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**First record of *Pygoderma bilabiatum* (Wagner, 1843)
(Phyllostomidae) for the Central Department of Paraguay and in
an urban area, with comments on its ecology**

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ABSTRACT

We present the first record of *Pygoderma bilabiatum* for the Central Department and its first occurrence in an urban environment in Paraguay, with comments on its ecology. An adult male individual of *P. bilabiatum* was captured on the campus of the National University of Asunción - San Lorenzo in a mist net at the edge of a secondary forest. This species is a seasonal migrant, present in the Humid Chaco ecoregion in the rainy season (October-February). This record provides new information on its distribution in the country and indicates the need for further studies related to urban areas that demonstrate their importance in supporting the high richness of bat species.

Keywords: Chiroptera, conservation, distribution, migration, urbanization

RESUMEN – Primer registro de *Pygoderma bilabiatum* (Wagner, 1843) (Phyllostomidae) para el Departamento Central-Paraguay y en un área urbana, con comentarios sobre su ecología. Presentamos el primer registro de *Pygoderma bilabiatum* para el Departamento Central y en un ambiente urbano en Paraguay, con comentarios sobre su ecología. Un individuo macho adulto de *P. bilabiatum* fue capturado en la localidad de San Lorenzo con una red de niebla al borde de un bosque secundario. Esta especie es migratoria estacional, presente en la ecorregión del Chaco Húmedo en temporada lluviosa (octubre-febrero). Este registro brinda nueva información sobre la distribución de la especie en el país e indica la necesidad de realizar más estudios en áreas urbanas, lo que demuestra su importancia como albergue de una alta riqueza de especies de murciélagos.

Palabras clave: Chiroptera, conservación, distribución, migración, urbanización

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Forested areas around the world are experiencing an intense process of fragmentation and habitat loss as a result of intense anthropogenic pressure (Huang et al. 2007, 2009; Asner et al. 2009; Lewis et al. 2009; Rudel et al. 2009; FAO 2011). While urbanization in developed countries is slowing, it has been increasing rapidly in developing countries in Asia, Africa, Latin America and the Caribbean, many of which have areas that are important because of their high biodiversity (Myers et al. 2000). Anthropogenic activities have an influence in wildlife communities with decreases in local species richness and diversity, reductions in connectivity between isolated habitats, and resulting in a loss of gene flow and ecological services (Fahrig 2003; Tabarelli et al. 2010; Laurance et al. 2011). However, there is also evidence that an intermediate level of urbanization and the maintenance of natural environments in their intersection may favor some animal populations (Voigt & Kingston 2016). Therefore, the existence of green areas in an urban matrix plays a fundamental role since they contribute to the preservation of biodiversity and to the improvement of the quality of life of the human inhabitants (MADES/PNUD/FMA 2019).

Bats are ecologically important due to their role in diverse ecological processes both in urban environments and natural areas, such as pollination of plants, seed dispersal, and control of insect populations (Jones et al. 2009). Bats also respond to human-induced changes in ecosystems (Fenton et al. 1992; Medellín et al. 2000) and are considered good ecological indicators of habitat quality (Willig 2012). Therefore, bats are a key group for the maintenance of biodiversity, and their conservation is a priority (Mickleburgh et al. 2002; Voigt & Kingston 2016).

Paraguay has 59 species of bats recorded, distributed among six families: Noctilionidae, Phyllostomidae, Vespertilionidae, Molossidae, Natalidae, and Emballonuridae (López-González 2005; Stevens et al. 2010; Owen et al. 2014; Moratelli et al. 2015). In Paraguay, as in the rest of South America, there is still little information regarding the conservation and ecology of these mammals in urban areas, and only one study related to the diversity of urban bats has been carried out within the country. The objective of this work is to present the first record of *Pygoderma bilabiatum* in the Central Department of Paraguay, expanding the known distribution of the species and recording it for the first time in an urban environment.

An AICOM (*Área de Importancia para la Conservación de los Murciélagos*) is a designated area containing bat species of national or regional conservation interest and is an essential tool used by the Latin American and Caribbean Network for the Conservation of Bats (*Red Latinoamericana y del Caribe para la Conservación de los Murciélagos/RELCOM*) to protect bat species and populations through the declaration of locally protected areas (Barquez et al. 2022). In Paraguay, there are currently eight AICOMs: one in the Dry Chaco, three in the Humid Chaco, two in the Cerrado, one in the Upper Paraná Atlantic Forest (UPAF), and another in the transition between the Humid Chaco, Grasslands, and the UPAF (Owen & Cubilla 2022). The most recently designated is the first (and only, to date) urban AICOM, the Campus of the National University of Asuncion (UNA), which lies within the Humid Chaco ecoregion.

In Paraguay, *Pygoderma bilabiatum* has been captured in mature tropical forests



and secondary vegetation (Myers 1981). The species has been recorded in the departments of Concepción, Amambay, San Pedro, Canindeyú, Cordillera, Alto Paraná, Itapúa, Paraguari, and Ñeembucú (López-González 2005; Owen & Camp 2021). These records document its presence in the Cerrado, UPAF, Humid Chaco, and Mesopotamian Grasslands. In Brazil, its presence is recorded around fruit trees (Peracchi & Albuquerque 1971) and in a variety of habitats in Argentina, such as in humid subtropical forests (Olrog 1967), including elevations as high as 2000 m a. s. l. (Bracamonte 2010). Two subspecies with disjunct distributions are recognized: *P. b. magna* known from southern Bolivia and northwestern Argentina, and *P. b. bilabiatum* distributed in eastern Paraguay, southeastern Brazil and northeastern Argentina (Webster & Owen 1984).

During bat sampling at the UNA Campus, in the city of San Lorenzo, Central Department, Paraguay (latitude -25.3378; longitude -57.5153) (Fig. 1), a white-shouldered bat *Pygoderma bilabiatum* (Wagner, 1843) (Phyllostomidae, Sternodermatinae) was captured, together with *Artibeus fimbriatus* (Gray, 1838), *A. planirostris* (Spix, 1823), *A. lituratus* (Olfers, 1818), *Sturnira lilium* (E. Geoffroy, 1810), *Eptesicus furinalis* (d'Orbigny, 1847), and *Myotis nigricans* (Schinz, 1821) (Table 1).

The individual was captured on October 8, 2021, with a mist net (9.0 m x 3.0 m) placed at the edge of a secondary forest, a remnant of a gallery forest. The net was opened after sunset for a period of four hours, and the bat was captured at approximately 22:30. The recommendations of Sikes et al. (2016) for proper handling of the individual were followed. For identification and taxonomy López-González (2005), Díaz et al. (2016), and Dos Reis et al. (2013) were followed. The individual was collected, and a standard skin and skull specimen was prepared and deposited in the Colección Zoológica de la Facultad de Ciencias Naturales (CZCEN) with catalog number CZCEN-M0187. The collecting permit was granted by the Ministry of Environment and Sustainable Development of Paraguay (MADES N° 225/2021).

The characteristics of the specimen conform to previous descriptions made for *P. bilabiatum*, as being a relatively small bat without an external tail, with large and well-developed nose leaf, broad uropatagium extending to the calcar, and covered with hair, tricolor fur, grayish brown at the base, light brown in the middle and dark brown to yellowish at the tips. The dorsal fur is darker than the ventral region and has a small white patch on each shoulder (Webster & Owen 1984; López-González 2005; Díaz et al. 2016). The specimen was an adult male showing glandular tissue well developed around the eyes and under the jaw (Fig. 2). External measurements (in mm) are as follows: head plus body length 70.9; forearm length, 38.6; ear length, 13.0; hind foot length, 8.0. In cranial morphology, it presents a bulging, almost cuboid rostrum, typical of the species and which distinguishes it from all other phyllostomids (Fig. 2). The cranial measurements (in mm) are: greatest skull length, 20.32; condylobasal length, 15.10; mastoid width, 11.41; zygomatic width, 13.97; interorbital constriction, 8.04; width between canines, 5.48; width across upper molars, 7.28; maxillary tooththrow length, 4.43; mandibular tooththrow length, 5.40 (Fig. 2). The dental formula (2/2, 1/1, 2/2, 2/2 = 28) also coincides with the formula described for males of the species (Owen



& Webster 1983).

With the record presented here, *Pygoderma bilabiatum* is recorded for the first time in an urban area in Paraguay, and the list of bat species present in the Municipality of San Lorenzo (Central Department) is updated to a total of 15 species, pertaining to 10 genera and three families (Table 1). Of the 15 species, nine are insectivorous and six frugivorous, representing 15% and 10% of the species cited for the country, respectively.

About 24% of the bat species known from Paraguay are known to make use of or at least occur in urban environments such as the Campus of the UNA. Aguita (2003) and Pacheco et al. (2008) mention that most of the bats present in urban environments are insectivorous, which was supported by Airaldi-Wood et al. (2018), who noted that artificial lights are important to attract insects, as urban structures provide shelter for these species. Regarding the nectarivorous and frugivorous species, urban areas provide sites for shelter in parks, plazas, and private areas (Uieda et al. 2008), highlighting the importance of these green areas for the conservation of urban bats.

Bats that are found in urban areas often exhibit a greater ability to forage and use available food, water, and shelters that allow them to sustain themselves in these anthropized and presumably suboptimal environments (Pacheco et al. 2008). It is also noted that behavioral and/or morphological traits of species may determine their adaptability more effectively in urban ecosystems (Jung & Threlfall 2016). The presence of *P. bilabiatum* at a site may also be due to the plant species related to its diet (Dos Reis et al. 2013). The diet of *P. bilabiatum* includes fruits of species of the families Sapotaceae, Melastomataceae, Moraceae, Solanaceae, and Myrtaceae, the latter two of which are present in our sampling site. There are also records of the consumption of fruits of *Pouteria*, *Miconia*, *Maclura*, *Ficus*, *Solanum*, and *Eugenia* (Peracchi & Albuquerque 1971; Faria 1997; Passos et al. 2003). *Pygoderma bilabiatum* is often mentioned as a resident frugivore associated with native forests and with varying degrees of habitat modification (Bracamonte 2010; Barquez et al. 2011; Sánchez et al. 2012; Sánchez 2016). In addition, Scultori & Silva (2018) inferred that the species exhibits migration or nomadism because its abundance at a site in southeastern Brazil was strongly correlated with the fruiting phenology of *Citharexylum solanaceum* (Verbenaceae), a tree native to the region whose genus is also cited within the vegetation of our sampling site in the Humid Chaco (Airaldi-Wood et al. 2018).

Esbérard et al. (2011) noted that temporal abundance patterns in *P. bilabiatum* appear to be linked to small elevational migrations associated with seasonal changes in temperature, precipitation, and reproductive cycles in females. For Paraguay, the movement patterns of the species were evaluated based on the proportion of all individuals captured in each department in each month, combining all years analyzed (1900-2002). Migratory movements were detected, designating *P. bilabiatum* as a migratory species within the country (short-distance migration), noting its presence and relative abundance for habitats found mainly in the UPAF ecoregion in the dry season (June-September) (Owen & Camp 2021). Similarly, it is more abundant during the rainy season (October-February) in other sites designated as “non-preferred habitats”. This migration pattern in Paraguay is visualized in Figure 3.



Following Owen & Camp (2021) and with our October record from the Humid Chaco, we suggest that *P. bilabiatum* uses habitats of the Humid Chaco ecoregion as an “alternative migration site” during the rainy (wet) season, indicating migration due to seasonal factors such as precipitation and temperature.

Pygoderma bilabiatum occurs in Argentina, Brazil, Paraguay, and the Plurinational

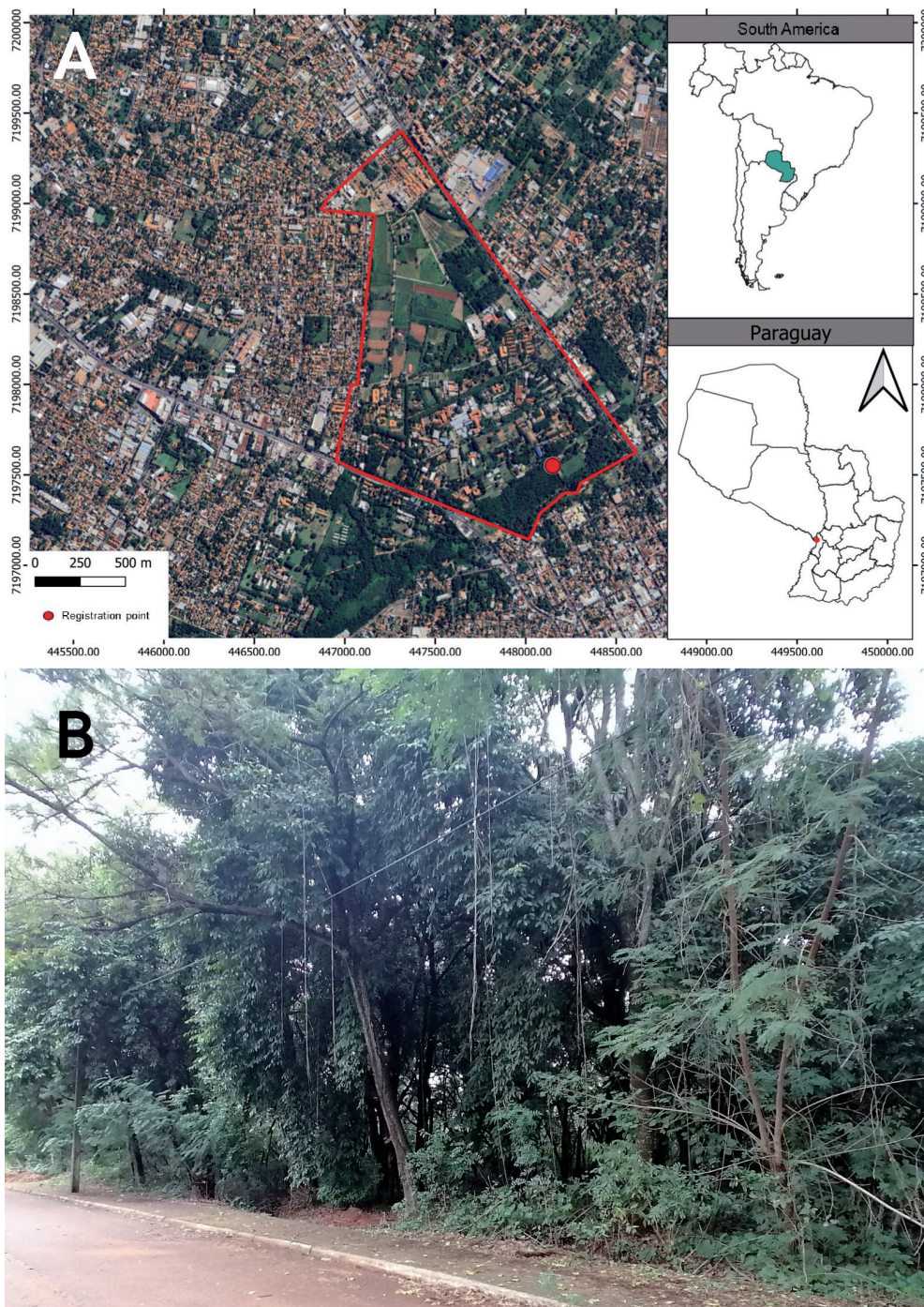


Figure 1. A) Satellite image showing the location of the new record of *Pygoderma bilabiatum* in the UNA campus, San Lorenzo, Paraguay; B) sampled area where *P. bilabiatum* was captured.

States of Bolivia (Gardner 2008; Barquez & Diaz 2015). Its global conservation status is listed by the IUCN as Least Concern (LC) (Barquez & Díaz 2015), in Argentina as Vulnerable (VU) (Sánchez et al. 2019), and in Paraguay as LC (Saldívar et al. 2017). It is estimated that their population has declined by 30% in recent years due to the loss and/or degradation of the forests where they live, which could lead to local extinctions in the short term and extinction at the ecoregional level (Sánchez et al. 2019), thus reflecting the urgent need for continued monitoring in protected wild areas as well as in AICOMs that are not located within otherwise protected areas, to monitor the current and real status of the populations throughout its distribution.

The record reported here extends the knowledge about the geographical distribution of the species known for the country, recognizing the scarcity of studies conducted in urban areas and the importance of these sites for conserving biodiversity. We also emphasize the need for further ecological studies focused on the interactions among species, aiming at a better understanding of the role of bats in these ecosystems.

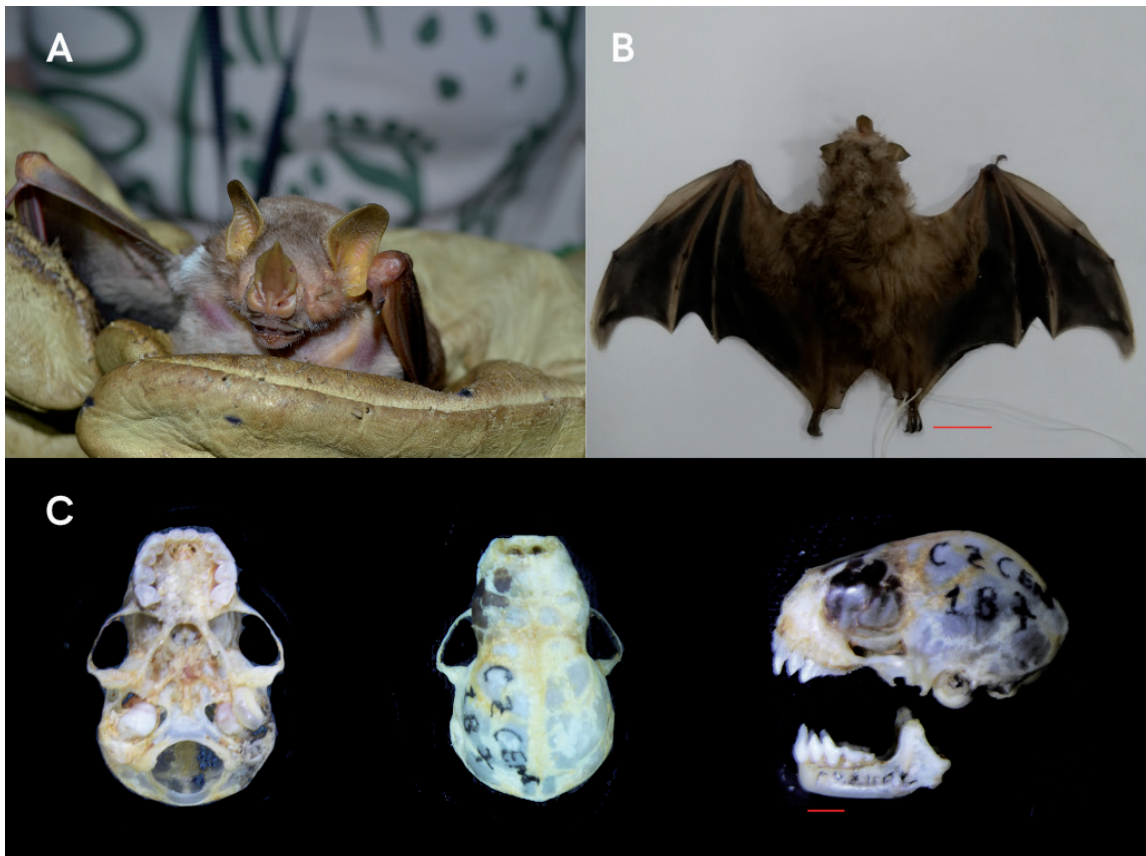


Figure 2. A) Captured specimen of *Pygoderma bilabiatum*; B) skin (scale = 20mm); C) skull (ventral, dorsal and lateral views) and mandible (lateral view), scale = 3mm.



Figure 3. Records of *Pygoderma bilabiatum* in Paraguay, by month. Relative abundance is shown as proportion of all bats captured in each department in that month, across all years (1900-2002) combined. Month followed by season in parentheses, W: Wet; V: Variable; D: dry.

Table 1. Bat species registered for San Lorenzo, Central Department, Paraguay.

Taxa	Airaldi-Wood et al. (2018)	López-González (2005)	This report (2021)
Family Phyllostomidae Gray, 1825			
Subfamily Stenodermatinae Gervais, 1856			
<i>Artibeus fimbriatus</i> (Gray, 1838)	X	X	X
<i>Artibeus planirostris</i> (Spix, 1823)	X	X	X
<i>Artibeus lituratus</i> (Olfers, 1818)	X	X	X
<i>Platyrrhinus lineatus</i> (E. Geoffroy, 1810)	X	X	
<i>Pygoderma bilabiatum</i> (Wagner 1843)			X
<i>Sturnira lillium</i> (E. Geoffroy, 1810)		X	X
Family Vespertilionidae Gray, 1821			
Subfamily Vespertilioninae Gray, 1821			
<i>Eptesicus furius</i> (d'Orbigny, 1847)	X	X	X
<i>Eptesicus diminutus</i> (Osgood, 1915)		X	
<i>Lasiurus villosissimus</i> (Palisot de Beauvois, 1796)		X	
<i>Lasiurus ega</i> (Gervais, 1856)		X	
Subfamily Myotinae Tate, 1942			
<i>Myotis nigricans</i> (Schinz, 1821)	X	X	X
Family Molossidae (Gervais, 1856)			
<i>Cynomops abrasus</i> (Temminck, 1827)	X	X	
<i>Molossops temminckii</i> (Burmeister, 1854)	X	X	
<i>Molossus molossus</i> (Pallas, 1766)	X	X	
<i>Molossus fluminensis</i> (Lataste, 1891)	X	X	
Total	10	14	7



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