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Evaluation of the potential highest altitudinal record of *Micronycteris hirsuta*

Evaluación del registro potencial de mayor altitud para *Micronycteris hirsuta*

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Micronycteris hirsuta is a species widely distributed in Central and South America at altitudes no higher than 1,500 m, and it is associated with conserved forests. We found a dead individual in Bogotá city at 2,600 m. Considering that previous records for this species come from lower altitudes and that this species is mostly found in undisturbed ecosystems, we question the presence of *M. hirsuta* in the city. To assess the possibility that this species inhabits areas close to the city, we developed an Ecological Niche Model (ENM), reviewed its distribution in Colombia, and the reported bat species from the city of Bogotá. We report the highest altitudinal record of *M. hirsuta* at 2,600 m. The specimen found exhibits all the diagnostic characters recognized for this species. However, we did not find evidence that supports the likelihood that *M. hirsuta* inhabits areas near Bogotá. According to our results and the species' ecological attributes, we do not support that *M. hirsuta* inhabits areas near Bogotá and other high-altitude ecosystems. We discuss other hypotheses that could explain this record's presence, including a possible migration or an accidental transport from lowlands. We highlight the importance of evaluating unusual distributional records of species using ENMs and discuss these below the light of species' ecological attributes.

Key words: Biological collections; ecological niche model; Micronycterinae; urban bats.

Micronycteris hirsuta es una especie ampliamente distribuida en el Centro y Sur de América en altitudes no mayores a los 1,500 m y asociada con bosques conservados. Se registró un individuo muerto de esta especie en la ciudad de Bogotá, a 2,600 m. Considerando que los registros previos provienen de altitudes más bajas y que esta especie no es frecuente en ecosistemas perturbados, se cuestiona la presencia de *M. hirsuta* en la ciudad. Para evaluar si es probable que esta especie habite en áreas cercanas a Bogotá, se desarrolló un modelo de nicho ecológico (ENM, por sus iniciales en inglés), se revisó la distribución de esta especie en Colombia y las especies reportadas para la ciudad de Bogotá. Se reporta el registro de mayor altitud de *Micronycteris hirsuta*, a 2,600 m. El espécimen encontrado exhibe todos los caracteres diagnósticos conocidos para esta especie. Sin embargo, no se encontró evidencia que respalde la presencia de *M. hirsuta* en áreas cerca de Bogotá. De acuerdo con los resultados y los atributos ecológicos de esta especie, no se respalda que *M. hirsuta* habite áreas cercanas a Bogotá y otros ecosistemas de altitud alta. Se discuten otras hipótesis que pueden explicar este registro, incluyendo una posible migración o un transporte accidental desde las zonas bajas. Se resalta la importancia de evaluar los registros inusuales en la distribución de las especies usando ENMs y analizándolos bajo la luz de los atributos ecológicos de cada especie.

Palabras clave: Colecciones biológicas; Micronycterinae; modelo de nicho ecológico; murciélagos urbanos.

Micronycteris hirsuta (W. Peters, 1869) has a wide distribution range. However, it is considered a rare species due to its low abundance from few and scattered localities (Arita 1993; Reid 2009). This species inhabits primary forests (Sampaio *et al.* 2016), deciduous lowland forests, and forest edges (Reid 2009), but also occurs in cleared areas and secondary vegetation (Handley 1978; Simmons and Voss 1998), always near to conserved forests (Sampaio *et al.* 2016). This species feeds on insects gleaned from vegetation and fruits depending on the season (Reid 2009) and, like other *Micronycteris* bats, can be considered as an indicator of undisturbed forests (Fenton *et al.* 1992; Medellín *et al.* 2000; Schulze *et al.* 2000).

Micronycteris hirsuta is distributed from the border between Honduras and Nicaragua to the south through Central America and northern South America. To the west of the Andes, it is present in Ecuador, and to the east through Colombia, Venezuela, Trinidad and Tobago, and the Guianas to the lowlands from Perú, the north of Bolivia, and the Brazilian Amazons; additionally, there is an isolated population in south-eastern Brazil (Williams and Genoways 2008; Sampaio *et al.* 2016). This species

is known on an altitudinal range from 0 to 1,500 m (Reid 2009). In Colombia, *M. hirsuta* is present in the lowlands of the Amazon, Andean, Caribbean, and Pacific regions in localities with elevations between 20 and 1,100 m (Mantilla-Meluk *et al.* 2009; Solari *et al.* 2013).

Recently, we found a dead individual of *M. hirsuta* in a street of Bogotá city that could correspond to the highest record for the species, at 2,600 m. However, because the species is known from lowlands and is infrequent in highly disturbed areas, we assess the likelihood of *M. hirsuta* inhabiting Bogotá through an Ecological Niche Model (ENM) and a review of its distribution. Additionally, we included a revision of the bat species recorded in Bogotá.

The record we report here corresponds to a carcass found in a sidewalk under a *Cecropia* sp. tree in the Chapinero neighborhood (Calle 53#3-27 Bogotá D. C. 4° 38′ 17″ N, 74° 03′ 36″ W) at 2,600 m on February 29, 2020. We preserved the specimen and tissue samples (foot) in 96 % ethanol and deposited it in the mammal collection "Colección de mamíferos Alberto Cadena García" at the Instituto de Ciencias Naturales, Universidad Nacional de Colombia (ICN), under the catalogue number ICN 24849.

We revised all known records of *M. hirsuta* for Colombia to describe its distribution and built a points distribution map, including the biogeographic provinces proposed by Hernández-Camacho *et al.* (1992). To do this, we examined all specimens of *M. hirsuta* deposited in six scientific collections, and verified the identification of each of them based on Simmons (1996): Instituto Alexander von Humboldt, Villa de Leyva, Colombia (IAvH); Colección de mamíferos "Alberto Cadena García", Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá, Colombia (ICN); Museo de Historia Natural Universidad del Cauca, Popayán, Colombia (MHNUC); Colección de mamíferos, Universidad del Valle, Cali, Colombia (UV); Colección Teriológica Universidad de Antioquia (CTUA); and the American Museum of Natural History, New York (AMNH). Additionally, we include Colombian specimens reviewed by Simmons (1996) and Castaño *et al.* (2003; Table 1).

We observed diagnostic characters and took morphological measurements of the voucher specimen (Figure 1). We took the external measurements from specimen tags. We measured the forearm and skull with digital calipers to the nearest 0.01 mm, following Simmons and Voss (1998). We registered a total of 5 external measurements and 8 skull measurements (Table 2). However, for ICN 24849 reported here, we were unable to take all measurements due to the specimen's condition. For ICN 24849, we measured the following (Table 2): length of the tail (TV), length of the hind foot (HF), length of the ear (EAR), and length of the forearm (FA).

To assess if the species is likely to occur in Bogotá and effectively finds suitable habitats around the city, first, we reviewed the bat species recorded in the urban area of Bogotá. We searched for *M. hirsuta* or closely related species that inhabit the vicinity of Bogotá through a Boolean Search of articles through Google Scholar, Scopus, and Web of Science. We conducted the search using the following keywords, in Spanish and English: Bats, Chiroptera, Bogotá, using the conjunction "AND". Additionally, we revised the ICN's online specimens' database (https://www.biovirtual.unal.edu.co/es/colecciones/search/mammals/) visited on April 20, 2020.

We used ENMs to explore the likelihood that suitable habitat for *M. hirsuta* exists near Bogotá. We based our analysis in all specimens with confirmed taxonomical identification through morphology (revised by us or included in Simmons 1996) or molecular information (Porter *et al.* 2007; Table 1) considering the high misidentification rates in other species of the genus (Morales-Martínez *et al.* 2018) that could have an impact in the modeling. We do not include records from southeastern Brazilian distribution because cytogenetic evidence supports cryptic diversity in eastern Brazilian populations (Ribas *et al.* 2013). We used these 42 records representing 32 localities of 6 countries and our record from Bogotá to construct our ENMs (Appendix 1). We spatially thinned our original data to reduce sampling biases, ensuring that the distance between all localities pairs exceeds 10 km, using the R package spThin (Aiello-Lammens *et al.* 2015).

We used the World Clim v2.1 data set (Fick and Hijmans 2017) as potential predictors of the species, all of them with a spatial resolution of 30 arc seconds (approximately 1 km^2 resolution at the equator). To exclude highly correlated variables (> 0.80), we calculated Pearson's correlation coefficients for every pairwise comparison of variables and chose 4 variables: Isothermality (Bio 3), Temperature Seasonality (Bio 4), Annual Precipitation (Bio 12), and Precipitation Seasonality (Bio 15). These variables are important in the distribution of different species of Neotropical bats due to their effect on primary productivity, the availability of food resources, and physiological requirements (McCain 2006; Ferreira *et al.* 2017). We delimited the study area to a buffer of two degrees around each locality and included 100,000 background points within the study area using the R packages sp and rgeos (Pebesma *et al.* 2005; Bivand *et al.* 2017) implemented in the package Wallace (Kass *et al.* 2018). To evaluate our models' accuracy, we used a *k*-fold cross-validation approach, with a random block spatial partition of $k = 4$, separating the Amazon, the central, north, and the eastern Andes.

We constructed two frameworks of niche models with maximum entropy (Maxent; Phillips *et al.* 2006) approach using Maxent (Phillips *et al.* 2017) and the r package dismo (Hijmans *et al.* 2017) in Wallace. The first framework omitted the record of Bogotá, and the second included the record of Bogotá in the selected localities. For each model, we tested five different feature class combinations: L, LQ, H, LQH, and LQHP (L = linear, Q = quadratic, H = hinge, P = product) and regularization multipliers from 0.5 to 5 (with a multiplier step value of 0.5) to construct a total of 100 models. We evaluated our models using ENMeval (Muscarella *et al.* 2014) and used the AUC scores and a

Figure 1. Morphological characters of *Micronycteris hirsuta* (ICN 24849): A) lower incisors: bifid, high crowned, and wedged between canines (see white arrow); B) dermal pads arranged in "V" (see white arrow); C) calcar greater than the foot (see white arrow).

second-order Akaike Information Criterion (AIC, Akaike 1973; 1998) correcting for small sample sizes (AICc; Anderson and Burnham 2004; Burnham and Anderson 2004) to compare the fit of the models to our data statistically. We selected the models with the highest AUC and the lowest Akaike scores.

Finally, we used the average presence suitability to assess this species' potential distribution, with the 10th percentile training presence used to create a presence-absence threshold (Hijmans *et al.* 2017). This procedure allowed us a stricter evaluation than a minimum training presence threshold (Waltari *et al.* 2007). We compare the two frameworks to test if the inclusion of the record of Bogotá influences the predicted model, increasing its distribution suitability near the city, and assess if the climate of the area is suitable for the species.

We report an unusual record of *Micronycteris hirsuta*, at 2,600 m (Figure 2C). Specimen ICN 24849 has all the diagnostic characters recognized for *M. hirsuta* (Simmons 1996; Simmons and Voss 1998; Williams and Genoways 2008). In terms of dental characters, the lower incisors are bifid, high crowned, and wedged tightly between the canines (Figure 1A). The specimen exhibits uniform brown coloration with bicolored long fur, ventral and dorsal fur not contrasting to each other, ears not completely rounded and connected by an interauricular band of skin, chin with a pair of dermal pads arranged in a "V" shape with no central papilla (Figure 1B), and a calcaneus greater than the foot (Figure 1C). The external measurements of the ICN 24849 are within the known range of the species. The averages of the examined specimens' measurements are higher in females than in males (see Table 2); this could be attributed to sexual dimorphism in size, although our sample size did not allow us to test it statistically.

In Colombia, we know *M. hirsuta* from 21 localities (Table 1) spanning over 6 of the 9 biogeographic provinces of the country (Hernández-Camacho *et al.* 1992): the Caribbean dry belt province, the Choco-Magdalena province, the Orinoquia province, the Guyana province, the Amazon province, and the Northern Andes province (Figure 2A). The altitude ranges from 0 to 500 m (71 % of the records), 500 to 1,000 m (14 %), and 1,000 to 1,500 m (10 %). The ICN 24849 is the only record above 1,500 m (Figure 2B).

We did not find evidence of records of *M. hirsuta* near Bogotá. Near the city, we documented 12 species according to 9 articles published between 1927 and 2015. Shamel (1927) described *Sturnira bogotensis* based on a series of specimens captured in the "La Uribe" train station. Tamsitt *et al.* (1964) reported 8 species for the urban area of Bogotá: *Carollia perspicillata, Sturnira ludovici, Myotis nigricans, Eptesicus fuscus, Histiotus colombiae, Aeorestes cinereus, Tadarida brasiliensis*, and *Eumops glaucinus.* After these early records, other species have been reported: *Sphaeronycteris toxophylum* (Rodríguez-Posada and Cárdenas-González 2012), *Lasiurus blossevillii* (Morales-Martínez and Ramírez-Chaves 2015), and *Choeroniscus godmani* (Morales-Martínez and Henao-Cárdenas 2015). Andersen (1906) reported a specimen of *Micronycteris megalotis* from Bogotá. However, Tamsitt *et al.* (1964) discarded this finding and attributed the specimen to an accidental introduction. Other specimens in the ICN collection online database correspond to *Anoura geoffroyi* (ICN 3425, 12971), *Promops* sp. (ICN 4719), *Artibeus* sp. (ICN 12964), and *Nyctinomops laticaudatus* (ICN 19199).

In Figure 2C, we include the map of the distribution of *M. hirsuta* following Rojas *et al.* (2018). In Figure 3A and 3B, we include the logistic suitability with and without Bogotá, respectively. In both frameworks, we selected the models with the highest AUC and the lowest AIC. Both models used a linear feature and a regularization value of 0.5 and predicted the presence of *M. hirsuta* in Bogotá when applying the 10th percentile training presence threshold (Figure 3C and 3D). However, the suitability of the climatic characteristics for this species in Bogotá is low (without Bogotá 0.321, with Bogotá 0.335; Figure 3A and 3B). Our highest supported model without Bogotá shows lower suitability of distribution (0.331, AUC = 0.654) compared with the model including Bogotá, which has slightly higher suitability (0.389, AUC = 0.617).

According to our results and the species' ecological attributes, we do not support that *M. hirsuta* inhabits areas near

Table 1. Number ID, source (we indicate uncatalogued numbers with the letter T in bold), locality, geographic coordinates, and altitude of the revised specimens of *Micronycteris hirsuta* in Colombia. ICN: Instituto de Ciencias Naturales, Universidad Nacional de Colombia; CTUA: Colección Teriológica Universidad de Antioquia; IAvH: Instituto Alexander von Humboldt, Villa de Leyva, Colombia; MHNUC: Museo de Historia Natural Universidad del Cauca, Popayán, Colombia; UV: Universidad del Valle, Cali, Colombia.

Number ID	Source	Locality	Geographic coordinates		Altitude (m)
			Latitude	Longitude	
1	ICN-**T**-ATG 161	Amazonas: La Pedrera	1° 19' 40.87" S	69° 33' 47.1" W	95
2	Simmons *et al.* (2002)	Antioquia: La Frijolera	7° 7' 0.12" N	75° 25' 0.12" W	1,500
3	CTUA 2405	Antioquia: Remedios	7° 3' 7.68" N	74° 18' 17.6" W	296
4	IAvH 9312	Arauca: Tame	6° 24' 6.5" N	71° 56' 35.9" W	792
5	CTUA 750	Atlántico: Santa Catalina	10° 35' 49.1" N	75° 17' 10.3" W	103
6	**ICN 24849**	***Bogotá D.C: Carrera 3 calle 45**	4° 38' 17" N	74° 3' 36" W	2,600
7	IAvH 7155	Caquetá: río Mesay	0° 4' 27" N	72° 27' 4.99" W	250
8	Simmons *et al.* (2002)	Cauca, río Saijá	2° 55' 36.52" N	77° 33' 52.9" W	38
9	MHNUC 814	Cauca: El Tambo	2° 43´ 2.99" N	76° 56´ 52.0"W	1,407
10	ICN 24461	Cesar: La Gloria	8° 35' 24.55" N	73° 34' 19.8" W	471
11	CTUA 750	Chocó: Quibdó	5° 47' 34.69" N	76° 37' 37.7" W	35
12	ICN 17236	Córdoba: Pueblo Nuevo	8° 24' 5" N	75° 22' 50" W	52
13	ICN 19413	Guajira: Maicao	11° 15' 24.1" N	72° 21' 39.0" W	105
14	ICN 23867	Guaviare: San José del Guaviare	2° 31' 31.87" N	72° 48' 26.8" W	224
15	Simmons *et al.* (2002)	Magdalena: Bonda	11° 14' 1.32" N	74° 7' 29.63" W	65
16	Simmons *et al.* (2002)	Magdalena: río Don Diego	11° 13' 59.8" N	74° 7' 59.88" W	53
17	ICN 24463	Meta: Mapiripan	2° 58' 43.06" N	71° 55' 0.11" W	208
18	ICN 14393	Meta: Cubarral	3° 48' 28.30" N	73° 52' 51.9" W	941
19	ICN-**T**-D3M541	Santander: Puerto Parra	6° 36' 36.82" N	74° 5' 4.52" W	104
20	UV 11497	Valle: Buenaventura	3° 14' 3.72" N	77° 32' 14.2" W	14
21	ICN 22829	Valle del Cauca: Yotoco	3° 52' 40.44" N	76° 25' 56.9" W	1,480

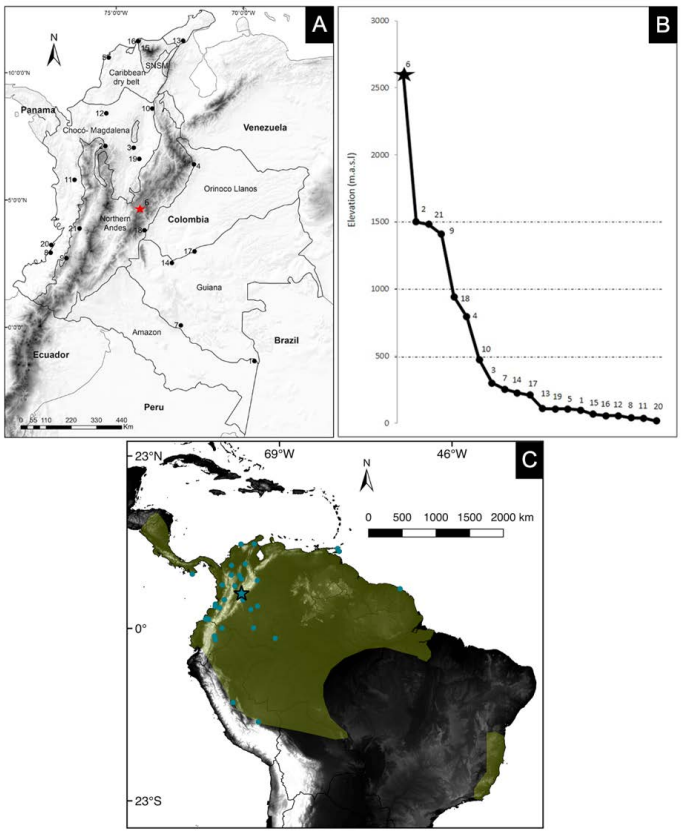

Figure 2. Distribution of *Micronycteris hirsuta* in Colombia: A) records of confirmed localities (circles), where the star corresponds to ICN 24849; B) elevation profile of *M. hirsuta* in Colombia; C) map of the distribution of *Micronycteris hirsuta* following Rojas *et al*. (2018). The dots refer to the localities used to make the Ecological Niche Model (see Appendix 1). The blue star corresponds to ICN 24849.

Bogotá and other high-altitude ecosystems. We found that, despite ENMs predicting areas with adequate climatic characteristics for *M. hirsuta* in high altitudes near Bogotá, it is unlikely to occur due to low suitability of presence in ENMs, previous information of Bogotá bat fauna, and ecological attributes of *M. hirsuta*.

In our search on bat records from the area of Bogotá, we include surrounding forests from the city above 2,500 m (*e. g*., Pérez-Torres and Ahumada 2004), and we did not find evidence of the presence of any species of *Micronycteris*. Our specimen revision and literature records show that *M. hirsuta* is mainly recorded below 500 m (Patterson *et al.*1996; Figure 3B). Even this species is still rare in scientific collections, and researchers do not usually capture it (Solari *et al.* 2019; Costa *et al.* 2020; Silva *et al.* 2020a, 2020b), *M. hirsuta* shows an extensive distribution in a variety of biogeographic areas and ecosystems below the 1,500 m corroborated by our ENMs results.

Our ENMs support the presence of a few amounts of suitable dispersed habitat for this species in the high altitudes of Bogotá, predicting that principally the lowlands surrounding the Bogotá savanna provide the continuous, suitable conditions for the presence of *M. hirsuta.* Some ecological attributes of the species cast doubt on ENMs predictions. For instance, the bat species that inhabit lowlands can occasionally reach high elevations have some characteristics such as high independence of continuous forest, often use underground roost, and their geographical ranges comprise high southern latitudes (de Carvalho *et al.* 2019). Contrary, *M. hirsuta* does not exhibit these characteristics because it shows a high dependence on continuous forest (Williams and Genoways 2008), and the most meridional record of the species is in the Atlantic forest in southeastern Brazil (Esbérard 2004). However, these populations probably correspond to an undescribed species (Ribas *et al.* 2013).

Additionally, *M. hirsuta* prefers undisturbed forests with no evidence of generalist habits (Williams and Genoways 2008; Medellín *et al.* 2000). The impact that urbanization has on bats has been defined as species-specific (Russo and Ancillotto 2015), showing that some are better adapted to city conditions while others avoid cities entirely. Highways have strong barrier effects on maneuverable, slow-flying bats that forage by gleaning (Kerth and Melber 2009) as *M. hirsuta* being unlikely that the species tolerate urban conditions.

Alternative hypotheses to explain this record include a possible migration of the species from lower altitudes. In tropical regions, there is evidence of altitudinal migrations in several bat species (McGuire and Boyle 2013). For Colombia, some species of the Phyllostomidae family might migrate attitudinally (Naranjo and Amaya 2009). Other species, like the vespertilionid (Vespertilionidae) *Aeorestes cinereus*, make altitudinal migrations on the Andes' western slopes (Sanborn and Crespo 1957). Although there is still an important lack of information on this behavior, there is

Table 2. External and skull measurements (mm), including the mean, the observed range (in parentheses), and the sample size of specimens per sex of *Micronycteris hirsuta* previously recorded in Colombia and external measurements (mm) of the specimen reported in the present study. Abbreviations: total body length (TL), tail length (TV), hind foot length (HF), ear length (EAR), forearm length (FA), greatest length of the skull (GLS), condyloincisive length (CIL), postorbital breadth (PB), braincase breadth (BB), zygomatic breadth (ZB), mastoid breadth (MB), maxillary toothrow length (MTRL), breadth across molars (BAM). ICN: Instituto de Ciencias Naturales, Bogotá, Colombia.

Measurements	Reviewed material		ICN 24849
	Males	Females	
TL	61.3 (48-75)7	78.3 (78-79)3	-
TV	13.3 (6-20)7	14.7 (14-15) 3	13.0
HF	12.6 (11-17)7	13.3 (11-15)3	11.0
EAR	23.2 (19-33)7	24.3 (22-26)3	20.0
FA	43.4 (40.7-46.2)10	44.2 (41.9-47)3	44.0
GLS	23.8 (22.5-25.0)10	24.0 (23.2-24.9)5	-
CIL	20.9 (20.2-21.6)9	21.1 (20.7-21.6)5	-
PB	5.0 (4.8-5.4)10	5.1 (4.9-5.5)5	-
BB	8.6(8.2-8.9)10	8.7 (8.5-8.9)5	-
ZB	11.4 (10.7-11.8)7	11.7(11.5-12)4	-
MB	10.3 (9.6-10.6)8	10.5(10.1-10.9)5	-
MTRL	9.3 (8.9-9.6)9	9.3 (9.0-9.8)5	-
BAM	4.5(4.3-4.6)10	4.5 (4.3-4.7)5	-

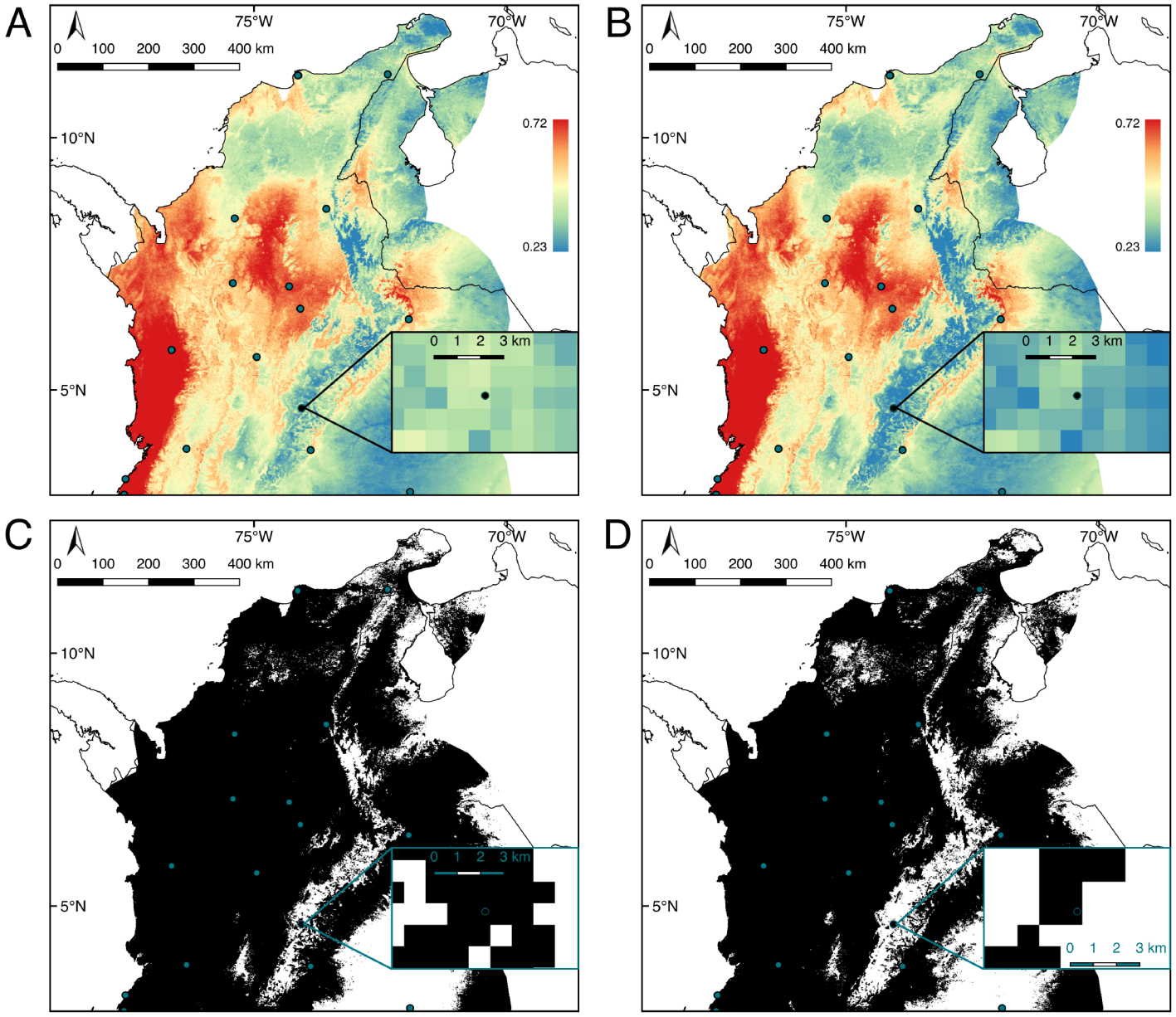

Figure 3. Selected Ecological Niche Model of *Micronycteris hirsuta* based on AICc support. A and B represent the logistic suitability with and without Bogotá, respectively. The suitability of *M. hirsuta* is low in both models for the collecting locality of ICN 24849. C and D show the presence-absence distribution map based on the 10th percentile training presence threshold with and without Bogotá, respectively.

no indication or consistent evidence of altitudinal migrations in *M. hirsuta,* or any other species of *Micronycteris*. Probably because some species in this genus have been attributed to having small home ranges (*e. g.*, *Micronycteris microtis* home range of 1 to 5 ha) and tend to remain in forest patches before venturing across open areas (Fleming *et al.* 1972; Albrecht *et al.* 2007; Geipel *et al.* 2013).

Another hypothesis is accidental transportation by a vehicle. Other authors have proposed this possibility for bat species' unexpected findings in other localities in the Neotropics (Tamsitt *et al. 1964*; Jarrin 2003; Morales-Martínez and Henao-Cárdenas 2015); this hypothesis might be possible if we consider the high vehicular traffic from the lowlands towards the city.

Our results suggest that the specimen ICN 24849 was accidentally transported from the lowlands to Bogotá. We strongly recommend the revision of verified identification records and the use of ENMs as a valuable tool to test the suitability of the presence of suspect records, especially of species that are threatened and poorly known. Since the specimen was found and delivered to us by a citizen, it reflects the importance of participatory science to gather species information, mainly in understudied places.

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Appendix 1

List of localities used to make the Ecological Niche Model. Country, locality, geographic coordinates, and source of information; the data with an asterisk correspond to the specimens reviewed in this paper, and we indicate uncatalogued numbers with the letter T (in bold). CTUA: Colección Teriológica Universidad de Antioquia; ICN: Instituto de Ciencias Naturales, Universidad Nacional de Colombia; IAvH: Instituto Alexander von Humboldt; MHNUC: Museo de Historia Natural del Cauca; UV: Universidad del Valle; QCAZ: Museo de Zoología Pontificia Universidad Católica del Ecuador.

Country	Locality	Latitude	Longitude	Source
Colombia	Antioquia: La Frijolera	7° 7' 0.12" N	75° 25' 0.12" W	Simmons *et al.* (2002)
Colombia	Antioquia: Remedios, Vda. Ojos Claros	7° 3' 7.68" N	74° 18' 17.65" W	CTUA 2405*
Colombia	Amazonas: La Pedrera	1° 19' 40.87" S	69° 33' 47.16" W	ICN-**T**-ATG 161*
Colombia	Arauca: Tame, Reserva Forestal protectora del río Tame	6° 24' 6.5" N	71° 56' 35.99" W	IAvH 9312*
Colombia	Caldas: Municipio Samana, corregimiento San Diego, vda Risaralda	5° 39' 12.41" N	74° 56' 50.16" W	Simmons *et al.* (2002)
Colombia	Caquetá: Río Mesay, PNN Chiribiquete, Puerto Abeja	0° 4' 27" N	72° 27' 5" W	IAvH 7155*
Colombia	Cauca: El Tambo, PNN Munchique, Sector El Cóndor	2° 43' 2.99" N	76° 56' 52.01" W	MHNUC 814*
Colombia	Cauca: Río Saijá	2° 55' 36.52" N	77° 33' 52.97" W	Simmons *et al.* (2002)
Colombia	Cesar: La Gloria	8° 35' 24.55" N	73° 34' 19.83" W	ICN 24461
Colombia	Chocó: Quibdó, Icho	5° 47' 34.69" N	76° 37' 37.72" W	CTUA 734*
Colombia	Córdoba: Pueblo Nuevo, Had. La Vaqueta	8° 24' 5" N	75° 22' 50" W	ICN 17236*
Colombia	Guajira: Maicao, Serranía del Perijá Carraipía, Pozo San Jonás	11° 15' 24.12" N	72° 21' 39.01" W	ICN 19413*
Colombia	Guaviare: San José del Guaviare	2° 31' 31.87" N	72° 48' 26.89" W	ICN 23867*
Colombia	Magdalena: Bonda	11° 14' 1.32" N	74° 7' 29.63" W	Simmons *et al.* (2002)
Colombia	Meta: Cubarral, Vda. El Vergel Alto	3° 48' 28.30" N	73° 52' 51.97" W	ICN 14393*
Colombia	Meta: Mapiripan	2° 58' 43.06" N	71° 55' 0.11" W	ICN 24463*
Colombia	Santander: Puerto Parra	6° 36' 36.82" N	74° 5' 4.52" W	ICN-**T**-D3M541*
Colombia	Valle del Cauca: Buenaventura, Punta Ají, Río Naya	3° 14' 3.72" N	77° 32' 14.21" W	UV 11497*
Colombia	Valle del Cauca: Yotoco,Reserva Natural Bosque de Yotoco	3° 49' 60" N	76° 19' 59.99" W	ICN 22829*
Ecuador	Esmeraldas: E San Lorenzo (toward Lita), Finca San José	1° 15' 54.50" N	78° 47' 5.31" W	Porter *et al.* (2007)
Ecuador	Esmeraldas: San Lorenzo, La Chiquita Experimental Station	1° 14' 35.19" N	78° 50' 59.1" W	Porter *et al.* (2007)
Ecuador	Esmeraldas: Mataje, Navy Base.	1° 20' 45.6" N	78° 43' 0.09" W	Porter *et al.* (2007)
Ecuador	Pastaza: Arajuno, Villano A	1° 29' 50.80" S	77° 32' 13.71" W	QCAZ 15478*
Ecuador	Sucumbíos: Hotería Montetour	0° 1' 39.33" N	76° 40' 11.81" W	QCAZ 6943*
Ecuador	Napo: Tena, Jatunsacha Reserva	1° 1' 59.71" S	77° 39' 37.10" W	QCAZ 210*
Ecuador	Esmeraldas: San Lorenzo, Estación La Chiquita	1° 13' 59.99" N	78° 45' 36" W	QCAZ 9125*
Ecuador	Esmeraldas: San Lorenzo, Mataje, Base Naval	1° 12' 43.70" N	78° 25' 57.82" W	QCAZ 9124*
Guyana Francesa	Paracou: near Sinnamary	5° 16' 31.08" N	52° 55' 24.96" W	Simmons and Voss (1998)
Panamá	Veraguas: Cerro Hoya, Rio Portobelo	7° 14' 28.38" N	80° 36' 43.13" W	Porter *et al.* (2007)
Perú	Perú: Pasco, Oxapampa, San Juan	9° 53' 3.76" S	75° 10' 38.40" W	Simmons (2002)
Perú	Perú: Madre de Dios, left bank Rıo Palotoa	12° 28' 36.17" S	71° 47' 47.62" W	Simmons (2002)
Trinidad y Tobago	Trinidad: County St. George	10° 38' 49.2" N	61° 15' 13.47" W	Porter *et al.* (2007)
Trinidad y Tobago	Trinidad: County Mayaro	10° 16' 49.22" N	61° 1' 46.81" W	Porter *et al.* (2007)