

A NEW SPECIES OF *ANOURA* (CHIROPTERA: PHYLLOSTOMIDAE) FROM THE ECUADORIAN ANDES

NATHAN MUCHHALA,* PATRICIO MENA V., AND LUIS ALBUJA V.

Department of Biology, University of Miami, P.O. Box 249118, Coral Gables, FL 33124, USA (NM)

Investigador Asociado, Departamento de Ciencias Biológicas, Escuela Politécnica Nacional, Quito, Ecuador (PMV)

Departamento de Ciencias Biológicas, Escuela Politécnica Nacional, Apartado 17-01-2759, Quito, Ecuador (LAV)

Here we describe a new species of *Anoura* from the Andes of Ecuador, distinguished from all other species of *Anoura* by its elongated tubelike lower lip and its much longer tongue. Based on size and other characteristics, *Anoura* n. sp. appears most similar to *Anoura caudifer*, but averages approximately 10% larger and has a wider uropatagium in the shape of an inverted V. *Anoura* n. sp. has been collected infrequently in cloud forests on the eastern and western slopes of the Andes throughout Ecuador, where it co-occurs with the more abundant *A. geoffroyi* and *A. caudifer*. Comparison with the diets of sympatric species of *Anoura* suggests that *Anoura* n. sp. visits flowers that have longer corollas, as might be expected given its much longer tongue.

Key words: cloud forest, Ecuador, glossophagine, long-tongued bat, nectarivore

The nectarivorous glossophagine bats of the genus *Anoura* are distributed from central Mexico to Bolivia, with the highest abundance and diversity in the Andes of South America (Barquez et al. 1999; Koopman 1981, 1993; Molinari 1994). The genus includes 5 recognized species: *A. latidens* Handley, 1984, *A. luismanueli* Molinari, 1994, *A. caudifer* E. Geoffroy, 1818, *A. geoffroyi* Gray, 1838, and *A. cultrata* Handley, 1960. The latter 3 species have largely overlapping ranges within Ecuador, based on Albuja (1999) and a review of museum collections. *A. caudifer* occurs throughout the western lowlands and on the eastern and western slopes of the Andes up to 2,500 m, reaching its highest abundance at midelevations. *A. geoffroyi* also is most abundant on the eastern and western slopes of the Andes, but differs from *A. caudifer* in occurring at higher elevations; it has been recorded at up to 3,500 m and only rarely below 1,000 m, and does not occur in the western lowlands. *A. cultrata* is rare in Ecuador; the few known specimens come from the slopes of the Andes from 50 up to 2,200 m.

In a study of the bat fauna of cloud forests in the Cordillera del Cóndor and Cordillera de Cutucú in southwestern Ecuador, one of us (PMV) collected a series of 8 *Anoura* that he could not identify. Muchhala independently encountered individuals of this species during studies of bat pollination in several cloud forest sites on the eastern and western slopes of the Andes.

Subsequent research in museum collections (Appendix I) revealed additional individuals misidentified as either *A. caudifer* or *A. geoffroyi*.

MATERIALS AND METHODS

We examined approximately 300 museum specimens of *Anoura*. Of these, we measured 16 individuals of the new species, 25 of *A. caudifer*, 25 of *A. geoffroyi*, and 10 of *A. cultrata* (Appendix I). In addition, we have external measurements and information on collection locality for 4 individuals of the new species, which were captured with mist nets and released. The museum specimens listed above include 9 *Anoura* n. sp. and 5 *A. caudifer* that we collected; these were captured with mist nets and euthanized by cervical dislocation. All procedures were in accordance with guidelines of the American Society of Mammalogists for the capture, handling, and care of mammals (<http://www.mammalogy.org/committees/index.asp>).

Mass was taken in the field with a Pesola scale (Pesola AG, Baar, Switzerland) and rounded to the nearest 0.5 g. External dimensions also were measured in the field with a plastic ruler, to the nearest 0.5 mm, or to the nearest 0.1 mm with dial calipers. External measurements include forearm length, from the elbow (tip of the olecranon process) to the wrist (including the carpals); total length, from tip of muzzle to tip of tail; tail length, from base of tail to tip of last caudal vertebra; uropatagium width, from base of tail to center of margin of interfemoral membrane; vibrissae length, length of longest rostral vibrissa; ear length, length of pinna from base of antitragus; and hind foot length, from ankle to tip of claw.

Craniodental dimensions were measured from cleaned skulls with dial calipers, to the nearest 0.1 mm. These include total skull length, from the posteriormost point of the occiput to the anteriormost point of the premaxillae; condylobasal length, a line connecting the posterior margins of the occipital condyles to the anteriormost point of the premaxillae; zygomatic breadth, greatest breadth across the zygomatic

* Correspondent: n_muchhala@yahoo.com

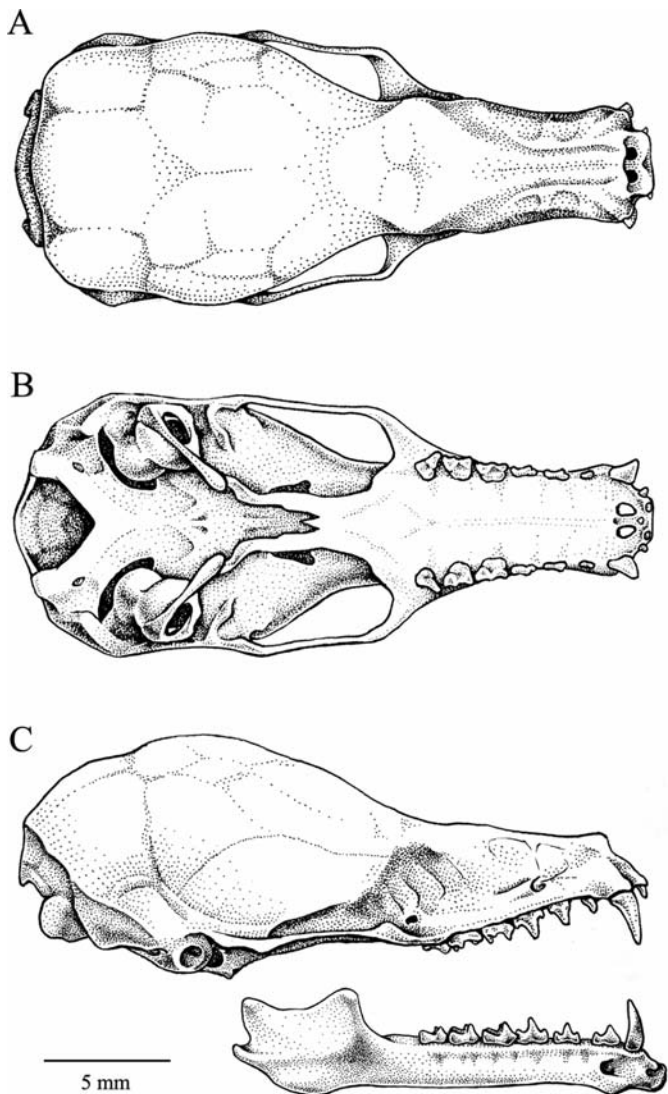


FIG. 1.—Cranial and dental morphology of *Anoura fistulata* (from holotype, EPN 9713). A) Dorsal and B) palatal view of skull, and C) lateral view of skull and mandible.

arches; postorbital breadth, least breadth across the frontals posterior to the postorbital process; braincase breadth, greatest breadth of the globular part of the braincase; palatal length, from the posteriormost margin of the upper medial incisor alveolus to the posteriormost point of the palate (including the postpalatal spine, when present); maxillary tooth-row length, from the anteriormost face of the canine to the posteriormost face of the crown of the 3rd molar; mandible length, from the anteriormost point of the mandible to the posteriormost point of the mandibular condyle; mandibular tooth-row length, from the anteriormost face of the canine to the posteriormost face of the 3rd molar; breadth across molars, greatest breadth across the outer edges of the crowns of the 3rd upper molars; and breadth across canines, greatest breadth across the outer edges of the crowns of the upper canines.

Anoura fistulata, new species

Holotype.—Adult male (EPN 9713), preserved in alcohol with skull removed (Fig. 1), collected 6 May 2003 by P. Mena V. (original number CM009), on the Condor Mirador (near the Destacamento Militar; 3°38'08"S, 78°23'22"W) of the Cordillera del Condor, 1,750 m, Zamora Chinchipe Province, Ecuador.

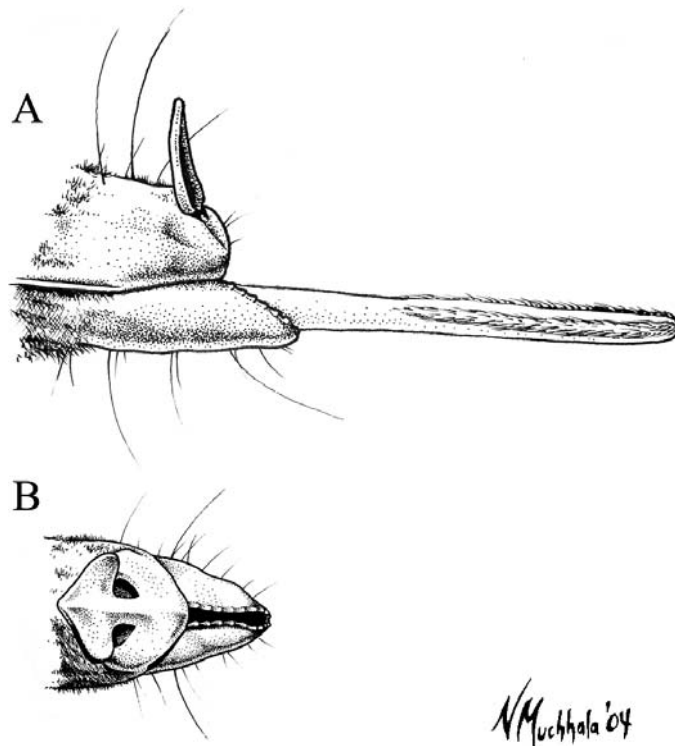


FIG. 2.—Lip morphology of *Anoura fistulata*. A) Lateral view of noseleaf, lip, and partially extended tongue with papillae; and B) dorsal view of noseleaf and lip.

Paratypes.—The 3 paratypes were collected by P. Mena V. at the type locality, and include an adult female (EPN 9710), skin and skull, collected 24 June 2003; an adult male (EPN 9711), skin and skull, collected 5 May 2003; and an adult female (EPN 9712), preserved in alcohol, collected 6 May 2003.

Diagnosis.—This is a medium-sized species of *Anoura* (forearm 35–40 mm). Distinguishing characteristics include an elongated, tubelike lower lip (extending 3.3–4.8 mm beyond upper lip; Fig. 2) and an extremely long tongue (6–8 cm in fresh individuals). The interfemoral membrane is relatively wide (3.3–7.5 mm) with an inverted V-shaped margin (versus narrow and U-shaped in other *Anoura*). The tail, which is normally absent or rudimentary in other *Anoura*, protrudes slightly beyond the edge of the interfemoral membrane.

Description.—Medium-sized for the genus; forearm length (35–40 mm) falls between that of *A. geoffroyi* and *A. caudifer*. Forearm and other body measurements average approximately 10% larger than those of *A. caudifer* (Table 1). Lower lip elongated, extending 3.3–4.8 mm anterior to the upper lip, and rolled into a tubelike structure that is slit dorsally (Fig. 2). Margins of this protrudent lower lip adorned with small tubercles. Tongue extremely long; 6–8 cm, as measured from fresh specimens in the field. Distal patches of hairlike papillae, common to all glossophagines, extends 4.8–6.0 mm along the tip of the tongue. Snout with many long vibrissae (up to 7 mm in length; Fig. 2). Interfemoral membrane relatively wide (3.3–7.5 mm), with margin in the shape of an inverted V; sparsely haired to naked dorsally and ventrally, with sparse fringe of hair along anterior one-half of this margin (i.e., around tail; margin naked closer to calcar). Calcar relatively long (4.6–5.8 mm). Tail (4.9 mm in length) protrudes slightly beyond edge of interfemoral membrane.

Fur dense and silky. Hairs of the dorsal pelage approximately 7 mm long, with 2 colored bands. Terminal band (two-thirds length of hair)

TABLE 1.—Measurements (in mm) and body masses (in g) of specimens of adult *Anoura fistulata*, *A. caudifer*, *A. geoffroyi*, and *A. cultrata*.

	Holotype	<i>Anoura fistulata</i> All specimens \bar{X} (range) <i>SD</i> , <i>n</i>	<i>A. caudifer</i> All specimens \bar{X} (range) <i>SD</i> , <i>n</i>	<i>A. geoffroyi</i> All specimens \bar{X} (range) <i>SD</i> , <i>n</i>	<i>A. cultrata</i> All specimens \bar{X} (range) <i>SD</i> , <i>n</i>
Total length	64.0	61.9 (57.0–67.0) 2.84, 13	54.6 (53.0–56.0) 1.13, 9	63.1 (58.7–71.5) 3.71, 14	66.1 (57.0–75.0) 6.01, 9
Tail length	4.5	4.9 (4.0–7.0) 1.10, 10	4.1 (3.0–5.0) 0.64, 8		4.9 (3.0–7.0) 1.27, 9
Hind foot length	8.5	8.9 (7.0–11.5) 1.39, 12	8.0 (7.0–9.0) 0.71, 9	10.5 (8.0–12.0) 1.42, 7	10.6 (9.0–13.0) 1.42, 9
Ear length	13.6	14.3 (12.3–17.0) 1.23, 14	12.3 (11.0–13.0) 0.71, 9	13.8 (12.0–15.6) 1.24, 7	14.3 (12.0–17.0) 1.92, 9
Forearm length	37.2	37.8 (35.0–40.0) 1.33, 19	35.9 (34.0–37.0) 0.83, 11	44.8 (43.2–46.1) 0.92, 18	40.4 (39.2–42.0) 1.14, 5
Mass	11.5	12.7 (9.5–17.5) 2.44, 12	9.4 (8.5–10.5) 0.56, 10	15.3 (13.0–18.0) 1.89, 7	16.4 (13.5–21.5) 2.97, 9
Total skull length	23.5	24.1 (22.9–26.1) 1.34, 6	21.8 (21.2–22.5) 0.39, 14	25.7 (24.9–26.5) 0.47, 10	24.1 (23.3–24.8) 0.66, 5
Condylbasal length	23.0	23.5 (22.3–25.1) 1.27, 6	21.0 (20.5–21.5) 0.26, 15	25.1 (24.4–25.7) 0.42, 10	23.3 (22.5–24.2) 0.79, 5
Zygomatic breadth	9.8	9.8 (9.4–10.3) 0.45, 3	9.1 (8.0–9.8) 0.61, 6	10.7 (9.9–11.5) 0.42, 10	10.6 (10.3–10.8) 0.26, 3
Postorbital breadth	4.5	4.7 (4.4–5.1) 0.26, 6	4.4 (4.2–4.6) 0.10, 15	4.9 (4.6–5.3) 0.21, 10	4.9 (4.7–5.2) 0.22, 5
Braincase breadth	9.4	9.4 (9.2–9.7) 0.17, 6	8.8 (8.3–9.0) 0.19, 15	9.9 (9.6–10.2) 0.20, 10	9.3 (8.9–9.7) 0.30, 5
Palatal length	12.0	12.5 (11.3–14.4) 1.08, 6	11.7 (10.6–12.8) 0.63, 15	13.9 (13.2–15) 0.56, 10	12.1 (11.7–12.4) 0.28, 5
Maxillary tooth-row length	8.6	8.9 (8.1–9.6) 0.52, 6	7.8 (7.5–8.3) 0.24, 15	9.5 (9.1–10.2) 0.33, 10	8.5 (7.9–9.2) 0.57, 5
Mandible length	17.0	17.7 (16.5–19.3) 1.09, 6	15.3 (14.8–15.8) 0.28, 15	18.4 (17.6–18.9) 0.38, 9	16.6 (16.0–17.1) 0.51, 5
Mandibular tooth-row length	9.0	9.0 (8.4–9.8) 0.62, 6	8.2 (7.8–8.5) 0.17, 15	10.4 (9.8–10.9) 0.33, 10	9.3 (7.9–10.2) 0.91, 5
Breadth across molar	5.9	5.5 (4.9–5.9) 0.38, 6	5.2 (4.9–5.5) 0.22, 9	6.0 (5.5–6.4) 0.29, 10	5.7 (5.4–6.3) 0.40, 5
Breadth across canines	4.4	4.4 (4.2–4.6) 0.16, 6	3.7 (3.5–3.8) 0.13, 8	4.9 (4.3–5.6) 0.41, 10	4.9 (4.5–5.4) 0.35, 5

dark brown (Raw Umber 223 to Vandyke Brown 121; all color names from Smith [1975]). Basal band white to cream (Pale Horn 92) on the head, neck, and upper back; grades to darker cream (Light Drab 119C) on the lower back. Hairs ventrally 5 mm long; on throat and upper chest also 2-banded with same colors and proportions as on the head, neck, and upper back, whereas on lower chest, abdomen, and uropatagium hairs unicolored dark brown (Raw Umber 223 to Vandyke Brown 121). Proximal one-third of forearms densely furred dorsally and ventrally. Legs sparsely furred proximally to knee dorsally, but ventrally naked. Hairs of forearms and legs 2 mm long; fringe in center of interfemoral membrane 3 mm long. Color of skin of ears, noseleaf, tragus, wings, and interfemoral membrane Sepia (219).

Cranium and mandibles similar in shape to those of *A. caudifer*, with most measurements approximately 10% larger (Table 1). Mandibular suture protrudes anteriorly (Fig. 1). Gap (0.54 mm, $n = 6$) often present between 1st and 2nd lower premolar. Dental formula identical to that of other species of *Anoura* (i 2/0, c 1/1, p 3/3, m 3/3, total 32). Postpalatal spine relatively short (0.3 mm, $n = 6$), although length is highly variable. Zygomata complete in all specimens examined.

Comparisons.—*Anoura fistulata* is readily distinguished from all other species of *Anoura* by the characteristic development of its lower lip, its longer tongue, and the shape and width of its interfemoral membrane. In other *Anoura*, the lower lip extends only slightly beyond

the upper lip (less than 1 mm) and has a V-shaped pattern of papillae on the lip margin, which is oriented vertically as seen in the frontal view of the head. In *A. fistulata*, the lip is elongated (4–6 mm beyond upper lip) and rolled into a tube, with the papillae forming a fringe along each margin of the dorsal slit in the tube (Fig. 2). The only other glossophagine with a similar development of the lower lip is *Choeronycteris periosus*. The tongue of *A. fistulata* is much longer than in congeners. Measured on fresh specimens in the field, the tongue is more than twice as long as that of *A. caudifer* (6–8 cm versus 3 cm). After preservation in alcohol, the tongue measures 5 cm, versus 2.4 cm for *A. cultrata* ($n = 3$), 2.9 cm for *A. geoffroyi* ($n = 10$), and 3.0 cm for *A. caudifer* ($n = 10$). The interfemoral membrane has an inverted V-shaped margin in *A. fistulata* (broadly U-shaped in other *Anoura*) and is wider than 3.5 mm (<3.5 mm in all other *Anoura* except *A. caudifer*).

Of the 5 known species of *Anoura*, *A. fistulata* is most similar to and likely most closely related to *A. caudifer*. Although *A. fistulata* is larger on average by approximately 10%, ranges of some measurements overlap (Table 1), and both species have tails and comparatively wide uropatagia. In addition to the characteristics listed above, it can be distinguished from *A. caudifer* by its shorter palatal spine and longer tail. *A. fistulata* also is similar in size to *A. luismanueli*, but lacks the ventrally heavily furred interfemoral membrane characteristic of this species. *A. fistulata* is smaller than the remaining species of *Anoura*; in

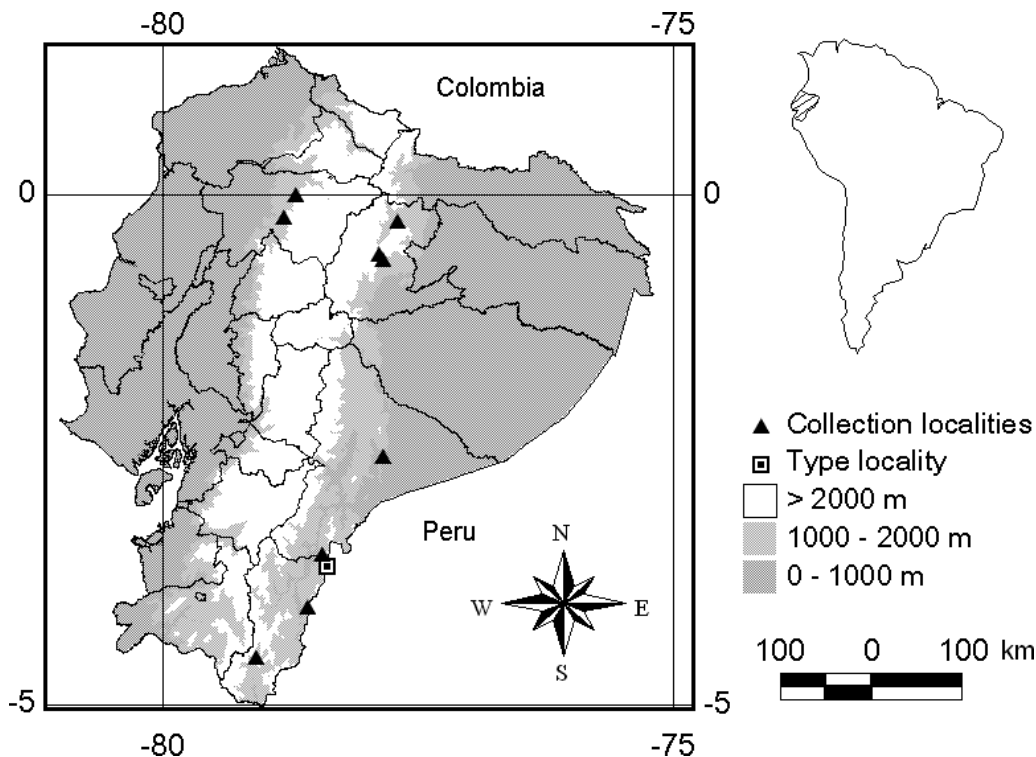


FIG. 3.—Geographic distribution of *Anoura fistulata* (black triangles) on eastern and western slopes of Andes, Ecuador. Type locality is marked with a square.

terms of forearm length, it does not overlap with *A. geoffroyi* or *A. latidens* and only slightly overlaps with *A. cultrata* (Table 1). It can be further distinguished from *A. geoffroyi* and *A. latidens* by the conspicuous tail, and it lacks the enlarged, bladelike 1st lower premolar characteristic of *A. cultrata*.

Distribution.—We recorded *A. fistulata* in 10 localities throughout the Ecuadorian Andes (Fig. 3), including the eastern and western slopes of the Andes of northern Ecuador, and the slopes of the Cordillera de C ndor and Cordillera del Cutuc  in southern Ecuador. Its known distribution is restricted to higher elevations (1,300–1,890 m on the eastern and 2,000–2,275 m on the western slopes), where it inhabits montane cloud forests. Although widespread, this species is uncommon, as demonstrated by the low rate of capture in mist nets and its relative rarity in museum collections. Given the proximity of several collection sites to the Peruvian border, it is highly likely that *A. fistulata* also occurs to the south in Peru, and it may occur to the north in Colombia, as well.

Etymology.—The specific epithet for this species is derived from the Latin word for tube (fistula), and refers to the characteristic tubelike lower lip. An appropriate common name for the species is the tube-lipped nectar bat.

Ecology.—*Anoura fistulata* inhabits midelevations of outer slopes of the Andes. One specimen was captured in the Numbala caves, where it was roosting with 4 other individuals. All specimens have been collected in mature cloud forest habitat.

Anoura fistulata consumes nectar and pollen from a number of large-flowered plants, and supplements its diet with insects. Pollen was collected from the fur of 4 individuals. Three were carrying pollen from unidentified bromeliads, 2 from *Marcgravia*, 2 from *Meriania*, 2 from *Centropogon nigricans*, and 1 from *Markea*. A fecal sample collected from 1 of these 3 contained pollen of *Marcgravia*, *Aphelandra acanthus*, and bromeliads, as well as wing scales of Lepidoptera and other insect parts. The gut contents of a 5th individual contained insect

parts and pollen from *Pitcairnia brogniartiana*, *Marcgravia coriaceae*, and *Markea*.

Remarks.—The most distinctive external characteristics of this new species involve soft tissues, including the tongue and lower lip. These tissues do not preserve well in skins prepared for museum collections, and are not commonly used in taxonomic studies. This may be the reason why the species has gone unnoticed until now. The tubular lower lip may represent an adaptation to aid in efficiently extracting nectar, or may simply serve to house the elongated tongue. The tongue, which is more than double the length of that in other *Anoura*, undoubtedly allows these bats to specialize on flowers that have longer corollas. The few data we have on flower visitation supports this hypothesis; pollen present in feces and on fur comes from large flowers, including bromeliads, *Centropogon nigricans*, *Markea*, *Marcgravia*, and *Meriania*. The pollen of species of *Burmeistera*, which have relatively short corollas, was conspicuously absent. *A. caudifer* and *A. geoffroyi* feed heavily on flowers of *Burmeistera*; in one study *Burmeistera* pollen was present on approximately 90% of mist-netted individuals (Muchhala and Jarr n-V. 2002).

RESUMEN

Aqu  describimos una nueva especie de *Anoura* de los Andes de Ecuador. Esta especie se la puede distinguir de todas las otras especies de *Anoura* por su alargado labio inferior en forma de un tubo y por su lengua dos veces m s larga que la de sus cong neres. Basado en su tama o y otras caracter sticas, *Anoura* n. sp. parece m s estrechamente relacionado con *A. caudifer*, pero es aproximadamente 10% m s grande y tiene un uropatagio m s ancho en forma de V invertida. Ha sido colectado infrecuentemente en los bosques nublados de ambos lados de

los Andes de Ecuador, donde co-ocurre con los más abundantes *A. geoffroyi* y *A. caudifer*. Comparando con las dietas de *Anoura* simpátricas, se sugiere que *Anoura* n. sp. visita flores con corolas más largos, como se puede esperar dado la largura de su lengua.

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APPENDIX I

Specimens examined.—The following specimens used in this study are preserved in the Escuela Politécnica Nacional, Quito, Ecuador (EPN); the Museo de Zoología of the Pontificia Universidad Católica del Ecuador, Quito, Ecuador (QCAZ); and the Museo Ecuatoriano de Ciencias Naturales, Quito, Ecuador (MECN). Sample size is given in parentheses.

Anoura caudifer (25): ECUADOR: Provincia El Carchi: El Pailón, 1,450 m elevation, 01°02'N, 78°15'W (EPN 1522). Provincia Esmeraldas: Río Piedras, 1,400 m, 00°32'N, 78°38'W (EPN 1519). Provincia Morona Santiago: Destacamento Militar Etza, 1,440 m, 03°03'41"S, 77°56'40"W (EPN 9805, 9806). Provincia Napo: Archidona, 1,600 m, 00°38'48"S, 77°49'25"W (EPN 1105); Cavernas Jumandí, Tena, 650 m, 00°56'S, 77°50'W (EPN 5053); Cascada San Rafael, 1,400 m, 00°54'54"S, 77°34'28"W (EPN 1515); El Salado, Alto Coca, 1,700 m, 00°11'S, 77°42'W (EPN 1537); Guamaní, 900 m, 00°43'06"S, 77°36'42"W (EPN 1526–1528). Provincia Pastaza: Mera, 1,150 m, 01°26'S, 78°06'W (EPN 1516); Mera, 1,200 m, 01°27'S, 78°07'W (EPN 1518); Arajuno, 400 m, 01°28'15"S, 77°26'W (EPN 1577). Provincia Sucumbios: Marian, 300 m, 00°01'S, 76°19'W (EPN 67). Provincia Orellana: Tarapoa, 180 m, 01°05'55"S, 75°38'58"W (EPN 831). Provincia Zamora Chinchipe: Tiink, 1,150 m, 03°19'40"S, 77°27'21"W (EPN 9807); La Herradura, 1,750 m, 04°02'02"S, 78°34'12"W (EPN 9857–9861); Mayaicu Alto, 900 m, 03°58'57"S, 78°37'47"W (EPN 9862–9864).

Anoura cultrata (10): ECUADOR: Provincia El Carchi: El Pailón, 1,450 m, 01°02'N, 78°15'W (EPN 1583). Provincia Esmeraldas: km 3 on road to Lita, 600 m, 00°52'48"N, 78°28'12"W (EPN 1580, 1581); Luis Vargas Torres, 10 km south of Río Santiago, 300 m, 00°49'N, 78°45'W (EPN 1582). Provincia Morona-Santiago: Uuntsuants, 1,000 m, 02°33'01"S, 77°54'37"W (EPN 9855). Provincia Orellana: Alto Coca, 450 m, 00°05'S, 77°15'W (EPN 1585). Provincia Pastaza: Mera, 1,150 m, 01°26'S, 78°06'07"W (EPN 1579); Cavernas Mera, 1,150 m, 01°27'S, 78°07'07"W (EPN 1584). Provincia Pichincha: Estación Biológica Maquipucuna, 1,200 m, 00°07'30"N, 78°37'36"W (EPN 1586). Provincia Zamora Chinchipe: Mayaicu Alto, 900 m, 03°58'57"S, 78°37'47"W (EPN 9856).

Anoura fistulata (17 plus 4 released): ECUADOR: Provincia Morona Santiago: Uuntsuants, 1,300 m, 02°33'9"S, 77°53'48"W (EPN 9806); Río Cristalino, 1,061 m, 03°31'12"S, 78°25'48"W (EPN 9700). Provincia Napo: Cotundo, 1,870 m, 00°38'30"S, 77°50'15"W (EPN 9539); El Salado, Alto Coca, 1,800 m, 00°15'S, 77°41'W (EPN 1531, 1537). Provincia Pichincha: Bellavista, 2,200 m, 00°00'8"S, 78°41'2"W (QCAZ 7500 plus 2 released); Guajalito, 2,000 m, 00°13'9"S, 78°48'0"W (QCAZ 3427, 3424); Pahuma, 2,275 m, 00°01'4"S, 78°38'W (1 released); Yanayacu, 2,075 m, 00°35'3"S, 77°52'8"W (1 released). Provincia Zamora Chinchipe: La Herradura, 1,750 m, 04°02'02"S, 78°34'12"W (EPN 9714–9716); Chinapinza, 1,700 m, 04°02'19"S, 78°35'40"W (MECN 572); Cuevas de Numbala, 1,890 m, 04°32'48"S, 79°04'05"W (EPN 1561); Destacamento Militar Cóndor Mirador, 1,750 m, 03°38'8"S, 78°23'22"W (EPN 9710–9713; holotype and paratypes).

Anoura geoffroyi (25): ECUADOR: Provincia El Carchi: Gruta de Rumichaca, 2,690 m, 00°49'N, 77°40'W (EPN 1616–1624). Provincia Manabí: San Sebastián, 350 m, 01°36'S, 78°42'W (EPN 732). Provincia Pichincha: Amaguaña, 2,650 m, 00°22'22"S, 78°30'14"W (EPN 1676–1685); Antisana, 3,250 m, 00°25'S, 78°22'W (EPN 1674, 1675); El Palmito, 1,600 m, 00°06'36"N, 78°37'12"W (EPN 1670, 1671, 1673).