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First record of four bat species for the state of Morelos and new bat records for the Sierra de Huautla Biosphere Reserve, Mexico

Primer registro de cuatro especies de murciélagos para el estado de Morelos y nuevos registros para la Reserva de la Biosfera Sierra de Huautla, México

Carmen Lorena Orozco-Lugo[1]✉, David Valenzuela-Galván[1], Antonio Guillén-Servent[2], Amantina Lavalle-Sánchez[3] and Andrew John Rhodes-Espinoza[3]

[1]*Departamento de Ecología Evolutiva, Centro de Investigación en Biodiversidad y Conservación, Universidad Autónoma del Estado de Morelos. Av. Universidad Núm. 1001, Col. Chamilpa, 62209 Cuernavaca, Morelos, México.*
[2]*Red de Biología y Conservación de Vertebrados, Instituto de Ecología, A. C. Carretera antigua a Coatepec 351, El Haya, 91070 Xalapa, Veracruz, México.*
[3]*Comisión Nacional de Áreas Naturales Protegidas. Camino al Ajusco Núm. 200, Col. Jardines en la Montaña, Tlalpan, 14210 México D. F., México.*
✉ *zotz@uaem.mx*

Abstract. Four bat species are reported for the first time in Morelos: *Centurio senex*, *Lasiurus intermedius*, *Myotis fortidens* and *Nyctinomops macrotis*, which were captured at the Tropical Dry Forest (TDF) of the Sierra de Huautla Biosphere Reserve (SHBR). Furthermore, 9 additional bat species that were previously unconfirmed in the SHBR are recorded. External morphometric data of the captured individuals is provided, as well as details regarding the sampling dates and sites and, when possible, information about echolocation sequences. The list of bat species in the SHBR has increased to 41 species (71% of the bat fauna in Morelos), which highlights the value of this area for protecting the biodiversity of Morelos.

Key words: tropical dry forest conservation, Chiroptera, Balsas River Basin.

Resumen. Se registra por primera vez la presencia de 4 especies de murciélagos para el estado de Morelos *Centurio senex*, *Lasiurus intermedius*, *Myotis fortidens* y *Nyctinomops macrotis*, capturados en la selva baja caducifolia de la Reserva de la Biosfera Sierra de Huautla (REBIOSH). Adicionalmente, se han documentado para esta misma región 9 especies de murciélagos sin confirmación previa de su presencia. Se proporcionan medidas morfométricas externas de los ejemplares capturados, detalles sobre las fechas y sitios de captura y para algunas especies información sobre sus pulsos y secuencias de ecolocación. Con estos registros, la riqueza de murciélagos de la REBIOSH aumenta a 41 especies (71% de la quiropterofauna del estado de Morelos) lo que resalta el valor de esta área para la protección de la biodiversidad del estado.

Palabras clave: conservación selva baja caducifolia, Chiroptera, cuenca del río Balsas.

Introduction

The bat fauna for Morelos and for the Sierra de Huautla Biosphere Reserve (SHBR) has been extensively described, based on confirmed records, mostly on 3 previous publications (Álvarez-Castañeda and López-Formet, 1995; Sánchez-Hernández and Romero-Almaraz, 1995; Álvarez-Castañeda, 1996). However it is important to note that although these publications presented comprehensive information about bat richness in the state, it is clear that still there is a need for more studies as has been shown by recent records of some species for the state (e.g. Orozco-Lugo et al., 2008 that reported for the first time for Morelos the bat *Enchistenes hartii*).

Although Morelos it is one of the smallest states in México, it presents a steep altitudinal gradient and hence a great variety of climatological zones which in combination with the topographic features and the fragmentation of the native vegetation cause the state to present a high environmental heterogeneity and a great variety of micro habitats.

In particular, the tropical dry forest (TDF), that was the dominant vegetation type in the state, may have a high relevance for the bat fauna of Morelos. However TDF in Morelos has suffered an intense pressure and nearly 60% of the original vegetation has been lost, and only 19% remains and is restricted to areas with steep slopes (Trejo and Dirzo, 2000).

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The TDF is a vegetation type with high biodiversity and a high number of endemic species; however, these forests are also among the most threatened tropical environments, and they are insufficiently represented in natural protected areas in Mexico (Janzen, 1988; Ceballos and García, 1995; Ceballos and Valenzuela, 2012).

Forests are a key habitat for microchiropteran bats all over the world. The highest diversity of bats at a generic level is in the Neotropics and it is likely that TDF play an important role in maintaining this diversity. The intense deforestation pressure on these forests, is a major concern for bat conservation (Hutson et al., 2001; Mickleburgh et al., 2002). TDF in México have been considered of high relevance for the conservation of some bat groups, such as the Glossophagine bats (Arita and Santos-del Prado, 1999), but the bat fauna of these of forests has been understudied. It is an urgent task to obtain better knowledge of the bat fauna and the biodiversity in general of TDFs, considering that they present deforestation rates as high as 1.4% by year for some regions in the country (Trejo and Dirzo, 2000).

Materials and methods

The Sierra de Huautla Biosphere Reserve (SHBR; recognized by the MAB-UNESCO program and included in the world net of biosphere reserves) in Morelos is the largest natural protected area (ca. 60 000 ha) devoted to the conservation of TDF in Central Mexico. Its mammalian fauna has been intensively studied since 2001, and it has been found that the bat fauna is highly diverse.

A monitoring protocol for bat species at the SHBR, including mist nets and ultrasound detectors, started in 2001 when the project entitled "Mastofauna de la Reserva de la Biosfera Sierra de Huautla, Morelos: Diversidad, Patrones Espacio-Temporales y Conservación" (Project J3490-V Conacyt, under the supervision of the second author) began. Since 2004, the bat fauna has been monitored twice a year (1 sampling event at the end of the dry season and another in the middle of the rainy season) at 4 sampling sites in the central region of the SHBR (Table 1). The dominant vegetation in this area is TDF with common tree or shrub species including: guayacán (*Conzattia multiflora*), tepehuaje (*Lysiloma divaricata*), cuachalalate (*Amphipterygium adstringens*), rosal (*Pseudobombax ellipticum*), pochote (*Ceiba parvifolia*), venenillo (*Sapium macrocarpum*), cacahuananche (*Licania arborea*), cuayotomate (*Vitex mollis*), amate blanco (*Ficus insipida*), texcalamate (*Ficus cotinifolia*), copal (*Bursera aloexylon* y *B. grandifolia)*, cardón (*Pachycereus grandis)*, bonete (*Jacaratia mexicana*), chiclillo (*Stemmadenia bella*), San Pablito (*Hamelia patens*), mata rata (*Gliricidia sepium*), cubata (*Acacia cochliacantha*) and guachocote (*Malpighia mexicana*).

Additionally, in 2004, 4 sites in the northeastern region and 4 sites in the southwestern region of the SHBR (mostly dominated by dry oak forest; Table 1) were also sampled, as part of another project entitled "Mamíferos y hormigas cómo bioindicadores en la Reserva de la Biosfera Sierra de Huautla" (part of the research project Semarnat-2002-C01-0790). In 2004, each site was sampled twice during each climatic season.

A total sampling effort of 184 hrs of ultrasound recording time and more than 24 561 m/hr on 92 sampling nights, has been accumulated so far, on which more than 1 631 individuals of 33 different bat species have been captured and the ultrasound sequences of 11 aerial insectivorous bat species has been recorded and identified (Orozco-Lugo et al., 2007; Orozco-Lugo et al., 2013). Specific identification of the captured bat species was aided by the use of field guides (Medellín et al., 1997, 2008; Reid, 1997, 2009) and also by the collection of specimens along with the use of a key for the identification of species via the morphological features of their skulls (Álvarez et al., 1994).

All specimens were collected under permits extended by Semarnat to the second author (FAUT-0251) and a special license to collect-SGPA/DVGS/02131, SGPA/DGVS/002296/11 and SGPA/DGVS/02581/12-linked to the research projects "Mastofauna de la Reserva de la Biosfera Sierra de Huautla, Morelos: diversidad, patrones espacio-temporales y conservación" and "Mamíferos y hormigas cómo bioindicadores en la Reserva de la Biosfera Sierra de Huautla", or licenses extended to the third author (FAUT-0145) or to C. Martínez (SGPA/DGVS/07803, linked to her research project "Restauración de la diversidad biológica en áreas degradadas de la Reserva de la Biosfera Sierra de Huautla"). All collected specimens were deposited in the mammals collection (MOR-MAM-177-075; CMC) at the Centro de Investigación en Biodiversidad y Conservación, Universidad Autónoma del Estado de Morelos or at the Colección de Vertebrados del Instituto de Ecología A. C., Xalapa, Veracruz, México (IEX).

Results

Here, 4 bat species are reported for the first time in Morelos: *Centurio senex*, *Lasiurus intermedius*, *Myotis fortidens* and *Nyctinomops macrotis*. These species were captured at the TDF of the SHBR, additionally 9 bat species, previously reported in Morelos but not previously confirmed within the SHBR, were also recorded: *Eumops underwoodi*, *Lasiurus cinereus*, *Macrotus waterhousii*, *Molossus sinaloae*, *Myotis yumanensis*, *Natalus mexicanus*, *Parastrellus hesperus*, *Pteronotus personatus*

Table 1. Information regarding the sampling sites at Sierra de Huautla Biosphere Reserve (SHBR). CTDF= conserved tropical dry forest; PTDF= perturbed tropical dry forest; AL= agricultural land; SV= secondary vegetatioN, CDOF= conserved dry oak forest

Region of the SHBR	*Sampling site code*	*Altitude range (m asl)*	*Dominant vegetation type*	*Average temperature (°C)*	*Geographic coordinates of site*
Central portion	QNP	958-1098	CTDF	24.3	18°31'0.43" N, 99° 1'11.25" W
	QP		PTDF/AL		18°30'44.28" N, 99° 0'52.86" W
	XNP		CTDF		18°26'42.04" N, 98°59'26.69" W
	XP		PTDF		18°26'10.28" N, 99° 0'5.59" W
North eastern portion	LP1	1249-1252	PTDF	22.5	18°30'51.41" N, 98°56'39.90" W
	LP2		PTDF/SV		18°32'10.43" N, 98°55'48.77" W
	LNP1		CTDF		18°30'3.36" N, 98°57'22.68" W
	LNP2		CTDF		18°31'35.54" N, 98°57'2.63" W
South eastern portion	CF14	1400-2000	CDOF	21.2	18°28'16.51" N, 99°16'41.46" W
	CF16		CDOF		18°28'1.51" N, 99°16'41.30" W
	CF18		CDOF		18°27'42.23" N, 99°16'32.71" W
	CF20		CDOF		18°27'50.47" N, 99°17'31.98" W

and *Tadarida brasiliensis*.

Some of these unpublished records were obtained during fieldwork that was part of the undergraduate and Masters thesis of the fourth and first authors of this report (Rhodes-Espínoza, 2005; Orozco-Lugo, 2007). We present here for the first time these unpublished records with related detailed information.

New records for Morelos

Wrinkle-faced bat (*Centurio senex*; Family Phyllostomidae).

On September 25, 2011, 8 mist nets (75/2 polyester, 2.6 m height, 12 m in length, spaced at 10-20 m) were set along a creek 1.5 km northwest of the town of Quilamula (Tlaquiltenango municipality) at 18°31'01" N, 99°01'11" W (1 103 m asl). At 22:09 hr, a juvenile female wrinkle-faced bat (*C. senex*) (forearm length= 40.45 mm; ear length= 14.2 mm; body mass= 10.1 g) was captured. Hair and tissue samples were collected from this individual via a small puncture (1 mm in diameter) of the wing membrane, and these samples were stored in an Eppendorf tube with 96% ethanol. The individual was collected, and its skin and skull were prepared prior to deposition at the CMC (catalog number CMC-2846).

Northern yellow bat (*Lasiurus intermedius*; Family Vespertilionidae).

Two individuals of this bat species were captured at 2 different sampling sites. On October 8, 2005, 1 adult male (forearm length= 54.4 mm; ear length= 15.3 mm; body mass= 23 g) was captured at 21:05 hr in a well-preserved TDF site (18°26'44" N, 98°59'19" W; 1 030 m asl) located 4.5 km at 106° from the town of Xantiopan (Tlaquiltenango). The animal was collected, stored in 70% ethanol and deposited in the CMC (catalog number CMC-2196).

On the night of May 20, 2006, at 00:20 hr, an adult female (forearm length= 59 mm; ear length= 14 mm; body mass= 26 g) was captured but not collected in a stream in a perturbed TDF 0.5 km at 43° from the town of Quilamula (Tlaquiltenango).

Cinnamon myotis (*Myotis fortidens*; Family Vespertilionidae).

On the nights of March 21 and 23, of 2001, 2 adult female individuals of *M. fortidens* were captured at Río Cuautla near the town of La Mezquitera in the municipality of Tlaquiltenango (18°33'39.12" N, 99°6'3.34" W). Both were collected, stored in 70° ethanol and deposited at the IEX (catalog numbers IEX-M0040 and IEX-M0041). The forearm lengths were 34.6 and 37.2 mm and weights were 5.3 and 5.25 g, respectively, for each individual.

Subsequently, more individuals were captured. One adult female individual of this species at the LP1 site on April 22, 2004, 2 adult female individuals at the QP site on May 22, 2004, and 1 adult female individual at the XNP site on May 21, 2005 (see Table 1 for data regarding the sites). None of these individuals were collected. According to ultrasound detection data, this species is fairly common in the area.

Big free-tailed bat (*Nyctinomops macrotis*; Family Molossidae).

One adult male individual (non-scrotal testes; forearm= 61.9 mm, body mass 22.0 g) was collected on March 23, 2001, at a site on the Río Cuautla near the town of La Mezquitera in the municipality of Tlaquiltenango (18°33'39.12" N, 99° 6'3.34" W) and deposited at IEX (catalog number IEX-M0032).

On January 18, 2013, an adult non-reproductive male individual (forearm= 61.4 mm, ear length= 22 mm and body mass= 25 g) of this bat species was captured at a site (18°27'37.43" N, 99°1'56.26" W; 1 006 m asl) at a creek near the dam of Cruz Pintada, which is 2.4 km at 335° from Huautla (Tlaquiltenango). The individual was collected, stored in 70% ethanol and deposited at the CMC (catalog number CMC-2847).

New records for SHBR

Since 2001, the bat monitoring protocol implemented has allowed 9 new records of bat species that were previously reported in Morelos but not at the SHBR, including 2 families (Molossidae and Natalidae) with no previous confirmed records at the SHBR.

Underwood's bonneted bat (*Eumops underwoodi;* Family Molossidae).

This species was recorded ultrasonically on every sampling date (14) and at all sampling sites (12). It was identified based on its characteristic echolocation calls (narrowband pulses of constant frequency lasting approximately 20 ms with an average maximum energy frequency of 16 kHz; Orozco-Lugo et al., 2013). Tapes and digital recordings of its echolocation calls are maintained as evidence.

One adult reproductive male was collected on the night of August 17, 2002 (forearm length= 71.9 mm; body mass= 54.4 g) and was deposited at the IEX (catalog number IEX-M0020). On the same night, another reproductive male was captured, measured (forearm length= 63.5 mm; body mass= 55.0 g) and released.

Hoary bat *(Lasiurus cinereus*; Family Vespertilionidae).

This species was captured only on 3 sampling dates (the dry seasons of 2004 and 2005 and the wet season of 2007) and at 2 sampling sites (QP and QNP). The 3 captured individuals were adult males that were non-reproductive (1 adult non-reproductive male was collected on May 12 of 2005, stored in 70% ethanol and deposited in the mammal collection of CIByC-UAEM (catalog number CMC-2195; forearm length= 52.5 mm; ear length= 17 mm; body mass= 20 g).

Waterhouse's leaf-nosed bat (*Macrotus waterhousii*; Family Phyllostomidae).

This bat species was captured on every sampling date and at 4 sampling sites in the central portion of the SHBR (XNP, XP, QP and QNP; Tables 2 and 3). The average morphometric data of captured individuals is presented in Table 4. This species is very abundant at SHBR and high numbers can be found roosting in caves and abandoned mines. However, most of present capture records were obtained during the dry season when 66% of the captured adult individuals were reproductive. One non-reproductive adult female that was captured during night of April 21, 2004, was collected (forearm length= 51.1 mm; ear length= 26.1 mm; body mass= 14 g). The specimen was stored in 70% ethanol and deposited at the CMC (catalog number CMC-2017)**.**

Sinaloan mastiff bat (*Molossus sinaloae*; Family Molossidae).

This bat species was recorded on 3 sampling dates (during the dry and wet seasons of 2004) at only 8 sampling sites within the 3 sampled regions of the SHBR (Tables 2 and 3; see Table 4 for the average morphometric data of captured individuals). Five of the 9 captured individuals were reproductive.

One adult reproductive male (forearm length= 50.4 mm; ear length= 14 mm; body mass= 39 g) captured on the night of May 22, 2005 was collected, stored in 70° ethanol and deposited in the mammals collection of CMC (catalog number CMC- 2018).

Yuma myotis (*Myotis yumanensis*; Family Vespertilionidae).

This species was captured on October 7, 2001 at the same site where an individual of *N. macrotis* was captured as described earlier (18°27'37.43" N, 99° 1'6.26" W; 1 006 m asl), at a creek near the damn of Cruz Pintada, 2.4

Table 2. Presence (1) or absence (0) of reported bat species at each sampling event. D= dry seasoN, R= rainy season. Numbers indicate the year. 1*= the record of the species is based on ultrasound detection. Tot= the total number of sampling events at which each species was recorded

	D2004	*D2004*	*R2004*	*R2004*	*D2005*	*R2005*	*D2006*	*R2006*	*D2007*	*R2007*	*D2008*	*R2008*	*D2010*	*R2010*	
Species	*S1*	*S2*	*S3*	*S4*	*S5*	*S6*	*S7*	*S8*	*S9*	*S10*	*S11*	*S12*	*S13*	*S14*	*Tot*
Eumops underwoodi	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	14
Lasiurus cinereus	0	1	0	0	1	0	0	0	0	1	0	0	0	0	3
Macrotus waterhousii	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14
Molossus sinaloae	1*	1	1	1	0	0	0	0	0	0	0	0	0	0	4
Myotis yumanensis	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Natalus mexicanus	0	1	0	0	0	0	1	1	0	0	0	0	0	0	3
Parastrellus hesperus	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Pteronotus personatus	1*	1*	1	0	0	0	0	0	0	0	0	0	0	0	3
Tadarida brasiliensis	1*	1*	1	1	0	0	1	0	0	0	0	1	0	0	6

Table 3. Presence (1) or absence (0) of reported bat species at each sampling site. The sites are those reported in Table 1. 1*= the record of the species is based on ultrasound detection. Tot= the total number of sampling sites where each species was recorded

Species	*CF14*	*CF16*	*CF18*	*CF20*	*LP1*	*LP2*	*LNP1*	*LNP2*	*QNP*	*QP*	*XNP*	*XP*	*Tot*
Eumops underwoodi	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	14
Lasiurus cinereus	0	0	0	0	0	0	0	0	1	1	1	0	3
Macrotus waterhousii	0	0	0	0	0	0	0	0	1	1	1	1	4
Molossus sinaloae	1*	1*	1*	1*	1*	1*	0	1*	0	1	0	0	8
Myotis yumanensis	0	0	0	0	0	0	0	0	1	0	0	0	1
Natalus mexicanus	0	0	0	0	0	0	0	0	0	0	1	1	2
Parastrellus hesperus	0	0	0	0	0	0	0	0	0	0	1	0	1
Pteronotus personatus	0	0	0	0	1*	1*	0	0	0	1	0	0	3
Tadarida brasiliensis	1*	1*	1*	1*	1*	1*	0	1*	0	1	0	0	8

Table 4. Morphometric data of captured individuals of the reported species. M= male; F= female; n= sample size; $\overline{\chi}$ FAL (± SD)= average forearm length in mm (± standard deviation); $\overline{\chi}$ EL (± SD)= average ear length in mm (± standard deviation); $\overline{\chi}$ W (± SD)= average body mass in g (± standard deviation)

Species	*Sex*	*N*	$\overline{\chi}$ *FAL (± SD)*	$\overline{\chi}$ *EL (± SD)*	$\overline{\chi}$ *W (± SD)*
Lasiurus cinereus	M	3	52.3 (0.3)	15.8 (1.6)	18.1 (1.7)
Macrotus waterhousii	F	55	51.7 (2.4)	24.5 (2.8)	15.2 (1.9)
Macrotus waterhousii	M	76	51.6 (2.4)	24.3 (2.8)	15.2 (1.9)
Molossus sinaloae	F	5	50.3 (1.4)	11.4 (1.7)	29.6 (5.3)
Molossus sinaloae	M	4	50.3 (0.2)	9.3 (1.3)	32 (5.0)
Myotis yumanensis	M	4	34.5 (0.9)	11.7 (1.2)	4.7 (0.5)
Natalus mexicanus	F	2	38.0 (0)	14.5 (2.1)	5.7 (0.4)
Natalus mexicanus	M	1	36.6	17.0	7.0
Parastrellus hesperus	F	1	31.2	15.7	5.0
Pteronotus personatus	F	2	42.0 (0.7)	17.8 (0.3)	7.1 (0.5)
Tadarida brasiliensis	F	30	43.0 (1.0)	15.4 (1.3)	11.9 (1.2)
Tadarida brasiliensis	M	2	43.0 (1.1)	15.4 (1.1)	12.0 (1.2)

km at 335° from Huautla (Tlaquiltenango). The captured individual was a non-reproductive adult male that was deposited at the IEX (catalog number IEX-M0043; forearm length= 32.3; body mass= 3.4 g). The species was recorded again during the rainy season sampling in September, 2010, when 3 adult reproductive male individuals were captured at 1 site in the central region of the SHBR (QNP; see Table 1). The captured individuals were not collected.

Mexican funnel-eared bat (*Natalus mexicanus*; Family Natalidae).

This species is fairly common in some caves and abandoned mines in the SHBR. Only 3 individuals (2 adult males and 1 adult female, all of which were non-reproductive) were captured on 1 sampling date during the dry season of 2004 and on 2 sampling dates in 2006 at 2 sampling sites in the central region of the SHBR (XP and XNP).

One of the individuals captured on May 21, 2006, which was an adult non-reproductive male (forearm length= 36.6; ear length= 17; body mass= 7 g), was collected, stored in 70% ethanol and deposited at the CMC (catalog number CMC-2845).

Western pipistrelle (*Parastrellus hesperus*; Family Vespertilionidae).

This bat species was captured 3 times in the SHBR. The first capture occurred on June 23, 2001 on the dirt road to Axuchitlan in the municipality of Tlaquiltenango (18°27'41.5" N, 99°0'0.0" W). The specimen was an adult female that was collected and deposited at the IEX (catalog number IEX-M0028).

Subsequently, on February 22, 2006, an adult male individual of this species was captured at the site near the damn of Cruz Pintada described previously, which is also where *N. macrotis* was captured (18°27'37.43" N, 99°1'56.26" W; 1 006 m asl). The specimen was collected and deposited in the same collection (catalog number IEX-M0029).

Finally, on May 20, 2010, 1 adult female was captured at 1 sampling site in the central region of the SHBR (XNP). This specimen was not collected.

Wagner's mustached bat (*Pteronotus personatus*; Family Mormoopidae).

Two lactating adult females of this species were captured during the wet season (July) sampling of 2004 at 1 sampling site in the central region of the SHBR (QP). Its ultrasound calls were recorded on 2 additional sampling dates, both of which were during the dry season (March and May) of 2004, at 2 sites in the northeastern region of the SHBR (LP1 and LP2). The species broadcasts a very characteristic echolocation call that can be readily identified from the sonogram ("Z"-shaped sonogram with frequencies of approximately 81 (FC) and 65 (FQC) kHz, connected by an intermediate FM sweep; Miller, 2003; Orozco-Lugo et al., 2013).

One non-reproductive adult female (forearm length= 41.5 mm; ear length= 18.0 mm; body mass= 6.75 g) captured in July, 2004 at the QP site was collected and deposited at the CMC (catalog number CMC-2019).

Brazilian free-tailed bat (*Tadarida brasiliensis;* Family Molossidae).

Thirty-three adult individuals of this bat species were captured on 4 sampling dates (wet season of 2004, dry season of 2006 and wet season of 2008) at 1 sampling site in the central region of the SHBR (QP). This species was also detected through its ultrasound calls on 2 additional sampling dates in 2004 and at 7 other sites: 4 in the southwestern region of the SHBR (CF14, CF16, CF18 and CF20) and 3 in the northeastern region of the SHBR (LP2 and LNP2). Of the individuals captured during the 2004 wet season sampling, 28 were lactating females.

At SHBR, ultrasound calls of this species have a narrow-band frequency modulation with a starting frequency of 38 kHz, a maximum energy frequency near 28 kHz, and a final frequency near 24 kHz (Orozco-Lugo et al., 2013).

One non-reproductive adult male individual (forearm length= 41.7 mm; ear length= 12.6 mm; body mass= 9.5 g) captured on September 10, 2004 at the QP site was collected and deposited at the CMC (catalog number CMC-2020).

Discussion

The present record of *Centurio senex* is the first for Morelos. The nearest localities where this species has been previously reported are Puebla at Molcaxac (18°44'11" N, 97°54'55" W; 2 750 m asl) and at Zapotitlan de las Salinas (18°20'16" N, 97°28'43" W; 1 500 m asl), which are located 118 km at 78° and 150 km at 102°, respectively, from the present capture site (Vargas-Miranda et al., 2008). *C. senex* also has been reported in Guerrero at Puerto del Gallo (17°29'04" N, 100°11'04" W; 2 450 m asl) and Nueva Delhi (17°25'12" N, 100°12'13" W; 1 350 m asl) at distances of 174 km at 225° and 176 km at 224°, respectively, from present capture site (León-Paniagua and Ávila, 2012).

Also *L. intermedius* it is recorded for the first time in Morelos and at the SHBR. The nearest localities at which this species was previously reported are in the State of México State near Ocuilan (18°58'11.0" N, 99°20'21.0" W; 2 200 m asl; León-Paniagua and Ávila, 2012), which is approximately 68 km at 328° and 58 km at 320° from capture sites reported here. Additionally, this species has been found in Puebla at Zapotitlan de las Salinas (18°20'16" N, 97°28'43" W; 1 500 m asl), approximately 150 km at 96°-102° from capture sites reported here (Vargas-Miranda et al., 2008) and 0.6 km west of Omiltemi, Chilpancingo de los Bravo (17°33'58.0" N, 99°42'42.0" W; 1 690 m asl; León-Paniagua and Ávila, 2012) at a distance of 108-118 km at 208°-206° from the present localities.

The captures of *M. fortidens* confirm its presence for the first time in Morelos and at the Sierra de Huautla Biosphere Reserve. The nearest locality at which this species was previously collected is Guerrero near Apaxtla de Castrejon at 17°59'00" N, 100°01'00" W (López-Vilchis, 1998), which is at a distance of nearly 106 km at 239° from our site.

For the species *N. macrotis*, unreported previously for Morelos and for the Sierra de Huautla Biosphere Reserve, the nearest localities at which this species was previously recorded were in Guerrero at an area 1.5 km north of Tlaxmalac (18°22'39" N, 99°24'13" W; 960 m asl; Almazan-Catalán et al., 2005) at distances of 39 and 42 km at 236° and 260°, respectively, from present capture sites.

E. underwoodi has been previously reported in Morelos at only 2 locations in the northern region of the state: one near Cuernavaca City and the other near Xochitepec at the Palo Bolero bathing resort (Álvarez-Castañeda, 1996). These locations are 30-45 km to the north and northeast of sampling sites reported here. This bat species is rarely captured in mist nets; however, ultrasound recording data shows that it is abundant and widely distributed in the SHBR and most likely all over the state. *E. underwoodi* is one of the few aerial insectivorous bats that produce echolocation calls within the human auditory range.

L. cinereus is a bat species that is far more common at temperate locations. It has been previously reported in Morelos (Álvarez-Castañeda, 1996) based on one report of an individual collected 1 km south of Oaxtepec (Ramírez-Pulido, 1969) nearly 40 km to the north of present sampling sites. Santillan-Alarcón et al. (2010) also reported that the species was present in a temperate forest in the Chichinautzin Biological Corridor, which is in the northern region of the state.

M. waterhousii has been previously reported in Morelos and considered very abundant and widely distributed throughout the state (Álvarez-Castañeda, 1996). Santillan-Alarcón et al. (2010) included this bat as part of the bat fauna in the Chichinautzin Biological Corridor (north of Morelos). The nearest locations at which it was previously collected are Cueva del Cerro and Cueva del Idolo, both of which are near Tequesquitengo, which are 10-30 km away from the different sampling sites within the SHBR. Sánchez-Hernández and Romero-Almaraz (1995) did not record this species at Sierra de Huautla; however, they inferred that it was very likely to be present.

M. sinaloae has been previously reported in Morelos (Álvarez-Castañeda, 1996), and it is thought to occur mostly in the tropical region of the state. Its capture is not common, but its ultrasound calls can be easily recorded and identified (constant frequency pulses lasting between 6 and 12 ms and an alternating pulse frequency

in which one pulse has a final frequency of ~30 kHz and the following pulse has final frequency of ~40 kHz with characteristically bent, staple-shaped sonograms; Miller, 2003; Orozco-Lugo et al., 2013). Thus, it is likely to be more common and widely distributed than suspected based on mist net samplings. The nearest locations where it has been collected are near Oaxtepec and Yautepec, which are both 40-50 km to the north of present sampling sites.

M. yumanensis was previously reported in Morelos (Álvarez, 1996) and was collected near Oaxtepec and Yautepec, 40-50 km north of present sampling sites. And Álvarez-Castañeda (1996) reported *N. mexicanus* in Morelos and indicated that this species has previously been recorded only at sites at low or medium altitudes, and large numbers are frequently found in caves. Sánchez-Hernández and Romero-Almazán (1995) did not record this species in the SHBR but stated that it could be present at this reserve. The nearest locations at which *N. mexicanus* was previously recorded are sites near Chinameca that are 10-15 km north of present sampling sites.

P. hesperus was previously, reported in Morelos (Ramírez-Pulido, 1969; Álvarez-Castañeda, 1996) based on only 1 individual captured 1 km south of Oaxtepec (nearly 50 km north of present sampling sites). *P. hesperus* is one of the smallest bat species in Mexico, and its distribution is commonly associated with semiarid and arid lands, where it is abundant (Léon-Paniagua, 2005). Its capture in mist nets is quite infrequent. Thus, it is possible that it is more common in Morelos than previously thought (Álvarez-Castañeda, 1996).

Sánchez-Hernández and Romero-Almazán (1995) did not record *P. personatus* at the SHBR but stated that it could be present at this reserve, and was previously reported for Morelos (Álvarez-Castañeda, 1996) based on several collected individuals, all of which were obtained at sampling sites near Tequesquitengo and Alpuyeca, which are 20-30 km to the northwest of present sampling sites. The first site is nearly 10 km away from the SHBR. The detection of this species by ultrasound is far more common that its capture in mist nets, so it is likely to be more widely distributed. However, it is much less common than its sympatric congeneric species *P. davyi* and *P. parnelli* (Orozco-Lugo 2007).

Ramírez-Pulido (1969a) reported *T. brasiliensis* in Lagunas de Zempoala and Álvarez-Castañeda and López-Forment (1995) reported this species at a site near PalpaN, both sites are in the northern region of the state. Later, Álvarez-Castañeda (1996) reported the species in Morelos based on the revision of 48 individuals collected all over the state; however, the locations nearest to the SHBR are near Yautepec (38-48 km to the north of present sampling sites) and Jonacatepec (22-33 km away from present sampling sites).

With all reported records here the list of bat species in the SHBR has increased to 41 species, a number that represents 71% of the known bat fauna in Morelos (considering that the bat species for the state increases to 54), which highlights the value of this area for protecting the biodiversity of Morelos and confirms that bat diversity at the TDF of the Balsas River Basin is high. It is critical to increase the protection of TDF in this region (Ceballos et al. 2010; Valenzuela et al. 2010).

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Literature cited

Almazán-Catalán, J. A., C. Sánchez-Hernández and M. L. Romero-Almaraz. 2005. Registros sobresalientes de mamíferos del estado de Guerrero, México. Acta Zoológica Mexicana (n.s.). 21 (3):155-157.

Álvarez-Castañeda, S. T. 1996. Los mamíferos de Morelos. Centro de Investigaciones Biológicas del Noroeste, S. C. 210 p.

Álvarez-Castañeda, S. T. and W. López-Forment. 1995. Datos sobre los mamíferos del área aledaña a Palpan, Morelos, México. Anales del Instituto de Biología, Universidad Nacional Autónoma de México, Serie Zoología 66:123-133.

Álvarez, T., S. T. Álvarez-Castañeda and J. C. López Vidal. 1994. Claves para los murciélagos de México. Publicación Especial, Centro de Investigaciones Biológicas de Baja California Sur y Escuela Nacional de Ciencias Biológicas, IPN, 65 p.

Arita, H. and K. Santos-del Prado. 1999. Conservation biology of nectar feeding bats. Journal of Mammalogy 80:31-41.

Ceballos, G. and A. García. 1995. Conserving neotropical diversity: the role of dry forests in Western Mexico. Conservation Biology 9:1349-1356.

Ceballos, G. and D. Valenzuela. 2010. Diversidad, ecología y conservación de los vertebrados de Latinoamérica.

In Diversidad, amenazas y regiones prioritarias para la conservación de las selvas secas del Pacífico de México, G. Ceballos, Lourdes Martínez, A. García, E. Espinoza, J. Bezaury and R. Dirzo (eds.). FCE, Conabio, Conanp, Alianza WWF-Telcel, Ecociencia, S. C. and Telmex. México, D. F. p. 93-118.

Ceballos, G., L. Martínez, A. García, E. Espinoza and J. Bezaury. 2010. Áreas prioritarias para la conservación de las selvas secas del Pacífico mexicano. *In* Diversidad, amenazas y regiones prioritarias para la conservación de las selvas secas del Pacífico de México, G. Ceballos, L. Martínez, A. García, E. Espinoza, J. Bezaury and R. Dirzo (eds.). FCE, Conabio, Conanp, Alianza WWF-Telcel, Ecociencia, S. C. y Telmex. México, D. F. p. 387-392.

Conanp (Comisión Nacional de Áreas Naturales Protegidas) 2005. Plan de manejo y conservación de la Reserva de la Biosfera Sierra de Huautla. Comisión Nacional de Áreas Naturales Protegidas de la Semarnat. México, D. F. 203 p.

Hutson, A. M., S. P. Mickleburgh and P. A. Racey (comp.). 2001. Microchiropteran bats: global status survey and conservation action plan. IUCN/SSC Chiroptera Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. 258 p.

Janzen, D. 1988. Tropical dry forest. The most endangered major tropical ecosystems. *In* Biodiversity, E. O. Wilson (ed.). National Academy Press, Washington, D. C. 130-137 p.

León-Paniagua, L. and V. Z. A. Ávila. 2012. Actualización de la base de datos de la Colección de mamíferos del Museo de Zoología "Alfonso L. Herrera". Universidad Nacional Autónoma de México. Facultad de Ciencias. Bases de datos SNIB2013-Conabio. Proyectos No. EC010, M099_ Mamíferos, J123_Mamíferos, H160, B002_Mamíferos. México D. F.

León-Paniagua, L. 2005. *Parastrellus hesperus* (H. Allen, 1864). 2005. *In* Los mamíferos silvestres de México, G. Ceballos and G. Oliva. (Coords.). Fondo de Cultura Económica / Conabio. p. 301-303.

López-Wilchis, R. 1998. Base de datos de mamíferos de México depositados en colecciones de Estados Unidos y Canadá. Universidad Autónoma Metropolitana-Iztapalapa. Informe final SNIB-Conabio. Proyecto No. P130. México, D. F.

Medellín, R., H. T. Arita and O. Sánchez. 1997. Identificación de los murciélagos de México. Clave de campo. Asociación Mexicana de Mastozoología, A. C. Publicaciones Especiales Núm. 2. 83 p.

Medellín, R., H. T. Arita and O. Sánchez. 2008. Identificación de los murciélagos de México. Clave de campo. Segunda edición. Instituto de Ecología, UNAM. 78 p.

Mickleburgh, S. P., A. M. Hutson and P. A. Racey. 2002. A review of the global conservation status of bats. Oryx, 36:18-34.

Orozco-Lugo, C. L. 2007. Efecto de la perturbación del hábitat en la comunidad de murciélagos insectívoros de selva baja caducifolia. Master thesis, Posgrado en Ciencias Biológicas, Instituto de Ecología, Universidad Nacional Autónoma de México. 118 p.

Orozco-Lugo, C. L., A. Guillén-Servent, D. Valenzuela-Galván and H. T. Arita. 2013. Descripción de los pulsos de ecolocalización de once especies de murciélagos insectívoros aéreos de una selva baja caducifolia en Morelos, México. Therya 4:33-46.

Ramírez-Pulido, J. 1969. Contribución al estudio de los mamíferos del Parque Nacional "Lagunas de Zempoala", Morelos, México. Anales del Instituto de Biología, Universidad Nacional Autónoma de México, Serie Zoología 40:253-290.

Ramírez-Pulido, J. 1969. Nuevos registros de murciélagos para el estado de Morelos, México. Anales del Instituto de Biología, Universidad Nacional Autónoma de México, Serie Zoología 40:123- 127.

Reid, F. 1997. A field guide to the mammals of Central America and Southeast Mexico. Oxford University Press. New York. 456 p.

Reid, F. 2009. A field guide to the mammals of Central America and Southeast Mexico. Oxford University Press. Second Edition. New York. 384 p.

Rhodes-Espinoza, A. J. 2005. Estructura y diversidad espacio temporal de la comunidad de murciélagos con relación a gradientes ambientales en la Reserva de la Biosfera Sierra de Huautla. Thesis, Escuela de Ciencias, Universidad de Las Américas, Puebla. 73 p.

Sánchez-Hernández, C. and M. L. Romero-Almaraz. 1995. Mastofauna silvestre del área de reserva Sierra de Huautla (con énfasis en la región noreste). Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Morelos-FOMES, Cuernavaca. 143 p.

Santillán-Alarcón, S., M. A. Lozano-García, A. L. Ortíz-Villaseñor y D. Porcado-Tavira. 2010. Estado actual de la mastofauna silvestre. *In* Biodiversidad, conservación y manejo en el Corredor Biológico Chichinautzin. Condiciones actuales y perspectivas, J. Bonilla-Barbosa, V. M. Mora, J. Luna-Figueroa, H. Colín and S. Santillán-Alarcón (eds.). Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Morelos, Cuernavaca. p. 123-134.

Semarnat, 2010. Norma Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental - Especies nativas de México de flora y fauna silvestres - Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio - Lista de especies en riesgo. Diario Oficial de la Federación. 30 de diciembre de 2010, Segunda Sección, México.

Trejo, I. and R. Dirzo. 2000. Deforestation of seasonally dry tropical forest: a national and local analysis in Mexico. Biological Conservation, 94:133-142.

Valenzuela, D., O. Dorado and R. Ramírez. 2010. Sierra de Huautla, Morelos, Guerrero y Puebla. *In* Diversidad, amenazas y regiones prioritarias para la conservación de las selvas secas del Pacífico de México, G. Ceballos, L. Martínez, A. García, E. Espinoza, J. Bezaury and R. Dirzo (eds.). FCE, Conabio, Conanp, Alianza WWF-Telcel, Ecociencia, S. C. and Telmex, México, D. F. p. 469-473.

Vargas- Miranda, B., J. Ramírez -Pulido and G. Ceballos. 2008. Murciélagos del estado de Puebla, México. Revista Mexicana de Mastozoología 12:59-112.