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RANGE EXTENSION OF *Anoura aequatoris* AND NOTES ON DISTRIBUTIONAL LIMITS OF SMALL *Anoura* IN COLOMBIA

EXTENSIÓN DEL RANGO GEOGRÁFICO DE *Anoura aequatoris* Y NOTAS SOBRE LOS LÍMITES DE DISTRIBUCIÓN DE LOS PEQUEÑOS *Anoura* EN COLOMBIA

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ABSTRACT

We report 33 new records of *Anoura aequatoris* for Colombia including a specimen from Cocorná, Antioquia which represents a significant expansion in the latitudinal distribution for this taxon of almost five degrees north. All new records of *A. aequatoris* reported in this work correspond to collecting localities on the Central and Western Cordilleras in the Colombian Andes. In addition, morphometric differences of small *Anoura* from the Western and Eastern mountain ranges of the Colombian Andes are investigated.

Keywords: *Anoura aequatoris*; *A. luismanueli*; Chiroptera; Colombia; Geographic limits; Morphological variation; Phyllostomidae.

RESUMEN

Se presentan 33 nuevos registros de *Anoura aequatoris* para Colombia, que constituyen un incremento significativo en la distribución latitudinal de este taxón. Todos los registros nuevos de *A. aequatoris* reportados en este trabajo corresponden a especímenes colectados en localidades de la Cordillera Central y Occidental de los Andes colombianos. Adicionalmente, se investigan las diferencias morfométricas entre los pequeños *Anoura* de las cordilleras Occidental y Oriental de Colombia.

Palabras clave: *Anoura aequatoris*; *A. luismanueli*; Chiroptera; Colombia; Límites geográficos; Phyllostomidae; Variación morfológica.

INTRODUCTION

Nectarivorous bats in the genus *Anoura* are typically found in the highlands of the Neotropics and it has been suggested that the variation documented within the genus is an evolutionary response to the ecological complexity of the Andean mountainous system (Mantilla-Meluk & Baker 2006). The smallest forms within the genus *Anoura* (greatest skull length, GSL <23.0 mm) are *A. aequatoris* (Lönnberg 1921) and *A. luismanueli* (Molinari 1994); both of them reported in Colombia by Mantilla-Meluk & Baker (2006). *Anoura aequatoris* was described from two small and dark Ecuadorian specimens collected in Ilambo (=Illambo) Gualea, western Ecuador (0° 7.00' N, -78° 44.00' W) at 1512 m, characterized by the presence of a fringe of hairs on the edge of the uropatagium and smaller skulls in comparison with typical *A. caudifer* from São Paulo, Brazil. On its side *A. luismanueli*, was described based on small and dark specimens collected in Mérida, Venezuela at 2000 m (Molinari 1994) also characterized by a fringe of hairs on the edge of the uropatagium. Morphometric ranges reported for *A. luismanueli* by Molinari (1994) partially overlap those proposed for *A. aequatoris* by Lönnberg (1921). Unfortunately, *A. aequatoris* and *A. luismanueli* were not compared by Molinari

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(1994) making difficult their taxonomic characterization. In Mantilla-Meluk & Baker (2006) small *Anoura* from the Central and Western Cordilleras were morphometrically discriminated from those on the Eastern Cordillera. Based on a typological criterion the authors assigned the names *A. aequatoris* to small *Anoura* from the Central and Western Cordillera, closer to Illambo, Ecuador and *A. luismanueli* to samples from the Eastern Cordillera, closer to Mérida, Venezuela. Mantilla-Meluk & Baker (2006) suggested that the northernmost limit of *A. aequatoris* was represented by a specimen collected in Belén, department of Huila, deposited at the Instituto de Ciencias Naturales of the Universidad Nacional de Colombia (ICN 7615). In a recent revision of representative of small *Anoura* deposited at the ICN and the Field Museum of Natural History (FMNH) we documented specimens from several localities northern than the department of Huila that matched both discrete characters and morphometric ranges differentiating *A. aequatoris*. In this work we report new Colombian localities for *A. aequatoris* and discuss on the distributional limits of *A. aequatoris* and *A. luismanueli* in the country.

MATERIALS AND METHODS

Morphological analysis. To tested for morphological differences between small *Anoura* populations from Colombian mountainous ranges separated by the Inter-Andean Valley of the Magdalena River a Discriminant Function Analysis (DFA) was performed on 13 skull measurements of specimens deposited at the Instituto de Ciencias Naturales of the Universidad Nacional de Colombia (ICN), the Field Museum of Natural History (FMNH), as well as one specimen from the Museo de Historia Natural of the Universidad de Caldas MHNUC, temporarily available at the collections of the ICN.

Skull measurements. Greatest skull length (GSL), codylobasal length (CB), palatal length (PAL), rostrum breadth (RB), postorbital breadth (POB), zygomatic breadth (ZB), braincase breadth (BB), braincase height (BH), mastoid breadth (MB), breadth across the upper canines (CC), breadth across the upper molars (MM), length of the tooth row (LTR), mandible length (ML), mandible height (MH), length of the mandible tooth row (CM3), and forearm length.

External characters. The following external characters were analyzed: 1) coat coloration, 2) individual hair coloration pattern in between the scapulas, 3) individual hair longitude in between the scapulas, 4) length of the fringe hairs on the edge of the uropatagium, and 5) density of the fringe hairs on the edge of the uropatagium. Coat color was determined based upon the international chart of color (Ridgway 1912).

Ten hairs from each individual were collected from the interscapular region of the back of five small *Anoura* individuals from the Western and Central Cordilleras and five small *Anoura* from the Eastern Cordillera (N=100) and mounted in a Neubauer chamber at 100X. Then, hair total longitude as well as the proportions of the colored and non-colored portions of the hair was estimated. To test for statistical differences in hair longitude a t-test was applied to the hair longitude data set. In addition, hair scale structure and imbrication pattern in the middle portion of every hair were registered. Specimens analyzed are listed in Appendix I.

RESULTS AND DISCUSSION

The small *Anoura* from the Central and Western Cordilleras in Colombia, include specimens previously identified as *A. caudifer* in group 2 of Mantilla-Meluk and Baker (2006). We examine 33 small *Anoura* from 11 sampling localities along the Central and Western Cordilleras of the Colombian Andes (Figure 1). Specimens of *Anoura* from the Central and Western Cordilleras of the Colombian Andes share all the characteristics described for *A. aequatoris* by Lönnberg (1921) (Appendix I).

Although ranges of skull and forearm measurements

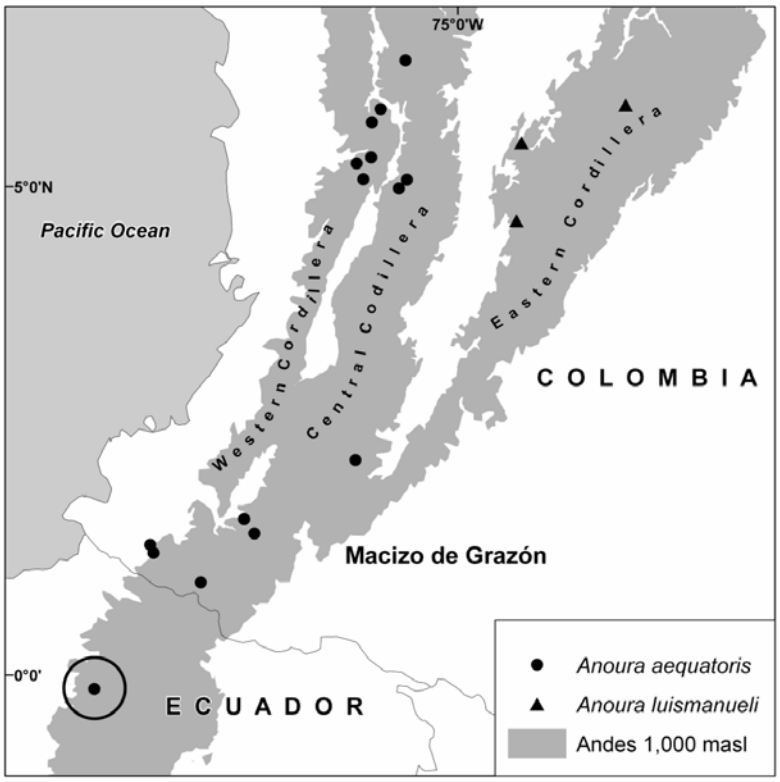

Figure 1. *Anoura* sampling localities analyzed in the present study. Black dots represent new additions of *Anoura aequatoris* for Colombia. The circled black dot represents *A. aequatoris* type locality, Triangles represent sampling localities of *A. luismanueli* of specimens examined in the present study (masl=meters above sea level).

overlap between small *Anoura* from the two analyzed geographic units, specimens from the Western range of the Andes were larger than small *Anoura* from the Eastern range for seven of the recorded measurements. Specimens from the Eastern range of the Colombian Andes averaged larger than small *Anoura* from western Colombia for three of the recorded measurements. For the remaining six measurements one species range was completely contained within the range of other species (Table 1). Our Discriminant Function Analysis discriminated small *Anoura* from the Central and Western Cordilleras from small *Anoura* from the Eastern Cordillera of the Colombian Andes (Wilk's Lambda F1=0.020, F2=0.294; p=0.0001) (Figure 2). Based on the observed morphometric evidence and proximity to type localities, we recognize populations of small *Anoura* from the Western range as *A.*

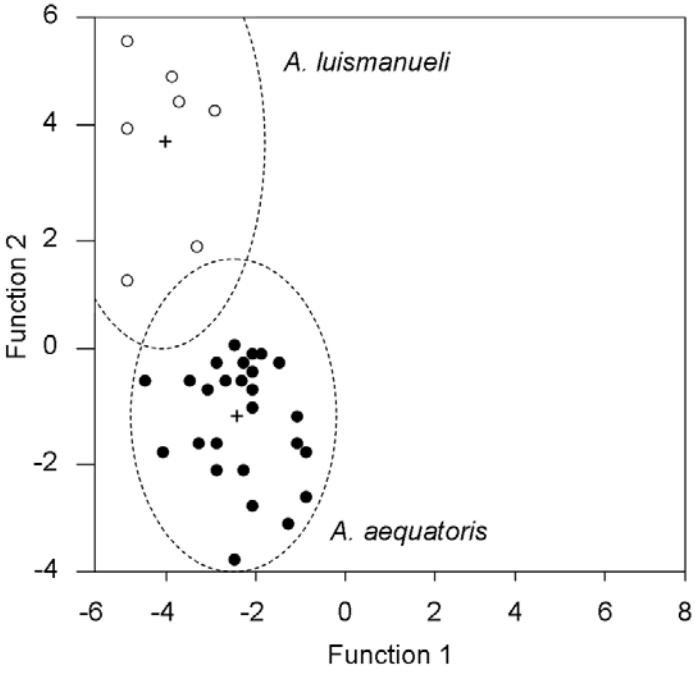

Figure 2. Discriminant Function Analysis among *Anoura aequatoris*, *Anoura luismanueli*.

Table 1
Skull measurements of *Anoura aequatoris* and *Anoura luismanueli* in Colombia

Cranial measurements	*Anoura aequatoris*	*Anoura luismanueli*	Size proportion
Forearm	34.08 – 37.40	34.10 – 35.43	=
GSL	21.08 - 22.81	20.50 - 21.97	→
CB	20.45 - 22.3	20.54 – 21.07	=
PAL	10.2 – 11.96	10.58 – 11.36	←
RB	4.24 – 5.18	3.62 – 3.88	→
POB	4.31 – 5.00	4.24 – 4.75	→
ZB	8.85 – 9.75	8.74 – 9.28	→
BB	8.77 – 9.77	8.88 – 9.19	=
BH	6.34 – 7.30	6.32 – 6.92	→
MB	8.04 – 9.10	8.19 - 8.32	→
CC	3.65 – 4.27	3.75 – 4.33	←
MM	4.9 – 5.85	4.52 – 5.08	=
LTR	7.35 – 8.54	7.02 – 7.88	→
ML	14.69 – 16.04	14.88 – 15.67	←
MH	3.30 – 4.16	3.51 – 4.04	=
CM3	7.99 – 8.68	7.69 – 8.80	=

Size proportion between the two species is indicated as follows: (→) *A. aequatoris* bigger than *A. luismanueli*, (←) *A. luismanueli* bigger than *A. aequatoris*, and (=) range completely contained. Measurements: greatest length of skull (GSL), condylo-basal length (CB), palatal length (PAL), width of the rostrum (RB), postorbital constriction width (POB), zygomatic arch width (ZB), brain-case height (BH), braincase width (BB), mastoid breadth (MB), distance across upper canines (CC), distance across third upper molars (MM), maxillary tooth-row length (LTR), mandible length (ML), mandible tooth-row length (CM3), and height of the ramus (MH).

aequatoris and populations of small *Anoura* from the Eastern range as *A. luismanueli.*

In addition to morphometric differences, *A. aequatoris* and *A. luismanueli* also differ in terms of discrete external characters, including coat coloration, hair length, and hair microstructure.

The general appearance in coat coloration among bats of the genus *Anoura* depends on 1) proportion of one-banded versus two-banded hairs, 2) thickness of the hair (microstructure), and 3) proportion of the pigmented versus non-pigmented band in the two-banded hairs that are intercalated along the surface of the skin. One-banded black hairs (monochromatic melanic hairs) are more common in the lower back of the bat, while two-banded (dichromatic hairs) are more common in the middle of the back in between the scapulas.

Anoura aequatoris coat coloration was darker than that of *A. luismanueli*. The predominant coat color among Colombian *A. aequatoris* was blackish brown N° 2, (Ridgway 1912), whereas predominant coat color of *A. luismanueli* was identified as dusky brown to blackish black 1 (Ridgway 1912). Dichromatic hairs in the middle of the intrascapular region of *A. aequatoris* were 15%-20 % longer than two-banded intrascapular hairs of *A. luismanueli* (Figure 3a). In contrast, the proportion of the colored portion of intrascapular two-banded hairs in *A. aequatoris* (35%- 30 %) was smaller than the proportion of the color portion of two-banded hairs at the intrascapular region of *A. luismanueli* (40%-45%) (Figure 3b). A t-test revealed significant differences ($p<0.01$) in hair longitude between *A.*

aequatoris (N=50) and *A. luismanueli* (N=50).

Our analysis of the microstructure of dichromatic hairs revealed a high variation in the shape of the scales along the hair. However, as it has been reported by Benedict (1957) for other bats species, scale structure and imbrication were more constant in the mid portion of the hair. Same type of scales was found in the hair of the *Anoura* specimens analyzed. Both, *A. aequatoris* and *A. luismanueli* had an imbricate arrangement of elongate-denticulated scales with no evidence of medulla (Figure 3c). Nevertheless, longer hair scales of *A. aequatoris* have a more compacted imbricate pattern than the one found among the shorter hairs of *A. luismanueli*. Long hairs of *A. aequatoris* were completely bleached on their bases and the colored tip was darker in comparison with the creamy to white base and the brownish tip of *A.luismanueli*. The combination of characteristics of dichromatic intrascapular hairs of *A. aequatoris* resulted in a more contrasted demarcation of the intrascapular area in comparison with *A. luismanueli*.

Although the uropatagia of both *A. aequatoris* and *A. luismanueli* were characterized by a fringe of hairs on their edge, uropatagia of *A. aequatoris* were more densely hirsute and their hairs were longer than those in *A. luismanueli* (Figure 3d).

The specimens reported herein represent a significant addition to *A. aequatoris* distribution. The eleven localities associated with the present *A. aequatoris* records represent a wide range of altitudes (880-2330 m). These records also include a wide variety of contrasting mountainous ecosystems ranging from the Semi-pluvial

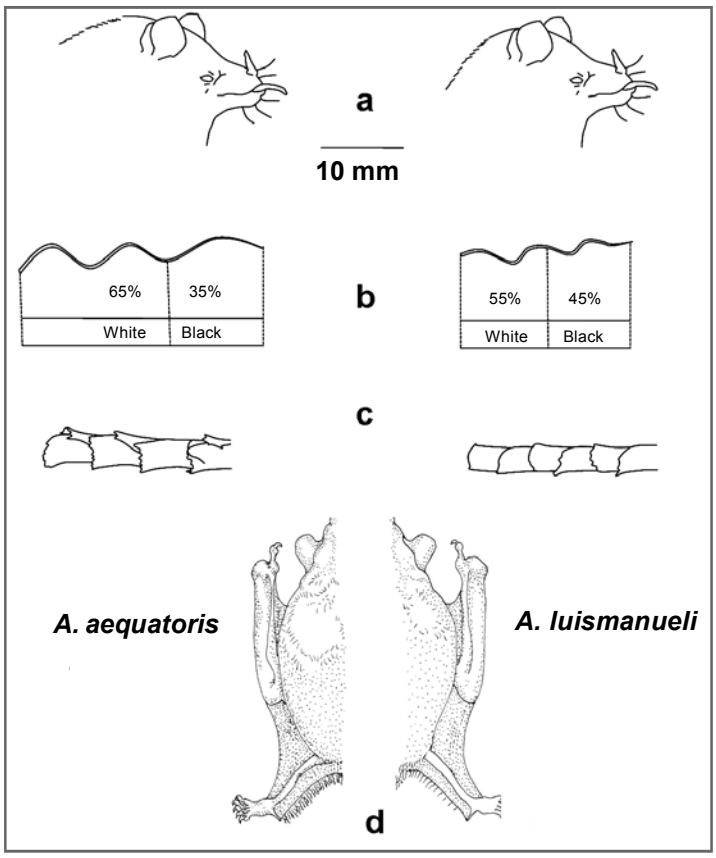

Figure 3. Differences in hair attributes between *Anoura aequatoris* (left) and *Anoura luismanueli* (right). a) hair distribution on the back of the neck, b) hair length, c) hair microstructure, d) hair distribution on the body and the uropatagium.

piedmont rainforest of the Pacific slopes (Rangel 2004) in the southern Biogeographic Chocó, to the Altoandino forest and the Páramo ecosystems in the northern ranges of the Central and Western Cordilleras (Rangel 2000). We failed to find an association between skull variation in size and altitude among representatives of *A. aequatoris* in Colombia. Our *A. aequatoris* record from Cocorná, department of Antioquia (7º 14' 24.00" N, 75º 34' 12.00" W) (ICN 9763) constitutes an increment in more than seven degrees northward to the distribution of *A. aequatoris*.

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APPENDIX I

Speciments examined. - Anoura aequatoris: COLOMBIA: Antioquia; Cocorná, 7º 14' 24.00" N, 75º 34' 12.00" W (ICN 9763); Medellín, Parque Regional Arui, La Aguada, 6° 17' 29" N, 75° 32' 10" W (ICN 18043,18045-47); Jericó, Parque Regional Las Nubes, Bosque Nacimiento la Peña 5º 47' 39.00" N, 75º 47' 4.00" W (ICN 18049); Jericó, Parque Regional Las Nubes, Bosque La Cascada 5º 47' 39.00" N, 75º 47' 4.00" W (ICN 18050). Caldas; Manizales, Quebrada Guayabala, Jardín de Mariposas, Recinto Pensamiento, Maltería 5° 4' 12.00" N, 75° 31' 14.00" W (ICN 16729), Sendero, La Gruta (B. CHECH) 5° 19' 58.00" N, 75° 47' 28.00" W (MHNUC 458). Huila; Belén, Hacienda Meremberg 2° 12' 4.00" N, 76° 2' 54.00" W (ICN 7615), Pitalito, 1° 52' 3.00" N, 76° 3' 23.00" W (FMNH 7615-16). Nariño; Barbacoas, Corregmiento, Junín, La Guarapería, 32 Km de Junín, 1° 39' 21.00" N, 78° 9' 55.00" W (ICN 13634-35); Barbacoas, Altaquer 1° 39' 21.00" N, 78° 9' 55.00" (ICN 13636), El Carmen, Oleoducto 1° 35' 43.00" N, 77° 11' 18.00" W (FMNH-1676, 1739); La Victoria, 1° 26' 60.00" N, 77° 4' 60.00" W (FMNH 113502-04); Llorente, 0° 49' 0.00" N, 77° 15' 0.00" W (FMNH 13608-10, FMNH 13612-13, FMNH 13616). Risaralda; Pueblo Rico, Camino a la Bocatoma 5° 14' 18.00" N, 76° 2' 11.00" W (ICN 11460,11462). Santuario, Vereda El Campamento 5° 4' 31.00" N, 75° 58' 2.00" W (ICN 11832). Mistrató, R. 1.5 Km E San Antonio del Chamí 5° 17' 58.00" N, 75° 53' 15.00" W (ICN 12296). Mistrató, Vereda Empalado Km 12 Carretera Mistrató-San Antonio del Chamí 5° 17' 58.00" N, 75° 53' 15.00" W (ICN 12534-36). *Anoura luismanueli*: COLOMBIA: Cundinamarca; Tena, Pedro Palo, 2000 m, 4° 39' 26.00" N, 74° 22' 7.00" W (ICN 5493). Yacopi, Vereda Guadalito 2100 m 5° 27' 58.00" N, 74° 20' 20.00" W (ICN 13786). Santander; Charalá, Virolin, left margin Oibita River 470 -1750 m 6° 17' 14.00" N, 73° 8' 50.00" W (ICN 6603, ICN 6605-06, ICN 6608, ICN 8123, ICN 8981, ICN 15295).