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An urban and Sonoran Desert bat: the most northwestern record of *Glossophaga mutica*

Un murciélago urbano y del Desierto Sonorense: el registro más noroccidental de *Glossophaga mutica*

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The Palla´s long-tongued bat *Glossophaga mutica* (Merriam, 1898) is one of the most generalist species of the subfamily Glossophaginae. *Glossophaga mutica* is common in tropical areas, but in the Sonoran Desert is a rare species that faces threats such as land-use change and disturbance in their roosts. To understand the urban species in Hermosillo, a city in the Sonoran Desert, we placed 2 mist nests in the Santa Martha Cave. The roost is located on Cerro La Cementera and is less than 120 m from the nearest avenue and less than 400 m in a straight line to a commercial mall. Also, to define the edge north of its range, we confirm the localities, identify incorrect georeferenced records, and identification of available preserved specimens. We describe the first record of 2 pregnant females of *G. mutica* in the urban area of Hermosillo, Sonora. We confirm that our record is the most northwestern of its range and increases its northern distribution by 125 km from the nearest historical record. Santa Martha Cave also has hundreds of *Macrotus californicus*. The site where we show the new record is concurred by people who go hiking and the roost faces human disturbance. Defining the northwestern limits of *G. mutica* range is crucial because conservation strategies are focused on core populations, but edge populations provide valuable conservation opportunities.

Key words: Cave; city; Glossophaginae; nectar-feeding bat; roost.

El murciélago lenguetón de Pallas *Glossophaga mutica* (Merriam, 1898) es de las especies más generalistas de la subfamilia Glossophaginae. *Glossophaga mutica* es común en áreas tropicales, pero en el desierto de Sonora es una especie rara, la cual enfrenta amenazas como cambios en el uso de la tierra y disturbio en sus refugios. Para tener conocimiento de las especies de murciélagos urbanos en Hermosillo, una ciudad en el desierto de Sonora colocamos un par de redes de niebla en la Cueva Santa Martha. Este refugio está ubicado en el Cerro La Cementera y se encuentra a menos de 120 m de la avenida más cercana y a menos de 400 m en línea recta de un centro comercial. Para definir la distribución norteña confirmamos las localidades, identificamos los registros con georreferencias incorrectas e identificación de los especímenes disponibles en GBIF. Reportamos el primer registro de 2 hembras preñadas de *G. mutica* en el área urbana de Hermosillo, Sonora. Confirmamos que nuestro registro es el más noroccidental de su distribución y se incrementa su distribución por 125 km del registro histórico más cercano. La Cueva Santa Martha también posee cientos de *Macrotus californicus*. El sitio donde mostramos el nuevo registro es concurrido por personas que practican senderismo y el refugio enfrenta disturbio humano. Definir los límites noroccidentales de la distribución de *G. mutica* es crucial porque las estrategias de conservación se enfocan en las poblaciones núcleos, pero las poblaciones que se encuentran en los límites de su distribución proveen oportunidades de conservación.

Palabras clave: Ciudad; cueva; Glossophaginae; murciélago nectarívoro; refugio.

The Palla´s Long-tongued bat *Glossophaga mutica* (Merriam, 1898) is a phyllostomid bat of the subfamily Glossophaginae. Recently it has changed its taxonomy and was raised as a valid species from the *Glossophaga soricina* species complex, which had 5 subspecies: *G. s. antillarum* (Rehn 1902) in Jamaica; *G. s. handleyi* (Webster and Jones 1980) synonymized with *G. mutica* from northern México to Central America and western Colombia; *G. s. mutica* (Merriam 1898) synonymized with *G. leachii* in Tres Marías Island, México; *G. s. soricina* (Pallas 1766) in South America east of the Andes and *G. s. valens* (Miller 1913) in South America west of the Andes (Calahorra-Oliart *et al.* 2022). Its distribution goes from northern México to Central America and northwestern Colombia (Calahorra-Oliart *et al.* 2021). According to the IUCN Red List, it is considered as Least Concern and has a stable population trend. However, *G. mutica* has elevated as a recent species and is not categorized by the IUCN but is included in *G. soricina* (Barquez *et al.* 2015).

Glossophaga mutica, is a medium-sized bat with brown to reddish-brown fur (Merriam 1898; Uribe and Arita 2005). Broad rostrum, flat and swollen (Merriam 1898), with a length very close to the cranial box (Uribe and Arita 2005). The upper canines divaricate so strongly that they are conspicuous when the skull is viewed from above (Mer-

riam 1898). The premolars are narrow and well-spaced; the molars are small and weak (Merriam 1898). The incisor teeth are well developed, the lower ones being relatively longer than the upper ones (Uribe and Arita 2005). The first upper incisor is notably larger than the external ones and noticeably procumbent (Alvarez *et al.* 1991). *Glossophaga mutica* has a complete zygomatic arch, in addition to a short tail of less than half the uropatagium (Miller 1913). Small, rounded ears; the interfemoral membrane is wide, and the post-palatal ridge is relatively uniform in height. They have relatively small wingspans with a wingspan of 25 cm on average (Uribe and Arita 2005). There is sexual dimorphism with females generally larger than males (Uribe and Arita 2005). There are morphological differences between *G. soricina* and *G. mutica*, while the insular *G. mutica*, *G. antillarum,* and *G. valens* show convergences in shape and size (Calahorra-Oliart *et al.* 2022).

It is considered the least specialized of the Glossophaginae subfamily since has an opportunist diet, mainly nectarivorous, but also eats fruits and insects (Gardner 1977; Sánchez-Casas and Álvarez 2000). Despite being the most widely distributed species of the genus (Sánchez-Casas and Álvarez 2000), there are no vegetation associations within its elevational range (< 3,000 m; Alvarez *et al.* 1991). *Glossophaga mutica* could be common in the tropical areas of its distribution, such as the Dry Forest of the Biosphere Reserve of Chamela-Cuixmala, Jalisco (Alvarez *et al.* 1991; Chávez and Ceballos 2001), but in the arid areas of the northwestern of México in Sonora, where we report this new record, is not common.

Hermosillo municipality main vegetation is scrubland and grassland, and it has large urban areas (INEGI 2010). Hermosillo municipality is characterized by its arid regions with "BWh", hot desert climate according to Köppen's climate classification (García 2004). The new record was carried out in Santa Martha cave (29° 3' 57.48" N, 110° 56' 41.91" W; 208 m), located in Cerro La Cementera, inside Hermosillo City (Figure 1). The cave is surrounded by buildings and streets. The cave is less than 120 m to the nearest avenue and less than 400 m in a straight line to a commercial mall. The vegetation in Cerro La Cementera is xerophytic shrubland with presence of *Bursera* sp., *Cercidium microphyllum, Fouquieria splendens, Guaiacum coulteri, Stenocereus thurberi,* and *Vachellia* sp. Despite the cave being inside the city, there are nearby croplands, induced grasslands, disturbed xerophytic shrubland, and Abelardo L. Rodríguez dam.

Unfortunately, the Santa Martha cave faces high levels of human disturbance. The cave roost is located next to

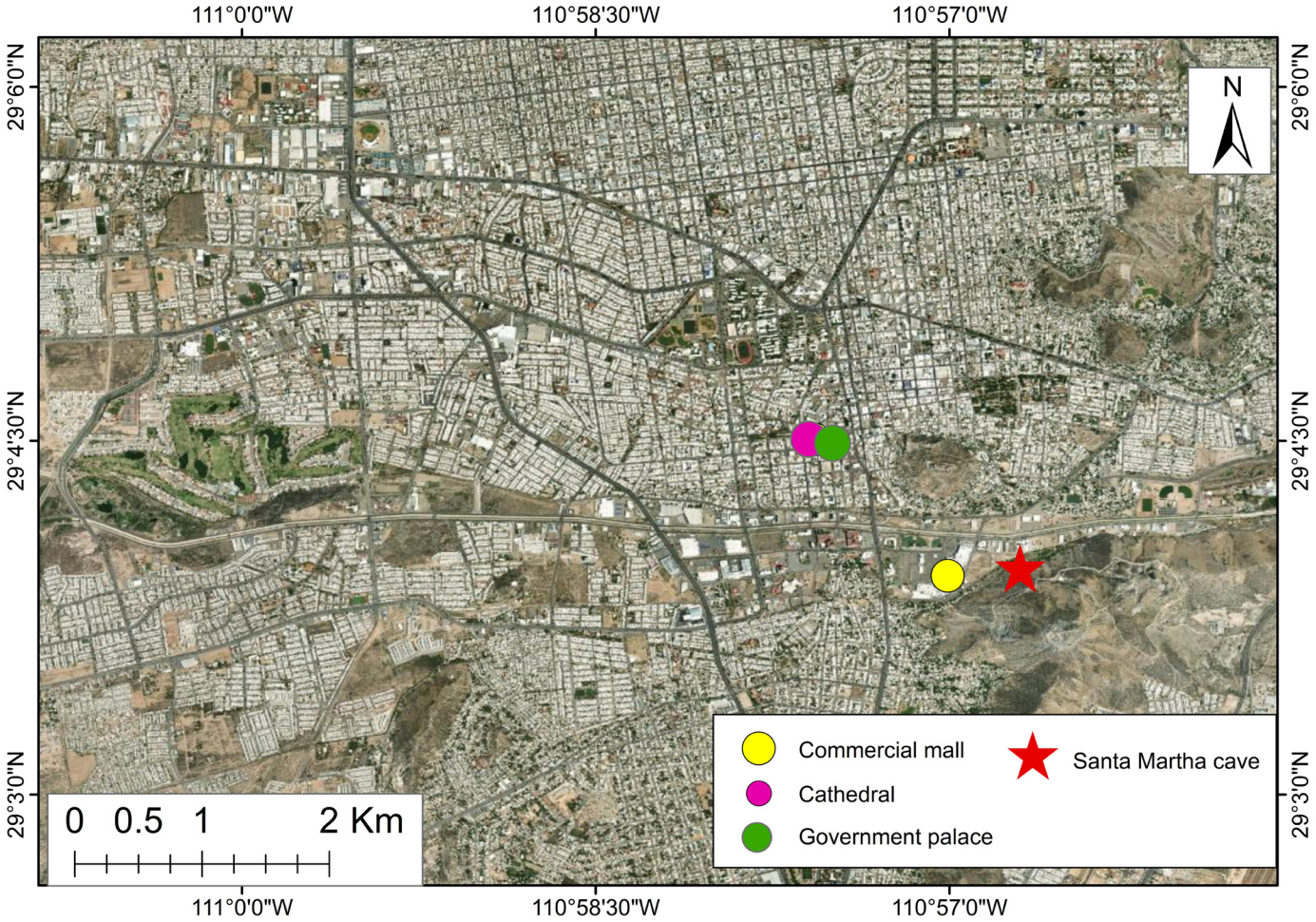

Figure 1. Santa Martha cave is inside the city of Hermosillo, Sonora, México. The commercial mall is less than 400 m from the cave and the government palace and cathedral are less than 1.7 km from the cave.

a trail that is visited by outdoors people. The disturbance can be reflected in the graffiti in the cave and its use as a trash dump (Figure 2). At the cave, the local speleological group (Grupo Espeleológico de Sonora) has done, in the past years, frequent cleaning events in collaboration with local people, in addition to continuous outreach activities. At the entrance of the cave, we installed 1 mist nest of 2 m and 1 of 6 m for 4 hr. We identified the bats using the Medellín *et al*. (2008) guide. The study followed the requirements of the General Wildlife Federal Law of México (Ley General de Vida Silvestre) under collection permit SPARN/DGVS/09981/23, issued to A. Guzmán-Velasco.

On June 3, 2023, we collected 2 pregnant female specimens of *G. mutica* in Santa Martha cave, Hermosillo City, Sonora (Figure 2d; Naturalista 2024). The individuals were captured following the guidelines of Sikes and The Animal Care and Use Committee of The American Society of Mammalogists (2016). We identified the individuals as *G. mutica* by the external characters such as the large lower incisors and the procumbent upper incisors. Also, by following the distribution of the 4 species of *Glossophaga* in México, we confirm that *G. mutica* is the only species that has distribution in the Sonoran Desert. *Glossophaga morenoi* is distributed in the Mexican Pacific lowlands from Michoacán to Chiapas and the Balsas River; *G. leachii* is an endemic species of Mesoamerica; and *G. commissarissi*, has distribution from south México until Panamá.

The forearm length of both specimens was measured with a digital caliper (0.2 mm) and was 35 and 36 mm. Because *G. mutica* is an uncommon species in the northern of its distribution and there were 2 pregnant female bats, we decided not to include a collection voucher. Our record is the most northwestern of its range and increases its northern distribution by 125 km from the nearest historical record (Figure 3). Moreover, we captured 4 non-reproductive female California leaf-nosed bats (*Macrotus*

Figure 2. a) Santa Martha cave in Cerro La Cementera, Hermosillo, Sonora with the entrance full of graffiti; b) a California leaf-nosed bat (*Macrotus californicus*) is emerging from Santa Martha cave; c) inside a chamber of Santa Martha cave can be seen graffiti; d) one of the 2 pregnant females of *Glossophaga mutica* recorded in Hermosillo, Sonora (NaturaLista 2024). Photos (a-c) by G. Gutiérrez. Photo (d) by L. de la Fuente.

californicus) in Santa Martha cave the same night. Despite its disturbance and myths surrounding the roost that could threaten the presence of bats, it hosts dozens of *M. californicus* across and *G. mutica* during summer (Figure 2a-b). This situation highlights the roost's importance for peri-urban bats and underscores the need for conservation actions to reduce disturbance.

To define the edge north of *G. mutica* range, we searched in GBIF (GBIF 2024) records with coordinates, using the scientific names "*Glossophaga soricina*", and "*Glossophaga mutica*", since not all records have updated nomenclature. We confirmed the name of collection locality, identified the incorrectly georeferenced records, and verified the identification of preserved specimens when available through digitized scientific collections. In total, we got 17,330 records (GBIF 2024). We found that the individuals apparently representing the northernmost in the distribution of *G. mutica* in Cananea municipality, Sonora, collected by Alfred L. Gardner in 1981, are incorrectly georeferenced records (GBIF ID 1897329165, 1897329169, 1897329178, 1897329213, 1897329219, and 1897329229; GBIF 2024). It is concluded that the records referring to Cananea (near the Mexico-United States border) were actually collected in Álamos, Sonora, 476 km south of Cananea.

In this way, the municipality of Álamos would have the highest number of records of *G. mutica* in Sonora. Álamos is located 288 km south in a straight line from the Santa Martha cave, making this cave the northwesternmost known record of *G. mutica* to date. Most of the records of *G. mutica* in northwestern México, including those reported here, are found in southern Sonora, in the environs of Sierra Madre Occidental, where the vegetation has a tropical affinity, mostly consisting of Seasonal Tropical Dry Forest (Álvarez-Yépiz *et al.* 2017; Bojórquez *et al.* 2021).

Another record of *G. mutica* on the northwestern limits, wrongly georeferenced, was collected in Sinaloa, but georeferenced in Baja California Sur (GBIF ID 1897329054). In the original tag of the specimen in the Smithsonian National Museum of Natural History (catalog number 553788) the collection locality was recorded in Sinaloa at 336 km south of our record (Smithsonian National Museum of Natural History 2024). Finally, in its northeast distribution, 3 records from 1957, collected by Richard D. Campbell and John H. Campbell were incorrectly georeferenced. These specimens were collected in Milpa Alta, México City, not Nuevo León (GBIF ID 1039516119, 1039523959, and 1039525282; GBIF 2024).

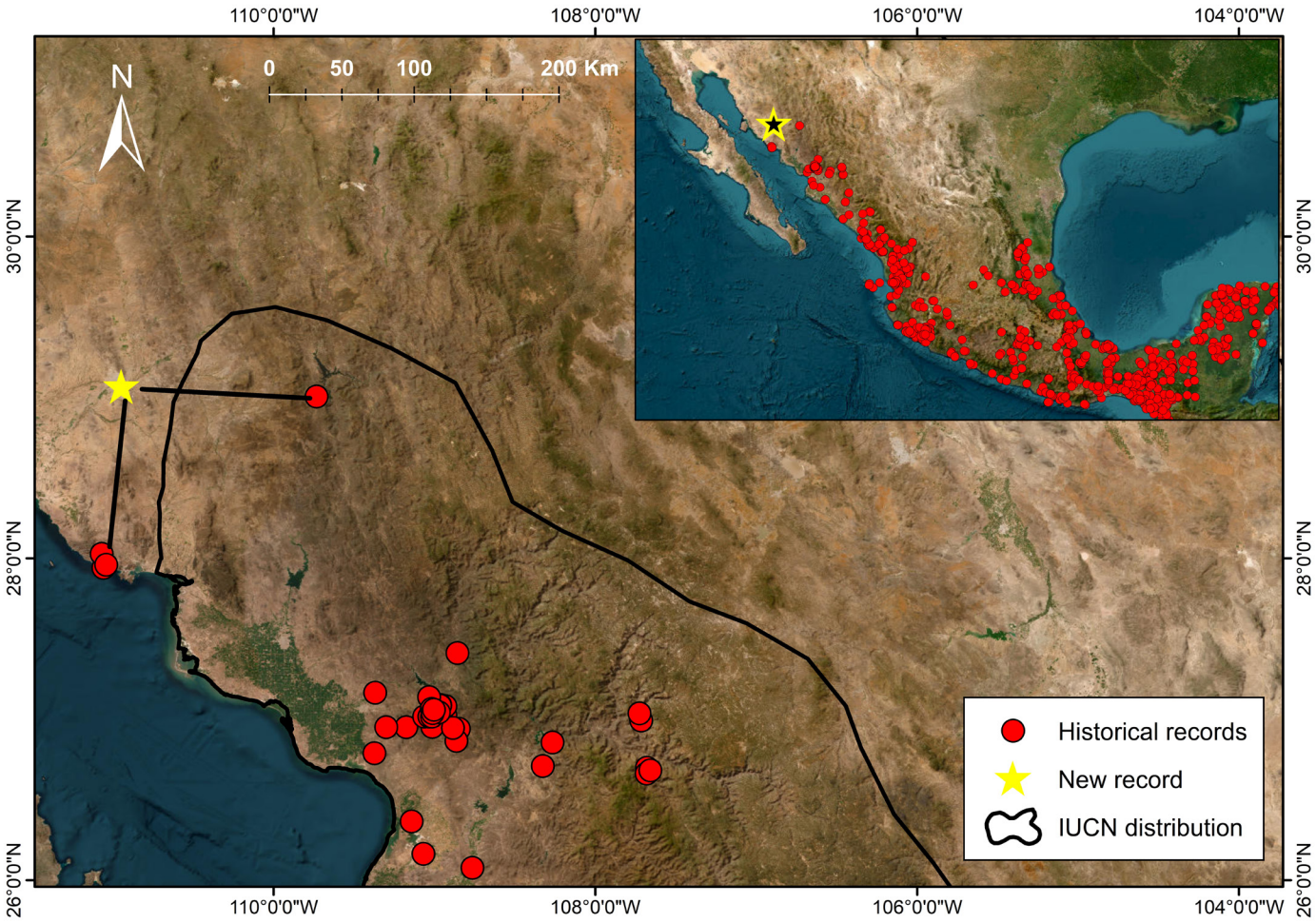

Figure 3. Map with the GBIF historical records, but without the incorrect georeferenced records in the north of the range of *Glossophaga mutica*. The new record in Hermosillo, Sonora is represented with a yellow star.

Also, we reviewed the flowering seasons of the plant species that we suspect *G. mutica* can visit to feed and were up to 70 km of the roost as the center point (*i.e.*, native columnar cacti, agave, and chiropterophilous species; Sánchez-Casas and Álvarez 2000). During the sampling day (June 3, 2023), the species that were not blooming were *Stenocereus thurberi, Carnegia gigantea, Lophocereus schottii, Pachycereus pecten-aboriginum, Stenocereus alamosensis, Acanthocereus tetragonus,* all of them are columnar cacti, and *Agave angustifolia* and *A. palmeri*. The species blooming was *Cresentia* sp., an ornamental species that is used near the roost and can produce flowers all year round; and *Pseudobombax ellipticum*, an ornamental species that blooms in May. It is important to highlight that both species that were blooming are exotic. Thus, the nectar availability was low in the study site, but it may be enough food resources to have pregnant females.

To our knowledge, this is the most northwestern and urban record of *G. mutica* and opens new ecological questions and conservation opportunities. The roost hosts dozens of *M. californicus* year-round, but for the first time, we record 2 pregnant female bats of *G. mutica*. Defining the limits of *G. mutica* range is crucial because conservation strategies are focused on core populations, but edge populations provide valuable conservation opportunities (Channell and Lomolino 2020). Of the 4 *Glossophaga* species that have distribution in México, *G. mutica* is the only one in the Sonoran Desert, but there were no historical records of the species in Hermosillo, Sonora next to an urban place. These records in a hot urban area are interesting for the occurrence of nectarivorous bat species, especially because of the proximity of the roost to the urban and commercial zone of northern Hermosillo. The roost is located at the edge of the city, thus cleaning events to remove trash and outreach activities in the long term can reduce the disturbance and allow the conservation of the cave-dwelling bat species present there.

Subterranean roosts are a limited resource for bats because of their scarce availability worldwide (Nurul-Ain *et al.* 2017). Also, the disturbance inside roosts is one of the main threats that cave-dwelling bats face (Frick *et al.* 2020). Caves next to urban areas face a high rate of land-use change, thus the ecosystem services provided could be at risk (Pretorius *et al.* 2021). Although the roost is in the vicinity of urban areas and faces high levels of disturbance, this site can become a great opportunity for conservation if it continues the cleaning programs to remove the thrash dump and the environmental education program about the importance of bats for the ecosystems and society.

The generalist diet of *G. mutica*, feeding on nectar and insects could help it to explore urban areas or next to them in a desert city. *Glossophaga mutica* can feed on insects (Clare *et al.* 2014), in natural or anthropic sites or with low food availability. But also, in anthropic sites can complement its diet with the nectar of exotic plant species (Pellón *et al.* 2021). Anthropic features such as exotic plant species could affect the occurrence of nectar-feeding bats as with *Glossophaga valens* (Pellón *et al.* 2021). Hummingbird feeders in Arizona could be affecting the foraging behavior of *Leptonycteris yerbabuenae* (Fleming 2022). So, similarly, the presence of blooming exotic species and other anthropic features could be affecting the occurrence and behavior of *G. mutica* in Hermosillo, but more studies are needed. Moreover, diet studies for nectar-feeding bats in México are almost nonexistent in Sonora, reflecting huge information gaps about the ecology of bats (Ortega-García and Saldaña-Vázquez 2022). Also, in ecological niche modeling, *G. mutica* is the one that tolerates the driest environments with low precipitation and dry seasons from the *G. soricina* complex (Calahorra-Oliart *et al.* 2022). This basic ecological data will help to inform conservation strategies of subterranean bat roosts that face disturbance and are next to urban areas. In conclusion, this northern and anthropic study site in Hermosillo opens an opportunity to address conservation and ecological topics for *G. mutica*.

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