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NOTES ON GEOGRAPHIC DISTRIBUTION

Mammalia, Chiroptera, Phyllostomidae, *Lonchophylla hesperia* G. M. Allen, 1908: Second record of the Western Nectar Bat in Ecuador after 70 years

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ABSTRACT: Herein we report the second record for *Lonchophylla hesperia* in Ecuador, and the first one since 1939. We captured an adult male in a mountainous dry valley at Comunidad San Jacinto, Catamayo Valley, Loja Province, southwestern Ecuador. The dominant landscape consists of agricultural lands, mainly of corn fields and pastures; while the natural forest is restricted to small patches. A description of the species' shelter and a predictive distribution model in Peru and Ecuador are presented, indicating the areas between the two countries were the habitat is climatically suitable for its presence.

The genus *Lonchophylla* is specialized on a diet of nectar and pollen; therefore they are known as Nectar Bats (Wilson and Cole 2000). As part of this adaptation, they have a much longer snout and tongue than any other bats, except other genera of glossophagines, such as *Platalina* Thomas, 1928; and *Musonycteris* Schaldach and McLaughlin, 1960 (Nowak 1994; Griffiths and Gardner 2008). The genus is characterized by a tongue with a deep lateral groove and without hair-like papillae on tip; the central upper incisors are long, larger than lateral ones; upper premolars differ, the first shorter than the second; and wings terminate at base of ankles (Nowak 1994; Tirira 2007; Griffiths and Gardner 2008).

The genus is endemic to the Neotropics, with a wide distribution in rainforests from Nicaragua south to the Guianas, Bolivia and southeastern Brazil. Moreover, this is one of the most diverse genera of bats in the Neotropics, with 12 species (Woodman 2007). Nine of these are found in Ecuador (Tirira 2007; Woodman 2007; Mantilla-Meluk *et al.* 2009), mainly in tropical evergreen rainforest and subtropical forest, in northwestern and Amazonia. Only *L. hesperia* is found in the southwestern dry forest (Tirira 2007).

Lonchophylla hesperia G. M. Allen, 1908, the Western Nectar Bat, is restricted to northwestern Peru (Pacheco 2002; Griffiths and Gardner 2008), and southwestern Ecuador (Albuja 1991; Tirira 1999). In Peru the species is known to occur from the tropical arid Pacific coast to an arid marginal portion of the Amazon drainage (Koopman 1978). In Ecuador, the species is known only from one record confirmed from Malacatos (04°18' S, 79°16' W, 1,600 m), approximately 30 km south of the city of Loja, in Loja Province (Albuja 1999; Tirira 2007) (Figure 1). This specimen was collected on 23 August 1939, by L. Gómez, and is deposited at the Field Museum of Natural History of Chicago (FMNH 53536) (FMNH data base). This species was mentioned for first time to the Ecuadorian fauna by Albuja (1991), yet the record from Malacatos remained unpublished and unknown for 50 years. Consequently, this species has been traditionally treated as endemic to Peru (*e.g.* Nowak 1994; Pacheco 2002; Griffiths and Gardner 2008); an endemism not mentioned by Koopman (1993), Simmons (2005) and Pacheco *et al.* (2009).

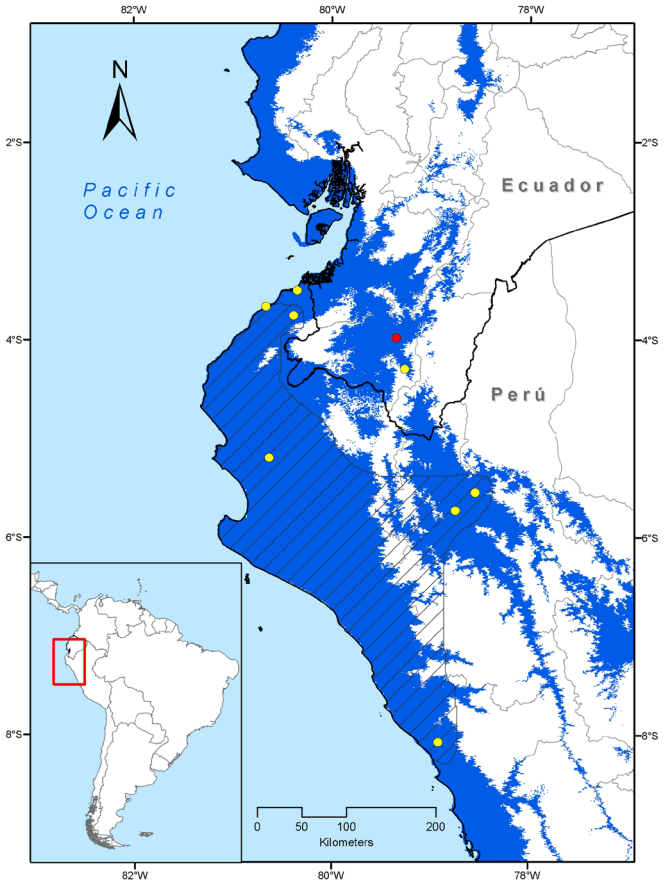

FIGURE 1. Distribution of the Western Nectar Bat (*Lonchophylla hesperia*). Black lines represent the current distribution as reported by Griffiths and Gardner (2008). Dark blue shading represents the predictive distribution model in Ecuador and Peru. Yellow dots represent the previous known Ecuadorian and Peruvian localities. Red dot represents the new locality reported in this work (Comunidad San Jacinto, Loja province).

The Ecuadorian locality of Malacatos is in subtropical dry forest, known as Matorral Seco Montano (according to the classification of Sierra 1999), which is characterized by an annual rainfall from 390 to 590 mm and an annual mean temperature of 23.7°C (Sierra 1999). The area is into the Southwestern Subtropical Ecuadorian zone (Albuja *et al.* 1980). Here we report the second record for this species in Ecuador, 70 years after its first collection, confirming its presence in the country.

The Western Nectar Bat is one of the rarer Neotropical bat species (Koopman 1978; Tirira 2007). Tuttle (1970) did not trap this species during field work between 1963 and 1964, in which 54 species of bats to the north and central Peru were reported. Pacheco *et al.* (2007), in a study of five localities in northwestern Peru, trapped 377 bats corresponding to 35 species, but only three were identified as *L. hesperia*. Carrera *et al.* (2010), conducting field work in 2001 and 2004, did not collect *L. hesperia* in a study that trapped 1,580 bats corresponding to 66 species in 16 localities in western Ecuador (10 of those localities were in the dry forest of the central and southwestern area of the country). That level of abundance is not corroborated by Thomas and Thomas (1977), who collected eight bats in three nights, four of which were identified as *Lonchophylla hesperia*. Currently, the species is known from 19 individuals corresponding to nine localities, six of which are known from a single record (Table 1).

Altitudinal records reported for the species indicate it occurs from sea level in Zorritos and Trujillo (Gardner 1976) to 1,600 m in Malacatos (Tirira 2007).

On July 14 2008 we collected a single individual of *L. hesperia* in Comunidad San Jacinto (03°59' S, 79°21' W, altitude 1,258 m), Catamayo Valley, Loja Province, on the slopes of the southwestern Ecuadorian Andes. As in the first Ecuadorian record, it was collected in subtropical dry forest, known as Matorral Seco Montano. San Jacinto is located in a mountainous valley with small streams (dry most of the year), at the confluence of the Catamayo River system. The dominant landscape consists of areas of human disturbance, mostly agricultural zones such as corn fields and pastures, with small patches of natural forest. The incline of the terrain is moderately pronounced with slopes of 30% or more.

The specimen consists of a fluid-preserved body (75% ethanol) and cleaned and dried skull of an adult male with scrotal testes. The individual is deposited in the Mammals Division of Museo de Zoología (QCAZ 10888) at the Pontificia Universidad Católica del Ecuador, in Quito.

The individual was encountered resting in its day roost, approximately 4 m above the ground in a small inhabited rustic dwelling, composed of a single room without closed attic. The bat was captured upon being manually stricken from its flight path, at 16:00 h. Three other bat species were identified in the same shelter, but without an apparently relative position in the dwelling: *Desmodus rotundus* (E. Geoffroy St.-Hilare, 1810), *Glossophaga soricina* (Pallas, 1766), and *Artibeus fraterculus* Anthony, 1924. The bat colony included approximately 100 individuals, where the dominant species was *Desmodus rotundus* (comprising 80% or more of the mixed-species group). Only a few specimens of *G. soricina* and *A. fraterculus* were observed; no additional individuals of *L. hesperia* were registered.

No information about use of man-made shelters has been previously mentioned. This specimen was found in an old inhabited house that demonstrates the species may be found in association with human buildings. The occurrence of this species in disturbed areas may indicate some tolerance to localities that have been impacted by human activity.

The morphological measurements reported are within the known range for the species. Selected external and cranial measurements (in mm) of the specimen QCAZ 10888, followed by maximum and minimum measurements reported by Allen (1908), Gardner (1976), Swanepoel and Genoways (1979), Woodman and Timm (2006), and Griffiths and Gardner (2008), are: head and body length, 59.1 (51–68); tail length, 8.7 (7–13); hindfoot length, 9.3 (8–15); ear length, 13.9 (10–16); forearm length, 38.3 (36–40.6); thumb length, 9.4 (8.5–9); leaf-nose length, 7.5 (8); calcar length, 8.5 (8.5–9.5); caudal membrane length, 20.9 (21); tibia length, 15.3 (14–15); greatest length of skull, 27.0 (25.4–28.0); condylobasal length, 25.6 (24.5–26.1); zygomatic width, 9.7 (10.0–10.1); braincase breadth, 8.8 (9.1–9.5); palatal length, 15.2 (14.7–16); postorbital constriction, 4.7 (4.7–4.9); mastoid breath, 9.4 (9.7–10); width across canines, 4.1 (4.2–4.3); width across molars, 5.7 (5.6–5.8); length of maxillary toothrow, 8.8 (8.3–9); mandibulary length, 19.2 (20.3); length mandibular toothrow, 9.4 (9.4). Body weight was not taken (literature: 10 g).

This individual had the typical diagnostic features for *L. hesperia* according to Allen (1908), Woodman and Timm (2006), Woodman (2007), and Griffiths and Gardner (2008), including: medium-sized to the genus (in fact *L. hesperia* is the smallest *Lonchophylla* in the group comprising the larger species of the genus; Woodman and Timm 2006; Tirira 2007; Woodman 2007; Griffiths and Gardner 2008); dorsum pale brown, and venter grayish brown, paler than back; and forearm shorter than 41 mm, but longer than 36 mm. The thumb measurement differs from that reported by Griffiths and Gardner (2008: 247), who mention that thumb length is shorter than 7.0 mm. However, in the collected specimen thumb was longer (9.4 mm), as was reported by Allen (1908) (8.5 to 9.0 mm).

The cranial and dental diagnostic features were also similar to those described in the literature (Allen 1908; Woodman and Timm 2006; Woodman 2007; Griffiths and Gardner 2008): skull narrow and elongated; rostrum elongated and inflated; supraorbital region narrow and inflated; greatest length of skull longer than 25 mm, but shorter than 28 mm; first and second upper molars essentially alike in form and size; conspicuous gap between outer margins of first and second upper incisors; outline of margins of upper incisors not transcribing a smooth arc; width across molars less than 6 mm; mastoid width less than 10 mm; length of maxillary toothrow less than 9 mm.

Some cranial measurements of the specimen were somewhat smaller (zygomatic width, braincase breadth, mastoid breath, width across canines) than those reported in the literature. However, the maximum and minimum measurements for the species were based on few records (sometimes only one or two), therefore we did not consider this variation to be relevant.

Most of the conservation status of *L. hesperia* remains

unknown. It is believed to be threatened by the intense clearing of dry forests that has been taking place in southwestern Ecuador and northwestern Peru, which has diminished the extent of its natural habitat considerably (Tirira 2011). According to the IUCN Red List, the species was first assessed as Vulnerable (evaluated in 1996 and 2008), and then downlisted to Near Threatened in 2009 (Solari and Velazco 2009). The current category is justified due to the fact that the species is likely in significant decline (but probably at a rate of less than 30% over ten years). This decline is a result of widespread habitat loss and degradation throughout much of its range, which makes the species close to qualifying for Vulnerable (Solari and Velazco 2009). In Ecuador the species was classified as Vulnerable in the first edition of the Red Book of the Mammals of Ecuador (Tirira 2001), but was changed to Endangered in the second edition (Tirira 2011). In Peru, it is treated as Vulnerable (Decreto Supremo No. 034-2004-AG *in* Pacheco *et al.* 2009). The species is expected to occur in some protected areas, like Arenillas Ecological Reserve and Puyango Petrified Protected Forest (in Ecuador), and Cerros de Amotape National Park and Tumbes National Reserve (in Peru).

Our new record of *Lonchophylla hesperia* was combined with the eight other records (Table 1) to generate a predictive distribution model using a Maximum Entropy approach implemented in Maxent software package (Phillips *et al.* 2006). Nineteen bioclimatic variables, at 30 second per pixel resolution, were used as environmental variables (from WorldClim, Hijmans *et al.* 2005). Eight replications of the model were run using jackknife with one record in each run (Pearson *et al*. 2007), and model performance was evaluated by measuring the area under the Receiver Operating Characteristic (ROC) curve (AUC). This methodology has been proven useful for species with small numbers of occurrence records (Brotons *et al.* 2004; Allouche *et al.* 2006; Elith *et al.* 2006). The average AUC for the model replications were 0.810 (minimum = 0.298, maximum = 0.997; SD = 0.272). The high standard deviation is caused by one of the repetitions that failed to predict the southernmost Peruvian point, lowering the AUC for that one run. This is a common effect in distribution models based on scarce and widely separated points (Hernandez *et al.* 2006). If such run were not part of the analysis the AUC would have been of 0.912 (SD = 0.118), which gives us confidence in using the model as a tool for understanding the distribution pattern of the species.

The model was generated in logistic output format and the presence/absence threshold used was 0.157, where both "Equal Training Sensitivity and Specificity" and "Maximum Training Sensitivity plus Specificity" calculations coincided.

The model predicts the distribution of the *L. hesperia* by habitat suitability in areas where the species has not yet been observed (Figure 1), including Peruvian and Ecuadorian Amazonia that may not be part of the realized niche, likely due to interactions with other species or historical factors such as geographic barriers limiting dispersion rather than climatic conditions.

The climatic aspects of the fundamental niche predicted by the model includes an annual mean temperature of 21.1°C (±3.54), and a low mean annual precipitation of 602 mm (±535). The two Ecuadorian localities in which this species has been recorded, Malacatos and San Jacinto, correspond to 20.1°C / 789 mm and 21.4°C / 790 mm, respectively. Also, two bioclimatic variables explained 83% of the variation seen in the model: the annual precipitation (responsible for 48.1% of the variation), and precipitation during the warmest quarter (model average: 59.1 mm). These values suggest an adaptation to dry weather and drought tolerance for the species.

An interesting result of the modeling is that suitable areas for the species does not only include dry warm regions (such as in the Ecuadorian records) or dry coastal forests, but also dry areas of higher altitude where the mean temperature could be as low as 12°C, such as Cotopaxi Province at 3,000 m above sea level, or as low as 10°C at 3,300 m in Cañar Province. Annual precipitation in these locations is still relatively low (675 and 883 mm, respectively). Within suitable areas predicted by the distribution model, the highest annual precipitation occurs in small patches in northwestern Ecuador, in Esmeraldas Province, where annual rainfall reaches 1,300 mm.

Table 1. Records of the Western Nectar Bat (*Lonchophylla hesperia*), in chronological order.

DEPARTMENT / PROVINCE	LOCALITY	ALTITUDE	SPECIMENS REPORTED	SOURCE
Peru				
Tumbes	Zorritos	0	6 (counting the holotype and two paratypes)	Allen (1908)
La Libertad	Trujillo	0	1	Tuttle (1970), Gardner (1976)
Cajamarca	Jaén	740	1	Gardner (1976)
Tumbes	5 km E Puerto Pizarro	5	4	Thomas and Thomas (1977)
Amazonas	Bagua Grande	724	1	Koopman (1978)
Piura	Piura	27	1	Koopman (1978)
Tumbes	Angostura	74	3	Pacheco *et al.* (2007)
Ecuador				
Loja	Malacatos	1,600	1	Albuja (1991)
Loja	San Jacinto	1,258	1	This publication

As information on the natural history of this species accumulates, analyses should be made to assess resource availability in predicted areas, since the model does not take into account the abundance of flowers this species feeds on. Meanwhile, caution should be taken when interpreting the resulting distribution model; it should be considered a tool to direct future collecting efforts and to gather information that would further refine the occupancy limits of the species.

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