Short Note

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Distributional extensions of *Carollia castanea* and *Micronycteris minuta* from Guatemala, Central America

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Abstract: Field expeditions in 2011 that inventoried the terrestrial vertebrate fauna of two wildlife protected areas in the tropical Caribbean of Guatemala have produced the first confirmed records of two bats for the country: the white-bellied big-eared bat, *Micronycteris* (*Schizonycteris*) *minuta* (Gervais 1856) and the Chesnut short-tailed bat *Carollia castanea* H. Allen, 1890, both of neotropical distribution and with their current northern limit at Lancetilla, Honduras. The record of *M. minuta* at Sierra de Caral, Guatemala extends the range of this species 137 km to the west, and the record of *C. castanea* at Cerro San Gil extends its range 147 km to the west.

Keywords: bats; distributional extension; Guatemala; neotropics.

Beginning in 2005, the Museo de Historia Natural of Universidad de San Carlos de Guatemala (USAC – Guatemala City, Guatemala) and the Museum of Vertebrate Zoology (MVZ – University of California, Berkeley, USA) have conducted joint studies of the diversity and evolution of the mountain vertebrate biota of Guatemala along with researchers from the Universidad Nacional Autónoma de México. In 2011, a group from these institutions visited two wildlife protected areas located in the administrative department of Izabal, in the low tropical humid mountains on the Caribbean versant of the country: Reserva de Manantiales Cerro San Gil and Sierra de Caral National Protected Area (Figure 1). The area represents a tropical region with high biological diversity, characterized by high precipitation levels. Typical vegetation includes the genera *Bombax* L. 1753, *Ceiba* Mill, 1754, *Callophyllum* L. 1753, *Sabal* Adans 1763, *Swietenia* Jacq. 1760, *Poulsenia* Eggers 1898, *Pouteria* Aubl., 1775, *Vitex* L. 1753, *Karwinskia* Zucc. 1832, *Pseudobombax* Dugand 1943, *Bursera* Jacq. ex L. 1762 and others (Ruiz 2006, Morales 2007). There are also plantations nearby, especially at the base of both mountains, like corn, pineapple and banana. Physiographically, these mountains can be considered part of the so called Motagua-Polochic fault zone, as defined by Marshall (2007), an area sandwiched between the Maya Block (North American plate) and the Chortís Block (Caribbean plate) and thus an area of high tectonic activity and frequent earthquakes. Izabal represents the northern-most limit for several neotropical mammals, such as the olingo *Bassaricyon gabbii* (J. A. Allen 1876) (Ordóñez et al. 1999) at Sierra de Caral, the bat *Trinycteris nicefori* (Sanborn 1949) and the mouse *Peromyscus tropicalis* (Goodwin 1942), at Cerro San Gil (Pérez et al. 2012, Pérez-Consuegra and Vázquez-Domínguez 2015). Kraker-Castañeda et al. (2016) included both *Carollia castanea* and *Micronycteris minuta* in the bat checklist of Guatemala, but without details on specimen descriptions, localities or habitats. The goal now is to provide further information on these specimens.

Between August 9th and 12th 2011, we collected bats around the Carboneras Biological Field Station (Figure 1) at Cerro San Gil, ca. 21.7 km South, 8.3 km West of Livingston, Izabal, Guatemala, altitude 371 m, latitude 15° 38′ 01.64″ North, longitude 88° 49′ 41.09″ West. Sampling work was next performed between August 15th and 19th 2011, at Sierra de Caral Biological Field Station (Figure 1), ca. 7.1 km South, 16 km East, Morales, Izabal, Guatemala,

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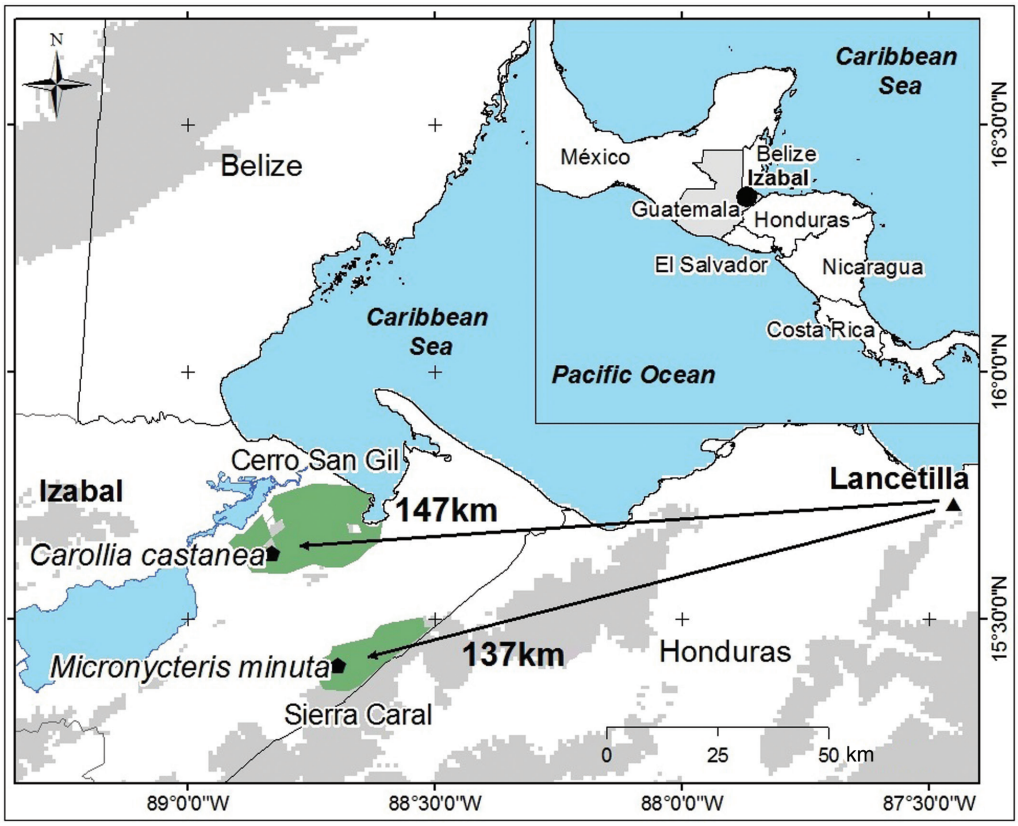

Figure 1: Map of northern Central America showing the location of Cerro San Gil and Sierra de Caral in Guatemala, Central America. Straight lines are shown for the distance of both localities from Lancetilla in Honduras, the present known north-western limit for both *Micronycteris minuta* and *Carollia castanea*.

altitude 513 m, latitude 15° 24′ 25.56″ North, longitude 88° 41′ 45.42″ West. We trapped bats with five to eight mist nets (varying between nights) at both sites, located along trails in the tropical forest at ground level, and checking each between approximately 18:30 h and 23:00 h. We initially identified all netted individuals with the help of a field guide (Reid 2009) and a field key (Medellín et al. 1997), but prepared vouchers representative of each species and field identifications were later verified in the museum, with keys as in Hall (1981). We prepared most specimens as standard dried study skins with skulls and skeletons subsequently cleaned by dermestid beetles, but some specimens were initially preserved in formalin and then transferred to 70% ethanol for long-term storage. We also took tissue samples (mainly liver) from all vouchered specimens. Preserved specimens have been archived in the collections of either the USAC or MVZ and both institutions house a tissue sample from each voucher. We also preserved ectoparasites from some specimens, all of which are stored at USAC. Some bats were identified and released in the field.

During field work, we took standard external measurements with a common ruler (in mm) and weight with a 50 g Pesola balance and recorded these measurements on specimen tags: total length (TL), length of tail (T), length of hind foot (HF), length of ear (E), and weight (Wg). Later in the laboratory, we measured directly from dry specimens the length of forearm (FA), distance from elbow of folded wing to wrist (including carpals). We then took a series of cranial measurements to the nearest 0.01 mm from the cleaned voucher specimens in the museum, using a Mitutoyo Absolute Coolant Proof IP 67 digital caliper. Selected measurements include: greatest length of skull (GLS), distance from anterior premaxilla (with incisors) to farthest point posterior on the cranium; condylobasal length (CBL), distance between anterior premaxillar (with incisors) to farthest point on the occipital condyle; mastoid breadth (MB), width across mastoid processes; zygomatic breadth (ZB), distance across widest position of arches; postorbital constriction (PC), narrowest breadth of postorbital region; breadth across canines (CC), measured at basal cusps; length of maxillary tooth row (C-M^3), distance between anterior cusp of canine to posterior cusp of last molar; length of auditory bullae (LB); and skull height (SKH). All measurements were taken in millimeters

Table 1: External and cranial measurements of *Carollia castanea* and *Micronycteris minuta*, as well as comparative specimens of related species from Guatemala (*Carollia subrufa*, *Carollia sowelli*, *Carollia perspicillata*, *Micronycteris schmidtorum*, *Micronycteris megalotis*, *Lampronycteris brachyotis* and *Trinycteris nicefori*).

	CAT#	Sex	TL	T	HF	E	Wg	FA	GLS	CBL	MB	ZB	PC	CC	CM3	LB	SKH
C. castanea	USAC5643	♂	59	6	18	11	10	36.4	18.94	17.01	10.11	9.57	5.17	4.24	6.07	2.58	8.6
	USAC5647	♀	62	9	17	12	12	36.2	19.98	17.73	9.89	9.52	5.2	4.24	6.14	2.13	8.82
	USAC5640	♀	62	7	18	12	12	35.7	19.85	17.95	10.28	9.21	5.42	4.53	6.22	2.49	8.98
	USAC5606	♀	58	6	13	14	10	36.3	19.57	–	9.67	9.87	5.42	4.3	6.28	2.67	9.03
	Mean		60.4	7	16.5	12.3	11	36.5	19.6	17.56	9.99	9.53	5.3	4.33	6.18	2.47	8.86
Carollia subrufa	USAC0142	♀	58	7	12	19	14	38.3	21.08	19.34	10.39	10.58	5.46	4.52	6.76	3.04	9.79
C. sowelli	USAC5642	♀	71	6	15	17	–	39	21.99	20.06	10.06	10.26	5.05	4.61	7.11	2.64	9.56
	USAC5572	♀	77	12	13	20	14	41	22.51	20.49	10.62	10.98	5.26	4.9	7.12	2.78	9.59
	Mean		74	9	14	18.5	14	40	22.25	20.28	10.34	10.62	5.16	4.76	7.12	2.71	9.58
C. prespicillata	USAC5618	♂	77	9	15	19	20	44	25.63	23.15	11.71	12.22	5.75	5.38	8.17	3.05	10.67
M. minuta	USAC5512	♂	55	11	10	20	6.2	32.7	17.57	15.23	8.08	7.75	4.12	2.81	6.3	2.67	8.08
	USAC5565	♀	54	11	10	20	5.6	33.7	17.67	15.78	8.33	_	4.12	2.82	6.33	2.64	8.29
	Mean		54.5	11	10	20	5.9	33.2	17.62	15.51	8.21	7.75	4.12	2.82	6.32	2.66	8.19
M. schmidtorum	USAC0997	♂	59	12	10	21	6.8	35.1	18.96	16.74	8.43	9.1	3.94	3.17	7.05	2.8	8.65
M. megalotis	USAC0999	♂	60	12	10	15	–	35.0	18.68	16.92	8.28	8.41	4.16	3.18	6.96	2.9	9.76
L. brachyotis	USAC3491	♀	74	14	13	18	–	41.4	21.3	18.93	9.48	10.577	4.99	4.1	8.18	2.83	9.57
T. nicefori	USAC1001	♂	65	08	13	16	9	37.8	21.05	19.10	8.95	9.75	4.55	3.15	7.45	2.84	8.51

CAT, catalogue number; for other acronyms see text.

(mm) and body mass in grams (g). For comparisons we conducted two principal component analyses (PCA), one for specimens of *Carollia castanea* related to three other species of the same genus captured in Guatemala, and a second analysis for specimens of *Micronycteris minuta* and three related species. We used the software Paleontological Statistics (PAST) version 3.02a (Hammer et al. 2001). Data were log-transformed to reduce the effect of differences in scale of measurements and we used mean value imputation for missing values.

We captured one adult male of *Carollia castanea* (USAC 5640, field number JEL187) and three adult females (USAC 5643, field number JEL190; USAC 5647, field number JEL194 and USAC 5606 field number SGP1834) at Cerro San Gil with mist nets set over the floor within a mature rain forest (between August 9th and 12th 2011). One female was lactating. External and skull measurements of the four specimens are given in Table 1. Comparative measurements of selected specimens of the three other related species known for Guatemala are also given: *Carollia sowelli* Baker et al. 2002, *Carollia perspicillata* (Linnaeus 1758) and *Carollia subrufa* (Hahn 1905), the first two sympatric with *C. castanea* at Cerro San Gil. *Carollia subrufa* is found mainly in the dry valleys south of this location. Principal component analysis (Figure 3B) shows the morphometric distinction of *C. castanea*, with component 1 (eigenvalue = 0.0109867) explaining 85.5% of the variation (highest component loadings: maxillary toothrow and greatest length of skull), and component 2 (eigenvalue = 0.00116845) explaining 9.1% of the variation (with highest component loadings: auditory bullae length and total skull length). *Carollia castanea* is the species of the group best segregated by its general smaller size (Mclellan 1984), but can also be externally distinguished from other related species in the area by the lack of a clear pattern of three color bands in the dorsal fur, typical of other species within the genus (Figure 2), by lacking the typical hairy forearm of *C. sowelli*, and by a browner and longer fur than *C. subrufa*, (Ortega et al. 2008). The skull of *C. castanea* shows a second lower premolar nearly twice the height of the first lower molar (Pine 1972, Hall 1981, Figure 2E).

One week later at Caral field station, we captured a single adult male of *Micronycteris minuta* (USAC 5512, field number SGP1878) and one adult female (USAC 5565, field number JAN56) on the night of August 18th 2011, along a trail through regenerated tropical forest. External and skull measurements of the two specimens and comparative measurements of other related species [*Micronycteris schmidtorum* (Sanborn 1935), *Micronycteris megalotis* (Gray 1842), *Lampronycteris brachyotis* (Dobson 1879) and *Trinycteris nicefori*] captured in Guatemala are given in Table 1. Principal component analysis (Figure 3A) shows specimens of *M. minuta* segregated from all other species (Table 1), with component 1 (eigenvalue = 0.0116387) explaining 82.6% of the variation (highest scores with breath across canines, length of maxillary toothrow and zigomatic breath), and component 2 (eigenvalue = 0.00124589) explaining 8.8% of the

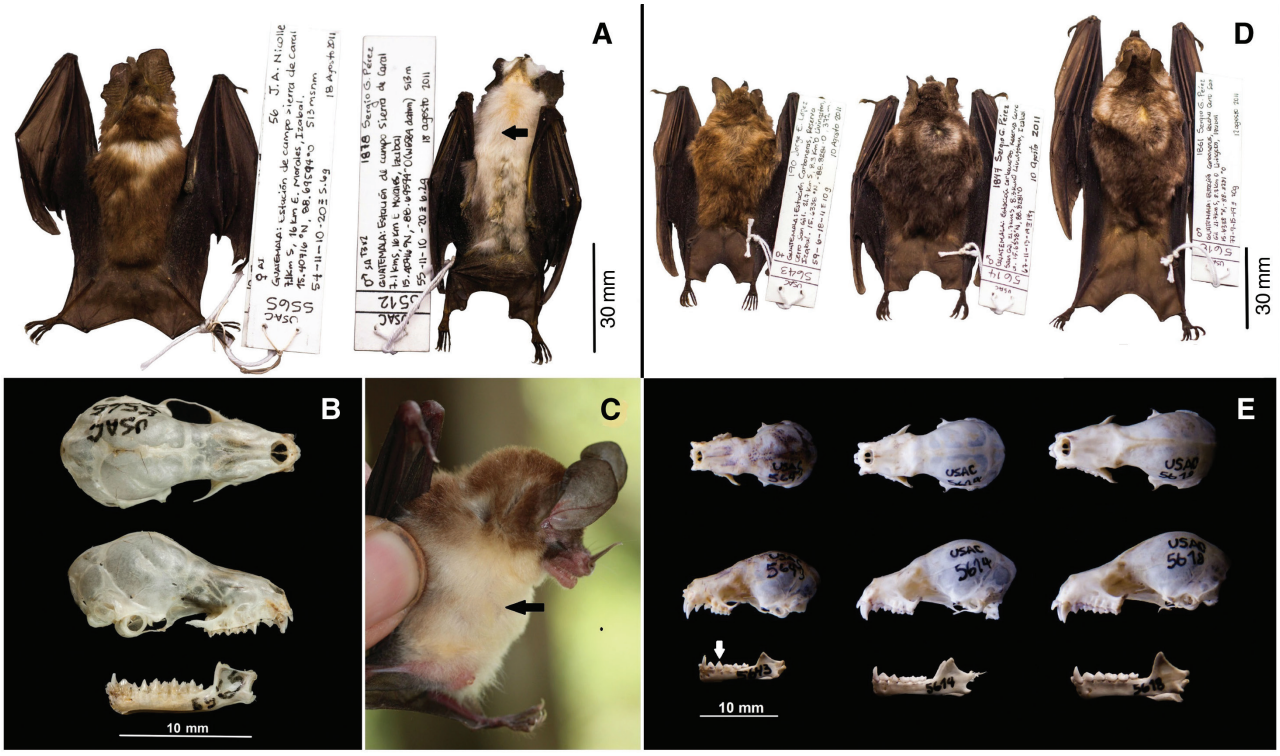

Figure 2: Specimens of *Micronycteris minuta* (left) and *Carollia* spp (right) captured during the expeditions to the Caribbean lowlands in north-eastern Guatemala in 2011. (A) Study skins of *Micronycteris minuta* (dorsal for USAC5565 and ventral for USAC5512); (B) dorsal, lateral and lateral mandible for *M. minuta* (USAC5565); (C) field photograph of *M. minuta* (arrow indicate the characteristic whitish ventral fur of this species); (D) study skins of three different and sympatric species of *Carollia* captured in Cerro San Gil, from left to right: *Carollia castanea*, *Carollia sowelli*, and *Carollia perspicillata*; (E) skulls of the same species of *Carollia* (dorsal, lateral and mandible view; arrow indicate the characteristic last premolar almost twice as high as first molar).

variation (highest scores with skull height and zigomatic breath). *Micronycteris minuta* is a small member of the genus, easily distinguished from other related species by its ventral lighter pelage which is almost white (see arrows in Figure 2A and C).

The type locality of *Carollia castanea* is at Angostura, Costa Rica, with its distribution extending southward to Colombia, Ecuador and eastern Venezuela, and northward to Lancetilla, Departamento de Atlántida, Honduras (ca.15°44′ North, 87°27′ West; Pine 1972, Baker et al. 2002, Solari and Baker 2006), the present north-western known limit. Our records from the Carboneras Station on Cerro San Gil, represent a distributional extension of 147 km west of Lancetilla (Figure 1).

Micronyctesis minuta is a relatively rare bat throughout its distributional range in tropical forested lowlands from Central America to South America, as well as in Trinidad (Reid 2009), with its type locality at Capella-Nova, Minas Gerais, Brazil. The northern-most record in Central America is Lancetilla, Departamento de Atlántida, Honduras (Pine 1972). The record from Sierra de Caral field station extends the distributional limits of this species 147 km west of Lancetilla (Figure 1). The species has been traditionally collected in swampy areas, forests, near plantations, and in orchards, pastures, croplands, and around buildings, which coincides with the common habitats at Sierra Caral.

Other bat species captured at Carboneras Station include *Platyrrhinus helleri* (Peters 1866), *Sturnira parvidens* (Goldman 1917), *Artibeus jamaicensis* (Leach 1821), *Dermanura watsoni* (Thomas 1901) and *Dermanura phaeotis* (Miller 1902). Other bat species captured on the same trip at Caral Field Station include *Phyllostomus discolor* (Wagner 1843), *Platyrrhinus hastatus* (Pallas 1767), *Vampyrum spectrum* (Linnaeus 1758), *Vampyresa thyone* (Thomas 1909), *Glossophaga commissarisi* (Gardner 1962), *Hylonycteris underwoodi* (Thomas 1903), *Carollia perspicillata*, *Carollia sowelli*, *P. helleri*, *S. parvidens*, *Sturnira hondurensis* (Goodwin 1940), *A. jamaicensis*, *Dermanura tolteca* (Saussure 1860), *Bauerus dubiaquercus* (Van Gelder 1959) and *Eptesicus furinalis* (d'Orbigny 1847).

In the neotropics, the overall bat species diversity appears to decrease along rainfall and elevation gradients (Fleming 1986), a situation that may explain the relatively high bat species richness of the two areas, which occupies

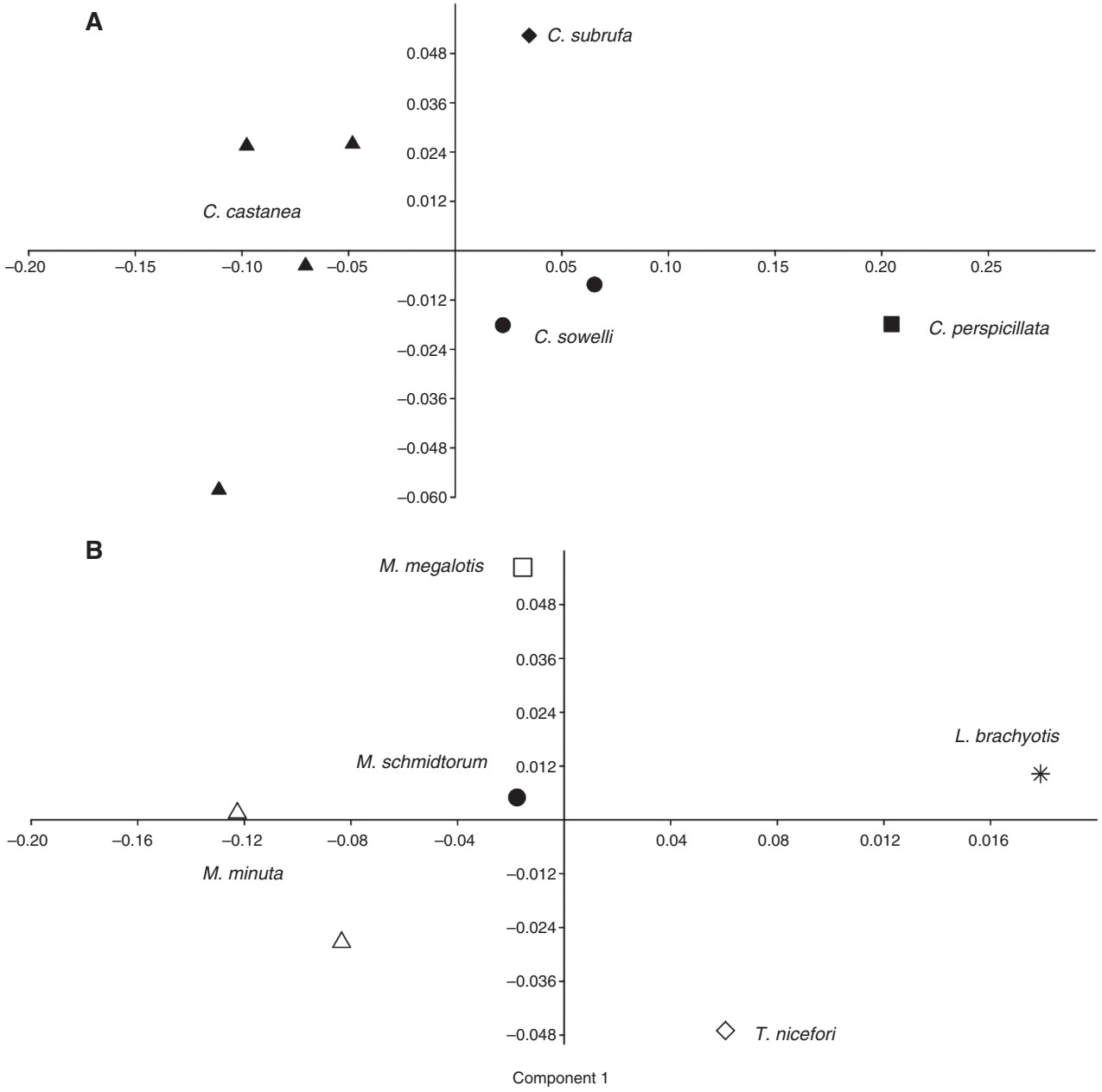

Figure 3: Scatter plot of the two principal components for species of *Carollia* (3A) and *Micronycteris* sensu lato (3B) from Guatemala (see Table 1).

the lowland portion of Guatemala with the highest rates of rainfall. Although there has been some amount of field bat collecting activities at Cerro San Gil in the past two decades, the recent finding of *Carollia castanea* suggests that the inventory of bats is still incomplete. Collecting activity at Sierra de Caral, on the contrary, has been very poor, but the finding of *Micronycteris minuta* suggests that the Atlantic tropical slope of Guatemala may harbor the richest mammal fauna of the country, and we suggest continuing the inventories there. The presence of a cluster of three sympatric and morphologically similar species of the genus *Carollia*, suggests also complex specific mutualistic interactions with plants that may not be present anywhere else in Guatemala.

It is interesting to note that two decades ago, there was a series of bat trapping activities at Cerro San Gil, mainly at Carboneras Field Station, but at that time there were no signs of *Carollia castanea*. There is a potential influence of global warming in the peripheral distribution of neotropical associated bats that merits study. We consider it to be important to establish a bat monitoring program in the area, both to complete inventories and to study ecological

aspects. Although both species of bats appear to be rare in their north-western limit of their distributions, they are considered of Least Concern (IUCN 2015) because they are a little more common in southward countries.

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