticophis bilineatus*) has been collected on the Río Bavispe "0-1 mi S of Presa Angostura" (UAZ 25249) just west of our study area boundary and is expected to occur elsewhere along the Río Bavispe, as well as in mountainous regions in our study area.

In 1983, Hale and James Jarchow discussed reptiles with Pancho, a life-long (60+ years) resident of Rancho la Bota (= Rancho Ojo de Agua Caliente) along Arroyo la Bota (Lower A. la Carabina) in the western foothills of the Sierra El Tigre. Pancho indicated that a large dark-colored snake with a light belly was occasionally observed near the spring and robbed the chicken coop, until they stopped keeping chickens. Pancho said his father would not kill the snake, despite its being a chicken-thief, because he feared the spring would dry up. While the story of bad luck to kill the large snake associated with a spring most often refers to the *corúa* (*Boa sigma*, Van Devender et al. 2020), the large dark-colored snake with a light belly could have been the Central American Indigo Snake (*Drymarchon melanurus*). The nearest record of *D. melanurus* is along the Río Bavispe about 30 km south of our study area, 1.0 km (by air) NNE of Huásabas (UTADC 9879, Peralta-Franco et al. 2023). Although very large, it often lives along riverine habitats and can rapidly disappear in water or vegetation so could be overlooked, and we expect it to occur farther north in the Río Bavispe drainage.

There is a record of Great Plains Skink (*Plestiodon obsoletus*) from "0.4 mi NE (by road) El Coyote" (MVZ 136764). This is likely Rancho El Coyote, 18 km N of Bacadéhuachi, south of our study area. There is also a recent iNaturalist record, 11.8 km E of Nacozari de García. Pancho of Rancho la Bota reported that a large yellow skink occurred on his ranch. Thus, we conclude that *P. obsoletus* has been collected near our study area and may occur within it.

Comparison with the Sierra Madre Occidental and other Herpetofaunas

Sierra El Tigre is geographically located between but to the north of the Sierras La Madera (ca. 44 km SW) and Bacadéhuachi (ca. 34 km S, Fig. 3). The Tigre herpetofauna shows similar species richness and many species in common with those reported for Sierra La Madera (11 amphibians, with 83% of species shared, and 48 reptiles, with 75% of species shared). Species richness in Sierra El Tigre is higher than that reported for Sierra Bacadéhuachi (9 amphibians, with 50% of species shared, 21 reptiles, with 34% of species shared; Van Devender et al. 2013). Some differences reflect a shorter inventory effort in Sierra Bacadéhuachi.

The affinities of the Sierra El Tigre herpetofauna are strongly with the Sierra Madre Occidental with notable disjunct populations of *Incilius mccoyi* and *Phrynosoma orbiculare*. Comparison with the Mesa Tres Ríos and Municipality of Yécora (47 km SE and 175 km S of Huachinera, respectively) herpetofaunas illustrates the much greater species diversity in the Sierra Madre Occidental than any Sky Island. The El Tigre herpetofauna reported here is 56 species (12 amphibians, 44 reptiles). A MDE Expedition to Mesa Mesa Tres Ríos encountered 35 species (9 amphibians, 26 reptiles, Rorabaugh et al. 2019). A more extensive

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survey of the Municipality of Yécora reported 166 species (93 amphibians, 73 reptiles, Enderson et al. 2014). The Yécora area includes the full vegetation gradient from high elevation pine-oak forest, oak woodland, and montane grasslands with tropical deciduous forest and foothills thornscrub below.

Montane species not found in the Sierra El Tigre area include amphibians: the salamander *Isthmura sierraoccidentalis* and anurans *Craugastor tarahumaraensis*, *Eleutherodactylus interorbitalis*, and *Hyla wrightorum*, and reptiles: the turtle *Kinosternon integrum*, lizards *Aspidoscelis costatus, A. exsanguis*, *Plestiodon parviauriculatus*, *Sceloporus poinsettii*, and *S. slevini*, and snakes *Geophis dugesi*, *Gyalopion canum*, *Masticophis bilineatus*, *M. mentovarius*, *Pituophis deppei*, *Salvadora bairdii*, *S. grahamiae*, *Storeria storerioides*, *Thamnophis melanogaster*, *T. unilabialis*, *Trimorphodon lambda*, and *Tropidodipsas repleta* (Rorabaugh and Lemos-Espinal 2016, Rorabaugh et al. 2019).

Species not found in the Sierra El Tigre but that occur in the diverse tropical Yécora lowlands and foothills include amphibians: anurans *Anaxyrus mazatlanensis*, *Pachymedusa dacnicolor*, *Leptodactylus melanonotus*, and *Rana magnaocularis* and reptiles: turtles *Kinosternon arizonens*e and *Terrapene nelsoni*, lizards: *Anolis nebulosus*, *Aspidocelis tigris*, *Coleonyx fasciatus*, *Crotaphytus nebrius*, *Ctenosaura macrolopha*, *Heloderma horridum*, *Phyllodactylus homolepidurus*, *Sceloporus albiventris*, and S. *nelsoni*, and snakes: *Boa sigma*, *Chilomeniscus stramineus*, *Crotalus basiliscus*, *Drymarchon melanurus*, *Lampropeltis polyzona*, *Leptodeira splendida*, *Leptophis diplotropis*, *Micrurus distans*, *Oxybelis aeneus*, *Pseudoficimia frontalis*, *Sonora aemula*, *Sympholis lippiens*, and *Trimorphodon tau* (Enderson et al. 2014, Rorabaugh and Lemos-Espinal 2016).

Herpetofaunal species in the Sierra El Tigre area not found in the Sierra Madre Occidental herpetofaunas include the anuran: *Anaxyrus woodhousii*, turtle: *Terrapene ornata*, lizards: *Aspidoscelis opatae*, *A. praeopatae*, *A. uniparens*, *Cophosauus texanus*, *Crotapytus collaris*, and *Heloderma suspectum*, and snakes: *Crotalus tigris*, *Rena humilis*, and *Tantilla yaquia. Aspidoscelis opatae* and *A. praeopatae* are regional endemic species. Most of the others are widespread in the southwestern United States in a variety of vegetation communities. *Crotalus tigris* and *Heloderma suspectum* occur in these habitats in the borderlands but also north into Arizona, west into Sonoran desertscrub, and south into thornscrub.

Taxonomic Notes

We adopt the taxonomy used in the latest compilation of Sonora's herpetofauna (Lemos-Espinal et al. 2019) with the following exceptions. Lemos-Espinal et al. (2019) used *Dryophytes arenicolor* for *Hyla arenicolor* (our preference) based on Duellman et al. (2016). We follow Fouquette and Dubois (2014) and amphibiaweb.org (accessed March 2025) in treating *Dryophytes* as a subgenus of *Hyla*. Barley et al. (2021) described *Aspidoscelis preopatae*, which we include on our list. Walker and Cordes (2011) elevated *A. burti burti* and *A. b. stictogrammus* to full species based on differences in body size, scutellation, and color pattern. However, lizards with characters intermediate between *A. b. burti* and *A. b. stictogrammus* occur from the Hermosillo area to the Sierra Libre (Duellman and Zweifel 1962, Rorabaugh and Lemos-Espinal 2016). Barley et al. (2019) showed that *A. burti* appears to grade into *A. costatus*, and Barley et al. (2021) remarked that *A. burti* contains morphologically distinct populations that are highly similar genetically. Consistent with Nicholson (2025) and until further phylogenetic studies are conducted, we elect to use *A. burti*, which would include Walker and Cordes's *A. burti* and *A. stictogrammus.*

We also elect to use *Lampropeltis getula*, rather than *L. splendida*, *L californiae*, or *L. nigrita*, and *L. pyromelana* rather than *L. knoblochi* that were used by Lemos-Espinal et al. (2019). The reasons are similar and follow from Chambers and Hillis (2020), Hillis (2020), and Hillis et al. (2021), who argue that to properly evaluate if clades represent distinct species, the behavior of those clades in their contact zones needs to be evaluated to test for reproductive isolation, and if genes are exchanged, to what degree those clades are evolutionarily independent. The publications that split *L. getula* (Pyron and Burbrink 2009; Harrington and Burbrink 2022) and *L. pyrolemelana* (Burbrink et al. 2011) failed to adequately assess behavior of their putative species in contact zones. Note that the two *L. getula* we observed on the Río Bavispe at Bavispe included one that was mostly black ("*L. nigrita*") while the other, although quite dark, showed the underlying desert grassland pattern typical of "*L. splendida*", if the names used by Lemos-Espinal et al. (2019) are accepted. Black individuals occur in *L. g. splendida* and are expected in the gene pool of adjacent intergrading subspecies. All hatchling *splendida* have the typical pattern, but some turn black with age. Many *nigrita* hatchlings from the Alamos area are unpatterned black.

Axtell (2009a) and Rorabaugh and Lemos-Espinal (2016) showed *Holbrookia elegans* occurring throughout most of Sonora, with a second species (*H. maculata*, Axtell 2009b; *H. approximans*, Rorabaugh and Lemos-Espinal 2016) occurring in the Sierra San Luis. Using morphological characters and color patterns defined by Axtell (2009a, b), Bezy (2010) showed that in southern Arizona, *H. elegans* occurs from the Patagonia and perhaps Huachuca mountains west to the Tohono O'odham Nation but also occurs in the extreme southeastern corner of the state. *Holbrookia maculata* occurs in intervening areas, mostly in grasslands in Cochise County. We applied Bezy's character key to

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identify *Holbrookia* specimens from the Sierra El Tigre study area that are in the UAZ (38984-38990, 38992). Based primarily on tail length/snout-vent length (TL/SVL), number of chevrons on the tail, and width of the blue areola (males) surrounding the black bars on the venter, we concluded that all but UAZ 38984 are *H. elegans.* UAZ 38984 is a female, which have shorter tails (61 mm tail, 60 SVL); it had six chevrons on the anterior half of the tail but had enlarged circumorbital scales; characters that are ambiguous. Based primarily on TL/SVL and number and position of the chevrons on the tail, all MDE/MABA *Holbrookia* observations with photographs from the Sierra El Tigre area (n = 5) are *H. elegans.*

Mulcahy (2008) used mtDNA and tRNA data to define a well-supported Cochise Clade of *Hypsiglena* from southeastern Arizona that he said was a distinct species, but it has yet to be described. His map shows the species extending into northeastern Sonora, but no specimens were available to support that premise. We examined UAZ 38941, a "*Hypsiglena torquata*" from our study area. It has characters intermediate between *H. chlorophaea* and the Cochise Clade. Until the Cochise Clade is formally described and its distribution and characters are better defined, we refer to *Hypsiglena* from our study area as *chlorophaea.*

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