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Filling gaps in the distribution of the four free-tailed bat species of the genus *Nyctinomops* Miller, 1902 (Mammalia, Chiroptera, Molossidae), with three new records for Guatemala

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Abstract
We found the four species of *Nyctinomops* Miller, 1902 living in sympatry in central Guatemala. All specimens were found dead under turbines of a wind farm. *Nyctinomops femorosaccus* (Merriam, 1889), was previously known from northern Mexico and southwestern United States, and this record extends its distribution at least 1150 km southward, representing the first record for Guatemala and Central America. Although *N. aurispinosus* (Peale, 1848) and *N. macrotis* (Gray, 1839) were already known from Central America (Honduras), and these are the first records for Guatemala.

Keywords
Carcass, Central America, Villa Canales, wind farm

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Introduction

The genus *Nyctinomops* Miller, 1902 comprises four Neotropical species: *N. laticaudatus* (E. Geoffroy St.-Hilaire, 1805), *N. femorosaccus* (Merriam, 1889), *N. aurispinosus* (Peale, 1848), and *N. macrotis* (Gray, 1839) (Simmons 2005; Eger 2008). All species of the genus were formerly included in *Tadarida* Rafinesque, 1814, with *Nyctinomops* treated as a subgenus (Freeman 1981; Hall 1981; Simmons 2005). Following an analysis of morphological and evolutionary relationships of bats within the family Molossidae, Freeman (1981) proposed to treat *Nyctinomops* as a distinct genus. Her results revealed that the four species were grouped apart from *Tadarida* (Freeman 1981; Kumirai and Jones 1990).

Both morphological and molecular phylogenies (Gregorin and Cirranello 2015; Dolman and Ammerman 2016) placed the four species in the genus *Nyctinomops* and found the genus to be monophyletic, although there is still some incongruence in the phylogenetic position of the genus among molossids. Molecular phylogeny within *Nyctinomops* (Dolman and Ammerman 2016), based on cytochrome b gene, places *N. macrotis* as the sister species of the other three, and *N. aurispinosus* as the sister species of a clade composed of *N. femorosaccus* and *N. laticaudatus*. There appears to be enough genetic difference between species, with *N. femorosaccus* and *N. laticaudatus* being genetically more similar, with approximately 1.7% of genetic divergence (Kimura 2 parameter), and they are at approximately 5.5 to 6% genetically differentiated from *N. aurispinosus*. The remaining species, *N. macrotis*, is 8–11% genetically distanced.

Although the genus is widely distributed in the Americas, the species frequently show fragmented patterns, with important gaps in Central America, a region poorly known for the group. This is probably due to the high-aerial flight habits of these species, their difficulty in being captured with mist nets; the complicated task of differentiating species from echolocation calls, and the lack of inventories. *Nyctinomops laticaudatus*, *N. aurispinosus*, and *N. macrotis* occur in North to South America but with large gaps in their geographic ranges in Central America.

Nyctinomops laticaudatus is probably the best-known species of the genus. It is distributed from Tamaulipas and Guerrero, Mexico, to northern Argentina and southeastern Brazil, and in the Caribbean, it has also been reported from Cuba and Trinidad and Tobago. In Central America, this species has been reported from Belize, Guatemala, El Salvador, Honduras, Nicaragua, and Panama. In Guatemala, *N. laticaudatus* is only known from a few scattered localities in central and northern parts of the country (Avila-Flores et al. 2002; Simmons 2005; Reid 2009; Medina-Fitoria 2014; Barquez et al. 2015b). *Nyctinomops aurispinosus* is distributed from Sonora and Tamaulipas, northwestern Mexico, to South America, with records from Venezuela, Colombia, Ecuador, Peru, Bolivia, Paraguay, and Brazil (Jones and Arroyo-Cabrales 1990; Simmons 2005; Solari 2019). In Central America, this species has been reported only from Honduras (Espinal et al. 2016). *Nyctinomops macrotis* is distributed in North America from British Columbia, Canada, and Iowa, USA, to southeastern Mexico, and from Colombia to northern Argentina and Uruguay in South America, and in the Caribbean, it is also known from Cuba, Haiti, Dominican Republic, and Jamaica (Milner et al. 1990; Simmons 2005; Reid 2009; Barquez et al. 2015a). In Central America, *N. macrotis* has been reported only from Honduras (Mora et al. 2016). Finally, *N. femorosaccus* was considered restricted to North America, from California, Arizona, Texas, and New Mexico, USA, to Nuevo León, Jalisco, Michoacán, and Guerrero, Mexico (Kumirai and Jones 1990; Simmons 2005; Arroyo-Cabrales and Alvarez-Castañeda 2015). In Mexico its southernmost limit is in Tlalchapa in Guerrero state (Almazán-Catalán et al. 2009).

The four species are morphologically similar and the main differences are size (Kumirai and Jones 1990; Dolman and Ammerman 2016). *Nyctinomops macrotis* is the largest species of the genus and, thus, is easily recognizable. Nevertheless, there is a possibility of misidentification of the remaining three species due to the overlap of some external morphological measurements. Therefore, cranial measurements become essential for the correct identification of these species.

Our objective of this study was to determine to species all specimens of *Nyctinomops* recently found dead in a wind farm in central Guatemala, as well as document other bat species affected by turbines.

Methods

Between 2015 and 2016, hundreds of bat carcasses were found on the ground under the turbines of a wind farm in Los Llanos village, approximately 5.7 km south and 3.5 km west of Santa Elena Barillas, Villa Canales municipality, Guatemala. Geographic coordinates for the locality are approximately 14°36′25″N, 090°55′27″W, and the elevation is approximately 1240 m (Fig. 1). All geographic coordinates use the WGS84 datum.

The wind farm is located on the northern slope of the Pacaya Volcano, very close to the shore of Lake Amatitlán, and it is near the southern part of the large metropolitan area of Guatemala City. The vegetation in the area near the wind farm is typical of the Premontane Humid Forest Ecosystem of central Guatemala, which has predominantly pine-oak species associations. The landscape surrounding the farm has mainly native forests, grasslands, reforested patches, crops of corn, coffee, and mostly pineapple, meadows, urbanization, and even some industries (Ixcot et al. 2007; IARNA-URL 2018).

Specimens were collected, temporarily preserved frozen and then transported to the School of Biology at Universidad de San Carlos de Guatemala in Guatemala City. In the laboratory, all specimens were prepared as study skins or as fluid preserved specimens, and skeletal material was cleaned with the help of a dermestid beetle colony (Fig. 2). Seventeen specimens of the genus *Nyctinomops* were deposited and catalogued at the collection of mammals, School of Biology, Universidad de San Carlos de Guatemala (USAC; Table 1).

Prior to the preparation of study skins, standard information was recorded, including sex, age, and reproductive condition of specimens. Age of specimens was determined based on the amount of ossification of the epiphysial cartilages of the fourth metacarpal-phalangeal joint (Brunet-Rossinni and Wilkinson 2009). External measurements were taken with a common ruler and included: total length (TL), tail length (T), length of right foot (F), length of right ear (E) and forearm length (FA). Cranial measurements were taken in the laboratory using Mitutoyo Absolute Coolant Proof IP 67 digital calipers to the nearest 0.01 mm.

Cranial measurements included the following: greatest length of skull (GLS), height of braincase (HB), mastoid width (MW), zygomatic width (ZW), length of rostrum (LR), postorbital constriction (PO), width across upper canines (CC), maximum external width between left and right upper molars (WUM), length of maxillary toothrow (CM^3), length of palatal (LP), length of mandible (LM), and length of mandibular toothrow (CM_3) (Hall 1981; Kumirai and Jones 1990; Gregorin and Taddei 2002; Gardner 2008). Measurements for each species defined *a priori* were compared with those cited by Hall (1981) and Kumirai and Jones (1990), in order to explore the grade of morphometric differentiation of species. For this purpose, we conducted a morphometric multivariate principal component analysis (PCA), using the software

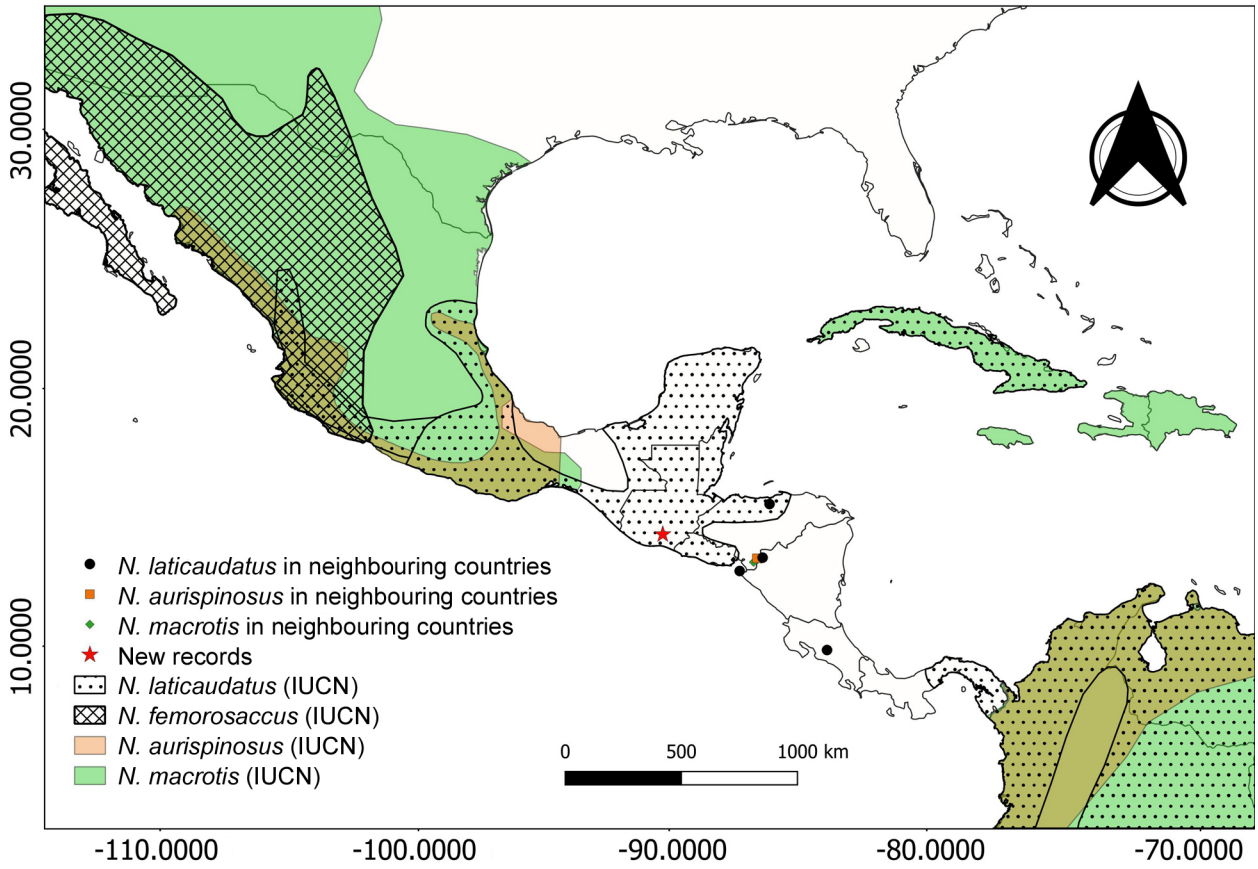

Figure 1. Distribution of *Nyctinomops* species according to the IUCN (Arroyo-Cabrales and Álvarez-Castañeda 2015; Barquez et al. 2015a, 2015b; Solari 2019): *N. laticaudatus*, *N. femorosaccus*, *N. aurispinosus*, and *N. macrotis*. New locality in Guatemala and records of the species in neighboring countries are plotted.

Table 1. Eighteen morphological measurements of 17 specimens of *Nyctinomops*. TL = total length, T = tail length, F = foot length, E = ear length and FA = forearm length; GLS = greatest length of skull, HB = height of braincase, MW = mastoid width, ZW = zygomatic width, LR = length of rostrum, PO = postorbital constriction, CC = width across upper canines, WUM = maximum external width between left and right upper molars, CM^3 = length of maxillary toothrow, LP = length of palatal, LM = length of mandible, CM_3 = length of mandibular toothrow. All measurements except weight are given in millimeters (mm). Sex and voucher number are included.

Species	Catalogue	Sex	FA	TL	T	F	E	W	GSL	HB	MW	ZW	PO	LR	CC	WUM	CM^3	PL	LM	CM_3
N. macrotis	USAC 06041	♀	61	134	54	14	30	22	23.6	7.97	12.45	na	4.35	6.30	5.01	8.94	8.96	8.51	17.31	9.98
N. aurispinosus	USAC 06042	♂	52	112	51	13	23	20	na	na	10.86	11.58	na	5.36	na	na	8.08	7.07	na	na
N. aurispinosus	USAC 06199	♀	50	na	na	na	na	na	21.07	7.65	11.37	11.81	3.85	5.37	4.47	8.53	8.08	7.68	14.66	8.56
N. femorosaccus	USAC 06040	♀	49	110	41	11	17	17	18.85	7.51	10.46	11.23	3.79	5.15	4.52	8.11	7.55	6.69	13.52	8.13
N. femorosaccus	USAC 06105	♀	49	107	42	11	20	13	na	na	10.32	11.28	na	na	na	na	7.56	na	13.11	8.11
N. laticuadatus	USAC 06098	♂	45	104	37	10	16	13	17.93	7.85	9.91	10.23	3.89	4.85	3.84	6.99	6.70	6.43	12.26	7.26
N. laticuadatus	USAC 06099	♀	43	95	27	10	17	11.5	17.49	7.89	9.84	9.88	3.66	5.00	4.06	7.02	6.79	6.17	12.05	7.16
N. laticuadatus	USAC 06100	♀	44	105	39	10	17	14	na	na	na	na	3.71	4.81	na	na	6.70	6.00	12.04	7.15
N. laticuadatus	USAC 06101	♀	44	104	40	10	17	12.5	17.63	7.66	9.68	9.85	3.79	4.88	4.08	7.05	6.59	6.04	11.84	6.98
N. laticuadatus	USAC 06102	♀	44	103	40	11	17	11	17.7	8.10	9.82	9.92	3.78	4.74	3.77	6.93	6.74	6.15	12.03	7.01
N. laticuadatus	USAC 06103	♀	43	100	36	9	18	11.5	na	na	na	9.46	3.80	4.81	3.81	6.90	6.49	5.90	11.99	6.85
N. laticuadatus	USAC 06106	♀	45	99	38	9	19	14	na	na	na	na	na	na	na	na	6.59	na	11.96	7.19
N. laticuadatus	USAC 06108	♂	45	101	38	10	16	11	17.52	7.57	9.94	10.01	3.64	4.24	4.03	7.04	6.70	6.13	12.11	7.18
N. laticuadatus	USAC 06109	♀	44	97	35	8	16	12	na	5.19	na	na	na	na	3.21	5.40	5.17	5.79	9.73	5.27
N. laticuadatus	USAC 06110	♀	46	102	37	10	14	11.5	17.85	na	9.82	9.96	3.71	4.59	3.97	7.23	6.74	6.27	12.02	7.00
N. laticuadatus	USAC 06111	♀	42	103	33	8	18	12	na	na	na	10.11	3.75	4.67	3.99	7.04	6.69	6.14	12.14	7.28
N. laticuadatus	USAC 06112	♂	43	104	40	8	17	13	17.39	7.73	9.70	10.05	3.74	4.24	3.71	7.30	6.71	6.45	12.06	7.19

XLSTAT v. 2019.3 (Addinsoft Inc., USA). All data were log-transformed (Log10) to reduce the effect of differences in scale of measurements and we used the nearest neighbor imputation value to fill in missing values (Beretta and Santaniello 2016).

Results

All 17 adult specimens analyzed had morphologically distinctive features of the genus *Nyctinomops*: deeply wrinkled upper lips; second phalanx of the fourth digit

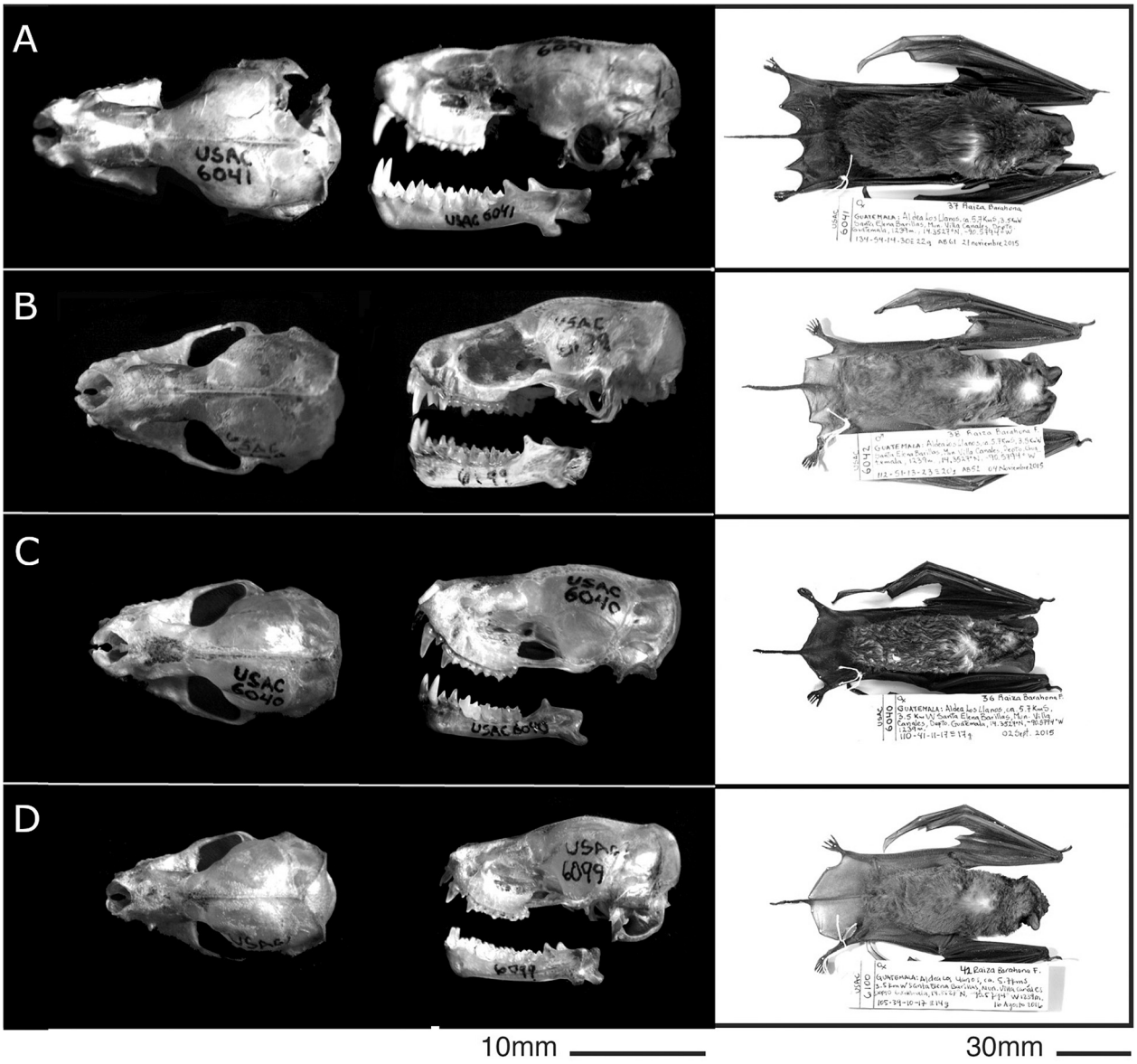

Figure 2. Dorsal view of skull, lateral view of skull and mandible, dorsal view of study skins. **A.** *Nyctinomops macrotis* (USAC 6041). **B.** *Nyctinomops aurispinosus* (USAC 6199). **C.** *Nyctinomops femorosaccus* (USAC 6040). **D.** *Nyctinomops laticaudatus* (USAC 6099).

less than 5mm; and large ears joined at the midline, which when laid forward reach the snout. The four species are mainly differentiated from one another by their size (Freeman 1981; Kumirai and Jones 1990). FA, GLS, and CM^3 are three diagnostic characters used to differentiate species (Hall 1981; Kumirai and Jones 1990; Gregorin and Taddei 2002; Dolman and Ammerman 2016). For each species, a unique range of values for these characters has been described, allowing for the classification of individuals by their multi-dimensional morphological distinctions (Table 2). Following this, 12 individuals were recognized as *N. laticaudatus*, two as *N. femorosaccus*, two as *N. aurispinosus*, and one as *N. macrotis* (Table 1).

Additionally, the distribution of the analyzed specimens on the PCA plot shows the distinction of four different groups, and in each of these groups there is the same number of individuals as found in the morphometric analysis (Fig. 3). First principal component (PC1) accounted for the largest amount of variation, approximately 82%, while PC2 accounted only to 8%. The distribution of specimens in the PCA points cloud shows segregation based on general size, in which the species are mainly distributed from smaller to larger, mainly along PC1. *Nyctinomops laticaudatus* is the smallest species of the genus with the specimens grouped in the left side of PC1 of the plot; the opposite end is occupied by the largest species, *N. macrotis*. In the center of the plot and very close to each other, are *N. femorosaccus* and *N. aurispinosus*, which despite their closeness, are clearly separated (Fig. 3).

Nyctinomops laticaudatus E. Geoffroy St.-Hilaire, 1805

Material examined. GUATEMALA • 12 specimens, 3 adult males and 9 adult females; Guatemala Department: Villa Canales Municipality, Los Llanos Village; 14°36′25″N, 090°55′27″W; 1240 m a.s.l.; 12 Aug. 2015,

Table 2. Comparison of diagnostic characters used to discriminate between *Nyctinomops* species; minimum and maximum values obtained from dead specimens found dead in a wind farm at Los Llanos, Villa Canales, Guatemala, Guatemala, contrasted with those described in 2 published keys (Hall 1981; Kumirai and Jones 1990). FA = forearm length, GLS = greatest length of skull, CM^3 = length of maxillary toothrow. All measurements are given in millimeters (mm).

Measurements	*N. macrotis*		
	Kumirai & Jones 1990	Hall 1981	This study
GLS	>22	22.2–24.0	23.6 (n = 1)
CM^3	>8.5	8.2–9.5	8.96 (n = 1)
FA	>54	58.0–63.8	61 (n = 1)
Measurements	*N. femorosaccus*		
	Kumirai & Jones 1990	Hall (1981)	This study
GLS	<20	18.4–20.3	18.85 (n = 1)
CM^3	>7.0 (≤ 7.5)	7.0–7.7	7.55–7.56 (n = 2)
FA	≤49 (45–49)	45–49.2	49 (n = 2)
Measurements	*N. aurispinosus*		
	Kumirai & Jones 1990	Hall (1981)	This study
GLS	≥20	20.5–21.6	21.07 (n = 1)
CM^3	≥ 7.9	7.8–8.2	8.08 (n = 2)
FA	>47 (48–53)	47.8–51.4	50–52 (n = 2)
Measurements	*N. laticaudatus*		
	Kumirai and Jones 1990	Hall (1981)	This study
GLS	< 20	16.7–18.5	17.39–17.93 (n = 7)
CM^3	< 7	6.1–6.9	5.17–6.79 (n = 12)
FA	41–45	40.8–45	43–46 (n = 12)

22 Aug. 2015, 2 Sep. 2015, 16 Oct. 2015, 22 Jul. 2016, 5 Aug. 2016, 16 Aug. 2016, 16 Aug. 2016 and 22 Sep. 2016; Raiza Barahona Fong and Lemuel Valle leg.; USAC 6098 to 6102, USAC 6103, USAC 6106, USAC 6108 to 6112.

Identification. *Nyctinomops laticaudatus* is the smallest species of the genus and therefore differs from *N. aurispinosus* and *N. macrotis*. In contrast, *N. laticaudatus* presents a small morphometric overlap with *N. femorosaccus* from which it can be distinguished by its larger-thumb, more-separated ears, and thicker-hairs in the uropatagium (Ávila-Flores et al. 2002). Morphological measurements described as diagnostic for this species are: FA = 40.8–45 mm; GLS = 16.7–18.5 mm; CM^3 = 6.1–6.9 mm (Hall 1981; Kumirai and Jones 1990), measurements obtained for the specimens analyzed in this study are: FA = 43–46 mm (n = 12); GLS = 17.39–17.93 mm (n = 7); CM^3 = 5.17–6.79 mm (n = 12).

Nyctinomops femorosaccus (Merriam, 1889)

Material examined. GUATEMALA • 2 specimens, adult females; Guatemala Department: Villa Canales Municipality, Los Llanos Village; 14°36′25″N, 090°55′ 27″W; 1240 m a.s.l.; 26 Aug. 2015 and 02 Sep. 2015; Raiza Barahona Fong leg.; USAC 6040 and 6105.

Identification. *Nyctinomops femorosaccus* is a small to medium-sized species that differs from *N. laticaudatus* by having a shorter-thumb, closer-ears, and fine-hairs in the uropatagium. It differs from *N. aurispinosus* in having smaller-teeth and a less inflated braincase and in its general size, with *N. aurispinosus* larger than *N. femorosaccus*. (Table 1; Kumirai and Jones 1990). Morphological measurements described as diagnostic for this species are: FA = 45–49.2 mm; GLS = 18.4–20.3 mm; CM^3 = 7.0–7.7 mm (Hall 1981; Kumirai and Jones 1990), measurements obtained for the specimens analyzed in this study are: FA = 49 mm (n = 2); GLS = 18.85 mm (n = 1); CM^3 = 7.55–7.56 mm (n = 2). Specimens of *N. femorosaccus* were also recognized based on two additional cranial features: posterior margin of palate terminating posterior to M3–M3; and crown of M1 nearly square (Fig. 4; Hall 1981; Kumirai and Jones 1990).

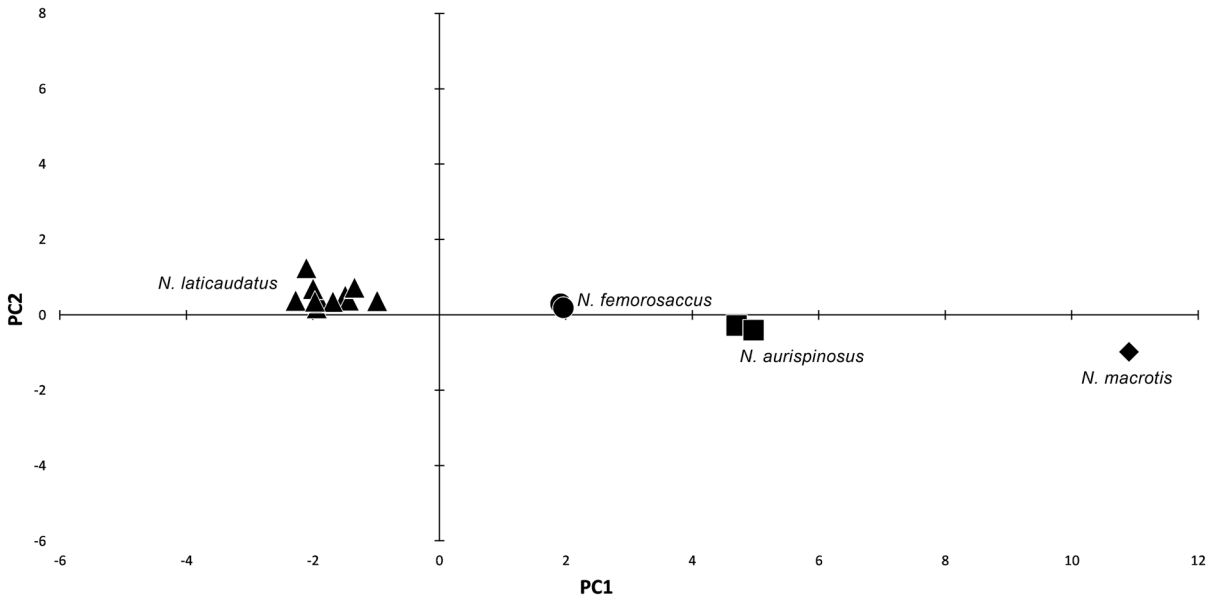

Figure 3. Scatter plot of the two principal components for 17 specimens of *Nyctinomops* from Los Llanos, Villa Canales, Guatemala, Guatemala.

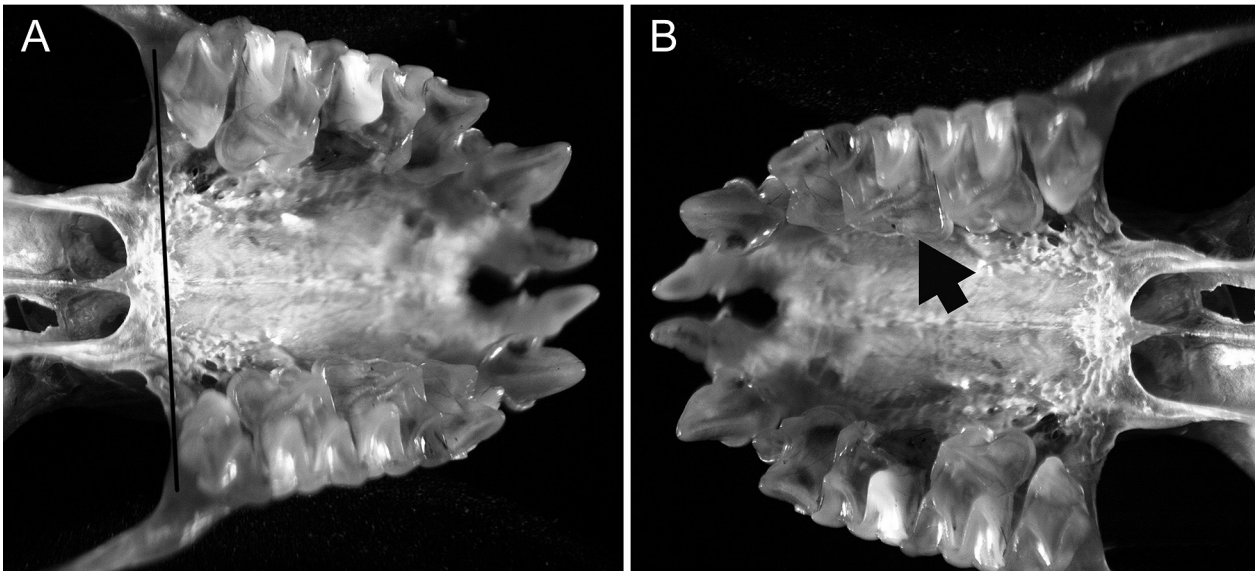

Figure 4. Characters used to validate the taxonomic identification of *N. femorosaccus* specimens. **A.** Posterior margin of palate terminating posterior to M3–M3 (line indicates the characteristic). **B.** Crown of M1 nearly square (arrow indicates the characteristic).

***Nyctinomops aurispinosus* Peale, 1848**

Material examined. GUATEMALA • 2 specimens, 1 adult male and 1 adult female; Guatemala Department: Villa Canales Municipality, Los Llanos Village; 14°36′25″N, 090°55′27″W; 1240 m a.s.l.; 04 Nov. 2015 and 23 Jun. 2016; Raiza Barahona Fong and Lemuel Valle leg.; USAC 6042 and 6199.

Identification. As stated above, *N. aurispinosus* is a medium-sized species that differs from *N. femorosaccus* in having larger CM^3 and CM_3 and a more inflated braincase. There is no overlap between *N. aurispinosus* and the smallest and largest species of the genus (Table 1; Jones and Arroyo-Cabrales 1990). Morphological measurements described as diagnostic for this species are: FA = 47.8–53 mm; GLS = 20.5–21.6 mm; CM^3 = 7.8–8.2 mm (Hall 1981; Kumirai and Jones 1990). Measurements obtained from the specimens in this study are: FA = 50–52 mm (n = 2); GLS = 21.07 mm (n = 1); CM^3 = 8.08 mm (n = 2).

***Nyctinomops macrotis* (Gray, 1839)**

Material examined. GUATEMALA • 1 specimen, adult female; Guatemala Department: Villa Canales Municipality, Los Llanos Village; 14°36′25″N, 090°55′27″W; 1240 m a.s.l.; 21 Nov. 2015, Raiza Barahona Fong leg.; USAC 6041.

Identification. *Nyctinomops macrotis* is the largest species of the genus, and there is no morphometric overlap with any of the other three species (Milner et al. 1990). Morphological measurements described as diagnostic for this species are: FA = 54–63.8 mm; GLS = 22–24 mm; CM^3 = 8.2–9.5 mm (Hall 1981; Kumirai and Jones 1990). Measurements obtained from the specimen analyzed in this study are: FA = 61 m (n = 1); GLS = 23.6 mm (n = 1); CM^3 = 8.96 mm (n = 1).

Discussion

The PCA highly support the clearly differentiation of our specimens into species. Our results agree with Freeman (1981) who found that *N. femorosaccus* and *N. aurispinosus* are the species of *Nyctinomops* most similar to each other. Both of these species are morphometrically also more similar to *N. laticaudatus* than to *N. macrotis*, which makes *N. macrotis* the least similar species (Fig. 3).

The presence of *N. laticaudatus* has been documented in Guatemala over the years. Nonetheless, the majority of records are from the lowlands of Petén, northern Guatemala, although some scattered records from Alta Verapaz and Sacatepéquez are also known at mid-elevation in the mountains (Dobson 1876; Alston 1879–1882; Shamel 1931; Murie 1935; Goodwin 1955; Ryan 1960; Jones 1966; Taibel 1977; McCarthy and Pérez 2006). *Nyctinomops laticaudatus* probably is the dominant species in a huge bat colony at Biotopo El Zotz, a protected area in Petén (S.G. Pérez unpubl. data). This is the first time that this species is reported from the Department of Guatemala.

Nyctinomops femorosaccus, *N. aurispinosus*, and *N. macrotis* are reported for the first time from Guatemala, and *N. femorosaccus* is documented for the first time from Central America; our records extend the range of the species by at least 1150 km south of its previously known range at Tlalchapa, Guerrero, Mexico (Almazán-Catalán et al. 2009). This is a large distributional extension which highlights the need of more research to accurately document the geographic distribution of this and other species of this poorly known group of bats.

Our records of *N. aurispinosus* and *N. macrotis* constitute the second reports of these species from Central America. *Nyctinomops aurispinosus* had previously been reported at San Marcos de Colón, Choluteca department, southern Honduras (Espinal et al. 2016), approximately

447 km south of our records at Aldea Los Llanos, and from the district of Tehuantepec, Oaxaca, Mexico, about 547 km north of Aldea Los Llanos. Similarly, *N. macrotis* was also known from San Marcos de Colón and El Corpus, Choluteca department, southern Honduras (Mora et al. 2016). The closest previously known locality to the north is at Coapilla, Chiapas, México, which is about 409 km north of Aldea Los Llanos (Martínez-Coronel and Vidal-López 1997). So, our records of *N. aurispinosus* and *N. macrotis* represent important new information on the distribution of these species and include large range extensions and help fill the gaps in the disjunct distributions for both species.

Despite the resemblance in their general distributions, all four species of *Nyctinomops* occur in sympatry only in a small part of the Pacific coast of Mexico. *Nyctinomops laticaudatus* and *N. femorosaccus* show a pattern of allopatric distribution over nearly all of their range (Kumirai and Jones 1990; Dolman and Ammerman 2016). We present the second known report of the four *Nyctinomops* species occurring in sympatry.

Nyctinomops species are possibly migratory, as suggested by the considerable accumulation of fat on the back of most examined specimens. These bats were collected only between June and November, and some North American individuals of *N. macrotis* are known to migrate to warmer regions in winter (Barquez et al. 2015a). Migration is unknown for the three other species.

It is remarkable how the negative impacts of wind turbines have become a way to increase our knowledge of bat diversity. Particularly in our study, bat fatalities from wind farm turbines allowed for the collection of species previously unknown from Guatemala. Similarly, the only records of *N. aurispinosus* and *N. macrotis* for Honduras were also dead specimens found at wind farms (Espinal et al. 2016; Mora et al. 2016).

In addition to the *Nyctinomops* species, we found carcasses of 29 other bat species which represents the 33 percent of the bat fauna documented for Guatemala (Kraker et al. 2016): (Emballonuridae: *Balantiopteryx plicata* Peters, 1867, *Peropteryx macrotis* (Wagner 1843), Phyllostomidae: *Choeroniscus godmani* (Thomas, 1903), *Glossophaga leachii* (Gray, 1844), *G. soricina* (Pallas, 1766), *Phyllostomus discolor* Wagner, 1843, *Sturnira parvidens* Goldman, 1917, *Artibeus jamaicensis* Leach, 1821, *A. lituratus* (Olfers, 1818), *A. toltecus* (Saussure, 1860), *Centurio senex* Gray, 1842, *Chiroderma villosum* Peters, 1860, Mormoopidae: *Mormoops megalophylla* (Peters, 1864), *Pteronotus davyi* Gray, 1838, *P. gymnonotus* (Natterer, 1843), *P. personatus* (Wagner, 1843), Molossidae: *Eumops auripendulus* (Shaw, 1800), *Molossus molossus* (Pallas, 1766), *M. rufus* E. Geoffroy, 1805, *M. sinaloae* , *Promops centralis* Thomas, 1915, and Vespertilionidae*: Eptesicus fuscus* (Beauvois, 1796), *Lasiurus blossevillii*, *L. ega*, *L. intermedius*, *Rhogeessa* cf. *bickhami* Baird, Marchán-Rivadeneira, Pérez, and Baker, 2012, *Myotis albescens* E. Geoffroy, 1806, *M. keaysi* J. A. Allen, 1914, and *M. velifer* (J. A. Allen, 1890), With these findings, the documented bat species list for Guatemala has increased to 103 species.

Our data highlight the high vulnerability of bats to wind farm projects. The impacts are better known in Europe and the USA (Kunz et al. 2007). To protect bats and ensure their conservation in Guatemala and Central America, it is essential to better understand the effects that wind energy projects might have on bat populations. This would be achieved by rigorous impact studies prior to and during operation. We know that wind farms in Guatemala are giving more attention to their negative effects on wildlife, and there is interest of mitigating them.

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Authors' Contributions

RB conducted the survey and collected some of the specimens. LAT, RB, and SGP prepared the study skins. LAT measured the specimens, took the photographs and made the map. LAT, RB, and SGP wrote the manuscript. All authors read and approved the final manuscript.

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