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SHORT NOTES

New findings on the ecology and echolocation calls of *Chrotopterus auritus* (Chiroptera: Phyllostomidae)

Nuevos hallazgos sobre la ecología y las llamadas de ecolocalización de *Chrotopterus auritus* (Chiroptera: Phyllostomidae)

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ABSTRACT

We report new data about the big-eared woolly bat (*Chrotopterus auritus*) from an individual recorded in an artificial roost in Tucumán province, Argentina. This record represents a new locality, the fourth record in Tucuman and an update of the presence of the species after an interval of 25 years. Skull fragments found inside the roost were collected, and echolocation calls were recorded using an Echo Meter Touch 2. The echolocation calls of *Chrotopterus auritus* are multiharmonic, with pulses of modulated downward frequency. The remains of prey fragments were identified as *Thylamys sponsorius*, corresponding to a new food item reported for *Chrotopterus auritus*.

Keywords: big-eared woolly bat, bioacoustics, diet, new record.

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RESUMEN

Reportamos nuevos datos del falso vampiro orejón (*Chrotopterus auritus*) con un individuo registrado en un refugio artificial en la provincia de Tucumán, Argentina. Este registro representa una nueva localidad, el cuarto para Tucumán y una actualización de la presencia de la especie tras 25 años. Se recogieron fragmentos de cráneos encontrados dentro del refugio y se registraron las llamadas de ecolocalización emitidas por este individuo utilizando un Echo Meter Touch 2. Las llamadas de ecolocalización de *Chrotopterus auritus* son multiarmónicas, con pulsos de frecuencia modulada descendente. Los restos de fragmentos presa fueron identificados como *Thylamys sponsorius*, correspondiente a un nuevo ítem de alimento reportado para *Chrotopterus auritus*.

Palabras clave: bioacústica, dieta, falso vampiro orejón, nuevo registro.

INTRODUCTION

Chrotopterus auritus (Peters, 1856) is one of the largest bats in the Americas (Medellín 1989). This species belongs to the family Phyllostomidae and, like most species of this family, is characterized by the presence of a noseleaf. In particular, in *C. auritus*, this structure is well-developed with the lower margin elevated forming an upright cup around the nostrils (Barquez and Díaz 2020). As a member of the subfamily Phyllostominae, *C. auritus* presents large, rounded ears, extensive uropatagium, and long calcar (Cirranello *et al.* 2016). The pelage is woody with a grayish ventral coloration and dark grayish brown dorsal coloration and its wing membranes are dark with white tips (Barquez and Díaz 2020).

The species has a wide distribution extending from southern Mexico to northern Argentina, including Central and South America with the exception of Chile and Uruguay (Díaz *et al.* 2021). Specifically, in Argentina, it is reported from the provinces of Chaco, Corrientes, Formosa, Jujuy, Misiones, Salta, and Tucumán, corresponding to the ecoregions of Fields and Weedlands, Humid Chaco, Dry Chaco, Delta and Parana Islands, Paranaense Forest, and Yungas Forest (Barquez and Díaz 2020). *Chrotopterus auritus* may be able to tolerate some fragmentation, but large and well-preserved forest patches are very important for its conservation (Vleut *et al.* 2019). These animals usually form small groups of three to six individuals and use roost such as tree holes, caves, mines, and even abandoned buildings (Medellín 1989).

Regarding its diet, it is a carnivorous species that feeds mainly on small mammals, large insects (e.g., Coleoptera, Diptera, Isoptera, Lepidoptera) and arachnids, but occasionally, it has also been reported to consume fruits (e.g., *Vismia* spp., *Piper* spp., *Solanum* spp., *Cestrum* spp., and *Cecropia* spp.), pollen, birds, other reptiles, and amphibians (Bonato *et al.* 2004, Nogueira *et al.* 2006, Uieda *et al.* 2007, Witt and Fabián 2010, Vleut *et al.* 2019). It is an opportunistic species that uses the sounds produced by its prey to locate them and to a lesser extent echolocation, vision, and smell (Gual-Suárez and Medellín 2021). As for its foraging strategy, the specimens of this species capture prey from the surface of logs or the ground, in closed and complex habitats (gleaning carnivores, Gual-Suárez and Medellín 2021). Consistently, its echolocation calls are characterized by being multiharmonic and high frequency, with a short duration and broadband, which is useful to obtain high resolution in high clutter environments (Belwood 1989, Medellín 1989).

In Argentina, *C. auritus* is categorized as Least Concern, in accordance with global classifications (Barquez *et al.* 2015, Gamboa Alurralde and Barquez 2019). Although it is considered a common species in some parts of the country, regional information on the natural history, ecological and behavioral characteristics of the species is scarce. In the southernmost extent of its distribution in the Yungas region, there are only a few documented occurrences even in highly fragmented habitats (Gamboa Alurralde and Díaz 2021). Here we present an updated record of *C. auritus* from a new locality in Tucumán province and a new prey item, contributing to the knowledge of this species in our country. In turn, given the research deficit on the echoloca-

tion of phyllostomid bats (Yoh *et al.* 2020), we contribute to filling this information gap by providing the first acoustic characterization of *Chrotopterus auritus* for Argentina.

MATERIALS Y METHODS

In August 2023, a specimen of *C. auritus* (Fig. 1) was recorded in an abandoned tunnel of the old hydroelectric dam in Quebrada de Lules, located 3 km from the city of Lules, Lules department, Tucumán province, Argentina (26°53' South, 65°23' West, 593 m above sea level) (Fig. 2a). The tunnel is constructed from Portland concrete (Fig. 2b) and has a length of 3318 m with a three-by-three cross-section (Amenta and Fernández 2005). The site is located in a recovering Yungas Forest, with a mixture of native vegetation, typical of montane forest (e.g., *Juglans australis* Griseb, *Handroanthus impetiginosus* (Mart. ex DC.), *Enterolobium contortisiliquum* (Vell.) Morong) and, to a lesser degree, some introduced species (e.g., *Citrus aurantium* L.) (Tecco and Rougès 2001). Although the site is surrounded by disturbed areas, it represents one of the few remaining fragments of undisturbed Yungas Forests in the province of Tucuman. Highlighting the high degree of fragmentation that these forests have undergone, with natural habitats becoming increasingly reduced and isolated (Eliano *et al.* 2010). The principal threat to the region is land use change, specifically the conversion of forest areas into agricultural use (Pacheco and Cristobal 2009).

For acoustic characterization, the specimen was recorded inside the tunnel using an Echo Meter Touch 2 and the Wildlife Echo Meter Touch application. The recordings were made while the animal was flying inside the structure. In addition, care was taken to ensure that no other phyllostomid species were present in order to ensure the accuracy of the identification of the recordings. Calls were recorded at a sampling rate of 256 kHz, with a frequency range of 8 kHz to 128 kHz at medium sensitivity. Recordings were stored as wav files and subsequently analyzed manually with BatSound version 2.1 software (Pettersson Elektronic AB, Uppsala, Sweden). The number of passes in each recording was counted, considering a pass as a sequence of three consecutive pulses of good quality (signal-to-noise ratio > 12 dB). The following parameters were measured for each pulse on the second and third harmonics: duration, interpulse interval, initial and final frequency, bandwidth, maximum energy frequency, and maximum and minimum frequency. The analyses were performed using a Hamming window with a Fast Fourier Transforms (FFT) of 512 and an overlap of 99 % (frequency resolution of 500 Hz). The time resolution of the oscillograms and spectrograms was 0.1 ms.

Figure 1. Specimen of *C. auritus*. Foto: Mónica Díaz

Furthermore, during the visit to the site we collected a broken skull which was preserved in an airtight bag for later analysis in the laboratory. The skull was cleaned according to the protocol described in Barquez *et al.* (2021) and compared to collection specimens deposited in the Colección Mamíferos Lillo (CML, supplementary material 1) for identification to the lowest possible taxonomic level.

RESULTS

A total of fifteen audio files were obtained, six of which were effective recordings. The remaining files were discarded due to a poor signal-to-noise ratio. Regarding acoustic recordings, a total of 20 passes corresponding to 75 pulses were obtained. The echolocation calls of *C. auritus* present pulses with at least three harmonics, with the second being the one with the maximum energy. They were characterized by a downward frequency modulated (FMd) component with a wide bandwidth ranging from 118.8 kHz to 69.3 kHz (Fig. 3). The values for each acoustic parameter and a comparison with reference literature from other countries are shown in Table 1.

The present record of *C. auritus* was obtained in Lules department, Tucumán Province, approximately 95 km from the nearest previously documented site. In Tucumán province, only three records of *C. auritus* had been previously confirmed (Alberdi, Burruyacú, and La Cocha) (Fig. 2a), with the last dating back to 1998 at Dique Escaba (Alberdi department).

The collected skull was found beneath the animal while it was perched, along with decomposing organic material whose nature could not be identified. The skull was determined to correspond to a *Thylamys sponsorius* (Thomas, 1921) (Didelphimorphia, Didelphidae) (Fig. 4). The characteristics that allowed its identification at the genus level were the fenestrated palate dentition and the shape of the nasals (Teta *et al.* 2009). Likewise, the supraorbital region lacked pointed processes and the rostrum was longer and narrower compared to sympatric species such as *Thylamys venustus* (Thomas, 1902) (Flores *et al.* 2000, Voss 2022).

The *C. auritus* individual was observed sharing the roost with *Desmodus rotundus* (É. Geoffroy Saint-Hilaire, 1810) (Phyllostomidae) and *Myotis* sp. (Vespertilionidae). Within the tunnel, individuals of different species were widely distributed, separated by about 1 km.

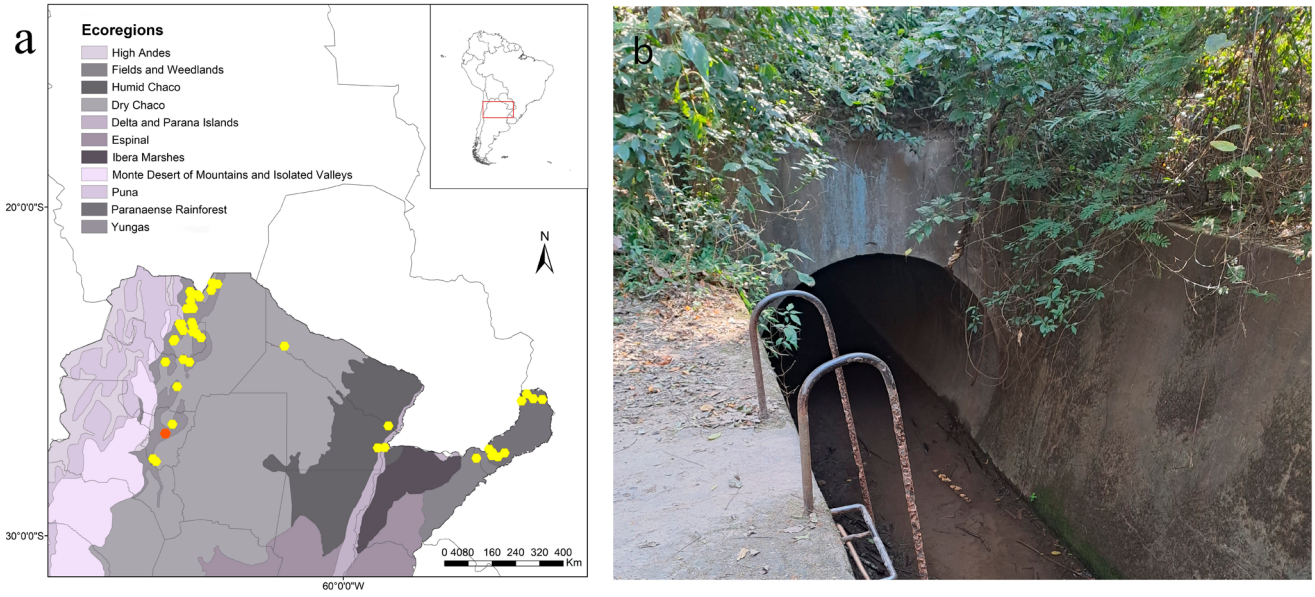

Figure 2. a. Map of the distribution of *C. auritus* in Argentina. The yellow dots show the known distribution of this species, and the red dot indicates the new locality added in this study. **b.** Artificial roost used by *C. auritus*

Table 1. Parameters of echolocation calls of *C. auritus* from the present study in comparison with those reported in the literature from Mexico and Brazil. Mean ± SD or the minimum–maximum ranges of the parameters (in parenthesis) are indicated.

Country	H	SF (kHz)	EF (kHz)	BW (kHz)	FME (kHz)	Fmin (kHz)	Fmax (kHz)	D (ms)	IP (ms)	References
Argentina	2	101.9±5.2	71.2±1.1	30.7±5.0	81.4±0.7	72.0±5.3	84.7±8.4	3.4±0.5	74.1±21.2	This study
	3	116.7±2.4	93.2±3.5	23.4±2.2	102.4±3.1	91.2±15.0	109.5±9.0	2.3±0.3	-	
Mexico	-	-	-	-	118.2±5.6	103.2±5.4	141.8±5.6	3.5±0.8	-	Ortega *et al.* (2022)
Brazil	2	83±3 (76–86)	71±3 (68–75)	-	77±1 (76–78)	88	67	1.1±0.2 (0.8–1.4)	-	Yoh *et al.* (2020)
	3	110±5 (98–117)	79 ±3 (74–85)	-	91±4 (84–102)	117	73	2.2±0.5 (1.4–29)	-	

H: harmonics, SF: start frequency, EF: end frequency, BW: bandwidth, FME: frequency with maximum energy, Fmin: minimum frequency, Fmax: maximum frequency, D: call duration, IP: inter-pulse interval

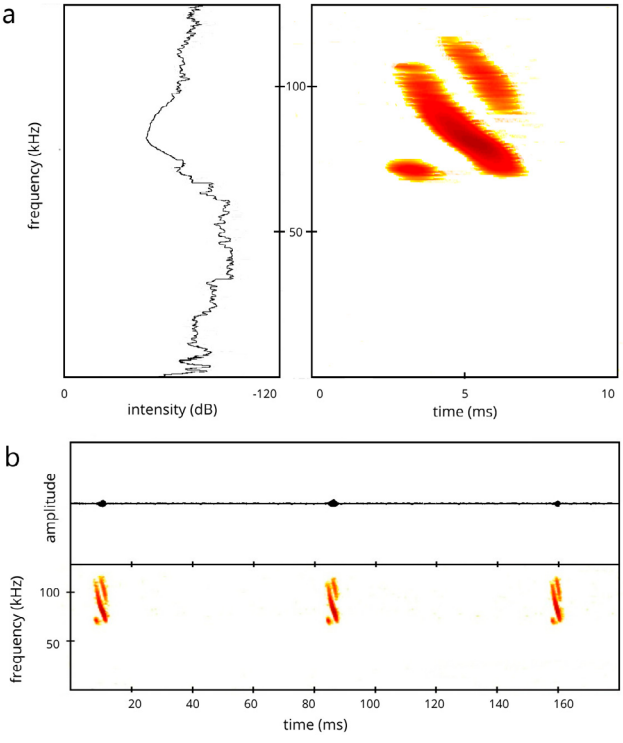

Figure 3. **a.** Representative power spectrum (left) and spectrogram of a single echolocation call emitted by *C. auritus* **b.** Representative oscillogram (above) and spectrogram (below) of a pass of echolocation calls emitted by *C. auritus*. Hanning window, FFT size 512, overlap 99 %, sample rate 256 kHz

DISCUSSION

The echolocation calls reported in this study are the first for *C. auritus* in Argentina and are consistent with those described in other parts of its distribution (Table 1). The characteristics exhibited in its calls are in line with the habitat type and foraging strategy of the species. The emission of multiple short-duration, broadband harmonics allows for more information about the environment and better discrimination of prey from background objects, which is especially useful in saturated environments such as forests (Jones 1999, Jakobsen *et al.* 2013). It should also be noted that phyllostomids produce calls of low intensity and high directionality (Brinkløv *et al.* 2009), making them difficult to record with acoustic devices. For this reason, mist netting remains the most efficient technique for capturing this family of bats (Denzinger and Schnitzler 2013). Consequently, most acoustic studies have focused on insectivorous species (Jennings *et al.* 2004, Jung *et al.* 2014, Arias-Aguilar *et al.* 2018), and data on call parameters remain scarce for many phyllostomid bats (Leiser-Miller and Santana 2020).

It has been documented that *C. auritus* often rejects the rostra of mammals, as well as other hard and bony areas, when consuming its prey (Medellín 1989). Although rodents are the most common prey of *C. auritus* (Bonato *et al.* 2004, Uieda *et al.* 2007), marsupials are also pres-

ent in its diet, though usually not identified to species level (Bonato *et al.* 2004, Witt and Fabián 2010). Here, we provide the first evidence of *T. sponsorius* remains consumed by *C. auritus*. *T. sponsorius* is a small marsupial endemic to Argentina with a body mass ranging from 12 to 56 g with scansorial habits (Martin c2019). It is distributed in the northwestern of the country, occurring in the provinces of Salta, Jujuy, Tucumán and Catamarca, with the Yungas ecoregion having the highest number of records (Flores et al. 2000, Martin c2019). No remains of bats, birds and other vertebrates were recorded in this case, despite their mention in other studies (Bonato *et al.* 2004, Borloti *et al.* 2019, Gual-Suárez and Medellín 2021). Because the data presented here constitute an occasional record, future research should adopt a systematic approach to improve knowledge of the trophic ecology of *C. auritus* in Argentina.

This record updates the known distribution of the species in Tucumán Province after more than two decades. It also provides an intermediate locality between previous records, suggesting the potential for a broader or more continuous distribution than previously reported.

The Yungas ecoregion is of particular relevance as it represents the southernmost distribution of Andean tropical forest (Brown *et al.* 2002). Forest fragmentation, reduced resource availability and bioclimatic factors negatively affect mammal richness and densities in this region (Ojeda *et al.* 2008, Castilla *et al.* 2020). Consequently, this area represents the southern distribution limit for many tropical bat species (Sandoval Salinas *et al.* 2021). Populations at distribution edges often occupy suboptimal and fragmented habitats, resulting in lower population densities compared to central areas (Hoffmann and Blows 1994, Brown *et al.* 1995). This could explain the fact that, despite C. *auritus* being regarded as having a low tolerance to environmental disturbances, it is occasionally recorded in moderately anthropized sites, as observed by our survey site (Wilson *et al.* 1996, Vleut *et al.* 2019, Gamboa Alurralde and Díaz 2021).

Further studies are required to determine the size and status of bat populations in the region, to enable the implementation of effective management plans for the conservation of these animals. In this context, and based on the findings reported here, the site it has recently been declared by RELCOM (Latin American and Caribbean Bat Conservation Network) as a SICOM (Site of Importance for the Conservation of Bats) (S-AR-008), proposed for the PCMA (Argentine Bat Conservation Program) in collaboration with the tourism agency of the town of Lules as one of the stakeholders involved. In this particular case, the site hosts species of conservation interest due to their important role in the functioning of the ecosystem. In addition, the site contains roosts that are used either permanently or temporarily by one or more conservation-relevant species. SICOMs are very important tools for bat conservation through the declaration of locally protected sites. The SICOM includes actively carrying out outreach, conservation, and research. The research aims to expand knowledge of the species of bats inhabiting the site.

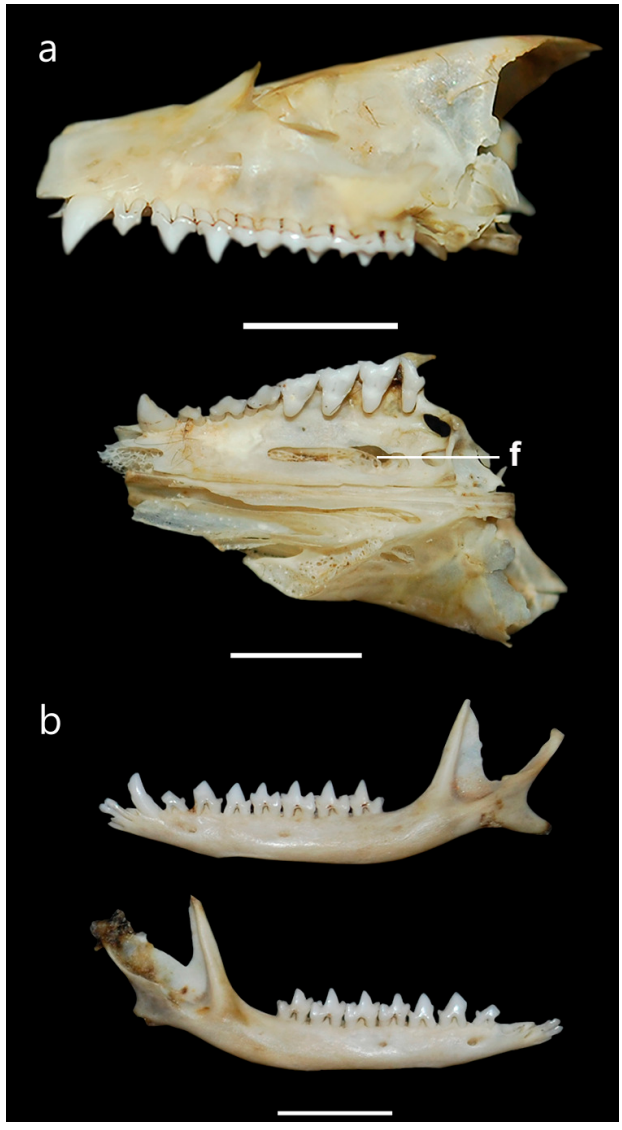

Figure 4. **a.** Lateral and ventral views of the skull of *T. sponsorius*, f: fenestrated palate. **b.** Lateral view of hemi-mandibles of *T. sponsorius*. Scale = 5 mm

AUTHOR CONTRIBUTIONS

All authors contributed to the study conception and design. Material preparation, data collection and analysis: CSGN, MFLB, MJP, MLO and MMD. Writing initial draft: CSGN. Writing critical review and commentary of revision: CSGN, MFLB, MJP, MLO and MMD. Supervision: MMD. All authors read and approved the final manuscript.

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CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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