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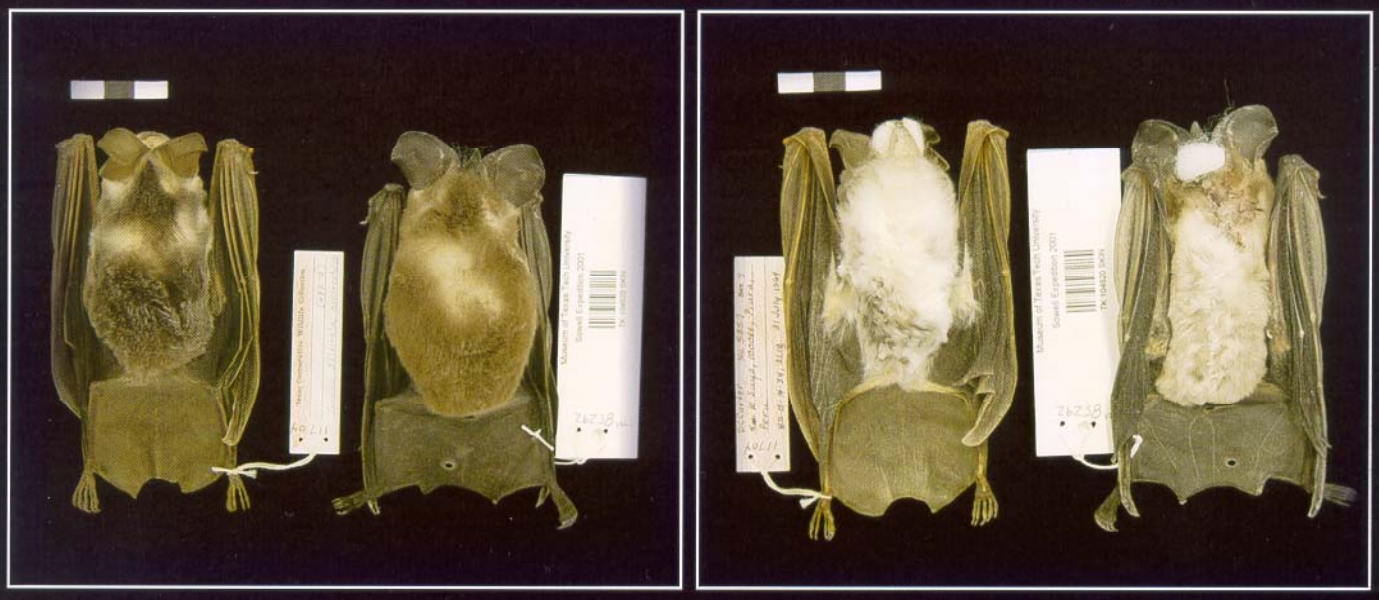

NEW BAT OF THE GENUS *LOPHOSTOMA* (PHYLLOSTOMIDAE: PHYLLOSTOMINAE) FROM NORTHWESTERN ECUADOR

Editorial Comment: Occasional Paper number 232 describes a new species in the genus *Lophostoma* from the lowlands of northwestern Ecuador. The authors used classical morphology, DNA sequence data and karyology to conclude that a species level description is appropriate. The application of the Genetic Species Concept is pivotal to their conclusions. As is the case with nearly all species descriptions, some questions remain to be answered that are critical to the story. In this case, there is a taxon, *Lophostoma silvicolum occidentalis*, described from the dry versant of Northwestern Peru for which there are no chromosomal nor DNA sequence data. Duane Schlitter (Texas Cooperative Wildlife Collection; Texas A&M University) was kind enough to permit a biopsy of two specimens of *L. s. occidentalis* but the authors were unable to generate reproducible sequence data and provide an estimate of genetic relatedness to the new species proposed herein. The significance of the amount of work that has gone into this description is an attempt to maintain high standards for the introduction of a new species name. Alternatively, the process of documenting the world's biodiversity is slowed because of the amount of work required to describe new species. At the current rate of new descriptions, is there sufficient time to describe, in a timely manner, all the undescribed species of vertebrates (much less the millions of undescribed invertebrates and other forms of life)? What is the significance of introducing a new name into the mammalogical literature? As any other type of scientific hypothesis, describing a new name is a taxonomic hypothesis that may be confirmed or rejected by further studies. If the taxon proves to be a "biological species" in the judgment of the scientific community then this species becomes one more component of the studies and inventories involving evolution, systematics, ecology, conservation, behavior and related fields. On the other hand, if the described taxon is judged not to be a "biological species", then it becomes a junior synonym in books full of junior synonyms. At any rate, a new name brings focus on certain populations, phylogroups or operational taxonomic units that scientists can interrogate concerning its proper systematic level and uniqueness. Without introducing a new name, the level of attention brought to this possible "biological species" would certainly be less than if a new name is described. We often ask of our students and colleagues "what percentage of descriptions would need ultimately to be judged biological species to make you comfortable in describing ten new species level taxa? Ten? Seven? Five? Three? One?" The answer to this question lies in the value to science and society of documenting a previously unrecognized species as opposed to the cost to science of introducing a junior synonym. Although we do not purport to know the answer to this balance, we do think that it is important to the science of Systematics to discuss the relationship between these two alternatives as well as the labor intensity associated with the introduction of new names. Finally, one of the reviewers, Don Wilson, has requested that for multi-authored papers introducing a new name, one or two individuals be designated as the authors of the description. Don points out that citing complicated author lines as a source of a name is becoming a significant problem in taxonomic reviews and species lists such as "Mammal Species of the World". Don's solution is an extension of the history of taxonomy where multiple authors might describe different taxa in books such as Long's "Account of an Expedition from Pittsburg to the Rocky Mountains." In such a book, descriptions as that of *Myotis subulatus* (Say 1823), were clearly the work of Say, the biologist, and not of Long, the leader of the expedition. The situation is much more complex now that species descriptions involve genetics, morphology, chromosomes and other data sets and the title of the paper is most likely some variation of "A New Species of X." If all of the authors really belong on the author line and if all of them contributed something that is an important part of the diagnosis of the new species, is it appropriate to have the description accredited two one or two individuals? Even when it is true that it is unfair to restrict the number of authors if several have been involved in the description in several ways, it is also true that many papers today have author lines where one to three of the six or ten authors involved have done most of the work. Although these author lines are sometimes justified for a variety of reasons, it is evident that a description of a new taxon is a different kind of credit. Only individuals who make a significant contribution to the discovery of a new species should be authors of the resulting scientific name. This is another issue that needs to be debated and discussed by those who want to be a part of the cataloguing of the world's biodiversity. It is our opinion that there are many currently unrecognized species of mammals and it is in the best interest of science and conservation that the process be efficient and expeditious in cataloging these new species level taxa.

RJB

Front cover: Holotypes of *Lophostoma silvicolum occidentalis* (left) from northwestern Peru and the new species of *Lophostoma* (right) from northwestern Ecuador in both dorsal and ventral views.

New Bat of the Genus *Lophostoma* (Phyllostomidae: Phyllostominae) from Northwestern Ecuador

Robert J. Baker, René M. Fonseca, Deidre A. Parish, Carleton J. Phillips, and Federico G. Hoffmann

Two specimens of *Lophostoma* from northwestern Ecuador appeared externally similar to *Lophostoma silvicolum*, but preliminary examination of cythocrome-*b* sequence data suggested trenchant differences to warrant further examination. Studies of DNA-sequence data, morphology, and karyology were designed to establish their identification and species-level relationships. Molecular, morphological, and karyotypic data support the conclusion that the two specimens represent a previously unrecognized species. In our analyses of cytochrome-*b* sequence data, these two individuals form a sister clade with *L. schulzi* rather than with *L. silvicolum*. However, as shown below, in morphology, size and karyotype, these two specimens are more similar to *silvicolum* than to *schulzi*. Further morphological comparisons indicate that the specimens possess several character states differentiating them from *L. silvicolum*. An examination of museum specimens revealed four other individuals of this taxon; all of these specimens are from northwestern Ecuador.

No species level names are available for *schulzi* (sensu Genoways and Williams 1980, Koopman 1993). Six species level names are available for *silvicolum*: *amblyotis* (Wagner 1843); *auritus* (Sanborn 1932); *centralis* (Davis and Carter 1978); *colombianus* (Anthony 1920); *laephotis* (Thomas 1910); and *occidentalis* (Davis and Carter 1978). Based on examination of the type specimen of *occidentalis*, and on individuals collected from geographic regions near the other type localities, we conclude that none of the available names can be applied to these specimens from northwestern Ecuador. As described below, DNA-sequence data from the mitochondrial cytochrome-*b* gene and the nuclear *RAG2* gene (Recombination Activation gene 2), morphological variation, and karyological data are more compatible with the conclusion that this taxon should be recognized as a distinct species. An examination of museum specimens reveals that the genus is in need of an extension revision based on skin and skull features and DNA sequence data. This paper is concerned with the introduction of a new species name and the needed revisions will be published elsewhere.

Systematics

***Lophostoma aequatorialis*, new species**

Holotype: QCAZ-6500, adult male, skin, skull, and skeleton to be deposited in the Museo de Zoología (QCAZ) of the Pontificia Universidad Católica del Ecuador. Loaned to the Museum of Texas Tech University and temporally catalogued with the number TTU 85292. Collected on 2 August 2001 from Ecuador, Province of Esmeraldas, Estación Experimental La Chiquita, near San Lorenzo town (1°16'60"N, 78°49'60"W) (UTM zone 17: 748935 E 0136902 N; 979 m) by a TTU and QCAZ field party on the Sowell Expedition, 2001. TK number 104520 identifies tissue samples housed in the Natural Science Research Laboratory (NSRL) at Texas Tech University and in the Museo de Zoología (QCAZ), as well as karyotype preparations housed in the Department of Biological Sciences, Texas Tech University.

The holotype was prepared as skin, skull, and postcranial skeleton by René M. Fonseca (original number RF–40). External measurements (in millimeters) of the holotype recorded in the field are: total length – 99; tail length – 22; hind foot – 18; ear – 31. Weight was 28.2 grams. Wing measurements of the dried specimen are: forearm length – 55; metacarpal III length – 46.7. Cranial measurements (in millimeters) of the holotype are as follows: greatest length of the skull – 27.7; condylobasal length – 23.7; zygomatic width – 13.2; zygomatic length – 7.9; mastoid width – 13.9; braincase width – 10.4; braincase height – 12.7; palatal length – 12.4; post-palatal length – 9.0; post-orbital

constriction width – 4.4; interorbital width – 5.0; greatest width across molars – 9.0; greatest width across canines – 6.1; maxillary toothrow length – 9.4; mandibular toothrow length – 10.9; coronoid process length – 7.5; mandibular length – 17.6.

Paratypes: Other specimens in the type series include five females. Two of these females (QCAZ 2384; TTU 85277) were from the type locality and three others (QCAZ 6071, Esmeraldas; USNM 522064, Los Ríos; USNM 528483, Pichincha) were from northwest Ecuador (see specimens examined).

Distribution: Known only from the Pacific coast of northwestern Ecuador, with records from the provinces of Esmeraldas, Los Ríos, and Pichincha. Possibly occurs in the Pacific versant of the Colombian Andes (Fig. 1).

Justification for species level recognition: The trees generated from the cytochrome-*b* (Fig. 2) and *RAG2* (Fig. 3) DNA sequences suggest that *L. aequatorialis* is more closely related to *L. schulzi*, *L. brasiliense*, and *L. carrikeri* than to *L. silvicolum*. *Lophostoma aequatorialis* is morphologically unlike

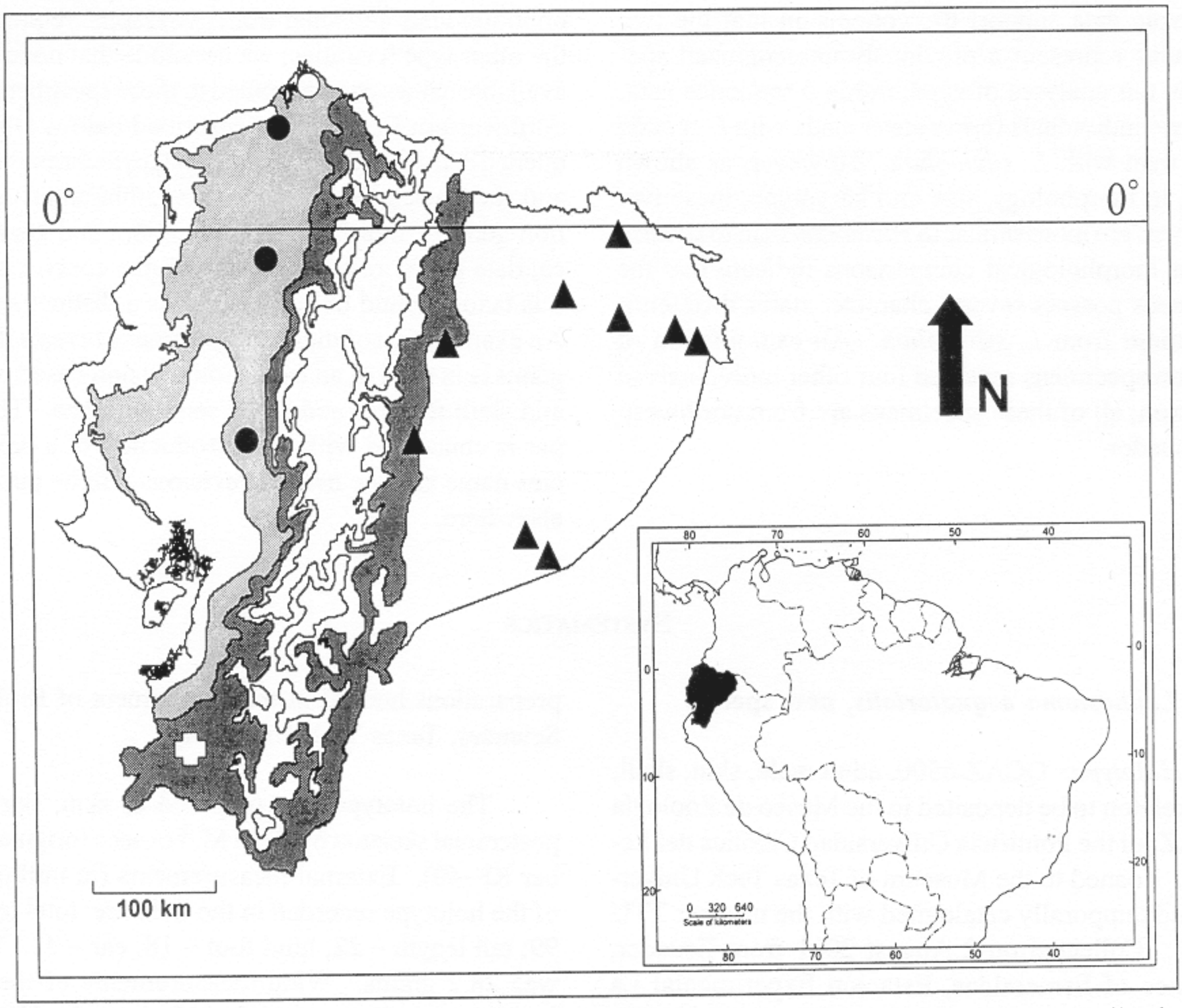

Figure 1. Geographic distribution of *Lophostoma aequatorialis* (black circles). Type locality is identified by a white circle. Records of *L. silvicolum* in Ecuador are represented by triangles for *L. s. silvicolum* and a white cross for *L. s. occidentalis*. Light gray region represents evergreen lowland forest, habitat where *L. aequatorialis* was found. Dark gray regions indicate western and eastern slopes of Ecuadorian Andes. Insert: Map of northern South American with Ecuador in black.

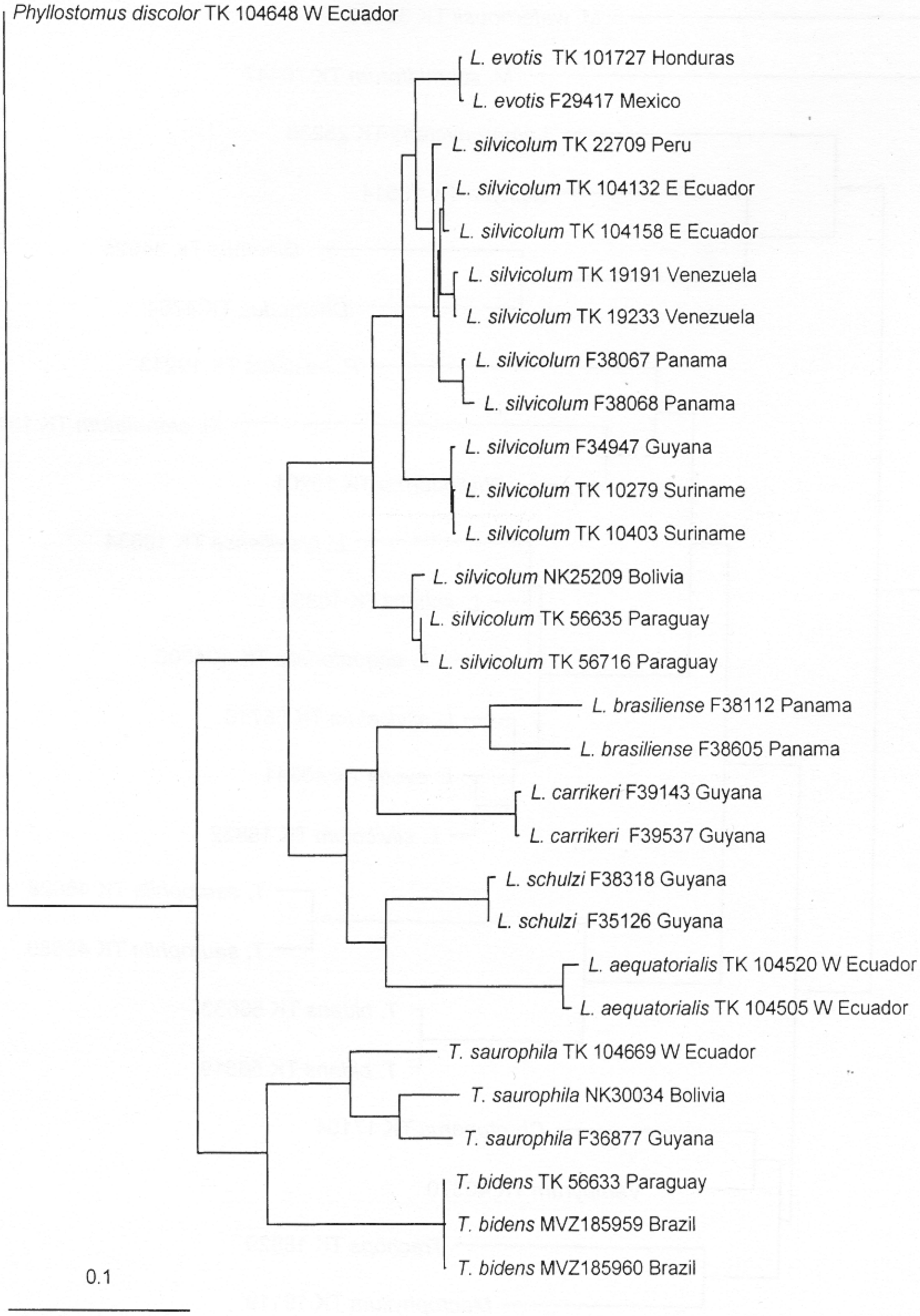

Figure 2. Neighbor-joining phylogram based on uncorrected pairwise distances from the mitochondrial cytochrome-*b* gene sequences showing relationships and genetic distances among species of *Lophostoma*.

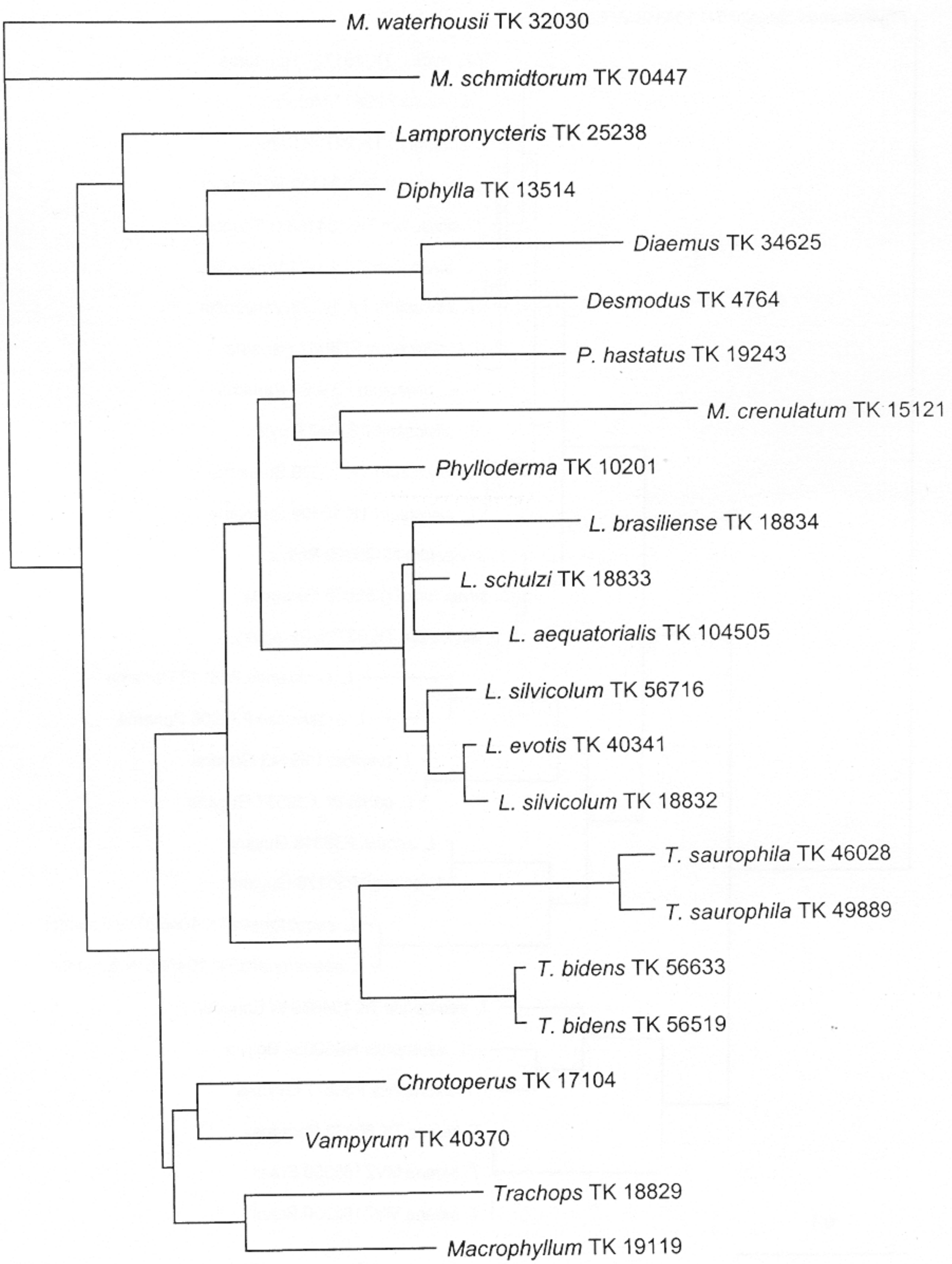

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Figure 3. Neighbor-joining phylogram based on uncorrected pairwise distances from the nuclear *RAG2* gene, showing relationships and genetic divergence among species of *Lophostoma*.

brasiliense, *carrikeri*, and *schulzi* based on its larger size as well as a number of morphological characters that distinguish *aequatorialis* from these three species (see description and comparison below). Data from the *RAG2* gene also indicate that *aequatorialis* is more closely related to *schulzi* and *brasiliense* than to *silvicolum* (*RAG2* data are unavailable for *carrikeri*). Because data are available for both the nuclear and the mitochondrial genomes suggesting that *aequatorialis* is a member of the clade giving rise to *brasiliense*, *carrikeri*, and *schulzi*, it is highly unlikely that *aequatorialis* is conspecific with *silvicolum*. Karyotypically, *aequatorialis* is more similar to *silvicolum* than to the other three species; however, this may be the result of shared, primitive characters that were present in the basal *Lophostoma* lineage. If this is true, then *L. aequatorialis* will be basal to the *schulzi/brasiliense/carrikeri* group and will have diverged from that group before the highly derived karyotypes became established in *L. schulzi*, *L. brasiliense*, and *L. carrikeri*.

Description and comparisons: Morphology— *Lophostoma aequatorialis* is a large sized species within the genus, snuff brown dorsally, pale olive-brown on the throat and the chest, and olive buff, deep olive-buff, or light brownish-olive coloration ventrally; mummy brown on wings and membranes (following Ridgway 1912). *Lophostoma aequatorialis* is similar in fur coloration to both subspecies of *L. silvicolum* present in Ecuador. *Lophostoma aequatorialis* differs externally from *L. s. occidentalis* by the absence of white auricular patches and by ventral coloration. Davis and Carter (1978) mentioned *occidentalis* being "more extensively whitish ventrally, and with distinctive whitish postauricular patches (p. 6)." We examined the type series of *L. s. occidentalis* and specimens from Peru collected in 1954 by C. Kalinowski near the type locality that are deposited in the Field Museum of Natural History (see specimens examined). Skins from the type series of *occidentalis* (TCWC 11700–11705; holotype: TCWC 11704) are in good condition and all present the features indicated by Davis and Carter (1978). White auricular patches are clearly evident, contrasting with the coloration present in the type series of *aequatorialis*. Additionally, the type series of *occidentalis* possesses a well-defined whitish venter, which is more accentuated in the holotype and contrasting also with *aequatorialis*. Auricular patches and the white venter are not evident in specimens of *occidentalis* from the Field Museum because they may have lost their original coloration. Auricular patches are also absent in specimens of *L. s. silvicolum* from east Ecuador. Ventral coloration also distinguishes *L. aequatorialis* from the typical white venter of *L. carrikeri* (McCarthy et al. 1992). Dorsal coloration of *L. aequatorialis* is frosted, but as distinctly as in *L. s. occidentalis* (see photographs on cover).

Lophostoma aequatorialis is larger in wing dimensions compared to *L. brasiliense*, *L. carrikeri*, *L. evotis*, and *L. schulzi*. Forearm of *L. aequatorialis* ranges from 52 to 54 mm, compared to values less than 40 mm in *L. brasiliense*, less than 45 mm in *L. schulzi*, and less than 50 mm in *L. carrikeri* and *L. evotis* (Davis and Carter 1978, Medellín and Arita 1989). Wart-like granulations on forearms and wing structures present in *L. schulzi* (Genoways and Williams 1980) are absent in *L. aequatorialis*.

Skull is robust and large (Fig. 4). Postorbital constriction is accentuated. Braincase is inflated and large. Sagittal crest and lambdoidal crest are well-developed. Interparietals are large and extend backward. Lateral projection of mastoid process is evident, with petrosal well-developed, projected laterally and strongly from mastoid process. Borders of foramen magnum are trapezoidal. Palate is faintly narrow. Basisphenoid pits are large and elongated. Upper central incisors are well-developed and protruding from skull in occlusal view. Lateral upper incisors are small, convergent, and extend half of the length of the middle incisors. Upper canines are elongated. Lower incisors are weak, smaller than in *L. s. silvicolum*, but similar in size compared to those in *L. s. occidentalis*. Lower canines are elongated, separated posterior-medially by a narrow gap. Third lower premolar (P_3) is small, similar in length and width, with the posterior cingulum contacting the fourth lower premolar (P_4) but without covering it (Fig. 5). Size and shape of P_3 are the most useful characters to separate *L. aequatorialis* from other members of the *L. silvicolum* complex in Ecuador. Davis and Carter (1978) indicated that in *L. s. occidentalis*, "the middle lower premolar is about half as large (p. 6)." From our examination, we define *occidentalis* by having a P_3 similar in length but generally wider compared to *aequatorialis*, covered by the cingulum of the second lower premo-

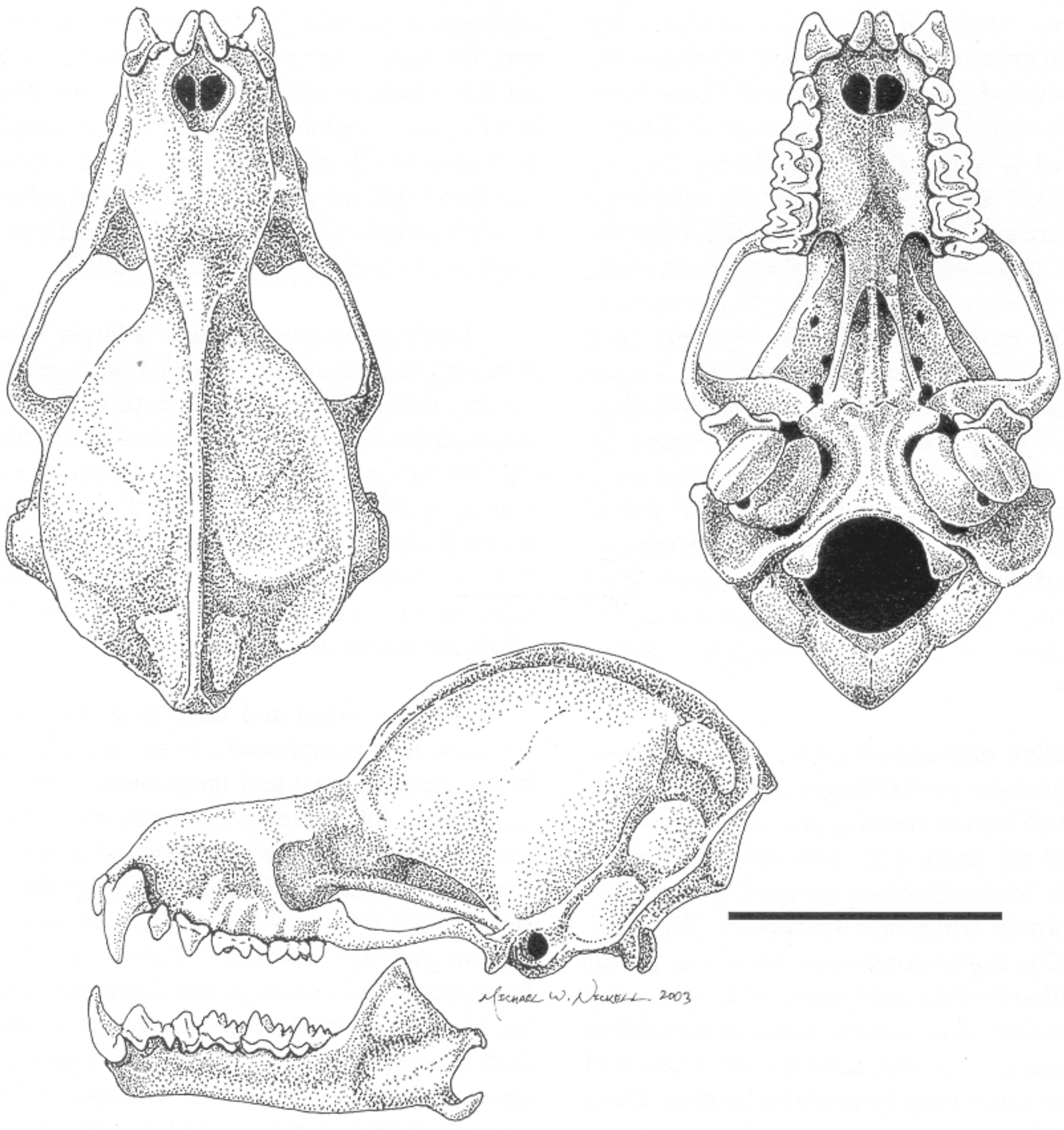

Figure 4. Dorsal, ventral and lateral views of the skull and lower jaw of the holotype (TTU 85292) of *Lophostoma aequatorialis*. Bar represents 10 mm. Drawing by Michael W. Nickell.

lar, and having similar aspect to that of *Tonatia saurophila* (Williams et al. 1995). In *L. s. silvicolum*, P_3 is larger and often partially covers the anterior cingulum of P_4, being distinguishable from *L. aequatorialis*. The mandibular ramus is thin, generally straight until the level of the coronoid process. Sexual dimorphism is evident in the type series, with the sagittal crest, the lambdoidal crest, and the lateral projection of the mastoid process being larger in the male holotype than in the female paratypes. Development of petrosal is more conspicuous in females than in the male holotype.

Measurements from females of *L. aequatorialis*, *L. s. occidentalis*, and *L. s. silvicolum* are quite similar (Table 1). Specific recognition among species closely related to the genus *Lophostoma*, such as *T. bidens* and *T. saurophila*, was based on qualitative morphological characters, especially related to the shape of the middle lower premolar (e.g., Williams et al. 1995).

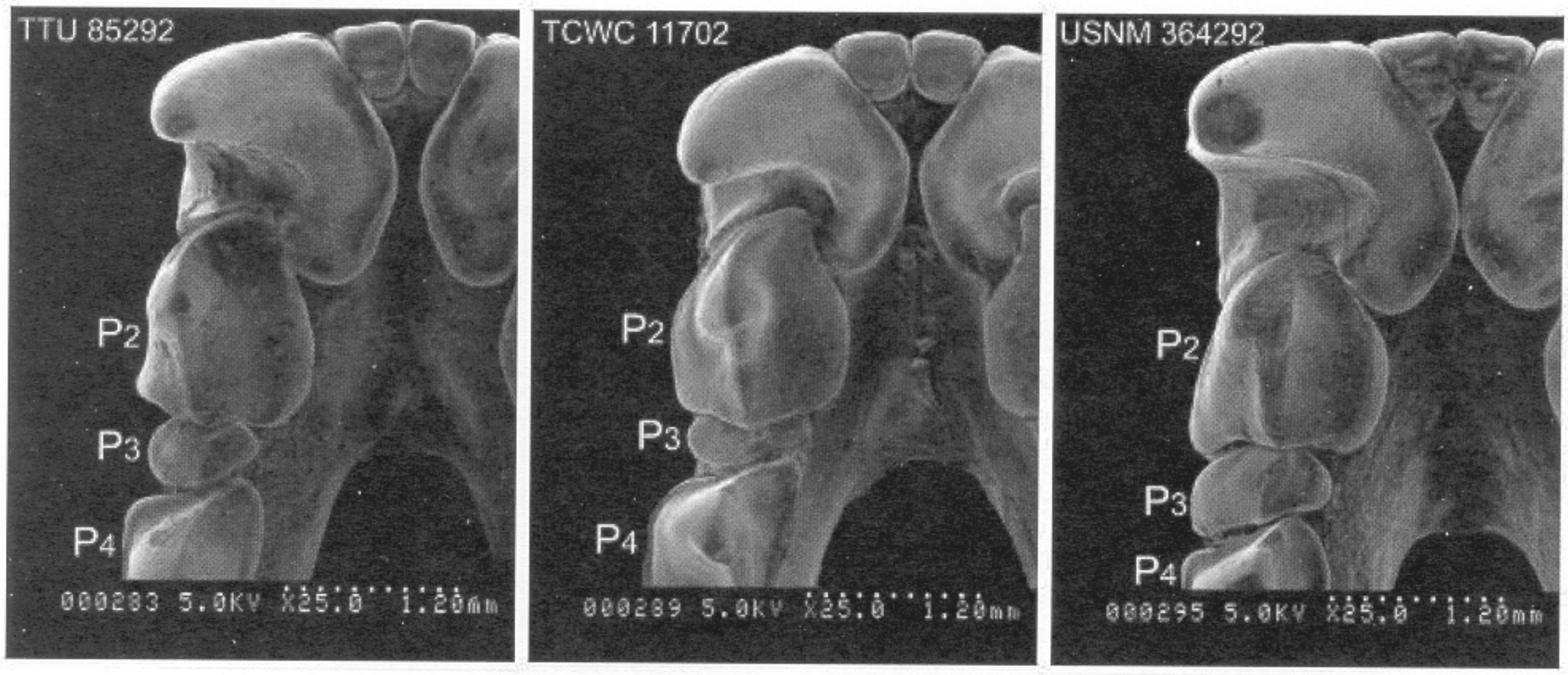

Figure 5. Electromicrographs showing differences in the size and shape of the middle lower premolar (P_3) among *Lophostoma aequatorialis* (holotype, TTU 85292), *L. silvicolum occidentalis* (TCWC 11702), and *L. s. silvicolum* (USNM 364292).

Table 1. Descriptive statistics of specimens of *Lophostoma aequatorialis*, *L. silvicolum occidentalis* from western Ecuador, and *L. s. silvicolum* from eastern Ecuador (see specimens examined). For each character, the average and one standard deviation (in parenthesis) are shown.

	L. aequatorialis		*L. s. occidentalis*		*L. s. silvicolum*	
	Males (n = 1)	Females (n = 5)	Males (n = 5)	Females (n = 6)	Males (n = 13)	Females (n = 15)
Forearm length	55.04	52.86 (1.37)	54.27 (0.99)	53.51 (2.02)	53.40 (1.46)	52.43 (1.48)
Metacarpal III length	46.66	44.22 (1.56)	44.22 (1.31)	44.75 (1.90)	45.10 (1.85)	44.78 (1.40)
Greatest length of the skull	27.69	26.66 (0.71)	26.81 (0.53)	26.21 (0.86)	27.06 (0.47)	26.20 (0.62)
Condylobasal length	23.73	22.87 (0.69)	23.34 (0.49)	22.81 (0.64)	23.54 (0.40)	22.75 (0.56)
Zygomatic width	13.19	13.04 (0.47)	13.21 (0.53)	12.57 (0.33)	13.29 (0.35)	12.91 (0.28)
Zygomatic length	7.94	7.87 (0.22)	7.83 (0.24)	7.91 (0.41)	8.10 (0.31)	7.78 (0.34)
Mastoid width	13.89	13.16 (0.25)	13.35 (0.39)	12.68 (0.31)	13.43 (0.38)	13.00 (0.48)
Braincase width	10.38	10.09 (0.23)	10.29 (0.12)	9.90 (0.21)	10.12 (0.23)	9.86 (0.35)
Braincase height	12.65	11.31 (0.34)	11.91 (0.35)	11.17 (0.35)	11.92 (0.71)	11.52 (0.54)
Palatal length	12.42	11.23 (0.20)	11.27 (0.30)	10.90 (0.21)	11.66 (0.45)	11.08 (0.45)
Post-palatal length	8.96	8.19 (0.20)	8.76 (0.27)	8.16 (0.24)	8.43 (0.33)	8.16 (0.26)
Post-orbital constriction	4.45	4.26 (0.18)	4.25 (0.13)	4.09 (0.15)	4.16 (0.11)	4.12 (0.19)
Interorbital width	5.03	4.91 (0.10)	5.02 (0.31)	4.61 (0.35)	5.20 (0.18)	5.02 (0.29)
Width across molars	9.00	8.61 (0.31)	8.85 (0.25)	8.47 (0.18)	8.58 (0.61)	8.53 (0.22)
Width across canines	6.06	5.55 (0.50)	5.98 (0.22)	5.39 (0.22)	6.22 (0.30)	5.74 (0.18)
Maxillary toothrow	9.43	9.37 (0.30)	9.47 (0.36)	9.19 (0.14)	9.49 (0.27)	9.19 (0.30)
Mandibular toothrow	10.88	10.51 (0.37)	10.83 (0.37)	10.33 (0.21)	10.66 (0.24)	10.36 (0.38)
Coronoid process length	7.46	6.96 (0.33)	7.73 (0.32)	6.98 (0.45)	7.59 (0.36)	7.01 (0.31)
Mandibular length	17.63	16.99 (0.40)	17.40 (0.36)	17.00 (0.47)	17.73 (0.38)	16.86 (0.40)

This morphological conclusion has been supported by molecular data from mitochondrial and nuclear genes (Porter et al. 2003). Even though there are no molecular data available from *L. s. occidentalis*, the magnitude of the qualitative morphological evidence justifies considering *L. aequatorialis* as different species from both subspecies of *L. silvicolum* present in Ecuador. Our findings and the results from Porter et al. (2003) suggest the possible paraphyly of this species complex and indicate the necessity for reassessing the morphologic and genetic variation in *L. silvicolum*.

Molecular – Genomic DNA was extracted from liver, kidney, or muscle tissue preserved by freezing, lysis buffer, or ethanol; using a phenol/PCI protocol (Longmire et al. 1997) or an SDS/ proteinase K/NaCl extraction with alcohol precipitation protocol (Miller et al. 1988, Maniatis et al. 1992). The complete mitochondrial cytochrome-*b* gene was amplified and sequenced using primers and conditions reported in Hoffmann and Baker (2001), with an additional internal sequencing primer To1L (5'- CTG CCT CTA CCT TCA TGT AGG AC-3'). *RAG2* sequence data for *L. aequatorialis* was obtained following the procedures described in Porter et al. (2003). Sequences were generated using an ABI Prism 310 Genetic Analyzer (Applied Biosystems, Inc., Foster City, California). Sequences were verified and aligned using Sequencher version 3.1.1 (Gene Code Corporation, Ann Arbor, Michigan) and VectorNTI (Informax Inc., Bethesda, Maryland). Additional *RAG2* sequences from specimens of *Lophostoma* and *Tonatia* were obtained from GENBANK. In both cases sequence alignment was unambiguous. Distance calculation and neighbor-joining tree searches were performed in Paup* ver 4.0b10 (Swofford 1999)

Lophostoma aequatorialis is genetically distinct in both nuclear and mitochondrial DNA sequences. Uncorrected genetic divergences between *L. aequatorialis* and other species in the genus range from 11.3 to 13.6% in the complete mitochondrial cytochrome-*b* gene, and from 0.8 to 1.6% in a 1363 base pairs long fragment of the nuclear *RAG2* gene. In each case, distance values are of the same order of magnitude as other interspecific comparisons within the genus (Table 2).

Karyology – Karyotypes were prepared in the field following the methods of Baker et al. (2003a). The karyotype (Fig. 6) of *Lophostoma aequatorialis* has a diploid number of 34 and a fundamental number (number of arms of the autosomal complement, FN) of 62. The autosomes comprise a gradational series of 15 pairs of metacentric and submetacentric chromosomes that range from large to small. No biarmed autosome consistently has an arm ratio less than one to two; however, in some spreads, pair 13 (Fig. 6) is subtelocentric in centromere placement. The smallest pair of autosomes is acrocentric. The X is a medium-sized submetacentric and the Y is a small acrocentric chromosome, approximately twice as large as the pair of autosomes that are acrocentric.

Karyotypic data have been published for four species of *Lophostoma*. *Lophostoma brasiliense* (2n=30, FN=56; Baker and Hsu 1970, Baker 1973, 1979, Gardner 1977, Patton and Baker 1978, Honeycutt

Table 2. Uncorrected genetic distance among species of Lophostoma in the complete mitochondrial cytochrome-*b* gene (1140 base pairs) and in a fragment of 1363 base pairs of the nuclear *RAG2* (Recombination Activating Gene 2).

	evotis	*silvicolum*	*carrikeri*	*schulzi*	*brasiliense*	*aequatorialis*
Cytochrome-*b*						
L. evotis	-					
L. silvicolum	5.1	-				
L. carrikeri	12.4	12.1	-			
L. schulzi	12.3	12.2	11.1	-		
L. brasiliense	13.2	13.3	12.1	12.4	-	
L. aequatorialis	12.3	12.3	12.4	11.3	13.6	-
RAG2						
L. evotis	-					
L. silvicolum	0.2	-				
L. carrikeri	-	-	-			
L. schulzi	0.8	0.8	-	-		
L. brasiliense	1.6	1.7	-	1.3	-	
L. aequatorialis	0.9	1.0	-	0.8	1.6	-

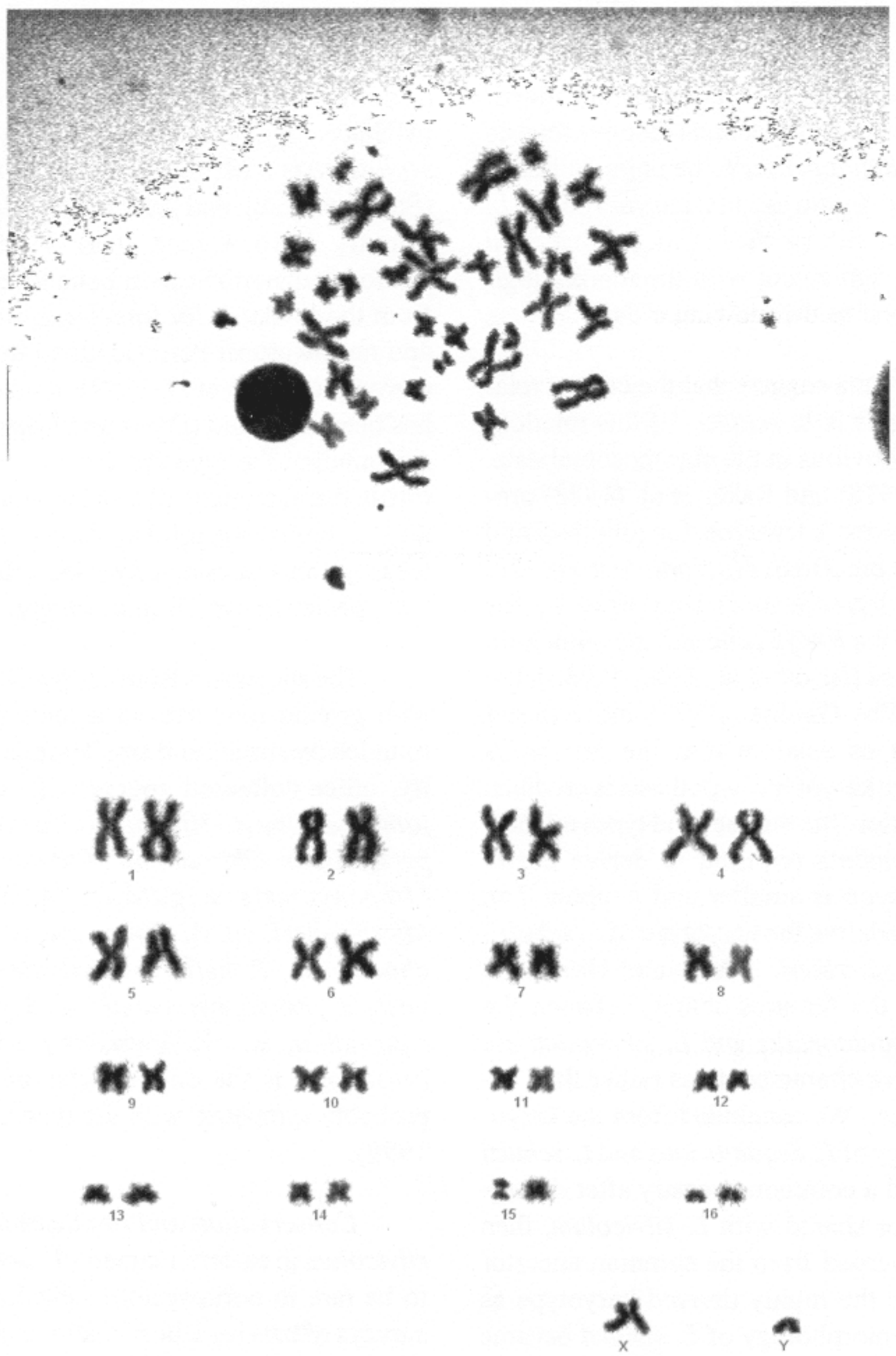

Figure 6. Karyotype of the holotype (TK 104520) of *Lophostoma aequatorialis* male showing centromere placements.

et al. 1980, Baker et al. 1982), *L. carrikeri* (2n=26, FN=46; Gardner 1977, Baker et al. 1981), *L. schulzi* (2n=28, FN=36; Honeycutt et al. 1980, Baker et al. 1981, 1982), and *L. silvicolum* (2n=34, FN=60; Gardner 1977, Honeycutt et al. 1980). A review of these published karyotypes based on standard, nondifferentially stained chromosomal features reveals the karyotype of *L. aequatorialis* to be unique. Based on these karyotypic features, the karyotype of *L. aequatorialis* is most similar to that of *L. silvicolum* (Fig. 7), which is in agreement with the morphological data but in contrast to the molecular data.

The molecular data suggest that the closest relative of *L. aequatorialis* is *L. schulzi*. If this relationship is real, it is not obvious in the chromosomal data. Patton and Baker (1978) and Baker et al. (1982) proposed that the primitive karyotype for phyllostomid bats is most like that present in *Macrotus waterhousii*. This chromosomal hypothesis is supported by the molecular data from the *RAG2* gene and the mitochondrial rDNA gene trees (Baker et al. 2000, 2003b), but has been questioned by Gardner (1977) and Wetterer et al. (2000). Let us assume that the *Macrotus waterhousii* primitive karyotype hypothesis is credible. Making this assumption, the number and types of chromosomal rearrangements required to derive the *L. aequatoralis* karyotype is smaller and simpler than would be required to derive the karyotype of *L. schulzi*, *L. brasiliense* or *L. carrikeri*. We cannot eliminated the possibility that the features shared between the karyotypes of *L. aequatorialis* and *L. silvicolum* are the result of primitive character states rather than derived character states. We concluded from the karyotypes and morphology of *L. aequatorialis* and *L. schulzi* is that if they shared a common ancestry after diverging from an ancestor shared with *L. silvicolum,* then *L. aequatorialis* diverged from the common ancestor of *L. schulzi* before the highly derived karyotype as well as the derived morphology of *L. schulzi* became established in that lineage.

Reproductive data—A lactating female from the type series (USNM 528483) was collected by Don E. Wilson in 31 January 1976, representing the only available reproductive record for the species.

Ecological notes—The type locality is associated with the evergreen lowland forest of the Ecuadorian coast (Dodson and Gentry 1991). The plant community in that area is dominated by species with a height more than 30 m (Cerón et al. 1999). The most common plant species are *Brosimun utile*, *Castilla elastica* (Moraceae); *Wettinia quinaria*, *Phytelephas aequatorialis* (Arecaceae); *Guarea polymera* (Meliaceae); *Otoba gordonifolia* (Myristicaeae); *Inga sichalensis* (Mimosaceace); *Theobroma gileri* (Sterculeaceae); and *Xanthosoma daguense* (Araceae) (Gentry 1986, Cerón et al. 1999). The lowland rainforest in northwestern Ecuador differs significantly from the lowland dry forest in southwestern Ecuador and northwestern Peru (lowland deciduous forest according to Cerón et al. 1999), where *L. s. occidentalis* has been collected (Davis and Carter 1978). The area surrounding the type locality has been extremely deforested and in many places banana and oil palm plantations replace the primary forest. At present, the type locality constitutes mainly a secondary forest with few tree species above 30 m of height.

The specimens from the type locality were caught with ground mist nets in a *terra firme* habitat, surrounded by shrubs and small palms. At the type locality, other collected species of bats were *Artibeus jamaicensis*, *A. lituratus*, *Carollia castanea*, *C. perspicillata*, *Chiroderma trinitatum*, *Dermanura* spp., *Micronycteris megalotis*, *Micronycteris* sp. A, *Micronycteris* sp. B, *Mimon crenulatum*, *Platyrrhinus chocoensis*, *P. helleri*, *Phyllostomus elongatus*, *P. hastatus*, *Rhinophylla alethina*, *Sturnira luisi*, *Tonatia saurophila*, and *Vampyressa pusilla*. *Lophostoma brasiliense* is the only species of this genus that is probably sympatric with the new species (see Albuja 1999).

Conservation and implications—Contrary to *L. silvicolum* in eastern Ecuador, *L. aequatorialis* appears to be rare in northwestern Ecuador. Although many surveys of bats have been made in that area (see Albuja 1999), *L. aequatorialis* is infrequent in museum collections. Similar to the areas surrounding the type locality, other sites where this species was recorded were completely deforested and transformed into plantations. Additionally, none of these localities have been included in the National System of Protected Areas (SNAP) in Ecuador, even though the entire area is considered part of a hotspot for conservation activities (Andelman and Willig 2003). Since northwestern Ec-

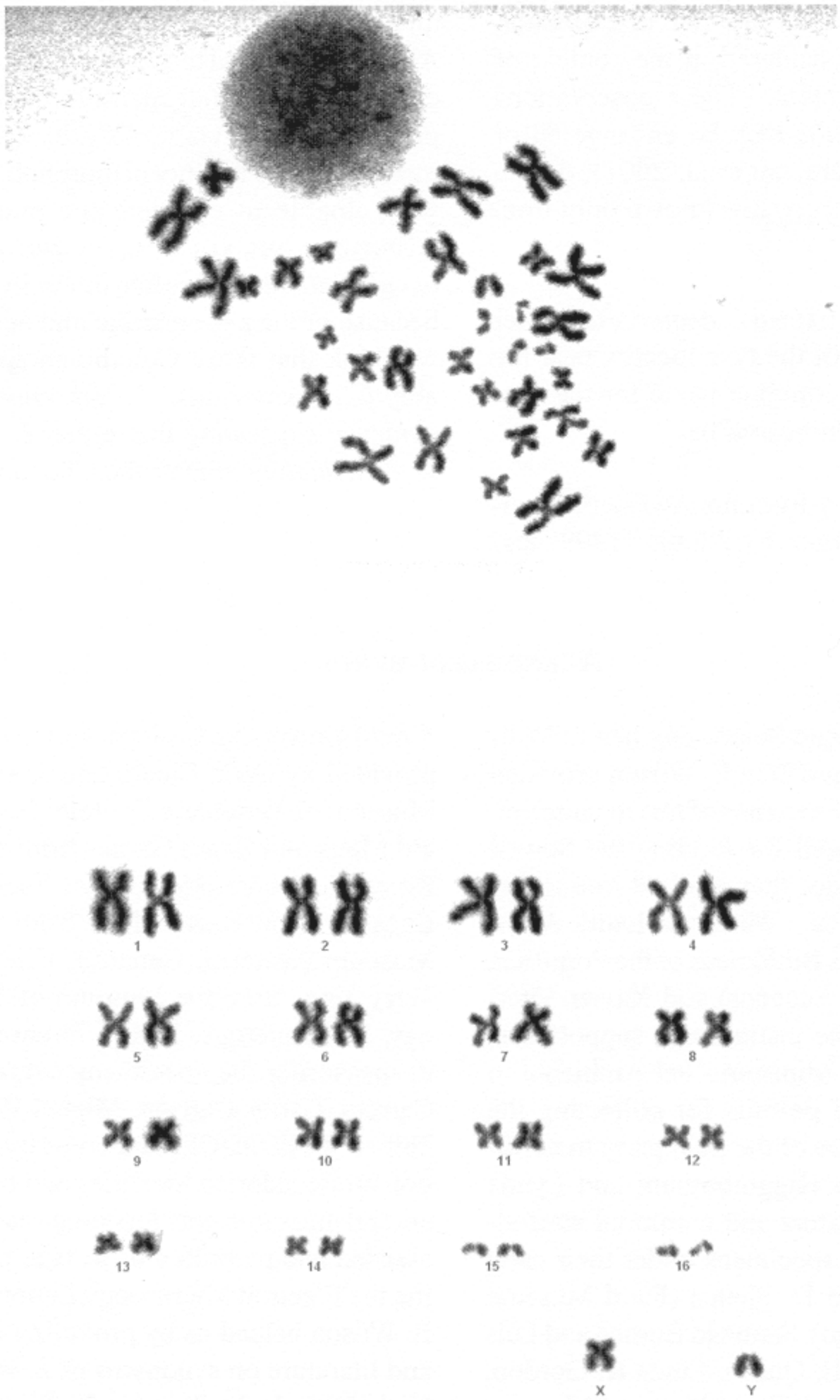

Figure 7. Karyotype of *Lophostoma silvicolum silvicolum* male (TK 104132) (2n=34, FN=60) collected from Fuerte Militar Amazonas, Province of Pastaza, Ecuador, eastern slopes of the Andes.

uador has one of the highest annual rates of deforestation in the world (2.0–4.0%; Rudel 2000) and has been dramatically transformed in the last 50 years (Dodson and Gentry 1991, Sierra 1996), the risk of extinction of this species must be considered in the context of conservation and management. These observations suggest that *L. aequatorialis* may be endangered or threatened (according to Hutson et al. 2001), due to the loss of habitat and because it is known only from four localities.

Etymology: We have named *L. aequatorialis* after Ecuador and the position of the type locality near the Equator. An appropriate common name for the species is the Ecuadorian round-eared bat.

Remarks: Specimens from northwestern Ecuador assigned to *L. silvicolum* by Albuja (1999) and Tirira (1999) are probably *L. aequatorialis*. Alberico (1994) indicated the presence of *L. s. occidentalis* in southwestern Colombia based on three specimens captured in Concesión de Bajo Colima (Valle del Cauca). Alberico identified those specimens by comparing their external and cranial measurements with the results published by Davis and Carter (1978), but without mentioning any additional morphological character. We were unable to examine the material reported by Alberico, but since *L. aequatorialis* and *L. s. occidentalis* do not differ much in size (Table 1) and because of their geographic and ecological proximity, we think that those Colombian specimens are probably *L. aequatorialis*. To our knowledge, there is no evidence suggesting that either *L. s. occidentialis* or *L. s. silvicolum* inhabit the Chocó region.

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SPECIMENS EXAMINED:

Specimens examined with respective museum numbers and localities are given below: Field Museum of Natural History (FMNH), Chicago, Illinois; Museo de Zoología of the Pontificia Universidad Católica del Ecuador (QCAZ), Quito; National Museum of Natural History (USNM), Washington, D.C; Texas Cooperative Wildlife Collection (TCWC) at Texas A & M University, College Station, Texas; Museum of Texas Tech University (TTU). An asterisk indicates specimens used for Table 1.

Lophostoma aequatorialis: ECUADOR – Province of Esmeraldas: Bosque Protector Quingue (QCAZ 6071*); Estación Científica La Chiquita, San Lorenzo (TTU 85277*, 85292* [holotype]; QCAZ 2384*). Province of Los Ríos: El Papayo, 7 km SW from Pueblo Viejo (USNM 522064*). Province of Pichincha: Estación Científica Río Palenque, 47 km S from Santo Domingo (USNM 528483*).

Lophostoma silvicolum occidentalis: ECUADOR – Province of Loja: 15 min N from Catacocha (TCWC 11702*). PERU – Department of Piura: 4 min W Suyo (TCWC 11700*, 11701*, 11703*, 11704* [holotype], 11705*); Ayabaca, Paymas (FMNH 81126*); Morropón, Hacienda Bigotes (FMNH 81113*, 81114*, 81120*, 81121*).

Lophostoma silvicolum silvicolum: ECUADOR – Province of Morona Santiago: Río Capihuari (USNM 260042*; FMNH 43149*, 43151); Río Bombonaza (USNM 260041*). Province of Napo: Parque Nacional Sumaco Napo-Galeras, línea 18 (QCAZ 1540*, 1543*); Río Suno, below Loreto (FMNH 31071*). Province of Orellana: El Edén, Río Yuturi (QCAZ 1435*, 1436*, 1508*, 1509*, 1510*); Parque Nacional Yasuní, Comuna Indillana (QCAZ 950*, 952*); Parque Nacional Yasuní, Estación Científica Yasuní (QCAZ 1303*); Río Yasuní (QCAZ 4489*); Tigüino, 130 km S from Coca (USMN 574504*). Province of Pastaza: Fuerte Militar Amazonas (TTU 84904 *, TTU 84930 *); Lorocachi (QCAZ 1431*); Taculin, near Puyo (USNM 548066*). Province of Sucumbios: Bosque Protector Los Cedros (QCAZ 86*, 101*, 104*); Reserva Biológica Limoncocha (QCAZ 575*, 576*); Reserva de Producción Faunística Cuyabeno, Laguna Grande (QCAZ 344*, 345*). PERU – Department of Cuzco: Hacienda Cadena (FMNH 68372, 78679). Department of Pasco: San Juan (USNM 364292).

TISSUES EXAMINED:

Museum numbers with respective tissue number used in Figure 2 (in brackets) and localities are given below: Royal Ontario Museum (F), Canada; Museum of Vertebrate Zoology (MVZ), University of California, Berkeley; Museum of Southwestern Biology (NK), University of New Mexico, Albuquerque; Natural Science Research Laboratory (TK) from Texas Tech University, Lubbock, Texas. Information on the museum number and localities of the specimens used in Figure 3 is given in Porter et al. (2003).

Lophostoma aequatorialis: ECUADOR – Province of Esmeraldas: Estación Científica La Chiquita, San Lorenzo (TK 104505, 104520 [holotype]).

Lophostoma brasiliense: GUYANA – Region of Upper Takutu-Upper Essequibo (TK 49898 [F 38605]). PANAMA – Province of Panamá: Parque Nacional Altos de Campana (TK 49896 [F 38112]).

Lophostoma carrikeri: GUYANA – Region of Potaro-Siparuni: Iwokrama Reserve, Burro Burro river, 25 km WNW of Kurupukari (TK 49899 [F 39143], TK 49900 [F 39537]).

Lophostoma evotis: MEXICO – State of Campeche: 44 km S of Constitución (TK 49870 [F 29417]). HONDURAS – Department of Atlantida: Lancetilla Botanical Garden (TK 101727).

Lophostoma schulzi: GUYANA – Region of Barima-Waini: Baramita, Old World (TK 49888 [F 35126]). Region of Potaro-Siparuni: Iwokrama Reserve, Burro Burro river, 25 km WNW of Kurupukari (TK 49897 [F 38318]).

Lophostoma silvicolum: BOLIVIA – Department of Cochabamba: Valle de Salta (TK 49885 [NK 30034]). Department of La Paz: Chijchipa (NK 25209 [TK 49884]). ECUADOR – Province of Pastaza: Fuerte Militar Amazonas (TTU 84904 [TK 104132], TTU 84930 [TK 104158]). PANAMA – Province of Panamá: Parque Nacional Altos de Campana (TK 49879 [F 38067], TK 49880 [F 38068]). PARAGUAY – Depart-

ment of San Pedro: Yaguarete Forest (TK 56635, 56716). PERU – Department of Huánuco: Tingo María (TK 22709). VENEZUELA – State of Bolivar: 8 km S, 5 km E of El Manteco (TK 19191, 19233). SURINAME – District of Brokopondo: Brownsberg Nature Park, 2 KM W, 8 KM S Brownsweg (TK 10403). District of Saramacca: Voltzberg (TK 10279).

Phyllostomus discolor: ECUADOR – Province of Esmeraldas: Estación Científica La Chiquita, San Lorenzo (TK 104648).

Tonatia bidens: BRAZIL – State of Sao Paulo: Base do Rio Verde, Estaca Biologica Jueria-Itatins (MVZ 185672 [TK 56518], MVZ 185673 [TK 56519]). PARAGUAY – Department of San Pedro: Yaguarete Forest (TK 56633).

Tonatia saurophila: BOLIVIA – Department of Cochabamba: Valle de Salta (TK 49885 [NK 30034]). ECUADOR – Province of Esmeraldas: Estación Científica La Chiquita, San Lorenzo (TK 104669). GUYANA – Region of Upper-Demerara-Berbice: Tropenbos, 20 km SSE of Mabura hill (TK 49891 [F 36877]).

LITERATURE CITED

Alberico, M. 1994. First record of *Sturnira mordax* from Colombia with range extentions for other bat species. TRIANEA (Acta Científica Tecnica INDERENA), 5:335–341.

Albuja, L. 1999. Murciélagos del Ecuador. 2nd edición. Escuela Politécnica Nacional, Cicetrónic Cia. Ltda, Quito.

Andelman, S.J., and M.R. Willig. 2003. Present patterns and future prospects for biodiversity in the Western Hemisphere. Ecology Letters, 6:1–7.

Anthony, H.E. 1920. New rodents and new bats from Neotropical regions. Journal of Mammalogy, 1:81–86.

Baker, R.J. 1973. Comparative cytogenetics of the New World leaf-nosed bats (Phyllostomidae). Periodicum Biologicum, 75:37–45.

Baker, R.J. 1979. Karyology. Pp. 107–155 *in* Biology of bats of the New World family Phyllostomatidae, Part III (R.J. Baker, J.K. Jones, Jr., and D.C. Carter, eds.). Special Publications, The Museum, Texas Tech University, Lubbock, Texas.

Baker, R.J., and T.C. Hsu. 1970. Further studies on the sex-chromosome systems of the American leaf-nosed bats (Chiroptera, Phyllostomidae). Cytogenetics, 9:131–138.

Baker, R.J., H.H. Genoways, and P.A. Seyfarth. 1981. Results of the Alcoa Foundation-Suriname Expeditions. VI. Additional chromosomal data for bats (Mammalia: Chiroptera) from Suriname. Annals of Carnegie Museum, 50:333–344.

Baker, R.J., M.W. Haiduk, L.W. Robbins, A. Cadena, and B.F. Koop. 1982. Chromosomal studies of South American bats and their systematic implications. Pp. 303–327 *in* Mammalian biology in South America (M.A. Mares and H.H. Genoways, eds.). Special Publication Series, Pymatuning Laboratory of Ecology, University of Pittsburgh, Linesville, Pennsylvania.

Baker, R.J., C.A. Porter, J.C. Patton, and R.A. Van Den Bussche. 2000. Systematics of bats of the family Phyllostomidae based on *RAG2* DNA sequences. Occasional Papers, The Museum, Texas Tech University, 202:i+1–16.

Baker, R.J., M. Hamilton, and D.A. Parish. 2003a. Preparations of mammalian karyotypes under field conditions. Occasional Papers, The Museum, Texas Tech University, 228:i+1–8.

Baker, R.J., S.R. Hoofer, C.A Porter, and R.A. Van Den Bussche. 2003b. Diversification among the New World leaf-nosed bats: an evolutionary hypothesis and classification inferred from digenomic congruence of DNA sequence. Occasional Papers, The Museum, Texas Tech University, 230:i+1–32.

Cerón, R., W. Palacios, R. Valencia, and R. Sierra. 1999. Las formaciones naturales de la costa del Ecuador. Pp. 55–78 *in* Propuesta preliminar de un sistema de clasificación para el Ecuador continental (R. Sierra, ed.). Proyecto INEFAN/GEF-BIRF y EcoCiencia, Quito.

Davis, W.B., and D.C. Carter. 1978. A review of the round-eared bats of the *Tonatia silvicola* complex, with description of three new taxa. Occasional Papers, The Museum, Texas Tech University, 53:1–12.

Dodson, C.H., and A.H. Gentry. 1991. Biological extintion in western Ecuador. Annals of the Missouri Botanical Garden, 78:273–285.

Gardner, A.L. 1977. Chromosomal variation in *Vampyressa* and a review of chromosomal evolution in the Phyllostomidae (Chiroptera). Systematic Zoology, 25:300–318.

Genoways, H.H., and S.L. Williams. 1980. Results of the Alcoa Foundation-Suriname Expeditions. I. A new species of bat of the genus *Tonatia* (Mammalia: Phyllostomidae). Annals of Carnegie Museum, 49:203–211.

Gentry, A.H. 1986. Species richness and floristic composition of the Choco region plant communities. Caldasia, 15:71–79.

Hoffmann, F.G., and R.J. Baker. 2001. Systematics of bats of the genus *Glossophaga* (Chiroptera: Phyllostomidae) and phylogeography in *G. soricina* based on the cytochrome-*b* gene. Journal of Mammalogy, 82:1092–1101.

Honeycutt, R.L., R.J. Baker, and H.H. Genoways. 1980. Results of the Alcoa Foundation-Suriname Expeditions. III. Chromosomal data for bats (Mammalia: Chiroptera) from Suriname. Annals of Carnegie Museum, 49:237–250.

Hutson, A.M., S.P. Mickleburgh, and P.A. Racey. 2001. Microchiropteran Bats: Global Status Survey and Conservation Action Plan. IUCN/SSC Chiroptera Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.

Koopman, K.F. 1993. Order Chiroptera. Pp. 137–241 *in* Mammal species of the world, a taxonomic and geographic reference (D.E. Wilson and D.M. Reeder, eds.). Smithsonian Institution Press, Washington, D.C.

Longmire, J.L., M. Maltbie, and R.J. Baker. 1997. Use of "lysis buffer" in DNA isolation and its implications for museum collections. Occasional Papers, The Museum, Texas Tech University, 163:1–3.

Maniatis. T., E.F. Fritsch, and J. Sambrock. 1992. Molecular cloning. A laboratory manual. Cold Spring Harbor Laboratory Press, New York.

McCarthy, T.J., A.L. Gardner, and C.O. Handley, Jr. 1992. Tonatia carrikeri. Mammalian Species, 407:1–4.

Medellín, R.A., and H.T. Arita. 1989. Tonatia evotis and Tonatia silvicola. Mammalian Species, 334:1–5.

Miller, S.A., D.D. Dykes, and H.F. Polesky. 1988. A simple 'salting out' procedure for extracting DNA for human nucleated cells. Nucleis Acids Research, 16:1215.

Patton, J.C., and R.J. Baker. 1978. Chromosomal homology and evolution of phyllostomid bats. Systematic Zoology, 27:449–462.

Porter, C.A., S.R. Hoofer, R.A. Van Den Bussche, T.E. Lee, Jr., and R.J. Baker. 2003. Systematics of round-eared bats (*Tonatia* and *Lophostoma*) based on nuclear and mitochondrial DNA sequences. Journal of Mammalogy, 84:791–808.

Ridgway, R. 1912, Color Standards and Color Nomenclature: 1st ed. Privately published, Washington, D.C.

Rudel, T.K. 2000. Organizing for sustainable development: conservation organizations and the struggle to protect tropical rain forests in Esmeraldas, Ecuador. AMBIO: A Journal of the Human Environment, 29:78–82.

Sanborn, C.C. 1932. Neotropical bats in the Carnegie Museum. Annals of Carnegie Museum, 21:171–183.

Sierra, R. 1996. La deforestación en el noroccidente del Ecuador, 1983–1993. EcoCiencia, Quito, Ecuador.

Swofford. D.L. 1999. PAUP*. Phylogenetic Analysis Using Parsimony (* and Other Methods), version 4. Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts.

Thomas, O. 1910. Mammals from the River Supinaam, Demerara, presented by Mr. F.V. McConnell to the British Museum. Annales and Magazine of Natural History, ser. 8, 6:184–189.

Tirira, D. 1999. Mamíferos del Ecuador. Publicación Especial 2, Museo de Zoología, Centro de Biodiversidad y Ambiente. Pontificia Universidad Católica del Ecuador, Quito.

Wagner, J.A. 1843. Diagnosen neuer Arten Brasilischer Hansflüger. Archiv für Naturgeschichte, 9:365–368.

Wetterer, A.L., M.V. Rockman, and N.B. Simmons. 2000. Phylogeny of phyllostomid bats (Mammalia: Chiroptera): data from diverse morphological systems, sex chromosomes, and restriction sites. Bulletin of the American Museum of Natural History, 248:1–200.

Williams, S.L., M.R. Willig, and F.A. Reid. 1995. Review of the *Tonatia bidens* complex (Mammalia: Chiroptera), with description of two new subspecies. Journal of Mammalogy, 76:612–626.

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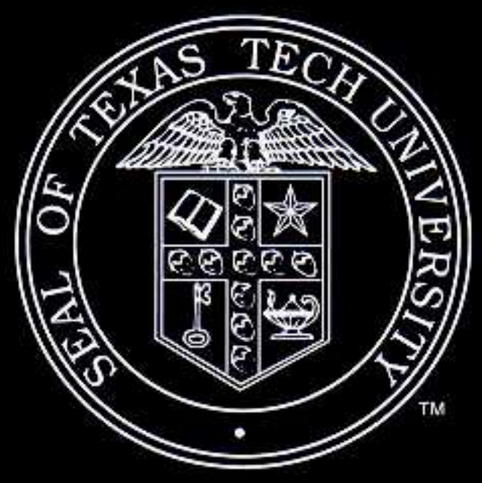
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