



Research note

New records and range extension of *Promops centralis* (Chiroptera: Molossidae)

Nuevo registro y ampliación de la distribución de Promops centralis (Chiroptera: Molossidae)

Tania P. González-Terrazas^{a,*}, Luis R. Viquez^{a,b}, Ana Ibarra-Macías^b, Adrián Tonatiuh Ruíz^c,
Leonora Torres-Knoop^b, Kirsten Jung^a, Marco Tschapka^{a,d}, Rodrigo A. Medellín^b

^a Institute of Evolutionary Ecology and Conservation Genomics, Albert-Einstein Allee 11, D-89069 Ulm, Germany

^b Instituto de Ecología, Universidad Nacional Autónoma de México, Tercer Circuito s/n, Ciudad Universitaria, 04318 Ciudad de México, Mexico

^c Institute of Neural Information Processing, University of Ulm, Albert-Einstein Allee 11, D-89069 Ulm, Germany

^d Smithsonian Tropical Research Institute, PO Box 0843-03092, Balboa, Panama

Received 4 May 2016; accepted 16 August 2016

Available online 15 November 2016

Abstract

We captured *Promops centralis* and recorded its echolocation calls in Bahía de Kino, Sonora, which represents the first record of this species for the state of Sonora, Mexico. Our new record extends the distribution of *P. centralis* at least 1,300 km northwest from the northernmost known locality, Cuautla, Jalisco. Until now, there was no evidence of the occurrence of *P. centralis* in the deserts of northern Mexico. These new records are ecologically significant as they show that this species also occurs in extreme dry areas such as the Sonoran Desert. Our findings suggest that *P. centralis* may be more widely distributed than previously thought.

© 2016 Universidad Nacional Autónoma de México, Instituto de Biología. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Keywords: Aerial insectivores; Bahía de Kino; Echolocation; Molossids; Northern Mexico

Resumen

Se capturó al murciélago *Promops centralis* y se grabaron sus llamadas de ecolocalización en la localidad de Bahía de Kino, Sonora; este es el primer registro de la especie para el estado de Sonora, México. Este nuevo registro amplía la distribución de *P. centralis* por lo menos 1,300 km al noroeste de la localidad más norteña previamente conocida, Cuautla, Jalisco. Hasta ahora no existía evidencia de la presencia de *P. centralis* en los desiertos del norte de México. Este nuevo registro es de importancia ecológica ya que por primera vez se muestra que esta especie puede subsistir en áreas extremadamente secas como el Desierto de Sonora. Nuestro hallazgo sugiere que *P. centralis* puede estar más ampliamente distribuido de lo que se pensaba con anterioridad.

© 2016 Universidad Nacional Autónoma de México, Instituto de Biología. Este es un artículo Open Access bajo la licencia CC BY-NC-ND (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Palabras clave: Insectívoros aéreos; Bahía de Kino; Ecolocalización; Molósidos; Norte de México

The Molossidae is a diverse group of bats (fourth largest bat family, ca. 100 species), with most of the species occurring in tropical and subtropical regions (Simmons, 2005). Molossids are

typical open space bats that hunt high up in the air and roam over large distances. They are rarely captured in mist nets so there is a general lack of information on many species. The genus *Promops* is restricted to the New World and currently encompasses 3 species (Gregorin & Chiquito, 2010): *Promops centralis*, *Promops nasutus* and *Promops davisoni*. *P. centralis* is the most widely distributed, from Mexico (Jalisco to Yucatán) throughout South America, from Colombia, Ecuador, and Peru, to the

* Corresponding author.

E-mail address: tania.gonzalez@uni-ulm.de (T.P. González-Terrazas).

Peer Review under the responsibility of Universidad Nacional Autónoma de México.



Figure 1. (A) Artificial pond where we captured *Promops centralis*. (B) The pond (red dot) is mainly surrounded by crops. This area is very dry and these water bodies are the only source of fresh water nearby.

Amazon basin in Brazil, western Bolivia, Paraguay, northeastern Argentina and the northern coast of Brazil, Guianas, and Venezuela (Eger, 2008; Pacheco, Cadenillas, Salas, Tello, & Zeballos, 2009; Simmons, 2005). Despite its large distributional range, little is known about the ecology of this species. Like most molossids, *P. centralis* possesses long and narrow-tipped wings (high wing loading and aspect ratio) which are well suited to fly at high speed but are less suited for high maneuverability (Freeman, 1981; Norberg & Rayner, 1987). In accordance, these bats are known to forage in open areas above the forest canopy or in open landscapes (Jung, Molinari, & Kalko, 2014; Kalko, Estrada-Villegas, Schmidt, Wegmann, & Meyer, 2008). *P. centralis* occurs in a very diverse range of habitats such as rain forest, tropical dry forest and pine-oak (Arita, 1997; Sánchez-Cordero, Bonilla, & Cisneros, 1993; Simmons & Voss, 1998), pastures (MacSwiney, Bolívar, Clarke, & Racey, 2006), and has even been reported in urban areas (Jung & Kalko, 2011; Regueras & Magaña-Cota, 2008). The echolocation calls of *P. centralis* are very conspicuous as they are characterized by upward frequency modulation similar to the genus *Molossops* (Jung et al., 2014). Within sequences up- and downward modulated calls can alternate irregularly. Species-specific variation of echolocation calls has been previously described in detail (while assigning it to *Cynomops mexicanus* by MacSwiney et al., 2006).

In Mexico, this species has been recorded from Jalisco southward throughout the west coast to the Yucatán Peninsula. We report here the capture of this species for the first time in the extreme north of Mexico, in the state of Sonora, where there was no record of this species in the northern desert habitats of Mexico.

Field work was conducted on the nights of the 8th and 9th of April 2014 in Bahía de Kino, Sonora. Our study site was one of the few artificial water reservoirs in this area (28°50'1.09" N, 111°35'57.20" W). The pond had a size of ca. 90 m × 90 m with some palm trees close to the edge of the water and mainly surrounded by crops (Fig. 1). However, the pond is relatively close to the natural vegetation typical for the Sonoran Desert, dominated by small shrubs and columnar cacti (Mexican giant

cardon: *Pachycereus pringlei*, saguaro: *Carnegiea gigantea*, organ pipe cactus: *Stenocereus thurberi*) (Van Devender, 2002). We used mist nets for capturing bats and acoustic monitoring to record the echolocation calls of all the bats flying near the study site. Captured bats were identified using a bat identification guide (Medellín, Arita, & Sánchez-Herrera, 2008). Acoustic recordings were obtained using a real time acoustic ultrasound recording device (batcorder, ecoObs GmbH, Nürnberg, Germany) located at 1.5 m above the ground. Both, mist netting and use of the acoustic recording device started at sunset and ended at midnight. We followed the guidelines for the use of wild mammal species in research as recommended by the American Society of Mammalogists (Sikes & The Animal Care and Use Committee of the American Society of Mammalogists, 2016). All captures were carried out under permission of the Secretaría de Medio Ambiente y Recursos Naturales, Mexico (FAUT-0001).

In total we captured 12 individuals of 2 bat families (Vespertilionidae and Molossidae). We identified 2 individuals of *P. centralis*, 1 in each capture night, both individuals presented the characteristic morphological features of *P. centralis*: upper lip without grooves (Fig. 2A), forearm less than 56 mm, dark pelage (darker in the dorsal part than in the ventral part) and the incisors protruding substantially from the front of the canines (Fig. 2B). The first captured individual was an adult male, reproductively inactive, with a forearm of 54.8 mm, the time of capture was around 22:00 h. The collected individual was deposited in the National Collection of Mammals, UNAM, Mexico (catalog number 47626). The second individual, captured around 20:00 h and released after taking measurements and photographs, was an adult male, reproductively inactive with a forearm of 55.4 mm.

We analyzed 13 echolocation sequences ($n = 206$ upward modulated echolocation calls) of *P. centralis*. Corroborating with previous publications, this species has very particular echolocation calls (Jung et al., 2014), which are easily identified using acoustic recordings for species inventory. Contrary to most molossids, their search calls are upward modulated quasi-constant frequency calls with a variable upward modulated

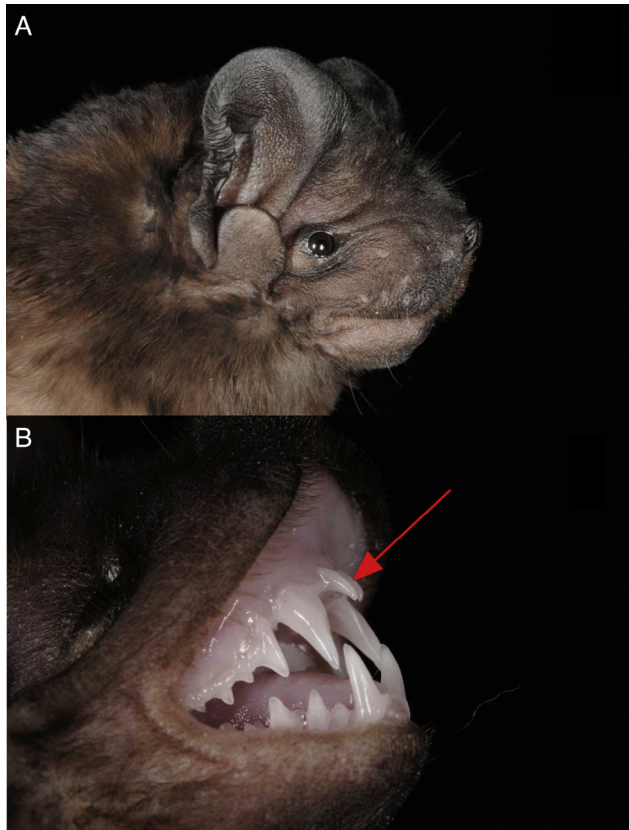


Figure 2. (A) Side view of one of the individuals of *Promops centralis*. The upper lip does not present vertical grooves. (B) The most remarkable characteristic of *P. centralis* are the incisors that protrude substantially from the front of the canines (red arrow).

FM-component at the beginning (i.e., the start frequency is lower than the end frequency). Call sequences are characterized by interspersed downward-modulated signals, especially before prey-capture attempts. Upward and downward modulated signals do not overlap in frequency range. The upward modulated search calls of *P. centralis* are long, low frequency quasi-constant calls with the highest energy in the first harmonic (Fig. 3; Table 1).

Our new records of *P. centralis*, besides being the first for the state of Sonora, extend the distributional range of this species by 1300 km northwesterly. So far, the northernmost records of *P. centralis* were from Cuautla, Jalisco (Watkins, Jones, & Genoways, 1972) and one recent record from the city of Guanajuato (Regueras & Magaña-Cota, 2008). Additionally, this is the

Table 1

Call parameters of the upward modulated calls (mean $\pm$ SD) of *Promops centralis*. We analyzed a total of 206 calls from 13 different sequences.

	Search calls ($n = 206$)
Call duration (ms)	20.6 ± 3.90
Peak frequency (kHz)	24.7 ± 0.57
Start frequency (kHz)	23.0 ± 0.72
End frequency (kHz)	25.6 ± 0.47
Bandwidth (kHz)	2.7 ± 0.56

first record of *P. centralis* for the Sonoran Desert (xeric shrublands). This type of habitat covers large part of northwestern Mexico and southwest of the United States, with an approximate area of 260,000 km² (Phillips & Comus, 2000). The xeric shrublands of the northern Mexican deserts covered originally approximately 40% of the Mexican territory (Rzedowski, 1978; Fig. 4B), nowadays they cover only ca. 30% of the country (Inegi, 2005). Our finding of the occurrence of *P. centralis* in this type of habitat suggests that the potential distribution of this species (Fig. 4A) may cover a much larger area than previously thought.

In addition to the 2 captures, we also recorded many echolocation passes of *P. centralis* during the 2 nights of acoustic monitoring. The measurements of the call parameters in this study are similar to those previously reported for *P. centralis* (Jung et al., 2014; MacSwiney et al., 2006). In contrast to most molossids, which demonstrate a high variability in echolocation call frequencies, hampering acoustic species identification (Gillam et al., 2009; Kalko et al., 2008) echolocation calls of *P. centralis*, are very characteristic and thus a reliable indicator for the occurrence of this species. Thus acoustic monitoring can be an important tool to enhance our knowledge about the ecology of this species.

In dry habitats, where water is limited, the few available water bodies are hot spots of activity of the regional fauna. We recorded echolocation calls and captured *P. centralis* while the animals were approaching the pond for drinking or capturing insects gathered near the water. With extensive monitoring efforts, combining acoustic and mist netting techniques at similar locations it may be possible to record this species at additional localities in the northern deserts of Mexico where this species has not yet been found. Our results indicate that, more than ever before, standardized, careful acoustic surveillance is rapidly becoming an essential tool for biodiversity monitoring.

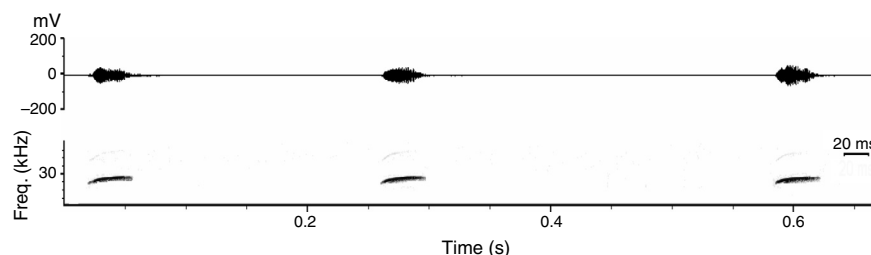


Figure 3. Three upward modulated echolocation calls of a search sequence of *Promops centralis*. Sonogram was created using a fast Fourier transform (FFT) with 512 point, a Hamming window and an overlap of 75%.

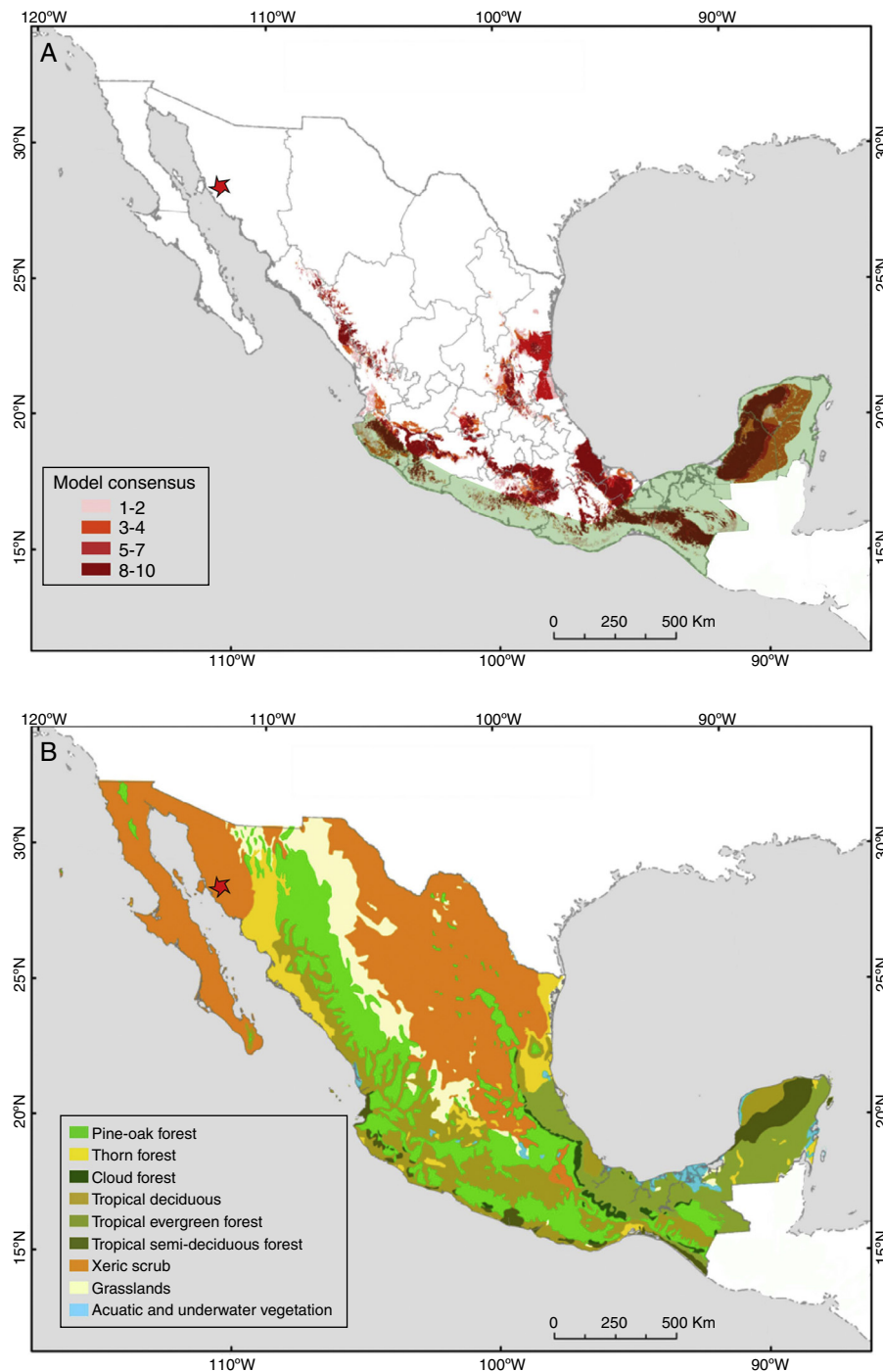


Figure 4. (A) Potential distribution of *Promops centralis* in Mexico (modified from Ceballos, Blanco, González y Martínez, 2006). Light green shading indicates the current known distribution of this species in Mexico (modified from Medellín et al., 2008). The red star represents the location of the new records reported in this study. (B) Potential vegetation of Mexico (modified from Rzedowski, 1990). These captures were in a type of habitat (xeric shrublands) where *P. centralis* was considered to be absent. This habitat type is extensively distributed in the north of Mexico, therefore, this species may be more widely distributed than previously thought.

We want to thank all the people who contributed to the field work. Scientific collecting permits were provided to R.A.M. by the Secretaría del Medio Ambiente y Recursos Naturales (FAUT-0001). This study was supported by a joint DFG-Conacyt Bilateral Cooperation program under the number 190901 [to R.A.M.] and TS 81/8-1 and 8-2 [to M.T. and K.J.]

References

- Arita, H. T. (1997). Species composition and morphological structure of the bat fauna of Yucatán, Mexico. *Journal of Animal Ecology*, 66, 83–97.
- Ceballos, G., Blanco, S., González, C. y Martínez, E. (2006). *Modelado de la distribución de las especies de mamíferos de México para un análisis Gap*. Cd. de México: Instituto de Biología, UNAM. Base de datos SNIB-Conabio, proyecto DS006.

- Eger, J. L. (2008). Family Molossidae P. Gervais, 1856. In A. L. Gardner (Ed.), *Marsupials, xenarthrans, shrews, and bats* (Vol. 1) *Mammals of South America* (pp. 399–440). Chicago: University of Chicago Press.
- Freeman, P. (1981). *A multivariate study of the family Molossidae (Mammalia, Chiroptera): morphology, ecology, evolution*. Mammalogy papers. Lincoln: University of Nebraska State Museum.
- Gillam, E. H., McCracken, G. F., Westbrook, J. K., Lee, Y. F., Jensen, M. L., & Balsley, B. B. (2009). Bats aloft: variability in echolocation call structure at high altitudes. *Behavioral Ecology and Sociobiology*, 64, 69–79.
- Gregorin, R., & Chiquito, E. A. (2010). Revalidation of *Promops davisoni* Thomas (Molossidae). *Chiroptera Neotropical*, 16, 648–660.
- Inegi (Instituto Nacional de Estadística y Geografía). (2005). *Conjunto de datos vectoriales de la carta de uso del suelo y vegetación: Escala 1: 250,000. Serie III*. (continuo nacional).
- Jung, K., & Kalko, E. K. V. (2011). Adaptability and vulnerability of high flying Neotropical aerial insectivorous bats to urbanization. *Diversity and Distributions*, 17, 262–274.
- Jung, K., Molinari, J., & Kalko, E. K. V. (2014). Driving factors for the evolution of species-specific echolocation call design in New World free-tailed bats (Molossidae). *PLOS ONE*, 9, e85279.
- Kalko, E. K. V., Estrada-Villegas, S., Schmidt, M., Wegmann, M., & Meyer, C. F. J. (2008). Flying high—assessing the use of the aerosphere by bats. *Integrative and Comparative Biology*, 48, 1–14.
- MacSwiney, G. M. C., Bolívar, B., Clarke, F. M., & Racey, P. A. (2006). Nuevos registros de *Pteronotus personatus* y *Cynomops mexicanus* (Chiroptera) en el estado de Yucatán, Mexico. *Revista Mexicana de Mastozoología*, 10, 80–87.
- Medellín, R. A., Arita, H. T., & Sánchez-Herrera, O. (2008). *Identificación de los murciélagos de México: clave de campo*. Mexico, D.F.: Instituto de Ecología, UNAM.
- Norberg, U. M., & Rayner, J. M. V. (1987). Ecological morphology and flight in bats (Mammalia; Chiroptera): wing adaptations, flight performance, foraging strategy and echolocation. *Philosophical Transactions of the Royal Society B*, 316, 335–427.
- Pacheco, V., Cadenillas, R., Salas, E., Tello, C., & Zeballos, H. (2009). Diversidad y endemismo de los mamíferos del Perú. *Revista Peruana de Biología*, 16, 5–32.
- Phillips, S. J., & Comus, P. W. (2000). *A natural history of the Sonoran Desert*. University of California Press.
- Regueras, Ó. S., & Magaña-Cota, G. E. (2008). Murciélagos de Guanajuato: Perspectiva histórica y actualización de su conocimiento. *Acta Universitaria*, 18, 27–39.
- Rzedowski, J. (1978). *Vegetación de México*. México: Limusa Wiley.
- Rzedowski, J. (1990). Vegetación potencial. IV.8.2. *Atlas Nacional de México. Vol II*. Escala 1:4000000. Cd. de México: Instituto de Geografía, UNAM.
- Sánchez-Cordero, V., Bonilla, C., & Cisneros, E. (1993). The Thomas' mastiff bat *Promops centralis* (Vespertilionidae) in Oaxaca, Mexico. *Bat Research News*, 34, 65.
- Sikes, R. S., & The Animal Care and Use Committee of the American Society of Mammalogists. (2016). 2016 Guidelines of the American Society of Mammalogists for the use of wild mammals in research and education. *Journal of Mammalogy*, 97, 663–688.
- Simmons, N. (2005). Order Chiroptera. In D. E. Wilson, & D. M. Reeder (Eds.), *Mammal species of the world: a taxonomic and geographic reference* (pp. 312–529). Baltimore: John Hopkins University Press.
- Simmons, N. B., & Voss, R. S. (1998). The mammals of Paracou, French Guiana: a neotropical lowland rainforest fauna. Part 1. Bats. *Bulletin of the American Museum of Natural History*, 1, 1–219.
- Van Devender, T. R. (2002). Environmental history of the Sonoran Desert. In T. H. Fleming, & A. Valiente-Banuet (Eds.), *Columnar cacti and their mutualists: evolution, ecology, and conservation* (pp. 3–24). Tucson: University of Arizona Press.
- Watkins, L., Jones, J., & Genoways, H. (1972). *Bats of Jalisco, Mexico* (Vol. 1) Special Publications of the Museum Texas Tech University. <http://digitalcommons.unl.edu/museummammalogy/176>