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First record of *Centronycteris centralis* (Chiroptera: Emballonuridae) from Honduras

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ABSTRACT
Centronycteris centralis Thomas, 1912 has been included in lists of Honduran mammals; however, there are no verified records of the species for the country. We present the first verified record based on acoustic sampling at the Texiguat Wildlife Refuge, northern Honduras. This bat is a forest specialist that needs protected areas for its survival. Although this new record does not extend the distribution of the species, it confirms its presence in Honduras and highlights the relevance of the protected area housing the species. With the current record of *C. centralis*, there are now 112 confirmed bat species for Honduras.

Key words: acoustic sampling, aerial insectivores, forests, biodiversity, Thomas' shaggy bat.

RESUMEN. Primer registro de *Centronycteris centralis* (Chiroptera: Emballonuridae) para Honduras. *Centronycteris centralis* Thomas, 1912 ha sido incluido en listas de mamíferos de Honduras, sin embargo, no existen registros verificados de su presencia en el país. Presentamos el primer registro verificado a partir de muestreos acústicos en el Refugio de Vida Silvestre Texiguat, en el norte de Honduras. *Centronycteris centralis* es un especialista de bosque que necesita áreas protegidas para su supervivencia. Si bien este nuevo registro no extiende la distribución de la especie, confirma su presencia en Honduras y resalta la relevancia de esta área protegida. Con el presente registro de *C. centralis* hay 112 especies de murciélagos confirmadas para Honduras.

Palabras clave: biodiversidad, bosques, insectívoros aéreos, muestreos acústicos, murciélago peludo de Thomas.

Thomas' shaggy bat *Centronycteris centralis* Thomas, 1912 (Chiroptera: Emballonuridae) is a small (5–6 g) and long-haired species with a shaggy appearance (Reid 2009). This species has ears that are distinctively long, sickle-shaped, and pointed (Reid 2009). It has been reported to range from southern Mexico

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to southeastern Peru, typically in lowlands up to 500 m in elevation, although in Panama, it has been documented up to 1,450 m (Simmons & Handley 1998; Alberico et al. 2000). Habitats where it has been found include primary, secondary and semi-deciduous forests, and occasionally disturbed areas, although it has always been considered a rare species (Reid 2009). There is little information available on its natural history (Timm et al. 1989; Arroyo-Cabrales et al. 2015). Emmons & Feer (1997) suggested that it begins foraging shortly after sunset and tends to repeatedly fly the same path. A review of long-term acoustic monitoring in Belize showed that activity frequently begins at civil twilight, before it is completely dark, and remains active throughout the night (B. Miller, unpublished data).

Most surveys for bats in the Neotropics have been based on mist net sampling, therefore more is known about phyllostomids than aerial insectivorous bats (Kalko & Handley 1996; Kalko & Schnitzler 1998). As a result of mist net sampling, published distributions, activity patterns, and habitat associations of many aerial insectivores, including Thomas' shaggy bat is biased (Miller 2003; Jung & Kalko 2011; Genoways et al. 2020). Ground-level nets sample less than 10% of the flight space under a typical rainforest canopy (Voss & Emmons 1996). Emballonurids such as *C. centralis* have well-developed echolocation and generally avoid mist nets. The majority of aerial insectivorous bats are captured with harp traps rather than mist nets and are more readily detected acoustically (O'Farrell & Miller 1999; Miller 2003; Palacios-Mosquera et al. 2020).

The vocal signature of *C. centralis* was first described in Belize in 1995 (O'Farrell & Miller 1999) and has an unmistakable FM single inverted "U" of "hoop" shaped pulses that are typical of the family Emballonuridae. Given the avoidance of mist nets and its low capture rates, the species has been previously considered rare (Emmons & Feer 1997; Simmons & Handley 1998; Reid 2009). For example, in Belize, prior to acoustic survey methods, there was only a single record for the species (Sanderson 1941). However, harp traps and acoustic surveys have shown that it is, in fact, relatively common in suitable habitats (Miller 2003, 2009). It is hypothesized that Thomas' shaggy bat feeds by gleaning insects from the surfaces of leaves and branches or by taking slow-flying insects on the wing; alternatively, it could use a combination of these two strategies (Woodman 2003). It roosts in hollow trees or on tree trunks (Reid 2009); however, there have been observations of *C. centralis* roosting on the underside of large leaves, such as those of *Philodendron* sp. (Castaño & Corrales 2007).

Thomas' shaggy bat has been included in lists of mammals occurring in Honduras (Mora et al. 2018) based on several sources (e.g., Goodwin 1942; McCarthy et al. 1993; Reid 2009). The International Union for Conservation of Nature shows its potential range crossing northern and eastern Honduras (Arroyo-Cabrales et al. 2015). However, there have been no verified records of this species in Honduras (Turcios-Casco et al. 2020). Vocalizations of the species apparently were recorded at the Cuyamel-Omoa National Park in the department of Cortés (Hernández et al. 2016). However, the authors did not provide more than the generalized location

in their unpublished report. Here we confirm the presence of Thomas' shaggy bat in Honduras based on vocalizations of this species recorded in the Department of Atlántida.

We undertook bat surveys at the Texiguat Wildlife Refuge (TWR) in northern Honduras (centered ca. latitude 15.5; longitude -87.3) in September 2018. The TWR includes the following life zones (sensu Holdridge 1967): the core area and buffer zones are Subtropical Wet Forest and Lower Montane Wet Forest, with the buffer zone also including Tropical Moist Forest (Fig. 1). These life zones have high floristic diversity, with trees that exceed 35 m in height, such as *Calophyllum brasiliense* Cambess, *Liquidambar styraciflua* Linnaeus, and *Magnolia yoroconte* Dandy (Mora 2012). The elevation ranges for the buffer zone are 352–1,767 m a. s. l., and for the core zone, 376–2,043 m a. s. l. The average annual temperature in these life zones ranges between 17°C and 24°C, while the average annual precipitation is between 2,000 and 4,000 mm (Holdridge 1967).

We used an Anabat SD 2 (Titley Scientific 2021. https://www.titley-scientific.com/us/) to opportunistically record bats at Campamento de Montaña (latitude -15.53068; longitude 87.29726; 1,004 m) and La Liberación (latitude -15.53056; longitude 87.29722; 987 m) for six nights on September and October 2018. Acoustic data were recorded in zero-crossing format and reviewed using the AnalookW (4.5.y) analysis program. Calls were compared to a reference library of known vocal signatures and measurements made with the same acoustic analysis program (O'Farrell & Miller 1999). The current master call library has over 1,990,000 call records, of which 7,373 are *Centronycteris centralis* recorded at 137 unique locations in five countries. In addition, we reviewed records of *C. centralis* in the Global Biodiversity Information Facility (GBIF 2021).

We identified 28 species of bats in Texiguat, counting 14 aerial insectivores, including *Eumops* sp., *Rhogeessa* sp., and Thomas' shaggy bat (Table 1). We recorded the search phase call of Thomas' shaggy bat (Fig. 2) on 21 October 2018, at 20:46 h and 20:47 h. This was 3 hours 21 minutes after sunset (17:25 h) at La Liberación, a degraded area of pastureland (Fig. 3) in the buffer zone of Texiguat located at approximately 1.5 km from the core zone of the refuge (Fig. 1). We also recorded the following species during the same recording session: *Saccopteryx bilineata* (Temminck, 1838) (Emballonuridae), *Pteronotus fulvus* (Thomas, 1892) and *Pteronotus gymnonotus* (Wagner, 1843) (Mormoopidae), and an unidentified *Eumops* species (Molossidae). Sonospecies are useful to identify unknown vocal signatures by genera and family (Ochoa et al. 2000). Several species of Molossidae and Vespertilionidae potentially occurring in Honduras have yet to be verified acoustically, noted by the sp. following the genus in Table 1. Five acoustic files of 15 seconds recorded between 20:46 h and 20:47 h included diagnostic calls of *C. centralis*.

The vocal signature of this species is characterized by a narrow band width, frequency modulated rising, and falling inverted "U" pulse shapes (Fig. 2), with the mean characteristic frequency (Fc) of the dominant harmonic being 40.6 kHz (O'Farrell & Miller 1997, 1999). A combination of shapes and characteristic frequencies of

pulses are diagnostic for this species identification. We measured 1,496 pulses with a mean Fc of 40.6 kHz diagnostic to *C. centralis*. The pulses measured (Table 2) from recordings at Texiguat had a Fc ranging from 38.1–41.4 kHz, and 90% covered the diagnostic 40.6 kHz frequency, thus falling within the range of this species.

Research on bats present in Honduras has increased in the last ten years (Mora 2018; Mora et al. 2020). As a result, 112 species are now confirmed for the country (Mora et al. 2021), including *C. centralis.* The general distribution range of *C. centralis* includes Honduras, and the species was included in the species lists of the bats of Honduras, although no official record existed to confirm its presence in the country (Turcios-Casco et al. 2020). Although the number of species for Honduras does not change, our report confirms the presence of the species in the country.

Thomas' shaggy bat is known to be very rare throughout its range (Simmons & Handley 1998; Arroyo-Cabrales et al. 2015). The GBIF database has 54 records listed as *C. centralis*, a relatively low number for a species with a wide-ranging distribution. This species belongs to a less mobile species group of bats, with large-surfaced, broad wings that are found mainly in forest habitats (Bader et al. 2015). This could explain why it is most commonly found in mature forests, and why its presence decreases in anthropogenically altered habitats such as pastures and settlements (Bader et al. 2015). Similarly, in a study in northern Costa Rica the species was only recorded at forested sites, with no individuals being detected on pineapple or banana plantations (Alpízar et al. 2019). In addition, several insectivorous bat species are known to forage primarily along forest edges, and in semi-open spaces within the forest or above the canopy far from vegetation (Schnitzler & Kalko 2001). For example, in Nicaragua, several Thomas' shaggy bats were observed foraging together along cleared telegraph right-of-ways (Bonaccorso 2019). The individual we detected in Texiguat was active over a pastureland cleared for livestock production, albeit 1.5 km from the nearest forest (Fig. 3). This area has an undulating topography that includes a ravine, with grasses in areas without strong slopes, and forest occupying the steepest areas such as the slopes adjacent to streams. However, mobile open-space and edge-foraging bat species may use altered habitats as potential foraging habitats and might even take advantage of temporary insect outbreaks in open areas (Alpízar et al. 2019). This could explain the presence of *C. centralis* in the open areas at Texiguat. Notwithstanding the foregoing, this bat seems to be a forest specialist with limited mobility, characteristics that have a high impact on its habitat occupancy, and thus the species can be used as a predictor of susceptibility to habitat change (Bader et al. 2015).

The TWR is one of the few protected cloud forests in Honduras, with the dominant vegetation being broadleaf forest and pine forest, and transition zones between these two types of forests (Galdames et al. 2018). The refuge has a high degree of endemism of flora and fauna (Mora 2011; Townsend et al. 2012). Unfortunately, despite being a protected area, forested areas within the buffer zone have been cleared for cattle ranching (Fig. 3) (Galdames et al. 2018). Thomas' shaggy bat roosts in hollow trees and on tree trunks in forest understories (Bonaccorso 2019). The species, therefore,

depends on forest cover to survive, and consequently, forest conservation is key to safeguarding both this species and bat species diversity in agriculturally dominated landscapes (Alpízar et al. 2019).

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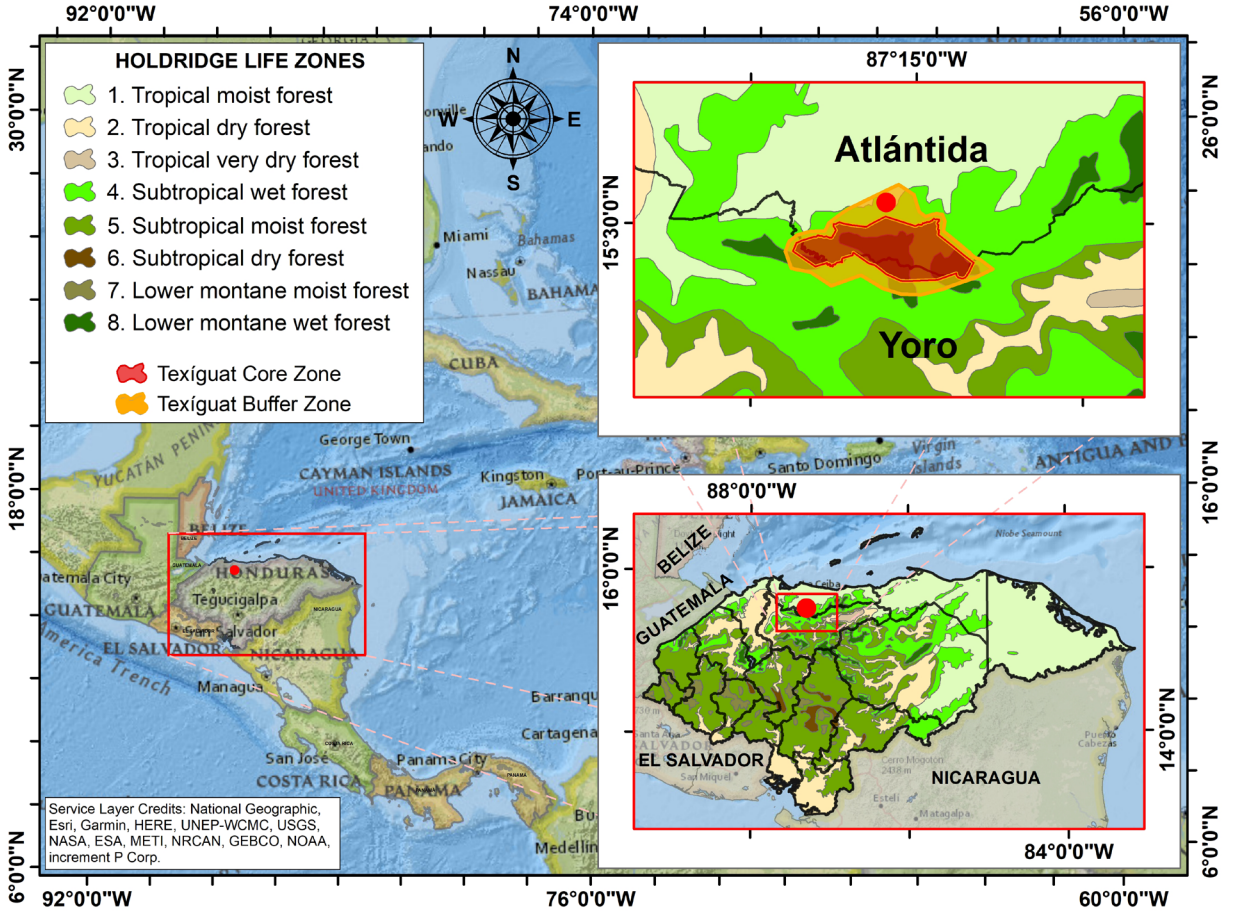

Figure 1. Location of the Texiguat Wildlife Refuge in Northern Honduras and where the *Centronycteris centralis* was recorded (red dot).

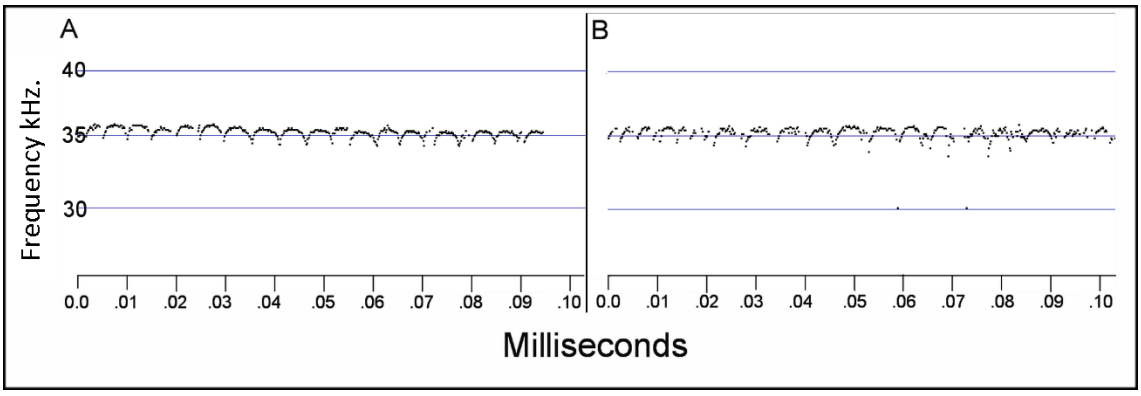

Figure 2. Diagnostic time-frequency display of a search phase call of *Centronycteris centralis*. An example of diagnostic calls recorded in Belize "A" (O'Farrell & Miller 1997, 1999) is provided for comparison of calls recorded in Texiguat National Wildlife Refuge, Northern Honduras "B". The time between calls is compressed in order to display the diagnostic call sequence. Both are displayed using AnalookW vers. 4.6.c.

Figure 3. Recording site of *Centronycteris centralis* at the edge of the forest (on the background) in a pastureland, a common land use in the cloud forest of the buffer zone of the Texiguat Wildlife Refuge, northern Honduras.

Table 1. Bat species recorded acoustically in two sites of the Texiguat Wildlife Refuge, northern Honduras: Campamento de Montaña (CdeM) and La Liberación (LL).

Family	Species	CdeM	LL
Emballonuridae			
	Centronycteris centralis Thomas, 1912		X
	Peropteryx macrotis (Wagner, 1843)		X
	Saccopteryx bilineata (Temminck, 1838)		X
Mormoopidae			
	Pteronotus davyi Gray, 1838		X
	Pteronotus gymnonotus (Wagner, 1843)		X
Vespertilionidae			
	Eptesicus furinalis (d'Orbigny & Gervais, 1847)	X	X
	Myotis elegans Hall, 1962	X	
	Rhogeessa sp.	X	X
	Bauerus dubiaquercus (Van Gelder, 1959)		X
	Lasiurus ega (Gervais, 1856)		X
	Lasiurus intermedius H. Allen, 1862		X
Molossidae			
	Eumops sp.		X
	Molossus nigricans Miller, 1902		X
	Molossus molossus (Pallas, 1766)		X

Table 2. Diagnostic parameters measured from calls of *Centronycteris centralis* at Texiguat Wildlife Refuge, Northern Honduras with 90% values of calls. Key parameters are pulse duration (Dur), interval between pulses (TBC) both measured in milliseconds, and the characteristic frequency (Fc) as KiloHertz of the dominant harmonic.

Parameters	N	Min	Max	Mean	Standard deviation	90%
Dur	1,496	0.19	6.76	1.07	1.48	3.15
TBC	1,491	0.3	2,247.2	34.5	112.0	107.0
Fc	1,496	38.10	41.45	39.89	0.54	40.61

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