(ISSN 0097-4463)

ANNALS
of CARNEGIE MUSEUM

CARNEGIE MUSEUM OF NATURAL HISTORY

4400 FORBES AVENUE • PITTSBURGH, PENNSYLVANIA 15213

VOLUME 48 7 SEPTEMBER 1979 ARTICLE 17

NOTES ON BATS (MAMMALIA: CHIROPTERA) FROM BONAIRE AND CURAÇAO, DUTCH WEST INDIES

HUGH H. GENOWAYS
Curator, Section of Mammals

STEPHEN L. WILLIAMS
Collection Manager, Section of Mammals

ABSTRACT

Five species of bats are reported from islands of Bonaire and Curaçao, Dutch West Indies. *Natalus tumidirostris* Miller is recorded from Bonaire for the first time. Significant differences are detected in three measurements for both sexes between populations of *Glossophaga longirostris* Miller from Curaçao and Bonaire. *Myotis nesopolus* Miller is shown to be a distinct species and the senior synonym for the taxon *M. larensis* LaVal.

INTRODUCTION

During the period 15 to 25 August 1977, a field party from the Carnegie Museum of Natural History collected bats on the islands of Bonaire and Curaçao in the Dutch West Indies. Five species are represented in the 435 specimens collected. Eight species of bats have been reported previously from Curaçao, and six have been taken on Bonaire (Koopman, 1958; Husson, 1960; Smith and Genoways, 1974). We report herein a seventh species, *Natalus tumidirostris*, from Bonaire. Also discussed are an examination of variation in *Glossophage longirostris* and the taxonomic relationships of the *Myotis* occurring on the islands.

This research and publication supported by the M. Graham Netting Research Fund through a grant from the Cordelia Scaife May Charitable Trust.
Submitted for publication 1 March 1979.

METHODS AND MATERIALS

External and cranial measurements were taken by means of dial calipers. All measurements are given in millimeters. Measurements given are those of adults (phalangeal epiphysis closed) except where noted, and were were made on preserved specimens. Measurements were taken as follows: *length of forearm,* from the posteriormost projection of the elbow to the anteriormost portion of the wrist joint with the wing flexed; *length of third metacarpal,* distance from the wrist to the distal end of the third metacarpal; *length of tibia,* length of lower leg from the knee to the ankle; *greatest length of skull,* distance from the posteriormost projection of the cranium to the anteriormost surface of the upper incisors; *condylobasal length,* distance from the posteriormost projection of exoccipital condyles to the anteriormost projection of premaxillae; *zygomatic breadth,* greatest width across zygomatic arches at right angles to longitudinal axis of cranium; *mastoid breadth,* greatest width across mastoid processes at right angles to longitudinal axis of skull; *postorbital breadth,* least width across the postorbital constriction at right angles to the longitudinal axis of the cranium; *length of maxillary toothrow,* distance from posterior lip of alveolus of M^3 to the anterior lip of alveolus of canine; *length of upper toothrow,* distance from posterior lip of alveolus of M^3 to the anterior lip of alveolus of I^1; *breadth across upper molars,* greatest distance from labial margins of the upper molars at the widest point; *postpalatal length,* distance from the posterior margin of the palate to the anteriormost portion of the foramen magnum; *depth of braincase,* distance from the line along the flat part of the braincase to a line on the midventral part of the cranium touching the palate and the basioccipital.

Statistical procedures were performed on an IBM-360 computer at Carnegie-Mellon University and a DEC-10 computer at the University of Pittsburgh. Univariate analyses were performed using the program UNIVAR. This program yields standard statistics (mean, range, standard deviations, standard error of the mean, variance, and coefficient of variation), and employs a single-classification analysis of variance (F-test, significance level 0.05) to test for significant differences between means (Sokal and Rohlf, 1969).

Stepwise discriminant analysis and canonical analysis (BMDP7M, Dixon and Brown, 1977) are techniqus that define and separate groups. The program performs a multiple discriminant analysis in a stepwise manner, selecting the variable entered by finding the variable with the greatest F value. The F value for inclusion was set at 0.01, and the F value for deletion was was set at 0.05. Canonical coefficients were derived by multiplying the coefficient of each discriminant function by the mean of each corresponding variable. The program also classifies individuals, placing them with the group that they are nearest to on the discriminant functions.

Most specimens examined are deposited in the Section of Mammals, Carnegie Museum of Natural History, and carry no institution designation in the lists of specimens examined. Specimens from the American Museum of Natural History are marked AMNH; those from the National Museum of Natural History, USNM.

SPECIES ACCOUNTS

Mormoops megalophylla intermedia Miller

Specimen examined (1).—BONAIRE: 8.5 km N, 2 km W Kralendijk, 1.

Our single specimen, an adult male with testes measuring 3 mm, was taken on the night of 21 August 1977. The habitat in the area was overgrazed pastureland with xeric mesquite-like vegetation. Also in the area was a natural spring that had been modified with concrete holding tanks. Nets were placed over the water where this individual was taken, and among the trees in the pastures.

This species has been reported previously from Bonaire (Husson, 1960; Smith, 1972). The length of forearm of our specimen (52.8) falls between the values of two specimens (50.3, 53.4) reported by Smith (1972) from Bonaire. We have followed Smith (1972) in the use of this trinomial.

Glossophaga longirostris elongata Miller

Specimens examined (404).—BONAIRE: 8.5 km N, 2 km W Kralendijk, 147; 7.5 km N, 6.5 km E Kralendijk, 52. CURAÇAO: 2.8 km S, 4.5 km E Westpunt, 3; 6.8 km N, 15.6 km W Willemstad, 10; 4 km N, 3 km W Willemstad, 157; Willemstad, 6; 4 km S, 13.4 km E Willemstad, 29.

On Curaçao, the large series of *Glossophaga longirostris* from 4 km N, 3 km W Willemstad was taken in and around a small cave. The habitat in the area was exceptionally dry with xeric forms of vegetation (including cactus) scattered over a rock surface or shallow rocky soil. Specimens from 4 km S, 13.4 km E Willemstad were taken at the entrances of two small caves occurring in the caprock bordering the coastline, whereas at 6.8 km N, 15.6 km W Willemstad bats were netted around an abandoned plantation house. Near Westpunt, mist nets were placed along the bed of a stream where the numerous large manzanillo trees formed a canopy over the area. In Willemstad, bats were taken in nets placed in a plant nursery possessing mesic types of vegetation.

The situation at 8.5 km N, 2 km W Kralendijk on Bonaire is described in detail in the account for *Mormoops*. At 7.5 km N, 6.5 km E Kralendijk, Bonaire, bats were collected in caves opening in the caprock along the coastline. The habitat in the area was dry, being dominated by low, xeric-adapted vegetation.

Represented in the specimens that we examined are 221 females and 183 males. Of the females taken between 16 and 25 August, 103 were lactating (46.6%). One female taken on 19 August at 7.5 km N, 6.5 km E Kralendijk was carrying a single embryo that measured 25 mm in crown–rump length. Many of the specimens in our sample are nearly adult-sized young-of-the-year. Examination of a random sample of 100 specimens from 4 km N, 3 km W Willemstad revealed the following age distribution: 15 adult males; 38 adult females (32 lactating); 17 subadult males (subadult pelage, but phalangeal epiphyses fused); 13 subadult females; eight young males (subadult pelage, phalangeal epiphyses unfused); nine young females. Average length of forearm in the young males was 37.4 (36.8–38.1) N = 8; young females, 36.9 (36.3–37.7) N = 10. All individuals were taken in mist nets, and were thus capable of flight. Obviously, we sampled these populations just at the end of a reproductive season; Wilson (1979) also reported this species reproducing in August elsewhere in its geographic range. Mean length of testes for 10 adult males was 3.6 (3–4).

Table 1.—*External and cranial measurements of male and female* Glossophaga longirostris elongata *from Bonaire and Curaçao.*

Locality	Sex	N	Mean	(Range) ± 2SE	CV
		Length of forearm			
Bonaire	♂	12	37.2	(36.1–38.1) ± 0.35	1.6
Curaçao	♂	18	37.2	(35.4–38.7) ± 0.38	2.1
Bonaire	♀	14	37.7	(36.8–39.0) ± 0.34	1.7
Curaçao	♀	23	37.8	(36.7–38.9) ± 0.21	1.4
		Greatest length of skull			
Bonaire	♂	12	23.8	(23.1–24.6) ± 0.23	1.7
Curaçao	♂	17	23.5	(22.7–24.2) ± 0.21	1.8
Bonaire	♀	13	23.7	(23.2–24.5) ± 0.20	1.5
Curaçao	♀	23	23.8	(23.3–24.5) ± 0.11	1.1
		Condylobasal length			
Bonaire	♂	12	22.2	(21.4–22.8) ± 0.24	1.9
Curaçao	♂	18	21.8	(20.8–22.5) ± 0.20	1.9
Bonaire	♀	14	22.1	(21.7–22.6) ± 0.14	1.2
Curaçao	♀	23	22.0	(21.6–22.7) ± 0.12	1.3
		Zygomatic breadth			
Bonaire	♂	11	9.3	(8.6–9.5) ± 0.16	2.9
Curaçao	♂	18	9.6	(9.1–9.8) ± 0.09	1.9
Bonaire	♀	10	9.2	(9.0–9.6) ± 0.11	1.8
Curaçao	♀	16	9.6	(9.3–9.3) ± 0.08	1.6
		Mastoid breadth			
Bonaire	♂	12	8.9	(8.3–9.2) ± 0.15	2.9
Curaçao	♂	18	9.1	(8.7–9.4) ± 0.10	2.2
Bonaire	♀	14	8.9	(8.7–9.2) ± 0.09	2.0
Curaçao	♀	23	9.1	(8.9–9.4) ± 0.06	1.5
		Postorbital breadth			
Bonaire	♂	12	4.6	(4.3–4.7) ± 0.08	3.0
Curaçao	♂	18	4.6	(4.4–4.8) ± 0.06	2.8
Bonaire	♀	14	4.5	(4.2–4.9) ± 0.10	4.2
Curaçao	♀	23	4.6	(4.3–4.8) ± 0.06	2.9
		Length of maxillary toothrow			
Bonaire	♂	12	8.0	(7.7–8.4) ± 0.12	2.5
Curaçao	♂	18	8.0	(7.5–8.3) ± 0.10	2.5
Bonaire	♀	14	8.1	(7.3–8.5) ± 0.16	3.8
Curaçao	♀	23	8.1	(7.3–8.5) ± 0.11	3.1
		Breadth across upper molars			
Bonaire	♂	12	5.9	(5.3–6.1) ± 0.14	4.0
Curaçao	♂	18	6.0	(5.7–6.3) ± 0.08	2.8
Bonaire	♀	13	5.8	(5.4–6.1) ± 0.12	3.7
Curaçao	♀	22	6.0	(5.7–6.2) ± 0.06	2.3

Because the morphometric relationship between the sexes of this species is unknown (Swanepoel and Genoways, 1979), we tested samples of males and females for secondary sexual variation. Results of these analyses (Table 1) revealed that females are significantly larger in three (length of forearm, greatest length of skull, and condylobasal length) of the eight measurements tested. In four of the remaining measurements, the sexes averaged the same, and, in the fifth (length of maxillary toothrow), females were 0.1 mm larger than males.

Miller's (1900*a*) *Glossophaga elongata* from Willemstad, Curaçao, was considered to be a distinct species until Koopman (1958) recognized it as a subspecies of *Glossophaga longirostris*. We also compared samples from Bonaire and Curaçao by sex to explore the relationship between these island populations (Table 1). Males from Curaçao differed significantly from those on Bonaire in three measurements. In two of these measurements (zygomatic breadth and mastoid breadth), the Curaçao sample averaged larger, whereas in the other measurement (condylobasal length) males from Bonaire were larger. Females from Curaçao averaged significantly larger than those from Bonaire in three measurements (zygomatic breadth, mastoid breadth, and breadth across upper molars). The exact meaning of the differences between these populations is unclear at the present time and must await comparisons with samples from Aruba and the adjacent mainland. Also genic information would be useful in documenting relationships among these insular populations. For the present, we have assigned populations from Curaçao and Bonaire to *Glossophaga longirostris elongata*.

Natalus tumidirostris tumidirostris Miller

Specimen examined (1).—BONAIRE: 8.5 km N, 2 km W Kralendijk, 1.

This is the first specimen of this species to be reported from Bonaire, making a total of seven chiropteran species known from the island. Our single example is an adult male (testes, measuring 1.5 mm in length) taken on 18 August 1977 under the conditions described in the account of *Mormoops megalophylla*.

This taxon, originally described from Curaçao by Miller (1900*b*), was reviewed by Goodwin (1959). We have assigned our specimen to *N. t. tumidirostris* based on its small size, which matches that of material reported from Curaçao by Goodwin. Differences in overall size are the main characteristics used to distinguish subspecies of *N. tumidirostris*. External and cranial measurements of our specimen are as follows: length of forearm, 35.0; greatest length of skull, 15.6; condylobasal length, 14.2; zygomatic breadth, 7.7; mastoid breadth, 7.0; breadth of braincase, 7.6; postorbital breadth, 3.0; length of maxillary toothrow, 6.7; breadth across upper molars, 5.1.

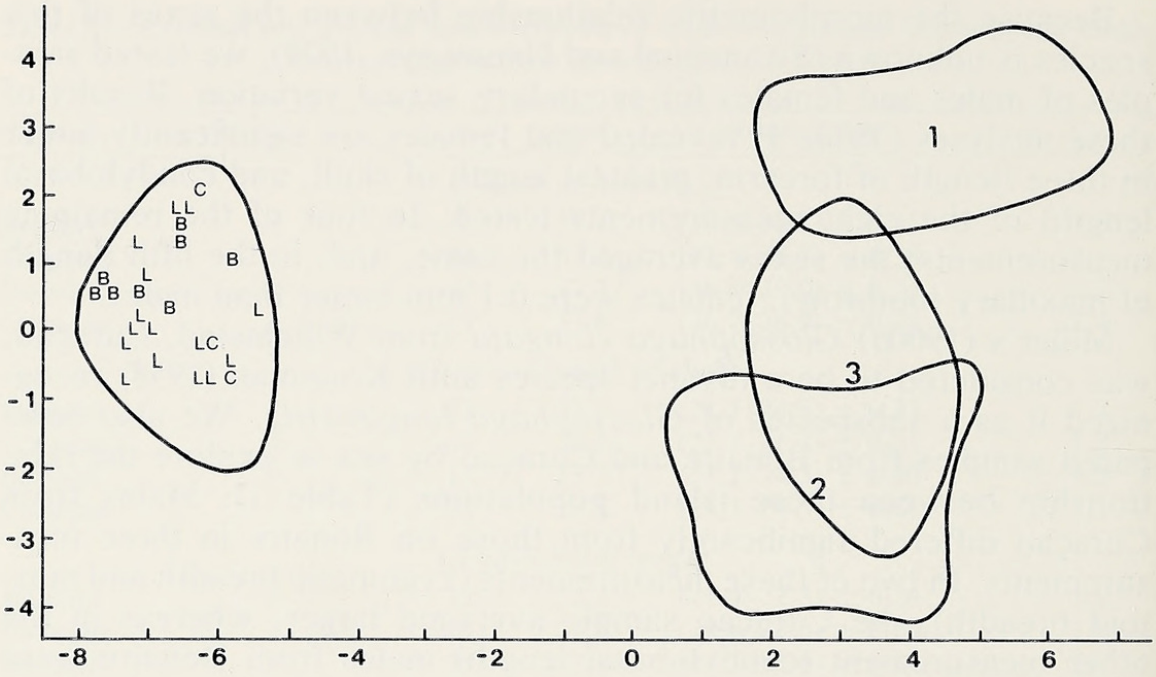

Fig. 1.—Plot of first two canonical variates, showing phenetic relationships among species of *Myotis*. Groups on the right side include *M. albescens* (1), *M. keaysi* (2), and *M. nigricans* (3). On the left side are clustered *M. nesopolus* from the mainland (L), Bonaire (B), and Curaçao (C).

Myotis nesopolus nesopolus Miller

Specimens examined (29).—BONAIRE: Boliva Dist., 1 (AMNH); 8.5 km N, 2 km W Kralendijk, 23. CURAÇAO: Punda, 1 (USNM); 2.8 km S, 4.5 km E Westpunt, 4.

The conditions under which these specimens were taken are discussed in earlier accounts. Of the 27 specimens taken during our work, only two were females; these individuals were non-pregnant when captured on Bonaire on 21 August 1977. Five males from Bonaire had testes length of 3, 4, 4, 4, and 4 when netted on the same date.

The Neotropical species of the genus *Myotis* were recently reviewed by LaVal (1973), but he did not include the taxon *M. nesopolus* described by Miller (1900*a*) from the island of Curaçao. This taxon has been considered (Koopman, 1958; Husson, 1960) a subspecies of the widespread *M. nigricans* since the work of Miller and Allen (1928). In order to determine the status of *M. nesopolus* we subjected morphometric data for it along with data for similar-sized *Myotis* from northern South America (*albescens, keaysi, larensis,* and *nigricans*) to canonical analysis.

Canonical analysis provides a mechanism for graphically representing phenetic relationships among samples with the characters weighted by variance-covariance analysis (Fig. 1). In Table 2, characters used in this analysis are listed from the most useful to the least useful in

Table 2.—*Variables used in discriminant function analysis of South American* Myotis. *Characters are listed in order of their usefulness in distinguishing groups, with the character with the greatest between-groups variance and the least within-groups variance being selected first. Other traits are ranked using the same criteria. The statistics are recalculated at each step.*

Step	Character	F-value	U-statistic
1.	Length of tibia	86.22	0.1864
2.	Length of forearm	83.80	0.0352
3.	Breadth of braincase	26.98	0.0146
4.	Greatest length of skull	8.82	0.0100
5.	Breadth across upper molars	4.05	0.0082
6.	Zygomatic breadth	2.82	0.0071
7.	Postorbital breadth	3.93	0.0059
8.	Postpalatal length	2.99	0.0050
9.	Length of third metacarpal	2.37	0.0044
10.	Depth of braincase	1.90	0.0040
11.	Length of upper toothrow	0.96	0.0038

discriminating groups. Variate I accounts for 82.8% of the total dispersion, and Variate II accounts for 13.1%. Characters with high positive canonical coefficients for Variate I (values greater than 1.0) are, in decreasing order of values, postorbital breadth, breadth of braincase, postpalatal length, and length of forearm. Those with high negative values include, ordered as above, length of tibia, zygomatic breadth, and length of upper toothrow. In Variate II, positive values of more than 1.0 were exhibited by postorbital breadth, breadth of braincase, and greatest length of skull, in order of decreasing value. The greatest negative value was possessed by breadth across upper molars in Variate II followed by depth of braincase and zygomatic breadth.

In Fig. 1, the specimens of *Myotis larensis* and those from Curaçao

Table 3.—*Matrix of classification, based upon the discriminant functions of 11 morphometric characters. Values indicate the number of individuals classified into each group.*

Samples	Classification groups				
	1	2	3	4	5
1. *Myotis albescens*	18	0	0	0	1
2. *Myotis keaysi pilosatibialis*	0	16	0	0	2
3. *Myotis nesopolus larensis*	0	0	15	1	0
4. *Myotis nesopolus nesopolus*	0	0	0	11	0
5. *Myotis nigricans nigricans*	1	3	0	0	16

Table 4.—*External and cranial measurements of two subspecies of* Myotis nesopolus. *See text for specimens examined. An asterick following the name of a measurement indicates that the taxa differ at the 0.05 level.*

Taxon	N	Mean	(Range)	± 2SE	CV
		*Length of forearm**			
M. n. nesopolus	12	30.3	(29.5–31.2)	±0.28	1.6
M. n. larensis	30	31.9	(30.4–33.2)	±0.26	2.2
		*Length of third metacarpal**			
M. n. nesoplus	12	29.3	(28.2–30.0)	±0.30	1.8
M. n. larensis	30	31.0	(29.5–32.1)	±0.25	2.2
		*Length of tibia**			
M. n. nesopolus	12	14.5	(14.3–14.9)	±0.12	1.5
M. n. larensis	30	14.9	(14.2–15.8)	±0.12	2.2
		*Greatest length of skull**			
M. n. nesopolus	12	13.1	(12.7–13.4)	±0.11	1.4
M. n. larensis	32	13.6	(13.0–14.4)	±0.10	2.2
		Depth of braincase			
M. n. nesopolus	12	4.8	(4.6–4.9)	±0.07	2.4
M. n. larensis	32	4.9	(4.5–5.2)	±0.06	3.6
		*Zygomatic breadth**			
M. n. nesopolus	11	7.9	(7.5–8.1)	±0.11	2.2
M. n. larensis	17	8.2	(8.0–8.3)	±0.05	1.3
		Breadth of braincase			
M. n. nesopolus	12	6.1	(6.0–6.2)	±0.04	1.0
M. n. larensis	31	6.1	(5.8–6.4)	±0.05	2.2
		Postorbital breadth			
M. n. nesopolus	12	3.2	(3.0–3.3)	±0.05	2.9
M. n. larensis	33	3.3	(3.0–3.5)	±0.04	3.2
		*Length of upper toothrow** (I^1–M^3)			
M. n. nesopolus	12	5.7	(5.4–5.9)	±0.08	2.4
M. n. larensis	33	6.1	(5.8–6.5)	±0.05	2.5
		*Breadth across upper molars**			
M. n. nesopolus	12	5.0	(4.9–5.1)	±0.04	1.3
M. n. larensis	32	5.2	(4.8–5.6)	±0.05	2.9
		Postpalatal length			
M. n. nesopolus	12	4.5	(4.0–4.7)	±0.11	4.3
M. n. larensis	30	4.6	(4.2–5.0)	±0.09	5.4

and Bonaire are grouped on the left side of the plot. Another group, composed of *M. albescens, M. keaysi,* and *M. nigricans* is found on the right side of the plot. These two groups are widely separated on Variate I. Clearly, mainland *M. larensis* and the *Myotis* from the is-

lands are distinct from the other species; however, their relationship to each other is less clear. Examination of Fig. 1 indicates that these samples can not be distinguished on either Variate I or Variate II. The classification matrix (Table 3), on the other hand, shows only one specimen of *larensis* misclassified with specimens from Curaçao and Bonaire. All specimens from Curaçao and Bonaire are classified in their own group.

This analysis clearly reveals that the material from Curaçao and Bonaire, to which the name *M. nesopolus* would apply, is most closely related to *M. larensis* of the South American mainland. The question remains as to whether these taxa are closely related species or subspecies of a single species. A univariate comparison of the two taxa (Table 4) indicates that *M. nesopolus* is significantly smaller than *M. larensis* in seven of the 11 measurements tested and they average smaller in three of the other measurements. LaVal (1973) characterized *M. larensis* as having a very long third metacarpal, tibia, and skull in relation to length of forearm (mean ratios 0.96, 0.48, and 0.43, respectively). These ratios for *M. nesopolus* are 0.97, 0.48, and 0.43, respectively. As is true for *larensis, nesopolus* can be distinguished on absolute length of forearm (shorter) and tibia (longer) from *nigricans, albescens,* and *keaysi.* Our specimens also generally seem to agree with *larensis* in coloration and distribution of fur. We think that the relationship between these taxa is best represented by considering them to be distinct subspecies of a single species, with the island form being characterized by overall smaller size. *M. nesopolus* is the senior synonym for this species and should be treated as follows:

Myotis nesopolus nesopolus Miller

1900. *Myotis nesopolus* Miller, Proc. Biol. Soc. Washington, 13:123, April 6.
1928. *Myotis nigricans nesopolus,* Miller and Allen, Bull. U.S. Nat. Mus., 144:182, May 25.

Type locality.—Punda area, Willemstad, Curaçao.

Holotype.—Adult male in alcohol with skull removed, 101849 USNM, collected on 4 November 1899 by L. B. Smith.

Distribution.—Known from the islands of Curaçao and Bonaire, Dutch West Indies.

Remarks.—Previous reports of *Myotis nigricans* from these islands by Hummelinck (1940), Koopman (1958), Husson (1960), and others almost certainly pertain to *M. nesopolus* although we have not examined all reported specimens.

Myotis nesopolus larensis LaVal

1973. *Myotis larensis* LaVal, Sci. Bull. Nat. Hist. Mus. Los Angeles Co., 15:44, February 14.

Type locality.—Río Tocuyo, Lara, Venezuela.

Holotype.—Adult female, skin and skull, 130709 AMNH, taken on 23 March 1938 by G. H. H. Tate.

Distribution.—Known from three localities around the Golfo de Venezuela in northwestern Venezuela.

Remarks.—For additional information concerning this taxon see LaVal (1973).

Specimens examined (33).—VENEZUELA: Capatarida, Falcon, 20 (USNM); Río Tocuyo, Lara, 12 (AMNH); 110 km N, 25 km W Maracaibo, Zulia, 1 (USNM).

Additional Specimens Examined

Myotis albescens (20).—VENEZUELA: Belen, T. F. Amazonas, 2 (USNM); 25 km SSE Puerto Ayacucho, T. F. Amazonas, 1 (USNM); San Juan, T. F. Amazonas, 8 (USNM); 41 km NW Puerto Paez, Apure, 9 (USNM).

Myotis keaysi pilosatibialis (18).—VENEZUELA: Rancho Grande Biological Station, Aragua, 9 (USNM); 4 km NW Montalban, Carabobo, 1 (USNM); 9.4 km N Caracas, D. F., 1 (USNM); 5 km N Caracas, 1 (USNM); 19 km E Caracas, Miranda, 4 (USNM); 8 km S Caracas, Miranda, 2 (USNM).

Myotis nigricans nigricans (20).—VENEZUELA: 9.4 km N Caracas, D. F., 3 (USNM); 1 km N, 3 km W Caripe, Monagas, 7 (USNM); 19 km NW Urama, Yaracuy, 10 (USNM).

Molossus molossus pygmaeus Miller

Specimen examined (1).—BONAIRE: 8.5 km N, 2 km W Kralendijk, 1.

Our specimen is a non-pregnant female taken on the night of 18 August 1977. Conditions under which the specimen was taken are described in the account for *Mormoops megalophylla*.

This species has been reported previously from Bonaire (Hummelinck, 1940; Husson, 1960). There is considerable confusion over the taxonomic status and relationships of small Neotropical *Molossus*. We follow Jones et al. (1971) in considering "most, if not all, mainland populations of small *Molossus* with pale-based hairs pertain to the species *Molossus molossus*, originally described from the Lesser Antilles." However, this view is not held by all recent authors (see for example, Handley, 1976). The taxon *pygmaeus* was originally described from Curaçao by Miller (1900*b*) and this name has been applied to specimens from Bonaire by earlier authors (see Hummelinck, 1940; Husson, 1960). We consider *pygmaeus* to be a subspecies of *M. molossus* here but its status must be determined in the future when this entire complex is studied.

ACKNOWLEDGMENTS

Fieldwork resulting in specimens reported herein was supported by the M. Graham Netting Research Fund through a grant from the Cordelia Scaife May Charitable Trust. Permits to collect on Bonaire and Curaçao were granted by Mr. R. Gorsira, Head of Veterinary Service, Abattoir-Parera, Willemstad, Curaçao.

We would like to thank Daniel F. Williams for assistance with the statistical programs, M. de la Fuente for field assistance, and Karl F. Koopman, (American Museum of Natural History) and Don E. Wilson, (National Fish and Wildlife Laboratory) for allowing us to examine material in their care.

LITERATURE CITED

DIXON, W. J., AND M. B. BROWN (eds.). 1977. BMD P-77: Biomedical Computer Programs, P-series. Univ. California Press, Berkeley, xiii + 880 pp.

GOODWIN, G. G. 1959. Bats of the subgenus *Natalus*. Amer. Mus. Novitates, 1977:1–22.

HANDLEY, C. O., JR. 1976. Mammals of the Smithsonian Venezuelan Project. Brigham Young Univ. Sci. Bull., Biol. Ser., 20:1–89.

HUMMELINCK, P. W. 1940. A survey of the mammals, lizards, and mollusks. Studies on the Fauna of Curaçao, Aruba, Bonaire, and the Venezuelan Islands, 1:59–108.

HUSSON, A. M. 1960. De zoogdieren van de Nederlandse Antillen. Mammals of the Netherlands Antilles. Fauna Ned. Antillen, 's- Gravenhage and Willemstad, viii + 170 pp.

JONES, J. K., JR., J. D. SMITH, AND R. W. TURNER. 1971. Noteworthy records of bats from Nicaragua, with a checklist of the chiropteran fauna of the country. Occas. Papers Mus. Nat. Hist., Univ. Kansas, 2:1–35.

KOOPMAN, K. F. 1958. Land bridges and ecology in bat distribution on islands off the northern coast of South America. Evolution, 12:429–439.

LAVAL, R. K. 1973. A revision of the Neotropical bats of the genus *Myotis*. Sci. Bull. Nat. Hist. Mus. Los Angeles Co., 15:1–54.

MILLER, G. S., JR. 1900*a*. Three new bats from the state of Curaçao. Proc. Biol. Soc. Washington, 13:123–127.

———. 1900*b*. A second collection of bats from the island of Curaçao. Proc. Biol. Soc. Washington, 13:159–162.

MILLER, G. S., JR., AND G. M. ALLEN. 1928. The American bats of the genera *Myotis* and *Pizonyx*. Bull. U.S. Nat. Mus., 144:viii + 1–218.

SMITH, J. D. 1972. Systematics of the chiropteran family Mormoopidae. Misc. Publ. Mus. Nat. Hist., Univ. Kansas, 56:1–132.

SMITH, J. D., AND H. H. GENOWAYS. 1974. Bats of Margarita Island, Venezuela, with zoogeographic comments. Bull. Southern California Acad. Sci., 73:64–79.

SOKAL, R. R., AND F. J. ROHLF. 1969. Biometry: the principles and practice of statistics in biological research. W. H. Freeman and Co., San Francisco, xii + 776 pp.

SWANEPOEL, P., AND H. H. GENOWAYS. 1979. Morphometrics. Pp. 13–106, *in* Biology of bats of the New World family Phyllostomatidae, Part III (R. J. Baker, J. K. Jones, Jr., and D. C. Carter, eds.), Spec, Publ. Mus., Texas Tech Univ., 16:1–441.

WILSON, D. E. 1979. Reproductive patterns. Pp. 317–378, Biology of bats of the New World family Phyllostomatidae, Part III (R. J. Baker, J. K. Jones, Jr., and D. C. Carter, eds.), Spec. Publ. Mus., Texas Tech Univ., 16:1–441.