



Noteworthy records of *Myotis* Kaup, 1829 species in northeastern Guatemala, including the first record of *M. volans* (H. Allen, 1866) (Chiroptera, Vespertilionidae) from the country

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Abstract. *Myotis* is the most diverse genus of bats in Central America, with 10 species currently reported for Guatemala. Here, we present the first record of *M. volans* (H. Allen, 1866), and third record of *M. auriculatus* Baker & Stains, 1955 in Guatemala, both from the cloud forest of the highlands of Sierra de las Minas Biosphere Reserve. This new locality may serve as one of the southernmost habitats akin to North American ecosystems for these two species. Our record of *M. volans* increases the number of bats in Guatemala to 105. Our findings underscore the importance of further research to understand patterns of biodiversity in Guatemala and Central America.

Key words. Bats, cloud forest, distribution limit, range extension, Sierra de las Minas Biosphere Reserve, USAC Mammal Collection

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INTRODUCTION

Myotis Kaup, 1829 represents the most speciose genus of Chiroptera, with over 140 recognized species (Moratelli et al. 2019; MDD 2023; Simmons and Cirranello 2024). Its global distribution is notable, as it is the only genus of mammals found on every continent except Antarctica (Moratelli et al. 2019a; Liu et al. 2023; Ruedi et al. 2013). The Neotropical region is renowned for its exceptional bat diversity, exhibiting a high richness and several endemic species (Moratelli et al. 2001, 2013, 2016, 2017, 2019a, 2019b; Moratelli and Wilson 2011, 2014; Novaes et al. 2021, 2022a, 2022b; Carrión-Bonilla et al. 2024).

In Central America, *Myotis* is also the most diverse genus of bat, with Guatemala having the greatest species richness in the region (Kraker-Castañeda et al. 2016; Martínez-Fonseca et al. 2020; Turcios-Casco et al. 2020; Ramírez-Fernandez et al. 2023). Currently, 10 *Myotis* species are reported from Guatemala, including the endemic *M. cobanensis* Goodwin, 1955. Alongside the Guatemalan *myotis*, there are four other species unique to the region, whose southernmost distribution extends to Guatemala: *M. thysanodes* Miller, 1897; *M. auriculatus*; *M. californicus* (Audubon & Bachman, 1842); and *M. fortidens* Miller & Allen, 1928 (Kraker-Castañeda et al. 2016).

Myotis auriculatus, Southwest *Myotis*, is native to the southwestern United States, particularly New Mexico and Arizona, and Mexico north of Veracruz (Warner 1982; Arroyo-Cabrales et al. 2017). Currently two subspecies are recognized, *M. a. auriculatus* in eastern Sierra Madre Oriental from Nuevo León to Tamaulipas and Veracruz (Mexico) and *M. a. apache* in northern Coahuila and southern Jalisco (Mexico) and the Arizona and New Mexico (USA) (Novaes 2019). In Guatemala, *M. a. auriculatus* has been reported from San Francisco El Retiro, Huehuetenango, located in the northwest of the country, and Muxbal, in the department of Guatemala in the central region of the country (GBIF 2024a; Portal de Biodiversidad de Guatemala 2024). *Myotis auriculatus* commonly inhabits arid woodlands and desert scrub, but it is also found in diverse habitats such



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as mesquite forests, chaparral, oak woodlands, and coniferous forests (Arroyo-Cabrales et al. 2017; Reid 2009; Warner 1982). They are associated with areas with rocky cliffs near water sources, often roosting in caves at elevations of about 300–2,200 m a.s.l. (Reid 2009; Warner 1982).

Myotis volans, Long-legged Myotis, is native to western North America. Its range extends from southeastern Alaska through Canada and the United States to central Mexico (Warner and Czaplewski 1984; Solari 2019). This distribution encompasses a vast range of geography and ecosystems, from temperate forests to arid landscapes (GBIF 2024b). Four subspecies are recognized, with *M. v. volans* found in northwestern Mexico, including Baja California, *M. v. amotus* in south-central Mexico, *M. v. interior* in the western and central United States, and *M. v. longicrus* the northwestern United States and western Canada to southern Alaska (Burgin 2019). It inhabits elevations ranging from 60 to 3,770 m a.s.l., although it is predominantly found between 2,000 and 3,000 m a.s.l. Mainland populations typically inhabit montane habitats and are rarely found in arid lowland areas (Warner and Czaplewski 1984; Solari 2019).

Here, we provide the first record of *M. volans* in Central America, from the Sierra de las Minas Biosphere Reserve (SMBR) in northeastern Guatemala. Additionally, we document the third record of *M. auriculatus* from Guatemala.

METHODS

Sierra de las Minas Biosphere Reserve (SMBR) is a 130 km mountain range in northeastern Guatemala between the Motagua and Polochic valleys and geological faults. This region is characterized by significant topographic variability, with elevations ranging from sea level to 3,015 m a.s.l. (Figure 1; Matson et al. 2016). The diverse geographical features of the SMBR contain a wide range of ecosystems, each with its own distinct climatic conditions and plant communities (Figure 2A, B; IARNA-URL 2018). Encompassing an approximate area of 2400 km², the SMBR is situated between the departments of El Progreso, Zacapa, Izabal, Alta Verapaz, and Baja Verapaz and includes the largest extent of cloud forest in Central America (Matson et al. 2016). The capture site was located on the southern slope of the mountain range, within the cloud forest of San Agustín Acasuaguastlán in El Progreso Department.

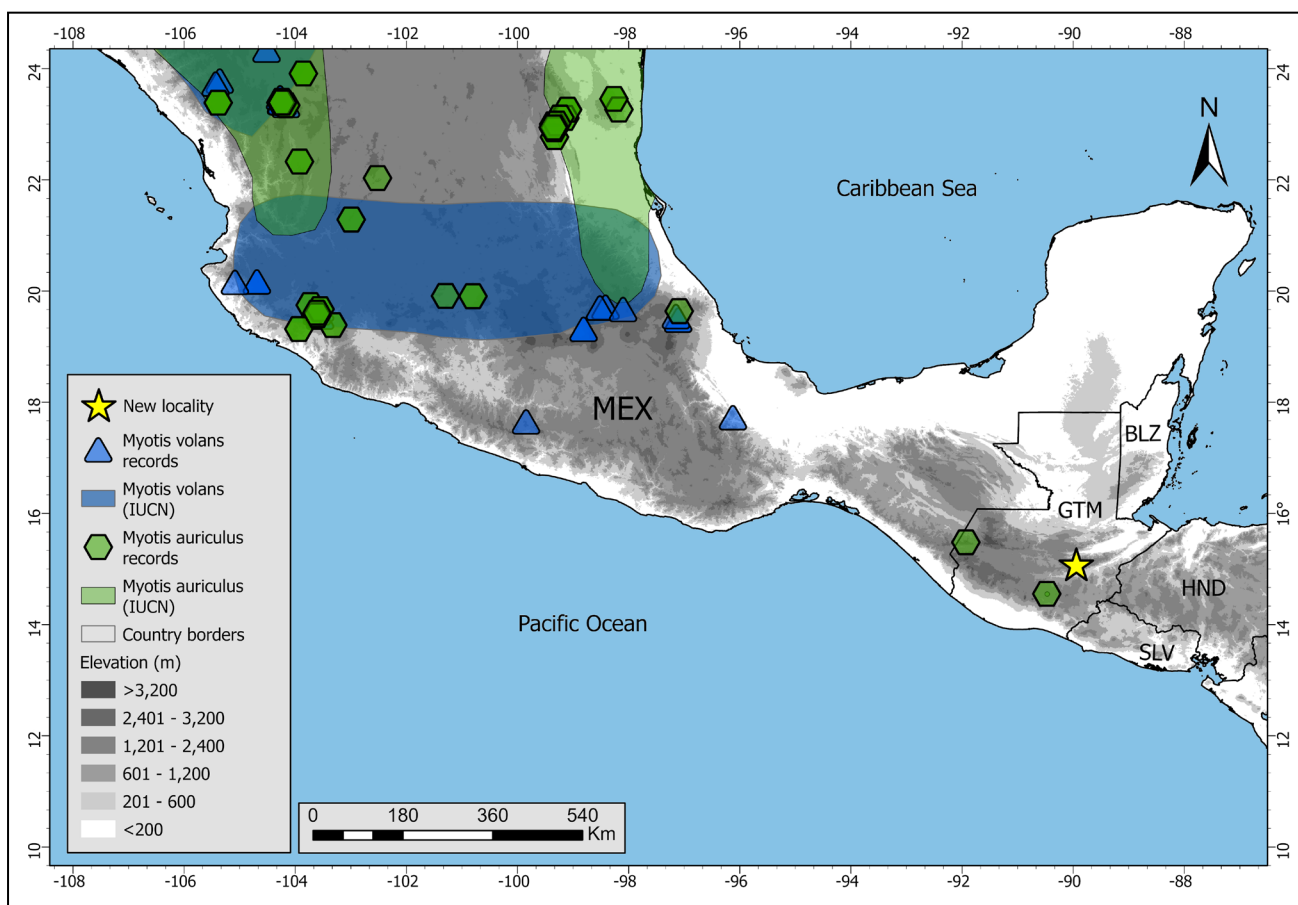


Figure 1. Distribution ranges and confirmed localities of *Myotis auriculatus* Baker & Stains, 1955 and *M. volans* (H. Allen, 1866) in southern Mexico and Central America. Yellow star indicates new locality for both species in Sierra de las Minas Biosphere Reserve in Guatemala.



Figure 2. Representative habitat in new locality, Sierra de las Minas Biosphere cloud forest. **A.** Forest path. **B.** View of the tree canopy.

Bats were captured using a combination of mist nets of varying lengths (6 and 12 m), positioned at ground level or using triple-high nets placed across natural flyways such as forest paths and water sources, following Kunz and Parsons (2009). Nets were deployed shortly before sunset (approximately at 5:30pm) and left open for about 5 h. We recorded morphometric measurements from each of the individuals including head and body length (HB), forearm length (FA), ear length (E), tail length (T), hindfoot (HF), tibia length (Tibia), and weight (Wt). Field identifications were made using the keys and guides by Medellín et al. (2008), Reid (2009), and York et al. (2019). Nomenclature and taxonomic order follow the guidelines provided by Simmons and Cirranello (2024). Individuals were handled in accordance with the protocols established by the American Society of Mammalogists (Sikes and the Animal Care and Use Committee of the American Society of Mammalogists 2016) and under permits granted by the Consejo Nacional de Áreas Protegidas (CONAP) as co-administrators of the protected area (governmental decree no. 93-93). The skin, skull, and tissues, as well as photographic records, were deposited in the Universidad de San Carlos de Guatemala Mammal Collection (USAC).

Existing locality records for the two species were reviewed using museum specimen localities available through the Global Biodiversity Information Facility (<https://www.gbif.org>; GBIF). Data from GBIF were acquired by defining the search based on: “Species = XXX”; “Basis of record = Preserved specimen; Material sample; Occurrence”; “Location = Including coordinates” (GBIF 2024a, 2024b). Complementary information was obtained through the Portal de Biodiversidad de Guatemala (<https://biodiversidad.gt/>). Additionally, we consulted the latest checklist and publications of bats in Guatemala to further understand the species’ distributions within the study area and the country (Kraker-Castañeda et al. 2016; Trujillo et al. 2020, 2021).

RESULTS

Myotis auriculus Baker & Stains, 1955

Figure 3A

New records. GUATEMALA – EL PROGRESO • San Agustín Acasaguastlán, Reserva de la Biosfera Sierra de las Minas; 15.08361, -089.94306; 2,573 m a.s.l.; 8.II.2024; CM, LAT, LEGL, JGMF, MH obs.; mist net set in a water body in preserved clouded forest fragment; FA 40 mm; E 17 mm; Wt 7 g; 1 ♂, adult, released, photographic record, USACF000017.

Identification. *Myotis auriculus* is a medium-sized to large bat compared to Mesoamerican *Myotis* and belongs to the long-eared myotis species group (Genoways and Knox 1969; Reduker et al. 1983; Gannon and Rácz 2006). Our specimen of *M. auriculus* (Figure 3A) is clearly distinguishable from its congeners in the region by its relatively large size and long ears; all measurements fall within the range described for *M. auriculus* (Reid 2009; Warner 1982). Our specimen had the typical long and woolly matte-brown dorsal fur, with bicolored hair having a dark brown base and duller brown or yellow-brown tips (Novaes 2019). The long brown ears turn black from the middle to the tip, and the narrow, pointed tragus is very evident and characteristic of the species (Novaes 2019). The calcar lacked a keel. This species can be further distinguished from other superficially similar species, like *M. thysanodes*, due to the absence of a fringe of hairs on the tail membrane and relatively shorter tail (Warner 1982; Medellín et al. 2008; Reid 2009).

Myotis volans (H. Allen, 1866)

Figure 3B-D

New records. GUATEMALA – EL PROGRESO • San Agustín Acasaguastlán, Reserva de la Biosfera Sierra de las Minas; 15.08361, -089.94306; 2,573 m a.s.l.; 8.II.2024; CM, LAT, LEGL, JGMF, MH leg.; mist net set over a water body in preserved clouded forest fragment; HB 47 mm; FA 40 mm; E 11 mm; T 40 mm; HF 8 mm; Tibia 21mm; Wt 5 g; 1 ♂, adult, skin, skull and tissues, USAC 6415.

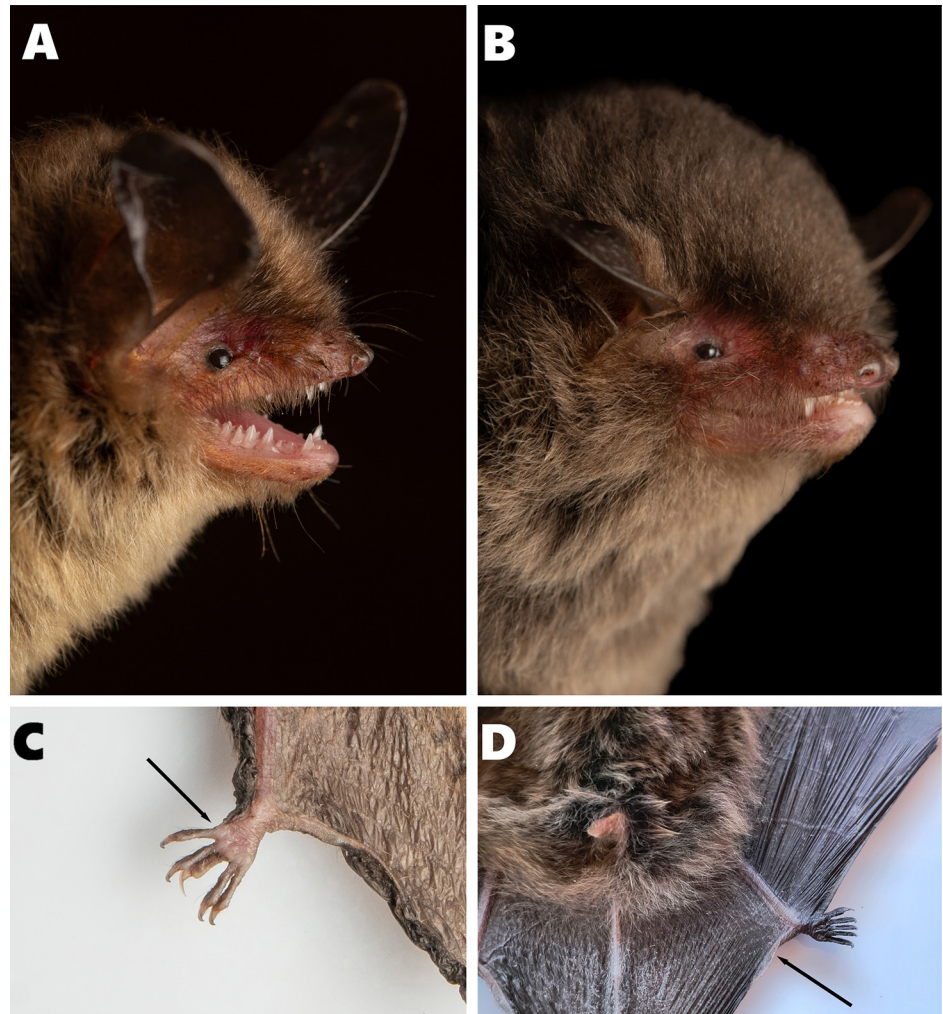


Figure 3. *Myotis auriculus* Baker & Stains, 1955 and *M. volans* (H. Allen, 1866) from Sierra de las Minas Biosphere Reserve, Guatemala. **A.** Lateral view of *Myotis auriculus* Baker & Stains, 1955, USACF000017. **B.** Lateral view of *Myotis volans* (H. Allen, 1866), USACF000018_1. **C.** Wing membranes attach to the hindfoot at the middle of the metatarsus in *M. volans* (H. Allen, 1866), USACF000018_2. **D.** Keeled calcar in *M. volans* (H. Allen, 1866), USACF000018_3.

Identification. *Myotis volans* is a medium-sized myotis species with a relatively long tail and short, rounded ears which, when laid forward, barely reach the snout (Ammerman et al. 2012). The examined specimen matches this general description with its short, furry snout (Figure 3B; Burgin 2019). Our specimens had dark brown dorsal fur and light brown ventral fur, as noted by Burgin (2019). The wing membranes in our specimen were attached to the hindfoot at the middle of the metatarsus, which is diagnostic for this species (Figure 3C; Warner and Czaplewski 1984). It also has a prominently keeled calcar (Figure 3D) and sparse fur on the wing membrane, which extends from the body to the line of the knee and barely reaches the elbow, which is also a diagnostic characteristic of this species (Warner and Czaplewski 1984; Ammerman et al., 2012; Schmidly and Bradley 2016). All measurements of our specimen are within the range described for the species (Warner and Czaplewski 1984; Ammerman et al. 2012; Schmidly and Bradley 2016; Burgin 2019). When compared to its congeners, our specimen has a relatively long tibia (21 mm). The only other species within the region with a keeled calcar is *M. californicus*, from which *M. volans* can be distinguished by its larger size (FA \geq 38 mm; Reid 2009; Burgin 2019). *Myotis californicus* is usually pale yellow in the southern limits of its distribution (Burgin 2019).

DISCUSSION

Our records extend the geographical range of *Myotis auriculus* and *M. volans* east and southward. For *M. auriculus*, this represents the third documented report of the species in Guatemala and Central America. Previously, the southernmost record for the species was at Muxbal, Guatemala, approximately 79 km into the central region of the country. Notably, two of these records represent the highest elevational records for the species: 2,573 m a.s.l. in the SMBR (this study) and 2,975 m a.s.l. in San Francisco El Retiro, Huehuetenango (USACM5757; available at biodiversidad.gt). The highest elevation where *M. auriculus* was previously reported was at 2,226 m a.s.l. in Arizona (Warner 1982; Arroyo-Cabrales et al 2017). Our record of *M. volans* in Guatemala also represents the first record for Central America, extending the range of the species by at least 910 km southeastward of its previously known range at Cofre de Perote in Veracruz, Mexico (GBIF 2024b).

The addition of *M. volans* to the bat fauna of Guatemala increases the number of reported species from the country to 105. In the last few years, the molossid species *Nyctinomops macrotis* (Gray, 1840), *N. aurispinosus* (Peale, 1848), *N. femorosaccus* (Merriam, 1889), and *Eumops underwoodi* Goodwin, 1940 were added to the bat fauna of Guatemala (Kraker-Castañeda et al. 2016; Trujillo et al. 2020; Trujillo et al. 2021). This supports the notion that Guatemala's bat fauna is significantly more diverse than previously thought. Indeed, it is safe to assume that there are several species yet to be found in the country (McCarthy and Pérez 2006). This pattern also holds true in other Central American countries (Martínez-Fonseca et al. 2024).

Our records reaffirm *Myotis* as the richest bat genera of the country (see also Kraker-Castañeda et al. 2016). It is noteworthy that five of these species reach their southernmost distribution limit in Guatemala: *M. californicus*, *M. volans*, *M. thysanodes*, *M. fortidens*, and *M. auriculus*. Furthermore, *M. auriculus*, *M. thysanodes*, and *M. volans* reach their limit in the SMBR (this study; McCarthy and Pérez 2006). The documentation of *M. auriculus* and *M. volans* in the SMBR is a significant addition to the understanding of bat diversity and its distribution in Guatemala and Central America. These findings highlight the importance of this region as a key habitat for bat species and underscore the critical need for further research to fully comprehend the ecological importance of the SMBR. The highlands of Sierra de las Minas may serve as one of the southernmost remaining habitats with conditions like those found in North American ecosystems for these species. Our findings emphasize the urgent need to strengthen conservation efforts to preserve these unique habitats and the biodiversity they support.

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ADDITIONAL INFORMATION

Conflict of interest

The authors declare that no competing interests exist.

Ethical statement

No ethical statement is reported.

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Author contributions

Conceptualization: LAT, JGMF. Data curation: LAT, JGMF. Investigation: LAT, JGMF, CM, MH, LEGL. Writing – original draft: LAT. Writing – review and editing: LAT, JGMF, CM, MH, LEGL. Visualization: JGMF, LAT.

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Data availability

All data that support the findings of this study are available in the main text.

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