October 2004

# THE FLORIDA BONNETED BAT, *EUMOPS FLORIDANUS* (CHIROPTERA: MOLOSSIDAE): DISTRIBUTION, MORPHOMETRICS, SYSTEMATICS, AND ECOLOGY

Robert M. Timm
*University of Kansas, Lawrence, KS*

Hugh H. Genoways
*University of Nebraska - Lincoln*, h.h.genoways@gmail.com

*Journal of Mammalogy,* 85(5):852–865, 2004

# THE FLORIDA BONNETED BAT, *EUMOPS FLORIDANUS* (CHIROPTERA: MOLOSSIDAE): DISTRIBUTION, MORPHOMETRICS, SYSTEMATICS, AND ECOLOGY

ROBERT M. TIMM* AND HUGH H. GENOWAYS

*Natural History Museum and Department of Ecology and Evolutionary Biology, University of Kansas, Lawrence, KS 66045-7561, USA (RMT)*
*University of Nebraska State Museum, W436 Nebraska Hall, University of Nebraska–Lincoln, Lincoln, NE 68588-0514, USA (HHG)*

A review and reappraisal of bats of the genus *Eumops* (Chiroptera: Molossidae) reveals that considerable geographic variation is present in the bonneted bat, *E. glaucinus*; it is a complex consisting of >1 species. Bonneted bats in Florida are significantly larger than those in all other populations, and have proportionally shorter and deeper basisphenoid pits, the glenoid fossa is broadly triangular with rounded apices, and bacular shape differs from that in other populations. Additionally, bonneted bats in Florida have a broader palate than bats from populations in South America. Given these differences, the correct name for both Pleistocene and Recent Florida bonneted bats is *Eumops floridanus* (Allen, 1932). We found no geographic variation in Recent populations of Florida *Eumops* and little secondary sexual variation. We describe and review the distribution, morphometrics, systematics, ecology, and taxonomic history of the species, which is restricted to southern Florida. *E. floridanus* has one of the most restricted distributions of any bat in the New World and is one of the most critically endangered mammalian species in North America.

Key words: Chiroptera, conservation, endangered species, *Eumops*, Florida, Molossidae, morphometrics, systematics

The New World bonneted bats of the genus *Eumops* (Chiroptera: Molossidae) are a monophyletic lineage of 8–10 species—*E. auripendulus*, *E. bonariensis*, *E. dabbenei*, *E. glaucinus*, *E. hansae*, *E. maurus*, *E. patagonicus*, *E. perotis*, *E. trumbulli*, and *E. underwoodi* (Eger 1977; Freeman 1981; Koopman 1978, 1994). Although the genus has few well-defined synapomorphies, species of *Eumops* can be distinguished from other molossids by the following combination of characteristics: lips smooth without grooves or wrinkles; ears large (extending beyond nostrils when laid forward) and joined at base; antetragus well developed, but not in shape of a circular disc; basisphenoid pits well developed; and anterior palatal emargination absent. Our study of bonneted bats reveals considerable geographic variation in the species currently known as *E. glaucinus*, and it is in fact a species-group consisting of >1 species. Two subspecies of *E. glaucinus* are recognized, *E. g. floridanus*, which occurs only in southern Florida, and *E. g. glaucinus*, which occurs from central Mexico to southeastern Brazil and northwestern Argentina, with populations also known from Jamaica and Cuba in the Greater Antilles (Koopman 1993). The Florida population has been the subject of considerable controversy, in part because it was 1st described from Pleistocene fossil remains, the 1st living individual was found in 1936, few colonies have been found, few specimens were available for study, and it has an extremely restricted geographic range. Barbour (1936) believed that the 1st Recent specimen known from Florida had been accidentally introduced on a fruit steamer ship from Cuba; the suggestion also has been made that the bat flew to Florida from Cuba (Hamilton 1943; Hamilton and Whitaker 1979). Albert Schwartz (1952:45) documented that the species was breeding in Florida with the discovery of young individuals from Miami, and considered that ''these bats may have been brought originally to Florida from Cuba during one of the hurricanes.'' However, bats from the Florida population are distinct from bonneted bats of Cuba and Jamaica, and have been since the Pleistocene (Allen 1932; Martin 1977; Morgan 1985, 1991; Ray et al. 1963).

Glover M. Allen (1932) described a new genus and species of Pleistocene free-tailed bat, *Molossides floridanus*, from a single partial mandible from what he believed was an early, but not precisely aged, Pleistocene deposit of south-central Florida. He characterized this Pleistocene species as differentiated from most extant molossids in having only a single lower incisor, with the dental formula i1, c1, p2, and m3. He

* *Correspondent: btimm@ku.edu*

**Table 1.**—Length of forearm and 9 cranial measurements for male and female *Eumops* from Florida.

| | Males | | | | Females | | | |
|---|---|---|---|---|---|---|---|---|
| Measurements (in mm) | *n* | $\bar{X}$ | Range | *SE* | *n* | $\bar{X}$ | Range | *SE* |
| Length of forearm | 23 | 63.9 | (60.8–66.0) | 0.28 | 4 | 64.7 | (63.1–66.0) | 0.75 |
| Greatest length of skull | 23 | 26.4 | (25.2–27.2) | 0.12 | 4 | 26.1 | (25.3–26.5) | 0.28 |
| Condylobasal length | 23 | 24.6 | (23.4–25.4) | 0.13 | 4 | 24.3 | (23.6–24.9) | 0.27 |
| Zygomatic breadth | 22 | 16.3 | (15.7–17.3) | 0.11 | 4 | 16.2 | (15.3–16.6) | 0.32 |
| Interorbital constriction | 24 | 8.5 | (8.0–9.2) | 0.06 | 4 | 8.4 | (7.9–8.6) | 0.16 |
| Postorbital constriction | 24 | 5.4 | (5.1–5.7) | 0.04 | 4 | 5.3 | (5.2–5.4) | 0.04 |
| Mastoid breadth | 22 | 14.1 | (13.5–14.7) | 0.07 | 4 | 14.2 | (13.8–14.5) | 0.15 |
| Palatal length | 24 | 10.8 | (10.1–11.2) | 0.05 | 4 | 10.6 | (10.5–10.7) | 0.06 |
| Length of maxillary toothrow | 24 | 10.1 | (9.4–10.5) | 0.07 | 4 | 10.0 | (9.6–10.2) | 0.13 |
| Breadth across upper molars | 24 | 10.6 | (9.4–11.4) | 0.10 | 4 | 10.6 | (9.8–11.4) | 0.29 |

described the bat as allied to *Molossus* and *Eumops*, primarily by comparing it to modern-day species of *Molossus* because he mistakenly believed the fossil had only a single lower incisor. The 1st Recent record of *Eumops* in Florida was a specimen from North Miami identified as *E. glaucinus* by Allen and Thomas Barbour (Barbour 1936, 1945), who attributed its occurrence in Florida to it ''having reached Florida on one of the boats'' from Cuba (Barbour 1936:414). In his list of Recent land mammals of Florida, Sherman (1939) listed the species reported by Barbour, and Hall and Kelson (1959) included *E. glaucinus* as occurring in Florida. Schwartz (1952) examined 6 specimens from Miami and Coral Gables, documented that young *Eumops* were found in the Miami region in January and April, and concluded that *Eumops* bred in Florida and the population should be considered a resident species. Ray et al. (1963) believed that Allen's Pleistocene mandible was not intact anteriorly and the specimen had 2 lower incisors, with the alveolus of i2 broken off. In comparing this specimen to modern-day molossids, Ray et al. (1963) transferred the Pleistocene species to the genus *Eumops*, stating that it resembled *E. glaucinus* in approximate size and overall proportions. Barbour and Davis (1969:231) commented that skulls of the Florida population are ''noticeably different'' from those of Central American *E. glaucinus* and that the Florida population probably represented an undescribed race. Koopman (1971) regarded the Recent specimens from the Miami area as conspecific with the single known Pleistocene fossil specimen, applying *E. glaucinus* to both and recognizing the considerably larger Florida bats as a subspecies distinct from the smaller bats of Cuba, Jamaica, and the Central and South American mainland. He considered the name *E. g. floridanus* (Allen, 1932) applicable to both the Pleistocene fossil and modern southern Florida populations, with all other populations, which extend from central Mexico through the northern two-thirds of South America, as belonging to the nominate subspecies, *E. g. glaucinus*.

Given the large disparity in size and cranial and bacular differences between *E. g. glaucinus* and *E. g. floridanus* and the restricted distribution of *Eumops* in Florida, geographic variation and the status of *E. g. floridanus* need to be reevaluated now that additional specimens are available. Our purpose herein is to report on all specimens of the Florida bonneted bat known to us; to assess age, secondary sexual, and geographic variation; to assess systematics of this bat; to review previous information available on the biology of the species; to report new information that has accumulated; and to provide critical comments on the current abundance and conservation status of the northernmost member of the *E. glaucinus* complex, which is restricted today to southern Florida.

## Materials and Methods

All measurements in accounts and tables that follow are given in millimeters and weights are given in grams. Forearms and crania were measured with dial or digital calipers to the nearest 0.1 mm. External measurements other than forearm are those recorded on specimen labels by collectors, as are testis measurements and selected ecological notes. The following cranial measurements were taken: greatest length of skull, condylobasal length, zygomatic breadth, interorbital constriction, postorbital constriction, mastoid breadth, palatal length, breadth across upper molars, and length of maxillary toothrow. Greatest length of skull includes incisors. Measurements of the maxillary toothrow are of the greatest alveolar length. Forearms were measured from the posterior extension of the radius–ulna to most anterior extension of the carpals. Length of ear was measured from notch to tip. Length of the basisphenoid pit was measured as the distance from anterior to posterior edges of the basisphenoid pit. All measurements of embryos are of crown–rump length. Capitalized color terms are from Ridgway (1912). Specimens categorized as adults are those with complete fusion of the epiphyses of metacarpals and phalanges, forearms $> 60$ mm, and mass $> 33$ g. Statistical analyses were performed with the StatView software package (Sager 1992). The paired *t*-test gave standard statistics for each sample and statistical significance of differences in group means. Values are presented as mean $\pm$ *SE*.

We examined a considerable number of specimens in the *E. glaucinus* complex, including 48 Recent Florida bonneted bats (Appendix I), and made direct comparisons of Allen's holotype of the late Rancholabrean fossil species he described as *Molossides floridanus* to *E. glaucinus* from throughout its geographic range, as well as to specimens of *E. auripendulus*, *E. bonariensis*, *E. hansae*, *E. perotis*, *E. trumbulli*, and *E. underwoodi* in collections of the University of Kansas Natural History Museum.

## Results

*Size*.—Table 1 presents morphometric data for length of forearm and 9 cranial measurements for 24 males and 4 females of *Eumops* from Florida. The sexes do not exhibit any significant secondary sexual variation in any of these measurements. Sample size could be a problem because only 4 adult

females were available for study; however, the means of the sexes differ by no more than 0.3 mm for 8 of 9 cranial measurements and are equal for 1 measurement. Males average slightly larger than females in all measurements except for length of forearm and mastoid breadth, and sexes average the same for breadth across upper molars. Thus, sexes were not segregated in other analyses.

To better assess secondary sexual variation across the geographic range of *E. glaucinus*, we tested morphometric data for length of forearm and 9 cranial measurements (see ''Materials and Methods''), comparing males to females from the 4 populations that were our largest sample sizes—Cuba (3 males, 11 females), Jamaica (4 males, 5 females), Mexico (6 males, 15 females), and Venezuela (8 males, 10 females). Throughout all populations, males averaged slightly larger than females in most characters; however, in only a few cases were the differences significant. Females from Cuba averaged larger than males in the most measurements of any population studied—postorbital constriction, mastoid breadth, and breadth across upper molars. In the other 3 populations, females averaged larger than males in only 1 measurement each—zygomatic breadth in Jamaica, length of forearm in Mexico, and length of maxillary toothrow in Venezuela. In the comparisons where we did find significant differences, males were always larger than females. In Cuba, males were significantly larger than females only in greatest length of skull ($P \leq 0.05$). In Jamaica, males were significantly larger than females in greatest length of skull ($P \leq 0.05$), condylobasal length ($P \leq 0.05$), interorbital constriction ($P \leq 0.001$), and length of maxillary toothrow ($P \leq 0.05$). Specimens from Mexican populations differed between the sexes in 5 of 10 measures; males were significantly larger than females in greatest length of skull ($P \leq 0.05$), condylobasal length ($P \leq 0.05$), zygomatic breadth ($P \leq 0.01$), mastoid breadth ($P \leq 0.01$), and palatal length ($P \leq 0.05$). In Venezuela, males were significantly larger than females in greatest length of skull ($P \leq 0.05$) and interorbital constriction ($P \leq 0.05$).

Table 2 presents comparative measurements for Florida *Eumops* and 6 samples from throughout the geographic range of *E. glaucinus*. Each sample of *E. glaucinus* was compared with the Florida sample to assess significant differences in length of forearm and the 9 cranial measurements. In all but 8 of the 60 comparisons, *Eumops* from Florida differed significantly from all other *E. glaucinus* at a significance level of $P \leq 0.0001$. This result confirms that *Eumops* from Florida are distinctly larger than all other members of the *E. glaucinus* complex. For 6 of the remaining 8 measurements (see Table 2), specimens from Florida were still highly significantly different from the Central American sample in postorbital constriction ($P \leq 0.0038$) and breadth across upper molars ($P \leq 0.0017$); the Venezuelan sample in interorbital constriction ($P \leq 0.0002$); and the Brazilian and Bolivian sample in interorbital constriction ($P \leq 0.002$), postorbital constriction ($P \leq 0.0038$), and length of maxillary toothrow ($P \leq 0.0002$). No significant variation was found in breadth across upper molars for the Venezuelan sample ($P \leq 0.093$), or the Brazilian and Bolivian samples ($P \leq 0.1131$; Table 2). The ratio of breadth across uppers molars divided by greatest length of skull is larger in the Brazilian and Venezuelan populations than in the Florida population and indicates that South American populations of *E. glaucinus* have a proportionally broader palate.

The 28 *Eumops* from Florida with complete data, along with samples of *E. glaucinus* from Cuba, Jamaica, Mexico, Central America, and South America, were submitted to principal components analysis (Fig. 1). The first 3 components combine to express 90.8% of the phenetic variation present in the samples (I, 79.2%; II, 7.4%; III, 4.2%). Results of the factor analysis showing the characters influencing the components indicate that the 1st component is heavily influenced by general size. All measurements had positive values for the size component; length of skull, zygomatic breadth, and length of maxillary toothrow had the highest values. The 2nd principal component combines a negative value for length of forearm with high positive values for 3 breadth measurements (interorbital constriction, postorbital constriction, and breadth across upper molars).

The Florida sample separates from all other populations of *E. glaucinus* along the highly important component 1 (Fig. 1). This indicates that in overall size, Florida *Eumops* exceed all other populations of the species, with no overlap in the range of variation.

For component 2, there is little separation of the populations, and variation in the population in Florida encompasses the range of variation of all other populations in this component (Fig. 1). However, populations from Jamaica and Cuba show little or no overlap with samples from Central and South America. Mexican populations are in an intermediate position, overlapping broadly with both groups (Fig. 1).

*Basisphenoid pits*.—Basisphenoid pits on all members of the *E. glaucinus* complex are distinct, ovoid in shape, and of moderate depth (Fig. 2). In the Florida population, the pits are shorter proportionally in length, albeit deeper, than they are in the populations from Cuba, Jamaica, Mexico, and Central and South America. When absolute length of basisphenoid pits of specimens from Florida ($n = 7$) is compared with those of bats from elsewhere in the geographic range of *E. glaucinus* ($n = 11$), specimens from Florida average slightly longer, but mean values are not significantly different (1.30–1.55 mm [1.49 mm $\pm$ 0.034 *SE*]; compared to 1.30–1.50 mm [1.43 $\pm$ 0.023 mm]). However, when length of the basisphenoid pit is expressed as a percentage of cranial length (condylobasal length), basisphenoid pits of the Florida population are significantly ($P \leq 0.01$) shorter than in other populations (5.35–6.18 [5.99 $\pm$ 0.128] compared to 5.94–7.01 [6.50 $\pm$ 0.101]).

*Bacular morphology*.—Brown (1967:653) described and illustrated the baculum from a single adult male *E. glaucinus* from Venezuela and reported that it was ''rounded basally, slightly expanded medially, and bluntly pointed distally. The bone is broad and bowed downward in lateral aspect. The base is round and enlarged. The specimen examined has a sharp tip at the upper surface of the distal end.'' Brown (1967) also figured and measured the specimen, reporting total length as 0.53 mm and width of base as 0.11 mm (specimen AMNH 130701).

**TABLE 2.**—Comparison of the sample of *Eumops* from Florida with populations of *Eumops glaucinus* from throughout its geographic range.

| | *Eumops floridanus* | *Eumops glaucinus* | | | | | |
|---|---|---|---|---|---|---|---|
| Measurements (in mm) and statistics | Florida ($n = 28$) | Cuba ($n = 14$) | Jamaica ($n = 10$) | Mexico ($n = 21$) | Central America ($n = 3$) | Venezuela ($n = 18$) | Brazil and Bolivia ($n = 3$) |
| Length of forearm | | | | | | | |
| $\bar{X}$ | 64.0 | 60.8 | 60.3 | 58.5 | 58.1 | 58.5 | 58.6 |
| Range | (60.8–66.0) | (59.1–62.0) | (58.7–61.0) | (56.5–61.3) | (56.9–58.7) | (56.9–60.2) | (56.6–60.2) |
| *SE* | 0.26 | 0.22 | 0.24 | 0.30 | 0.62 | 0.23 | 1.05 |
| Greatest length of skull | | | | | | | |
| $\bar{X}$ | 26.3 | 24.4 | 24.4 | 23.8 | 23.5 | 24.6 | 24.1 |
| Range | (25.2–27.2) | (23.7–25.0) | (23.4–25.0) | (23.2–24.4) | (23.3–23.7) | (23.8–25.6) | (23.6–24.5) |
| *SE* | 0.11 | 0.09 | 0.13 | 0.08 | 0.12 | 0.11 | 0.26 |
| Condylobasal length | | | | | | | |
| $\bar{X}$ | 24.5 | 22.6 | 22.7 | 22.0 | 21.5 | 22.7 | 22.3 |
| Range | (23.4–25.4) | (21.9–23.1) | (21.9–23.5) | (21.2–22.7) | (21.3–21.7) | (22.1–23.2) | (22.1–22.5) |
| *SE* | 0.11 | 0.09 | 0.16 | 0.09 | 0.12 | 0.08 | 0.12 |
| Zygomatic breadth | | | | | | | |
| $\bar{X}$ | 16.3 | 14.9 | 14.6 | 14.3 | 14.1 | 14.9 | 14.5 |
| Range | (15.1–17.3) | (14.5–15.2) | (14.0–15.1) | (13.7–14.8) | (13.9–14.2) | (14.3–15.4) | (14.3–14.7) |
| *SE* | 0.10 | 0.06 | 0.10 | 0.07 | 0.10 | 0.07 | 0.12 |
| Interorbital constriction | | | | | | | |
| $\bar{X}$ | 8.4 | 7.5 | 7.4 | 7.4 | 7.2 | 8.1 | 7.9 |
| Range | (7.9–9.2) | (7.1–7.7) | (7.3–7.6) | (7.1–8.0) | (7.1–7.3) | (7.6–8.7) | (7.8–8.0) |
| *SE* | 0.06 | 0.05 | 0.04 | 0.15 | 0.07 | 0.07 | 0.07 |
| Postorbital constriction | | | | | | | |
| $\bar{X}$ | 5.3 | 4.9 | 4.8 | 4.9 | 5.0 | 5.0 | 5.0 |
| Range | (5.1–5.7) | (4.6–5.0) | (4.6–4.9) | (4.7–5.2) | (5.0–5.1) | (4.8–5.7) | (5.0–5.1) |
| *SE* | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.05 | 0.03 |
| Mastoid breadth | | | | | | | |
| $\bar{X}$ | 14.1 | 13.3 | 13.1 | 12.9 | 12.7 | 13.1 | 13.1 |
| Range | (13.5–14.7) | (12.9–13.5) | (12.9–13.4) | (12.5–13.4) | (12.3–13.0) | (12.6–13.4) | (12.6–13.4) |
| *SE* | 0.06 | 0.05 | 0.05 | 0.05 | 0.21 | 0.05 | 0.25 |
| Palatal length | | | | | | | |
| $\bar{X}$ | 10.8 | 10.1 | 9.8 | 9.6 | 9.2 | 9.9 | 9.4 |
| Range | (10.1–11.2) | (9.7–10.5) | (9.4–10.4) | (8.6–10.3) | (9.0–9.4) | (9.4–10.7) | (9.1–9.5) |
| *SE* | 0.05 | 0.08 | 0.11 | 0.12 | 0.12 | 0.08 | 0.18 |
| Length of maxillary toothrow | | | | | | | |
| $\bar{X}$ | 10.1 | 9.3 | 9.3 | 9.0 | 8.7 | 9.4 | 9.3 |
| Range | (9.4–10.6) | (9.0–9.5) | (9.1–9.6) | (8.7–9.4) | (8.5–9.0) | (8.9–9.7) | (9.0–9.6) |
| *SE* | 0.06 | 0.04 | 0.05 | 0.04 | 0.15 | 0.06 | 0.18 |
| Breadth across upper molars | | | | | | | |
| $\bar{X}$ | 10.6 | 10.0 | 9.9 | 9.7 | 9.6 | 10.4 | 10.2 |
| Range | (9.4–11.4) | (9.8–10.3) | (9.7–10.2) | (9.1–10.2) | (9.5–9.7) | (9.9–10.8) | (10.0–10.3) |
| *SE* | 0.09 | 0.06 | 0.05 | 0.07 | 0.07 | 0.07 | 0.09 |

The bacula of members of the *E. glaucinus* group are simple and minute, but informative observations can be made (Fig. 3). Measurements from 4 individuals from the northern half of the range include bats from Florida (total length, 0.70 mm; width of base, 0.10 mm; KU 157447), Cuba (total length, 0.625 mm; width of base, 0.125 mm; TTU 52644), the Yucatan Peninsula (total length, 0.50 mm; width of base, 0.10 mm; TTU 47522), and Venezuela (total length, 0.50 mm; width of base, 0.125 mm; TTU 33407).

The baculum of a specimen from north-central Venezuela (TTU 33407) is similar in size and morphology to that of the specimen from northwestern Venezuela (AMNH 130701) figured by Brown (1967). The primary difference between the 2 is that base of the baculum in the 1st specimen is wider than the shaft, whereas the base does not appear to be expanded beyond the width of the shaft in the 2nd specimen.

Bacula from both specimens from Venezuela and 1 from Florida are weakly crescent-shaped in lateral view. The baculum of the specimen from Florida is larger than that of the Venezuelan specimens and appears to more closely resemble the specimen figured by Brown (1967) because the base of the baculum is similar in width to that of the shaft (Fig. 3).

Bacula of specimens from Cuba and the Yucatan Peninsula are similar in general morphology, with the Cuban specimen

being larger. In contrast to other populations, both bacula are broadest at the base, but the shaft of the Cuban specimen narrows quickly, whereas the specimen from the Yucatan Peninsula gradually tapers to the tip. In the lateral view of both, the shaft is straight, with the tip depressed distally. This morphology differs from that of material from Venezuela and Florida in that the shaft is crescent-shaped.

The morphology of the bacula of *Eumops* from Florida appears to most closely resemble that of bacula of *E. glaucinus* from Venezuela, whereas it differs in important ways from the morphology of bacula from populations on Cuba and the Yucatan Peninsula. Of the bacula of 4 species of *Eumops* figured by Brown (1967), bacular morphology of the population from Florida most closely matches that of *E. underwoodi*. These observations should be considered to be preliminary because the bacula of all species of *Eumops* are not known nor is individual variation in bacular morphology understood within members of the genus.

*Genetics*.—Warner et al. (1974) reported that 3 different karyotypes are known for *E. glaucinus* from throughout its geographic range and that the species shows considerable chromosomal variation. There are 28 biarmed autosomes; the smallest is a subtelocentric and there are 8 small acrocentric autosomes. Specimens from Costa Rica, Honduras, and Mexico have a diploid number (2n) of 38 (fundamental number [FN] = 64), whereas specimens from Colombia have 2n = 40 (FN = 64) and there is considerable variation in centromere placement of the X chromosome in Mexican and Central American populations. Genoways et al. (in press) report that autosomes in the Jamaican populations are identical to those from Mexico and Central America, with differences in diploid number between Colombian and Jamaican populations best explained by centric fusion of 2 pairs of acrocentrics present in the Colombian populations. Both acrocentric and submetacentric X chromosomes are present in these populations. Warner et al. (1974) suggested that karyotypic variation represented either population polymorphisms or the existence of geographic races. Genoways et al. (in press) report that examination of karyological data suggests that the Jamaican population of *E. glaucinus* has affinities with Mexican and Central American populations, rather than the South American population. They considered the 2n = 40 cytotype as probably primitive to the 2n = 38 cytotype.

## Discussion

The available evidence confirms that the species known as *E. glaucinus* is a composite of >1 species. The population of bonneted bats in Florida is distinct and characterized by consistent morphological differences in comparison with all other samples and has been so since the Pleistocene. With our recognition that the Florida bonneted bats are specifically distinct from all other populations of the *E. glaucinus* group, the correct name for the Florida population becomes *Eumops floridanus* (Allen, 1932). *E. floridanus* is one of the few species of Recent mammals that was described from the Pleistocene fossil record before the discovery of living individuals.

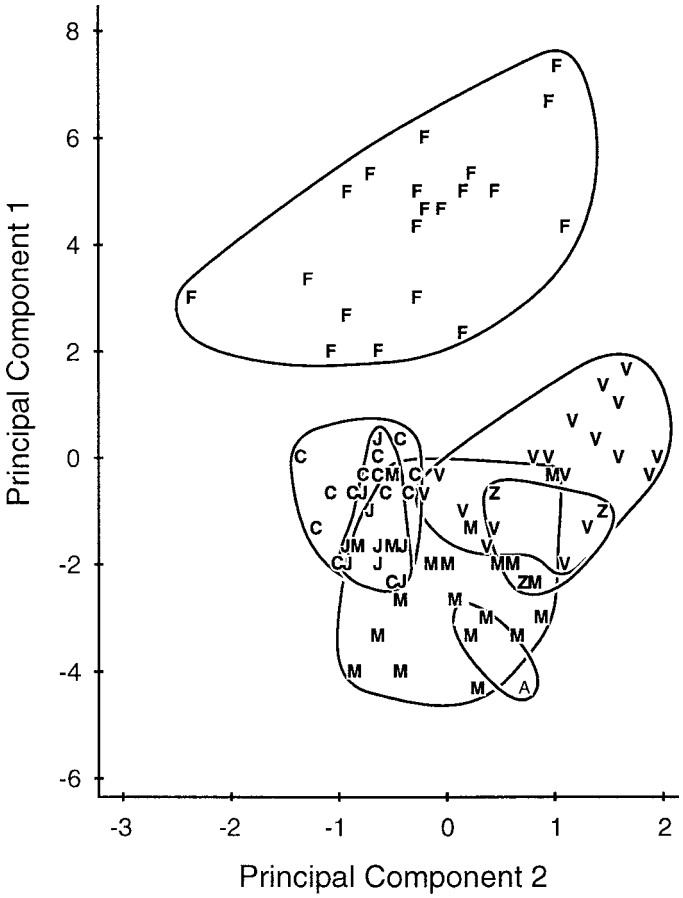


**Fig. 1.**—Specimen scores on principal component 1 and principal component 2 from principal components analysis of cranial and forearm means of adult specimens of *Eumops* examined in this study. Abbreviations: F, specimens of *Eumops* from Florida; C, from Cuba; J, from Jamaica; M, from Mexico; A, from Central America; V, from Venezuela; and Z, from Bolivia and Brazil. Axes are scaled relative to their eigenvalues (proportion of the variation explained).

*Eumops floridanus* (G. M. Allen, 1932)
Florida Bonneted Bat

*Molossides floridanus* G. M. Allen, 1932, Journal of Mammalogy 13:257.

*Eumops floridanus* Ray et al., 1963, Journal of Mammalogy 44:377.

*Eumops glaucinus floridanus* Koopman, 1971, American Museum Novitates 2478:5.

*Holotype*.—MCZ (17672); a left lower jaw with m1–3 present; incisors, canine, and premolars lacking; intact anteriorly, but posteriorly lacking coronoid, articular, and angular processes; collected by C. P. Singleton; 1929.

*Type locality*.—Florida: Brevard County; Melbourne, stratum 2, Melbourne Bed, Pleistocene [fossil bed subsequently dated as late Rancholabrean; 28°04′N, 80°41′W—Morgan 1991].

*Distribution*.—*Eumops floridanus* has one of the most restricted distributions of any species of bat in the New World. Recent specimens are known only from extreme southern and southwestern Florida, including Charlotte, Collier, and Lee counties on the Gulf Coast and Dade County on the Atlantic

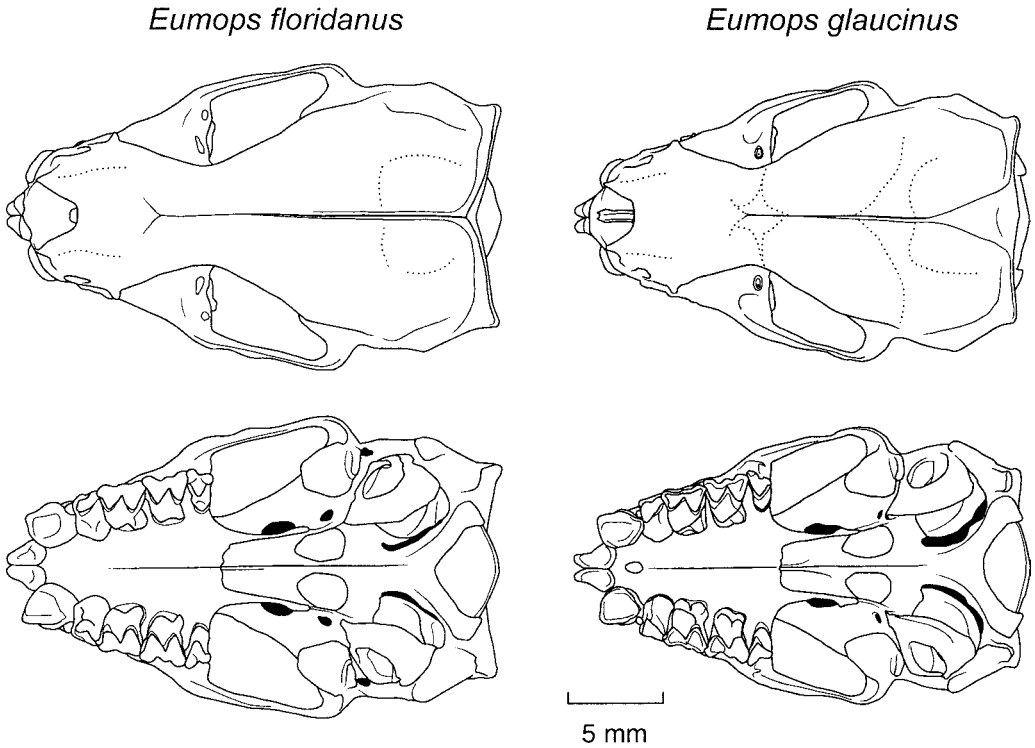


**Fig. 2.**—Dorsal and ventral views of cranium of an adult male *Eumops floridanus* (left) from Coral Gables, Dade County, Florida (greatest length of skull is 26.5 mm; KU 153920) and an adult female *Eumops glaucinus* (right) from Sylvestre, Minas Gerais, Brazil (greatest length of skull is 24.7 mm; USNM 391180).

Coast (Fig. 4). Most of the records are several decades old and from the cities of Coral Gables and Miami in extreme southeastern Florida. Layne (1974:389) stated "This bat has the most restricted range of any Florida mammal, being known from Miami, Coral Gables, and Coconut Grove, where it inhabits buildings in residential areas with lush vegetative growth." Late Pleistocene remains are known from Melbourne, Brevard County, and Monkey Jungle Hammock, Dade County, and Holocene remains are known from Vero Beach, Indian River County, which is considerably farther north than living individuals have been found (Allen 1932; Martin 1977; Morgan 1985, 1991, 2002; Ray 1958).

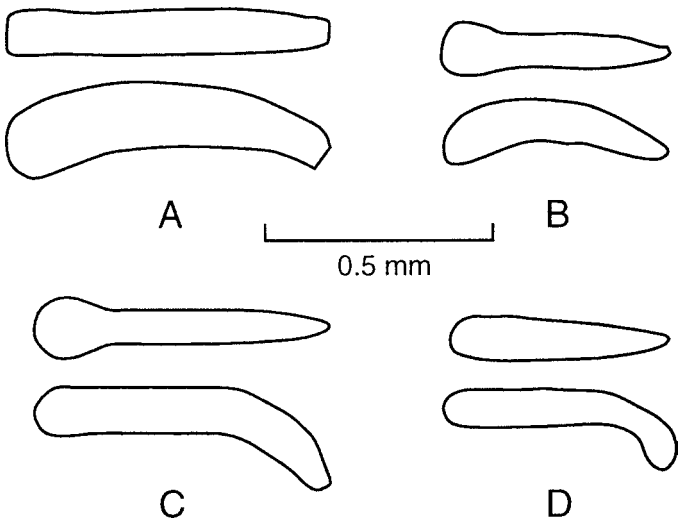


**Fig. 3.**—Drawings of bacula from individuals in each of 4 populations of the *Eumops glaucinus* complex. A) Vicinity of Miami, Dade County, Florida (KU 157447). B) 45 km S Calabozo, Guárico, Venezuela (TTU 33407). C) Guantánamo Bay Naval Station, Guantánamo, Cuba (TTU 52644). D) Mérida Club Campestre, Yucatan, Mexico (TTU 47522). Distal end is at right in all drawings; upper view is dorsal aspect, lower view is lateral aspect with ventral surface of baculum downward.

*Description.—Eumops floridanus* is a large free-tailed bat with masses averaging 39.7 g (33.8–46.5 g) for 7 males, 1 nonpregnant female, and 1 individual of unknown sex, with a pregnant female weighing 55.4 g. External measurements (in mm) of adults include total length, 130–165; length of tail, 46–57; length of hind foot, 11–15; length of ear, 20–30; and length of forearm 60.8–66.0. Males and females are not significantly different in size for any external measurement or the 9 cranial measurements studied (Table 1). The fur is short and glossy with hairs sharply bicolored, with a white base. The color varies from black to brown to brownish gray or cinnamon brown; ventral pelage is paler than dorsal. Using the Ridgway (1912) system, dorsal coloration can be characterized as Snuff Brown to Bister and Sepia. However, color is highly variable in this species, which is true for many molossids. The basisphenoid pits are ovoid and moderately deep. We found no evidence of geographic variation in the species in either cranial or external measurements. Comparative measurements for individuals from both the Gulf and Atlantic coasts of the southern Florida Peninsula are given in Table 3. The male from Punta Gorda was the largest individual in 6 of the measurements

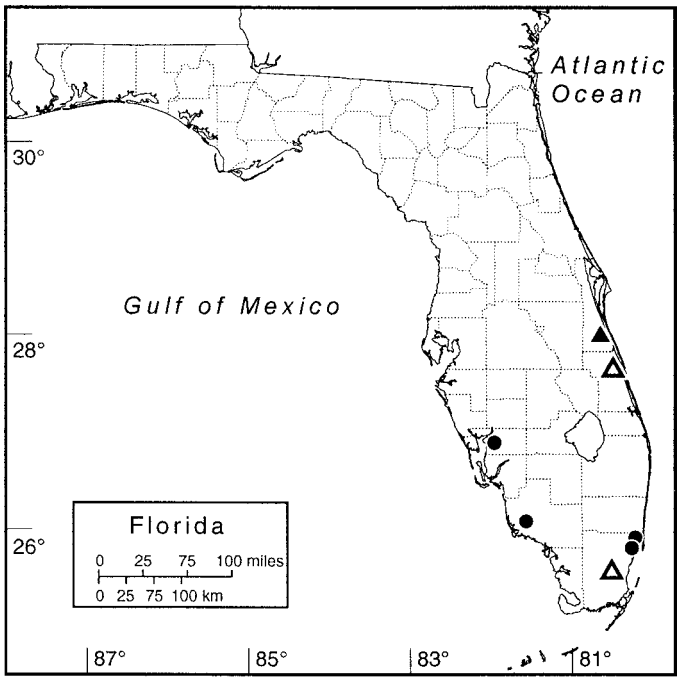


FIG. 4.—Florida, showing distribution of all known specimens of *Eumops floridanus*. All Recent specimens are denoted by closed circles (●); the holotype (MCZ 17672) from the late Rancholabrean Melbourne Bed, Brevard County, is denoted by a closed triangle (▲); all other fossil specimens, both Pleistocene and Holocene, are denoted by open triangles (△).

taken and smallest for 1, whereas the female from there was the largest individual for 1 measurement and smallest for 2. The individual of unknown sex from Collier County was the largest individual for 1 measurement, smallest for 3, and identical for smallest in 1. The male and female from Dade County were each the largest for 1 measurement and smallest for 2 measurements (and the female tied for smallest palatal length). Thus, there is no pattern of size-related geographic variation in this species. The glans penis was studied by Ryan (1991), based on a specimen from Miami High School, and found to be similar to that of *E. auripendulus* and *E. perotis*, but the glans has not been described for any other species of *Eumops*.

*Description of holotype*.—Allen (1932:259) provided drawings of the jaw fragment that constitutes the holotype and reported the following measurements (in mm): ''anterior tip of jaw to back of m3, 11.5; depth of mandible at front of m1, 3.4; length of m1, 2.5; of m2, 2.5; of m3, 2.3; combined greatest length of molars 1–3, 7.3; height of m1, from outer base to tip of protoconid, 2.6.'' Ray et al. (1963) described the holotype in greater detail and provided both photographs and comparisons with other species of *Eumops*. They described differences the fossil exhibits from the northernmost species of *Eumops* and from species of *Molossus*, and correctly concluded that Allen's *Molossides* is a junior synonym of *Eumops*. However, the comparisons they made to *E. glaucinus* were to specimens from Brazil, rather than to specimens from Florida, so they were in fact comparing 2 distinct species. Ray et al. (1963) found that the fossil most closely resembled their *E. glaucinus*, although it did share some characteristic with *E. abrasus* [= *auripendulus*]. The fossil differed from the modern Brazilian specimen of *E. glaucinus* in some details of the anatomy of its ramus and dentition. Koopman (1971) provided additional measurements of the holotype and the 1st measurements of Recent specimens from the Miami region, concluded that Allen's name should be applied to the living Florida bonneted bats, and recognized all as a distinctive subspecies with the name *E. g. floridanus*. Morgan (1991) provided a useful comparison of the holotype measurements and 2 other fossils from Florida with those of other species of *Eumops*, including a sample of 7 *E. floridanus* from the Miami area. For the holotype, he reported that the length of m1 = 2.7 mm and length of m2 = 2.6 mm, which are slightly larger measurements than Allen's and identical to the means of the 7 Recent specimens of *E. floridanus*. The dental measurements of all 3 fossil specimens fall within the range of measurements of the Recent sample; however, it may be noteworthy that the 2 measurements of the ramus of the fossil from Monkey Jungle fall outside the range of Recent specimens and 1 measurement of the fossil ramus from Vero Beach was at the upper extreme of the Recent sample (Morgan 1991).

We compared Allen's holotype of *Molossides floridanus* with a large series of Recent Florida bonneted bats as well as a number of other species of *Eumops* (see ''Materials and Methods'' and ''Specimens examined''). The left ramus is intact anteriorly, as Allen described, despite what was reported by Ray et al. (1963). Although the alveolus for the missing canine is enlarged postmortem, both alveoli for the 2 minute, upwardly displaced incisors typical of the *E. glaucinus* group are present. The anterior symphyseal foramen is present. The size of individual teeth and placement of cusps are nearly identical to those of Recent Florida bonneted bats. One difference is that the paraconid shelf of m3 is more squared posteriorly and at a slightly less oblique angle to the ramus in

TABLE 3.—Length of forearm and 9 cranial measurements of 5 specimens from the extremes of the geographic range of *Eumops floridanus*, including Charlotte County and Collier County, along the Gulf coast, and Dade County, along the Atlantic coast, of Florida.

| | Charlotte County | | Collier County | Dade County | |
|---|---|---|---|---|---|
| Measurements (in mm) | Male[a] | Female[b] | Sex unknown[c] | Male[d] | Female[e] |
| Length of forearm | 65.0 | 66.0 | — | 65.2 | 63.8 |
| Greatest length of skull | 27.0 | 26.4 | 25.5 | 26.9 | 26.5 |
| Condylobasal length | 25.0 | 24.9 | 23.9 | 25.1 | 24.3 |
| Zygomatic breadth | 16.7 | 16.6 | 16.4 | 16.3 | 16.6 |
| Interorbital breadth | 8.8 | 8.4 | 8.6 | 8.5 | 8.5 |
| Postorbital constriction | 5.2 | 5.2 | 5.5 | 5.4 | 5.4 |
| Mastoid breadth | 14.2 | 14.3 | 14.4 | 14.1 | 14.5 |
| Palatal length | 11.1 | 10.7 | 10.5 | 10.7 | 10.5 |
| Length of maxillary toothrow | 10.6 | 10.2 | 9.8 | 10.0 | 10.0 |
| Breadth across upper molars | 11.2 | 10.8 | 10.9 | 10.9 | 10.9 |

[a] Punta Gorda (UF 11436).
[b] Punta Gorda (UF 10923).
[c] Fakahatchee Strand (UF 29945).
[d] Coral Gables (KU 153921).
[e] Coral Gables (KU 150202).

the type than in the Recent specimens. The shape of this cusp also was noted by Allen (1932). The drawing of the right mandible of the late Rancholabrean specimen from Monkey Jungle Hammock also shows the wide paraconid shelf, although perhaps it is not as extreme as that of the holotype (Martin 1977). We fully concur with Ray et al. (1963) in relegating Allen's *Molossides* to a junior generic synonym of *Eumops* Miller. The differences between the late Rancholabrean specimens and Recent specimens of Florida bonneted bats are best regarded as temporal variation, with the Pleistocene and Recent specimens being treated as conspecific.

*Comparisons*.—Members of the *E. glaucinus* complex are medium sized for *Eumops* (forearm length, 58–66 mm), and characterized by a broad and square tragus, last upper molar considerably reduced, and basisphenoid pits relatively deep. This group can be distinguished from the similar-sized *E. auripendulus* by paler color, white basal band on fur, and square and broad tragus. *E. floridanus* is the largest member of the *E. glaucinus* complex. *E. floridanus* can be distinguished from all other populations by its overall large size (Table 2) and mass ranging from 33.8 to 46.5 g. Additionally, basisphenoid pits in *E. floridanus* are proportionally shorter relative to condylobasal length than in *E. glaucinus*, and *E. floridanus* has a proportionally narrower palate than members of other populations of this species complex in South America.

The differences between the Florida bonneted bat and the other populations of *E. glaucinus* have been noted by previous authors. In transferring the Pleistocene fossil *Molossides floridanus* (Allen, 1932) to the genus *Eumops*, Ray et al. (1963:380) compared it to *E. glaucinus* as well as other *Eumops*, stating that ''In spite of its similarity in most details to one or another of the species of *Eumops*, the fossil jaw cannot be assigned with confidence to any one of them.'' They noted that *E. glaucinus* differs in being slightly smaller in size and having a shallower horizontal ramus, more blocky molars, and more anteroposteriorly compressed cheekteeth, although the fossil and modern species resemble each other in approximate size and overall proportions. However, the comparisons of the Florida fossil were made to *E. glaucinus* from Brazil. In his recognition of the Florida populations as subspecifically distinct, Koopman (1971:2, 4) stated ''It is clear that the fossil mandible agrees more with the Recent Florida specimens than with the Recent tropical American material. . . . I tentatively regard *floridanus* as a well-marked subspecies of *Eumops glaucinus*.''

In her phenetic analysis of the species of *Eumops*, Eger (1977) found both significant size and proportional differences in populations of *E. glaucinus*, with no apparent north–south cline. *E. glaucinus* from Florida were always significantly larger than bats from all other populations in forearm length, condyloincisive length, condylobasal length, zygomatic width, and width across the 3rd molars; she concluded that, ''*E. glaucinus floridanus* is always significantly different from all other localities'' (Eger 1977:20). Additional populations she identified as being significantly different from others included bats from Mexico, Honduras, and Costa Rica, and those from Guyana, Colombia, and Venezuela. In some characters, specimens from Cuba clustered closer to populations in Mexico and in some they clustered closer to populations in Colombia and Venezuela. Based on both protein electrophoretic data and mitochondrial cytochrome-*b* gene sequences, Sudman et al. (1994) documented a close relationship between Peruvian *E. glaucinus* and *E. perotis*.

*Bacula*.—The baculum of *E. floridanus* is minute, as is the case for other members of the genus. Total length of the baculum from an adult male is 0.70 mm and width of base is 0.10 mm. The shaft is weakly crescent-shaped in lateral view and the base is of similar width to the shaft (Fig. 3A). For comparisons to other species see above.

*Genetics*.—The karyotype and all others aspects of the genetics of *E. floridanus* are unknown.

*Reproduction*.—*Eumops floridanus* has a fairly extensive breeding season during summer months and examination of the limited available data suggests that it may be polyestrous, with a 2nd birthing season perhaps in January–February. Schwartz (1952) was the 1st to document that bonneted bats in Florida are a breeding population rather than dispersers from Cuba. He reported that young bats were found in January and April. Barbour and Davis (1969) reported that a female aborted a fetus on 5 July, 8 days after it had been captured, and that 2 young, estimated to be about 2 weeks old, were found in June. On 7 September 1979, 5 postlactational females were captured together in a tree cavity and a 6th female (UF 10923) was pregnant with a single fetus that had a crown–rump length of 23 mm (Belwood 1981). An adult female (forearm length, 63 mm; weight, 42 g) found in Coral Gables aborted a fetus (UF 24317) that had a crown–rump length of 38 mm on 4 September 1988 (Robson et al. 1989). A subadult male in dark juvenile pelage that was able to fly short distances was found alive in June 1955 (Jennings 1958). A young female (forearm, 59.8 mm; KU 153919) that was probably volant, but had unfused epiphyses, was obtained in Miami on 19 November 1960, and a young male (forearm, 56.8 mm; FMNH 74271) with unfused epiphyses was found at Miami High School on 11 July 1953. During the 1950s, Miami High School, and perhaps other schools in the area, probably housed a breeding colony of Florida bonneted bats, based upon the number of young individuals that were found there as well as the presence of both adult males and females.

Testes measured 7 × 3.5 mm in an adult male (forearm, 63.4 mm; AMNH 179948) obtained on 18 September 1950, and 9 × 7 mm (forearm, 65 mm; UF 11436) in an adult male obtained on 7 September 1979. A large, well-developed chest gland is evident on an adult male obtained on 1 April 1953 from Miami (UF 12869).

*Ecology*.—Little is known of the ecology of the Florida bonneted bat. There are few specimens in collections, most specimens represent injured or young individuals that were not in normal areas, and living individuals have not been studied systematically. Interestingly, the sex ratio of specimens in collections is heavily biased toward males—37 males, 8 females, and 7 unsexed. Previous reviews of the biology of *E. glaucinus* are based primarily on the populations from Cuba, Mexico, and Central America (Best et al. 1997; Eger 1999; Hall 1981; Harvey et al. 1999; Silva Taboada 1979).

Belwood (1981) reported a roosting colony from the Punta Gorda area in Charlotte County that consisted of 8 individuals (7 females and 1 male), all of which were adults, found roosting together in a pine tree cavity. The cavity was 4.6 m high and had been excavated by a Red-cockaded Woodpecker, *Picoides borealis*, and later enlarged by a Pileated Woodpecker, *Dryocopus pileatus*. Bat guano had accumulated to the depth of roughly 1 m in the cavity, and a sample contained coleopterans (55% by volume), dipterans (15%), and hemipterans (10%). Belwood suggested that the cavity was a permanent roost site and that the colony was likely a harem group. This discovery is especially interesting in that it extended the distribution of bonneted bats some 260 km northwest of the then-known modern distribution in the Miami area of Dade County in extreme southeastern Florida. Belwood (1992) reported that tree cavities are rare in southern Florida. In Coral Gables and Miami, bonneted bats also roost under Spanish-style barrel roof tiles (Barbour and Davis 1969; Belwood 1992; Owre 1978). Additionally, these bats have been found roosting in cavities of royal palm fronds, *Roystonea regia* (Belwood 1992). Jennings (1958:39) mentioned that bonneted bats were known ''from perhaps as many as 20 specimens, all taken in residential Miami, Coconut Grove, and Coral Gables. Most of these were taken from buildings, low shrubbery . . .''

For a number of years, a colony of Florida bonneted bats roosted in a limestone outcropping on the north edge of the University of Miami campus in Coral Gables. The limestone contained a large number of flat, horizontal, eroded fissures in which the bats roosted. Because this outcropping was adjacent to the old biology building at the university, it is likely the source of many of the bats that were preserved as specimens in the 1960s and labeled as coming from ''Coral Gables.''

Barbour and Davis (1969:233) reported ''This bat leaves its roost after dark and flies high where it is seldom seen. It has a very loud piercing call . . . they seldom fly below 30 feet.'' Unlike most free-tailed bats that are able to launch into flight only after dropping from a roost, Florida bonneted bats can take flight from a flat surface (Barbour and Davis 1969). The discovery of an adult (KU 153913) for which the specimen tag says ''found under rocks when bull-dozing ground'' suggests that *E. floridanus* may roost in rocky crevices and outcrops on the ground.

A specimen (UF 29945) from Fakahatchee Strand State Preserve, Collier County, Florida, was found in a regurgitated owl pellet on 17 June 2000 by Mike Owen. This specimen is from approximately 10 km inland, which is somewhat interior to where *Eumops* had been found previously, and represents the only record of natural predation upon this species.

There is no evidence nor reason to suspect that *E. floridanus* is migratory. However, there might have been seasonal shifts in roosting sites because Belwood (1992:217) reported that bonneted bats were found ''during the winter months in people's houses.''

*Fossil record.*—Morgan (1985, 1991, 2002) studied all available Pleistocene fossil specimens of Florida *Eumops* and provided measurements, detailed descriptions, and comparisons to the holotype of Allen's *Molossides floridanus*. *E. floridanus* is now known from a number of specimens from 4 late Pleistocene fossil sites in the southern half of the Florida peninsula. The fossil mandibles he examined from Melbourne, Monkey Jungle, and Vero Beach are within the size range of Recent mandibles from southern Florida, and he considered the late Pleistocene (Rancholabrean) fossils to be conspecific with Recent populations from the Miami area. We studied the holotype of *Molossides floridanus* (MCZ 17672) and concur that there is little variation between the late Pleistocene and Recent species, although shape of the paraconid shelf of m3 is more squared posteriorly in the Pleistocene holotype than it is in modern-day individuals. Southern peninsular Florida was drier and cooler during the late Pleistocene than at present (Morgan 2002). If *E. floridanus* roosts in crevices and rock outcrops in addition to tree holes and buildings, this may explain how many of the Pleistocene and Holocene fossils were preserved.

*Remarks.*—Koopman (1971) compared specimens of *E. glaucinus* from throughout its range with specimens from Coral Gables and Miami and applied the name *E. g. floridanus* to the considerably larger Florida bonneted bats. Koopman was extremely conservative in his taxonomic decisions. We now recognize this taxon as a full species. Webb (1974), without explanation, used the name *E. floridanus* (Allen) for the fossil from Melbourne, but was perhaps unaware of Koopman's work because no reason was provided for this name combination.

The 1st Recent specimen of a bonneted bat in Florida was that reported by Barbour (1936:414); it was a ''stuffed bat spread on a board'' in the laboratory of ''Mrs. Palmer, who teaches biology at Edison High School'' in North Miami. Barbour (1936) stated that the specimen was returned to Mrs. Palmer after G. M. Allen confirmed the identification as *E. glaucinus*. A specimen currently deposited at the Carnegie Museum of Natural History (CM 106404) is almost certainly the specimen reported by Barbour (1936), although no locality or date are associated with it. The word ''Palmer'' is clearly written in pencil on the data tag, the specimen is prepared as a dried carcass with outspread wings, and the pin holes where the wings were attached to a backing board are visible. This is the only specimen that we have located that is preserved with outspread wings. The specimen is the only one known that was not originally prepared by a skilled preparator and is simply a dried carcass with outstretched wings. The skull was secondarily removed and prepared. Koopman (1971) stated that the specimen was from Miami. Although the communities of Coconut Grove and Fort Lauderdale are mentioned in the older literature as localities where bonneted bats occurred, no specimens from either are in collections.

Two young animals both have prominent white abdominal bands. A female (unfused epiphyses; forearm, 57.9 mm; KU 153919) found alive on 15 November 1950 has a 7- to 10-mm-wide white band across the abdomen, and a younger individual (KU 152227) with unfused epiphyses, as well as unfused forearm bones, has a white band about 5 mm wide across the chest.

At least partially on the basis of the presence of this species, Genoways et al. (1998) suggested that southern Florida and the Florida Keys may be best placed biogeographically in the West Indian Faunal subregion. Additional discussions on the biogeography of Florida bonneted bats were provided by

Layne (1974), Rosen (1975), Baker and Genoways (1978), and Koopman (1989), who assumed that that Florida population of *Eumops* was conspecific with *E. glaucinus* of the Greater Antilles and Central and South America, following Koopman (1971). However, until the relationships of the *E. glaucinus* group are better understood, the biogeographic affinities of *E. floridanus* are an open question because the species clearly was distributed more widely in the Pleistocene than it is today.

*Current status*.—Barbour (1945), Schwartz (1952), Jennings (1958), and Layne (1974) all noted the scarcity of bats in southern Florida, so it is probable that *E. floridanus* has been uncommon for several decades. Surveys in 1989 by the Florida Game and Fresh Water Fish Commission in southern Florida for this species with bat detectors failed to locate any individuals. M. S. Robson (1989, in litt.) concluded that ''Loss of native forested habitat, reduced insect abundance, and the active persecution of bats by humans likely are the major impacts on the population of mastiff bats.'' However, Belwood (1992:217) reported that this species was once believed common on Florida's eastern coast, in Miami, and in Coral Gables because individuals were found in houses during the winter months, but stated, ''Bats in southern Florida, including *E. g. floridanus*, appear to have declined drastically in numbers in recent years,'' citing the loss of roosting sites and effects of pesticides as the cause for the decline. Belwood (1992) noted that tree cavities were rare in southern Florida, that competition for them was steep, and that nonurban areas such as the Fakahatchee–Big Cypress region were places where *Eumops* probably could be found in the future. Coupled with habitat loss from development and increased use of pesticides, we believe that Hurricane Andrew, an intense Category 5 hurricane that struck southeastern Florida in 1992, may have had a significant impact upon the already low population of bonneted bats.

On 24 August 1992, Hurricane Andrew made landfall in southeastern Florida in southern Dade County. The storm had sustained surface wind speeds of more than 145 mph (125 knots) with gusts exceeding 175 mph (150 knots). The sustained hurricane-force winds destroyed the vast majority of older trees in southeastern Florida for a distance of several kilometers from the coast. It is likely that most older, hollow trees that were potentially available as roost trees for *E. floridanus* were destroyed during this storm. Eger (1999:132) stated that ''old, mature trees are essential roosting sites for this species'' in forested areas.

In the greater Miami area, only 3 records exist of the Florida bonneted bat after 1965. The most recent of these are from the 1990s; 1 is a single recent specimen from Coral Gables and 1 is an acoustic recording. Additionally, an extant, albeit probably small, population occurs along Florida's southwestern coast in Lee County near Fort Myers and adjacent Collier County in the Fakahatchee–Big Cypress area. This is one of the few areas in southern Florida that has not been sprayed with pesticides and because of this, it is one of the preferred areas for entomologists to obtain native Florida insects (L. Wilkins, pers. comm.).

In Lee County, a small colony of *E. floridanus* was observed occupying a man-made bat house in North Fort Myers in February 2003 (Florida Bat Center, http://www.floridabats.org/Trokey.htm, accessed 13 July 2004). The house has been inhabited for the past 1.5 years by as many as 8 individuals, including 3 young that were observed in 2003 (S. Christiansen-Trokey, in litt.). In Collier County, the remains of an adult *E. floridanus* (UF 29945) were found in a regurgitated owl pellet in June 2000.

Extensive recent acoustical surveys in southern Florida (2000–2002) that used the Anabat bat-detecting system (Titley Electronics, Ballina, New South Wales, Australia) to detect and identify ultrasonic signals from free-flying bats detected *Eumops* only in Collier and Dade counties (G. Marks, pers. comm.). On 25 May 2000, acoustic surveys were made on and around Dismal Key, a small island just south of Goodland, Collier County. No bat calls were detected until 2225 h, when the 1st *Eumops* call was recorded. A total of 4 *Eumops* calls were recorded from 2025 to 2238 h, likely of the same bat. These recordings were confirmed to be *Eumops* by C. Corben and M. O'Farrell (pers. comm.). On 10 August 2000, Dismal Key and the surrounding area were surveyed, with numerous bat calls of various species of vespertilionids recorded, but calls of *Eumops* were not detected. Bonneted bats were identified in acoustic surveys conducted on Janes Scenic Drive in Fakahatchee Strand State Preserve, Collier County, on 1 October 2000, in the area where a *Eumops* skull was found in an owl pellet on 17 June 2000. Calls of *Eumops* were recorded at 1958 and 2018 h, and a number of vespertilionid calls were detected at the site. Audible calls of *Eumops* were heard at a 2nd site along a canal. An acoustical survey in Coral Gables on 30 September 2000 obtained calls of *Eumops* at 2002, 2005, and 2019 h. Despite extensive searches, no bonneted bats were located in Charlotte County, in the area where a colony was discovered in a woodpecker cavity in 1979 (G. Marks, pers. comm.).

The Florida bonneted bat, under the name *E. g. floridanus*, had been classified as an Endangered Species by the Florida Game and Fresh Water Fish Commission (Logan 1997), but was removed from candidate status as a federally protected Endangered Species by the U.S. Fish and Wildlife Service (U.S. Department of the Interior 1996:7460). Bonneted bats do not appear as a species needing protection in the recent U.S. Fish and Wildlife Service's South Florida Multi-species Recovery Plan. The 1996 reclassification of the Florida bonneted bat by the U.S. Fish and Wildlife Service was unfortunate, but in part based on information available at the time, including the belief that the species was found in Florida, throughout much of Central and South America, and in the Greater Antilles.

Nevertheless, the Florida bonneted bat is one of the most critically endangered mammal species in North America. With the conclusion herein that *E. floridanus* merits recognition as a full species, that it has a very restricted distribution, and that its numbers have decreased in the past several decades, all remaining populations should receive full protection as both a federally and state-designated endangered species. *E. floridanus* has one of the most restricted distributions of any bat in the New World and the remaining populations seem to have been negatively impacted by loss of appropriate roosting sites as well as by the use of pesticides. Florida bonneted bats

are extant in 3 Florida counties, but almost certainly in limited numbers.

*Eumops glaucinus* (Wagner, 1843)
Wagner's Bonneted Bat

*Dysopes glaucinus* Wagner, 1843, Archiv für Naturgeschichte 9(1):368.
*Molossus ferox* Gundlach, 1861, Monatsberichte der Königlichen Preussische Akademie des Wissenschaften zu Berlin 1861:149.
*Molossus glaucinus* Dobson, 1876, Proceedings of the Zoological Society of London 1876:714.
*Nyctinomus orthotis* H. Allen, 1889, Proceedings of the American Philosophical Society 26:561.
*Promops glaucinus* Miller, 1900, Annals and Magazine of Natural History, Series 7, 6:471.
*Eumops glaucinus* Miller, 1906, Proceedings of the Biological Society of Washington 19:85.

*Holotype*.—"NMW (not numbered): juvenile of undetermined sex, probably male; skin, skull not removed" (Carter and Dolan 1978:90). Collected by Johann C. Natterer, in Naturhistorisches Museum Wien, Vienna, Austria.

*Type locality*.—Brazil: Mato Grosso; Cuiabá [Cuyabá]. Sanborn (1932:353) suggested that there was "some doubt as to the correctness of the recorded locality," although Carter and Dolan (1978) believed that it is correct.

*Distribution*.—This medium-sized bonneted bat is known from western and central Mexico southward through Central America to approximately the northern two-thirds of South America, including Peru, Bolivia, Paraguay, and southeastern Brazil, and from Jamaica and Cuba in the Greater Antilles.

*Description and comparisons*.—Data presented herein and our review of the published literature document 3 distinct populations in the remaining members of the *E. glaucinus* complex—Jamaica and Cuba, Mexico and Central America, and mainland South America. Until additional specimens and genetic information are available to clarify species limits, distributions, and relationships in these bonneted bats, we believe that it is best to recognize all populations as belonging to the species *E. glaucinus* without recognition of subspecies.

Secondary sexual dimorphism has been reported previously in *E. glaucinus* (sensu lato), with males being larger than females, as well as in some cases females being larger than males. Eger (1977) reported that males are significantly larger than females in her treatment of the species *E. glaucinus*, which included the Florida population. In Yucatán, males were reported to be significantly larger than females in mass, averaging 35.9 and 34.4 g, respectively (Bowles et al. 1990); however, in Cuba, males were reported to average 36.6 g and females 37.3 g (Silva Taboada 1979).

Because the holotype of *E. glaucinus* is a juvenile animal with the skull remaining in a poorly made skin, we herein describe and illustrate an adult female (Fig. 2; USNM 391180) from Sylvestre, Minas Gerais, Brazil, which is from the same general area of Brazil as the type locality in Mato Grosso. Measurements of this female are length of forearm, 60.2 mm; greatest length of skull, 24.5 mm; condylobasal length, 22.5 mm; zygomatic breadth, 14.7 mm; interorbital constriction, 7.8 mm; postorbital constriction, 5.0 mm; mastoid breadth, 13.4 mm; palatal length, 9.1 mm; breadth across upper molars, 10.3 mm; and length of maxillary toothrow, 10.3 mm. Basisphenoid pits of this specimen are 1.45 in length.

*Remarks*.—*Eumops glaucinus* seems to have a patchy distribution, especially in Central America. LaVal and Rodríguez (2002:280) considered it "apparently rare in Costa Rica—but 24 were captured at a site in the Central Valley. Elsewhere seem to occur only in lowland situations . . . Costa Rican females were recorded as being pregnant in December and May, and lactating in April, May, and August. These data suggest an extended, perhaps year-round, breeding season." The highest elevational record we have identified for the species was for 4 specimens collected at 880 m taken at Cariblanca, Costa Rica (TCWC 10464, 10465). Reviews of the biology and distribution of *E. glaucinus* may be found in Villa-R. (1967), Silva Taboada (1979), and Best et al. (1997).

In Cuba, *E. glaucinus* has been found roosting in buildings, in tree hollows, and in woodpecker holes in trees (Silva Taboada 1979). George E. Watson collected 3 *E. glaucinus* at Finca Dayaniguas, Río los Palacios, Pinar del Río Province, Cuba, from a palm stub, 3 m high and 25–30 cm in diameter. The bats were in an abandoned woodpecker hole; the tree stub stood in a mixed palm–pine savanna that was low and seasonally flooded where cattle grazed. Collector's data on a series (USNM) of *Eumops* from El Yarey, Guantánamo, Provincia de Guantánamo, Cuba, taken by C. T. Ramsden, are labeled as having been secured from a hole in a dagame tree (*Calycophyllum candidissimum*; Rubaceae), 5 m above the ground.

## Resumen

Una revisión y reevaluación de los murciélagos del género *Eumops* (Chiroptera: Molossidae) revela que hay variación geográfica considerable en *E. glaucinus*; es un complejo que consiste en >1 especie. *E.* "*glaucinus*" en Florida es significativamente más grande que las demás poblaciones y tiene fosas basiesfenoides más cortas y más profundas. Además hay diferencias en la forma del báculo y la fosa mandibular, y tiene un paladar más ancho que las poblaciones de Sudamérica. Dado estas diferencias, el nombre correcto para *E.* "*glaucinus*" en Florida, del Pleistoceno y del Reciente, es *Eumops floridanus* (Allen, 1932). No encontramos variación geográfica en las poblaciones recientes de *Eumops* de Florida y hay poca variación sexual secundaria. Describimos y revisamos la distribución, morfometría, sistemática, ecología e historia taxonómica de la especie, la cual se restringe a la parte austral de Florida. *E. floridanus* tiene una de las distribuciones más restringidas de los murciélagos del Nuevo Mundo y es una de las especies de mamíferos más amenazadas en Norteamérica.

## Acknowledgments

We are especially grateful to T. J. Doonan and J. A. Gore (Florida Fish and Wildlife Conservation Commission) and L. Wilkins (University of Florida) for providing us information on the current and historical status of bonneted bats in Florida. G. Marks (Florida Bat

Center) generously provided the data from their recent Anabat acoustical surveys for *Eumops* in Florida. For loans of comparative material and permission to work with specimens under their care, we thank the following curators and collection managers: T. Daeschler (Academy of Natural Sciences of Philadelphia); N. Simmons (American Museum of Natural History); S. McLaren (Carnegie Museum of Natural History); W. Stanley (Field Museum); G. Proctor (Institute of Jamaica); M. S. Hafner and J. Light (Museum of Natural Science, Louisiana State University); C. R. Schaff (Museum of Comparative Zoology, Harvard University); D. A. Schlitter (Texas Cooperative Wildlife Collection, Texas A&M University); R. J. Baker (Texas Tech University); L. Gordon and H. Kafka (U.S. National Museum of Natural History); C. McCaffery and L. Wilkins (University of Florida); P. Myers (University of Michigan Museum of Zoology). B. L. Clauson, T. J. Doonan, and G. S. Morgan provided valuable suggestions on the manuscript. A. Fox, staff artist for the University of Nebraska State Museum, prepared final versions of the figures.

## Literature Cited

Allen, G. M. 1932. A Pleistocene bat from Florida. Journal of Mammalogy 13:256–259.

Baker, R. J., and H. H. Genoways. 1978. Zoogeography of Antillean bats. Pp. 53–97 in Zoogeography in the Caribbean (F. B. Gill, ed.). Special Publication 13, Academy of Natural Sciences of Philadelphia, Philadelphia.

Barbour, R. W., and W. H. Davis. 1969. Bats of America. The University Press of Kentucky, Lexington.

Barbour, T. 1936. *Eumops* in Florida. Journal of Mammalogy 17:414.

Barbour, T. 1945. A naturalist in Cuba. Little, Brown and Company, Boston, Massachusetts.

Belwood, J. J. 1981. Wagner's mastiff bat, *Eumops glaucinus floridanus*, (Molossidae) in southwestern Florida. Journal of Mammalogy 62:411–413.

Belwood, J. J. 1992. Florida mastiff bat, *Eumops glaucinus floridanus*. Pp. 216–223 in Rare and endangered biota of Florida. Volume I. Mammals (S. R. Humphrey, ed.). University Press of Florida, Gainesville.

Best, T. L., W. M. Kiser, and J. C. Rainey. 1997. *Eumops glaucinus*. Mammalian Species 551:1–6.

Birney, E. C., J. B. Bowles, R. M. Timm, and S. L. Williams. 1974. Mammalian distributional records in Yucatán and Quintana Roo, with comments on reproduction, structure, and status of peninsular populations. Occasional Papers, Bell Museum of Natural History, University of Minnesota 13:1–25.

Bowles, J. B., P. D. Heideman, and K. R. Erickson. 1990. Observations on six species of free-tailed bats (Molossidae) from Yucatan, Mexico. Southwestern Naturalist 35:151–157.

Brown, R. E. 1967. Bacula of some New World molossid bats. Mammalia 31:645–667.

Carter, D. C., and P. G. Dolan. 1978. Catalogue of type specimens of neotropical bats in selected European museums. Special Publication 15, The Museum, Texas Tech University, Lubbock.

Eger, J. L. 1977. Systematics of the genus *Eumops* (Chiroptera: Molossidae). Life Sciences Contributions, Royal Ontario Museum 110:1–69.

Eger, J. L. 1999. Wagner's mastiff bat, *Eumops glaucinus*. Pp. 132–133 in The Smithsonian book on North American mammals (D. E. Wilson and S. Ruff, eds.). Smithsonian Institution Press, Washington, D.C.

Freeman, P. W. 1981. A multivariate study of the family Molossidae (Mammalia, Chiroptera): morphology, ecology, evolution. Fieldiana: Zoology (New Series) 7:vii + 1–173.

Genoways, H. H., R. J. Baker, C. J. Phillips, and J. W. Bickham. In press. Bats of Jamaica. Occasional Papers, Museum of Texas Tech University.

Genoways, H. H., C. J. Phillips, and R. J. Baker. 1998. Bats of the Antillean island of Grenada: a new zoogeographic perspective. Occasional Papers, The Museum, Texas Tech University 177:1–28.

Hall, E. R. 1981. The mammals of North America. 2nd ed. John Wiley & Sons, New York. 1:1–600 + *90*.

Hall, E. R., and K. R. Kelson. 1959. The mammals of North America. Volume 1. Ronald Press, New York.

Hamilton, W. J., Jr. 1943. The mammals of the eastern United States. Comstock Publishing Company, Inc., Ithaca, New York.

Hamilton, W. J., Jr., and J. O. Whitaker, Jr. 1979. Mammals of the eastern United States. 2nd ed. Cornell University Press, Ithaca, New York.

Harvey, M. J., J. S. Altenbach, and T. L. Best. 1999. Bats of the United States. Arkansas Game & Fish Commission and U.S. Fish & Wildlife Service, Asheville, North Carolina.

Jennings, W. L. 1958. The ecological distribution of bats in Florida. Ph.D. dissertation, University of Florida, Gainesville.

Koopman, K. F. 1971. The systematic and historical status of the Florida *Eumops* (Chiroptera, Molossidae). American Museum Novitates 2478:1–6.

Koopman, K. F. 1978. Zoogeography of Peruvian bats with special emphasis on the role of the Andes. American Museum Novitates 2651:1–33.

Koopman, K. F. 1989. A review and analysis of the bats of the West Indies. Pp. 635–643 in Biogeography of the West Indies: past, present, and future (C. A. Woods, ed.). Sandhill Crane Press, Gainesville, Florida.

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.

Koopman, K. F. 1994. Chiroptera: systematics. Handbook of Zoology, Volume 8. Mammalia. Walter de Gruyter, New York.

LaVal, R. K., and B. Rodríguez-H. 2002. Murciélagos de Costa Rica: bats. Instituto Nacional de Biodiversidad (INBio), Santo Domingo de Heredia, Costa Rica.

Layne, J. N. 1974. The land mammals of South Florida. Pp. 386–413 in Environments of South Florida: present and past (P. J. Gleason, ed.). Memoir Miami Geological Society 2:1–452.

Logan, T. H. 1997. Florida's endangered species, threatened species and species of special concern. Florida Game and Fresh Water Fish and Commission, Tallahassee.

Martin, R. A. 1977. Late Pleistocene *Eumops* from Florida. Bulletin of the New Jersey Academy of Science 22:18–19.

Morgan, G. S. 1985. Fossil bats (Mammalia: Chiroptera) from the Late Pleistocene and Holocene Vero Fauna, Indian River County, Florida. Brimleyana 11:97–117.

Morgan, G. S. 1991. Neotropical Chiroptera from the Pliocene and Pleistocene of Florida. Pp. 176–213 in Contributions to mammalogy in honor of Karl F. Koopman (T. A. Griffiths and D. Klingener, eds.). Bulletin of the American Museum of Natural History 206:1–432.

Morgan, G. S. 2002. Late Rancholabrean mammals from southernmost Florida, and the neotropical influence in Florida Pleistocene faunas. Smithsonian Contributions to Paleobiology 93:15–38.

Owre, O. T. 1978. The Florida mastiff bat, *Eumops glaucinus floridanus*. Pp. 43–44 in Rare and endangered biota of Florida. Volume 1. Mammals (J. N. Layne, ed.). University Presses of Florida, Gainesville.

RAY, C. E. 1958. Additions to the Pleistocene mammalian fauna from Melbourne, Florida. Bulletin of the Museum of Comparative Zoology 119:421–449.

RAY, C. E., S. J. OLSEN, AND H. J. GUT. 1963. Three mammals new to the Pleistocene fauna of Florida, and a reconsideration of five earlier records. Journal of Mammalogy 44:373–395.

RIDGWAY, R. 1912. Color standards and color nomenclature. Privately published, Washington, D.C.

ROBSON, M. S., F. J. MAZZOTTI, AND T. PARROTT. 1989. Recent evidence of the mastiff bat in southern Florida. Florida Field Naturalist 17:81–82.

ROSEN, D. E. 1975. A vicariance model of Caribbean biogeography. Systematic Zoology 24:431–464.

RYAN, J. M. 1991. Comparative morphology of the glans penis in *Molossus*, *Promops*, and *Eumops* (Chiroptera: Molossidae). Pp. 122–137 in Contributions to mammalogy in honor of Karl F. Koopman (T. A. Griffiths and D. Klingener, eds.). Bulletin of the American Museum of Natural History 206:1–432.

SAGER, S. 1992. StatView. Abacus Concepts, Inc., Berkeley, California.

SANBORN, C. C. 1932. The bats of the genus *Eumops*. Journal of Mammalogy 13:347–357.

SCHWARTZ, A. 1952. The land mammals of southern Florida and the upper Florida keys. Ph.D. dissertation, University of Michigan, Ann Arbor.

SHERMAN, H. B. 1939. List of the Recent land mammals of Florida. Proceedings of the Florida Academy of Sciences for 1936 1:102–128.

SILVA TABOADA, G. 1979. Los murciélagos de Cuba. Academia de Ciencias de Cuba, Habana, Cuba.

SUDMAN, P. D., L. J. BARKLEY, AND M. S. HAFNER. 1994. Familial affinity of *Tomopeas ravus* (Chiroptera) based on protein electrophoretic and cytochrome *b* sequence data. Journal of Mammalogy 75:365–377.

TIMM, R. M., AND H. H. GENOWAYS. 2003. West Indian mammals from the Albert Schwartz Collection: biological and historical information. Scientific Papers, Natural History Museum, University of Kansas 29:1–47.

U.S. DEPARTMENT OF THE INTERIOR. 1996. Endangered and threatened species; notice of reclassification of 96 candidate taxa, proposed rules. 50 CFR Part 17. Federal Register 61:7457–7463.

VILLA-R., B. 1966 [1967]. Los murciélagos de México. Instituto de Biología, Universidad Nacional Autónoma de México, México City, México.

WARNER, J. W., J. L. PATTON, A. L. GARDNER, AND R. J. BAKER. 1974. Karyotypic analyses of twenty-one species of molossid bats (Molossidae: Chiroptera). Canadian Journal of Genetics and Cytology 16:165–176.

WEBB, S. D. 1974. Chronology of Florida Pleistocene mammals. Pp. 5–31 in Pleistocene mammals of Florida (S. D. Webb, ed.). The University Presses of Florida, Gainesville.

*Submitted 19 August 2003. Accepted 1 December 2003.*

*Associate Editor was Robert D. Bradley.*

## APPENDIX I

Specimens listed as ''Specimens examined'' include the locality as it appears on the specimen tag, sex, number of specimens from the locality, museum acronym, and catalog number. When information is added, it appears in brackets. Specimens listed as ''Additional records'' are localities of record from the literature or museum specimens, which we have not examined; the citation or museum acronym and catalog number are provided. Specimens listed as examined are in the collections of the Academy of Natural Sciences of Philadelphia (ANSP); American Museum of Natural History, New York (AMNH); Bell Museum of Natural History, University of Minnesota, St. Paul (MMNH); Carnegie Museum of Natural History, Pittsburgh (CM); Field Museum, Chicago (FMNH); Florida Museum of Natural History, University of Florida, Gainesville (UF); Institute of Jamaica, Kingston (IJ); Museum of Comparative Zoology, Harvard University, Cambridge (MCZ); Museum of Natural Science, Louisiana State University, Baton Rouge (LSUMZ); Museum of Texas Tech University, Lubbock (TTU); National Museum of Natural History, Washington, D.C. (USNM); Natural History Museum (London) (BMNH); Texas Cooperative Wildlife Collection, Texas A&M University, College Station (TCWC); and University of Kansas Natural History Museum, Lawrence (KU). Abbreviation: mi = mile(s).

### *Eumops floridanus*

*Specimens examined* (47).—UNITED STATES: Florida: Brevard County; Melbourne, stratum 2, Melbourne Bed [28°04′N, 80°41′W] (1, MCZ 17672—holotype); Charlotte County; Punta Gorda [26°55′N, 82°02′W] (1♂, 2♀♀, UF 10923, 11436, 11437); Collier County; Fakahatchee Strand State Preserve (1 sex?, UF 29945); Dade County; Coral Gables [25°45′N, 80°16′W] (14♂♂, 2♀, 2 sex?, AMNH 212252–212254, 216584, 216585; KU 150202, 150204, 150205, 152227, 153912–153918, 153920–153922, 161933); Miami (4♂♂, 2♀♀, AMNH 179949, 179951; FMNH 66225; KU 150203, 152155, 153919); Miami, Miami High School (4♂♂, FMNH 74270–74273); Miami, Miami Senior High School (4♂♂, 1♀, UF 12701, 12704, 12869, 30370, 30371); Miami, North Miami High School (2♂♂, 1♀, AMNH 179950; UF 12820, 23853); Miami, 27th & Flagler (1♂, AMNH 179948); vicinity of Miami (3♂♂, KU 157447–157449); no locality (1♂, UF 30369); ''Palmer'' (1 sex?, CM 106404; see ''Remarks''). Also see Timm and Genoways (2003).

*Additional records*.—United States: Florida: Broward County; Fort Lauderdale (Barbour and Davis 1969; Belwood 1992); Dade County; Coconut Grove (Barbour 1945; Jennings 1958; Layne 1974); Coral Gables (1♂, UF 24317); Miami, North Miami High School (2 sex?, UF 5182, 5183); Monkey Jungle Hammock, 5 km W of Goulds [25°34′N, 80°26′W] (late Rancholabrean—Martin 1977; Morgan 1991); Monkey Jungle 2, 5 km W of Goulds [25°34′N, 80°26′W] (Holocene—Morgan 1991, 2002); North Miami (Barbour 1936, 1945); Indian River County; Vero Beach [27°39′N, 80°24′W] (Holocene—Morgan 1985, 1991); Lee County; North Fort Myers (Florida Bat Center, http://www.floridabats.org/Trokey.htm, accessed 13 July 2004).

### *Eumops glaucinus*

*Specimens examined* (137).—BOLIVIA: Beni: Magdalena, Iténez (2♀♀, USNM 390643, 390644). BRAZIL: Amazonas: Rio Purús, Itabóca [4°54′S, 62°42′W] (1♀, FMNH 140795); Minas Gerais: Sylvestre, near Viçosa (1♀, USNM 391180—''taken from crevice in rafter of old church''). COLOMBIA: Bolívar: Bahia de Cartagena, Bocachica, Fuerte de San Fernando (1♂, 1♀, FMNH 122073, 122074). COSTA RICA: Alajuela: Cariblanca, 18 mi [29 km] NE Naranjo, 2900 ft (= 880 m) (1♂, 3♀♀, TCWC 10464–10467); San José: Moravia; La Guardia, near San José (1♂, KU 135081—''roosting in house''). CUBA: Provincia de Guantánamo: Guantánamo (2♀♀, USNM 300565, 300566); Guantánamo Bay Naval Station (8♂♂, 20♀♀, TTU 52612,

52613, 52616–52625, 52627–52630, 52632, 52634, 52636–52645); El Yarey (6♂♂, 7♀♀, USNM 300551–300564—"hole in dagame tree, 15 ft [4.6 m] from ground"). HONDURAS: Francisco Morazán: 10 mi [14.8 km] N Tegucigalpa (1♀, TTU 13470). JAMAICA: St. Andrew Parish; Half Way Tree (1♀, 2 sex?, USNM 114035–114037); 12 Stoney Hill Road, Kingston (2 sex?, uncataloged, IJ); St. Anne Parish; Queenhythe (5♂♂, 7♀♀, CM 44612–44616; 2♂♂, 4♀♀, TTU 22083–22088); St. Catherine Parish; Spanish Town (1♂, 1♀, 1 sex?, BMNH 47.12.27.12; USNM 9397, 9398); Westmoreland Parish; Savanna-La-Mar (1♀, BMNH 47.12.27.18); Parish unknown; no specific locality (3♂♂, 3♀♀, 2 sex?, ANSP 5547, 5548; BMNH 7.1.1.586, 45.10.25.47, 49.5.30.1; MCZ 45780; USNM 122656, 122657). MEXICO: Chiapas: Palenque (1♂, FMNH 64190); Colima: Las Juntas, 5 km SE Pueblo Juárez (1♂, 1♀, TTU 6129, 6130); Sinaloa: 2 km S El Dorado (1♂, USNM 559803); Veracruz: Jesús Carranza (3♀♀, KU 19232–19234); 23 km by road W Puente Nacional (1♂, 2♀♀, TTU 13473–13475); Yucatán: Hacienda San Antonio Teztiz, 4.7 mi [7 km] S, 4 mi [5.9 km] W Kinchil (1♂, 1♀, MNNH 12084; TTU 25915); 6 km S, 5 km W Kinchil (1♀, MNNH 12820); Mérida (3♂♂, 4♀♀, TTU 25918–25924); Mérida, Colonia Buenavista, Country Club Campestre (1♂, 6♀♀, MNNH 12821–12826—Birney et al. 1974; TTU 47522). PANAMA: Chiriquí: 1 mi [1.5 km] SW Progreso (1♀, USNM 363142). VENEZUELA: Amazonas: San Juan, 163 km ESE Pto. Ayacucho, Río Manapiare, 155 m [5°21′N, 66°11′W] (5♂♂, 10♀♀, USNM 409584, 409585, 409587, 409591, 409593–409595, 409603, 409605–409607, 409609, 409627, 409628—"hand caught in hollow tree"); Bolívar: 2 km NE of Maripa (1♂, KU 119176); Guárico: 45 km S Calabozo (2♂♂, TTU 33407, 33408); Sucre: Cumaná (1♂, KU 119175).

For additional records see Villa-R. (1967), Eger (1977), and Silva Taboada (1979).