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## The Bats of Liberia: Systematics, Ecology, and Distribution

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### ABSTRACT

Lists of bat species were (with critical taxonomic study when necessary) compiled for six countries of West Africa from Ghana to Guinea-Bissau (79 from Ghana, 62 from Ivory Coast, 57 from Liberia, 57 from Sierra Leone, 37 from Guinea, 24 from Guinea-Bissau) with a total (for all six countries) of 94 species. All but two species extend east of this region, 40 extend west of it, and two (*Rhinolophus guineensis*, *Hipposideros marisae*) appear to be confined to it. On the basis of overall distribution, 42 species are classified as basically for-

est, 18 as savanna, 29 ecologically widespread, and 5 (*Rhinolophus simulator*, *R. clivosus*, *R. maclaudi*, *Hipposideros marisae*, *Myotis tricolor*) as upland, at least in West Africa. A more detailed analysis is attempted for those species occurring in Liberia. This has revealed a number of uncertainties and alternative interpretations. Some of these are probably related to the progressive deforestation that has accompanied human impact in Liberia as elsewhere.

### INTRODUCTION

The senior author (Koopman, 1989) previously published on the taxonomy and distribution of the bats of Liberia then available. This was based on the literature at hand and on several collections of Liberian bats at the American Museum of Natural History. Since

then, two important collections have been made which contain additional records and shed additional light on taxonomical and distributional problems. Also, several new sources of records have appeared. These include the second, third, and fourth install-

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ments of Bergmans' (1989, 1990, 1994) treatment of the taxonomy and biogeography of African fruit bats beyond the first section (Bergmans, 1988) with species accounts of the following western African genera: *Epomophorus*, *Micropteropus*, *Epomops*, *Hypsignathus*, *Nanonycteris*, *Scotonycteris*, *Eidolon*, and *Rousettus*. Van Cakenberghe and De Vree have completed their treatment of African *Nycteris* (1993, in press). Happold (1987) has published a distributional table, by country, of all western African species of mammals known from Nigeria. This table includes most (but not all) of the bats recorded from far western Africa. A more comprehensive paper giving additional records and discussing taxonomic and distributional conclusions therefore seems in order. The geographical framework is the same as that in the earlier paper, namely Africa west of 0° and south of 12°. This includes nearly all the High Forest and Invasive Guinea Woodland (originally also High Forest, but now degraded or deforested) in far western Africa. A comparison is made of the bats of Liberia with those of the five additional countries of the region mapped by Rosevear (1965) as having High Forest, Invasive Guinea Woodland, or true Guinea Woodland (Ghana, Ivory Coast [= Côte d'Ivoire], Sierra Leone, Guinea, Guinea-Bissau). (Country names are taken from the latest Times Atlas.) Two species of bats, occurring west of 0° and south of 12°, do not occur in any of the above six countries. They were recorded from Burkina Faso (= Upper Volta) by Koopman et al. (1978). Neither of these two species (*Pipistrellus deserti*, *Mops midas*), is known from anywhere near Liberia and both appear to be confined to Sudan savanna and vegetation zones even more arid. They are therefore not considered further.

One of the two new collections was made by the American Museum of Natural History expedition to Liberia in March of 1990, headed by R. W. Dickerman and including C. G. Schmitt. The bats were all obtained from the Wonegizi Mountains near Ziggida (Lofa Co.) in northwestern Liberia, for the most part in apparently undisturbed High Forest. The junior authors participated in the Dickerman expedition, and had made earlier collections from November 1988 to July 1989 at several

localities in Liberia: Lofa Co. (Zorzor), Grand Cape Mount Co. (Robertsport), Bong Co. (Hendi, Kpatawee Falls, Cuttington University College), Nimba Co. (Yekepa), and Sino Co. (Juazohn = Juarzon). Other American Museum material, previously reported (Koopman, 1989), is from the following localities: Lofa Co. (Voinjama, Ngilima, Bomi Wood Camp), Montserrado Co. (Monrovia, Harbel), Bong Co. (Sanoyie = Sanoyea), Nimba Co. (Gahnpa, Sanokole = Saniquellie), Grand Jide Co. (Zwedru, Jaoudi), and Sino Co. (Greenville). Localities referred to as "upland" are all in either Lofa or Nimba counties.

The Dickerman expedition also collected a limited number of other mammals, mostly represented by skulls only. These include *Colobus polykomos*, *Cephalophus maxwelli*, *C. dorsalis*, and *C. niger*. A skin and skull of *Colomys* was also obtained, which Dr. Guy Musser assures us probably represents a new species and is certainly a major range extension for the genus west from Cameroon.

We are indebted to Dr. Robert Dickerman for presenting the fine Wonegizi collection to the American Museum of Natural History (except for a few specimens of common species that went to the Museum of Southwestern Biology in Albuquerque, New Mexico). The senior author also thanks his colleagues in the Department of Mammalogy (Dr. Guy Musser, Dr. Audrone Biknevičius, Mr. Helmut Sommer) for identifications of the non-bat specimens from this collection. Dr. Michael Carleton of the National Museum of Natural History, Washington, D.C., kindly made available computer printouts of bats from Liberia and nearby countries in the National Museum of Natural History collection (USNM); he is also thanked for numerous courtesies during visits there. The senior author, who is responsible for all identifications, is indebted to the entire staff at the British Museum (Natural History) (BM) for innumerable courtesies on his visits there. Dr. Lawrence Heaney of the Field Museum of Natural History (FMNH) lent specimens of *Hipposideros fuliginosus* from Ghana. Dr. Wim Bergmans of the University of Amsterdam, Netherlands, very kindly sent a copy of a rare paper, and Dr. Victor Van Cakenberghe of the University of Antwerp sent an

advance copy of his paper in press. The junior authors were in Liberia under sponsorship of the Fulbright program.

We also thank Dr. Dieter Kock (Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt) and Dr. Duane Schlitter (Carnegie Museum of Natural History, Pittsburgh) for thoughtful reading of the manuscript. However, Dr. Schlitter has recommended use of standard statistics (mean, standard deviation) and this calls for some comment. These statistics are designed to demonstrate the existence of a difference between two populations, something that is rarely at issue here. What we are interested in is demonstrating a gap between the variations of two populations, thereby suggesting a specific difference. While it may be argued that the probability of a gap can be inferred from means and standard deviations, this involves certain assumptions of normality that in many cases are not warranted. To us the use of ranges accords better with the present state of our knowledge, though admittedly ranges are more reliable when many, rather than fewer, specimens are present. This is the rationale for using ranges here.

## ADDITIONAL RECORDS

### FAMILY PTEROPODIDAE

*Eidolon helvum*: Bergmans (1990) recorded this species from all six of the countries with High Forest or Invasive Guinea Woodland.

*Rousettus egyptiacus* (= *aegyptiacus*): The Dickerman expedition obtained 49 specimens from the Wonegizi Mountains. Bergmans (1994) recorded this species from Ghana, Ivory Coast, Liberia, Sierra Leone, and Guinea, but there are no records from Guinea-Bissau.

*Rousettus angolensis*: The Dickerman expedition obtained 24 specimens from the Wonegizi Mountains. Happold (1987) recorded the species from Ghana, Ivory Coast, Liberia, Guinea, and Guinea-Bissau. He was apparently unaware that the type locality of *R. a. smithi* is in Sierra Leone (see Rosevear, 1965: 84).

*Myonycteris torquata*: The Dickerman expedition obtained 16 specimens from the Wonegizi Mountains. The junior authors ob-

tained seven from Cuttington University College and one from Kpatawee Falls. Happold (1987) recorded the species from Ghana, Ivory Coast, Liberia, and Guinea. He was apparently unaware that the type locality of *M. t. leptodon* is Sierra Leone (Rosevear, 1965: 121).

*Hypsignathus monstrosus*: The Dickerman expedition collected two specimens from the Wonegizi Mountains. Bergmans (1989) recorded this species from Ghana, Ivory Coast, Liberia, and Sierra Leone.

*Epomops franqueti*: In our area, Bergmans (1989) recorded this species only in Ghana and Ivory Coast. Happold (1987) also indicated its occurrence in Liberia and Sierra Leone, but we strongly suspect that Bergmans is right and that its true western limit is in the Ivory Coast. Though initially some of the *Epomops* specimens we had studied from Liberia seemed to agree with *franqueti* in small size and undivided third palatal ridge, they all proved to be immature *E. buettikoferi* when the skulls were extracted and cleaned. The problem is, as Bergmans (1989: 106) pointed out, that in *Epomops* adults and immatures are not easily distinguished and, as Bergmans and others have pointed out, the character of the third palatal ridge is not entirely reliable. Therefore, though it is clear that *franqueti* and *buettikoferi* are separate species, it is easy to confuse immatures. It is, of course, possible that *E. franqueti* does extend farther west than Bergmans indicated. However, the senior author has examined specimens at the National Museum of Natural History from Sierra Leone identified as *Epomops franqueti* and, in his opinion, all are *E. buettikoferi*. We prefer to reserve judgment concerning alleged specimens of *E. franqueti* from Sierra Leone at the Royal Ontario Museum.

*Epomops buettikoferi*: This species is obviously common and widespread in Liberia. The Dickerman expedition collected two specimens in the Wonegizi Mountains. The junior authors obtained nine from Zorzor, five from Hendi, two from Kpatawee Falls, 40 from Cuttington University College, one from Yecapa, and two from Juarzohn. See Kofron and Chapman (1994) for further information on these specimens. Bergmans (1989) recorded this species from Ghana,

Ivory Coast, Liberia, Sierra Leone, and Guinea.

*Epomophorus gambianus*: Bergmans (1988) recorded this species from all six countries, but the Liberian occurrence continues to rest on a single doubtful record. Another species, *E. labiatus* (= *anurus*), was recorded by Happold (1987) from Guinea, but Bergmans (1988) did not identify any specimens west of Nigeria with this species, so we would regard occurrence in our area as very doubtful.

*Micropteropus pusillus*: The junior authors collected four specimens from Robertsport. Bergmans (1989) recorded the species from all six countries.

*Nanonycteris veldkampii*: The Dickerman expedition obtained 10 specimens from the Wonegizi Mountains. Bergmans (1989) recorded this species from Ghana, Ivory Coast, Liberia, Sierra Leone, and Guinea. Rosevear (1965) indicated great difficulty in distinguishing this species from *Micropteropus* externally, but Happold's (1987) character of the arrangement of palatal ridges (which can usually be seen unless the mouth is tightly closed) will readily distinguish the two species at a glance.

*Scotonycteris zenkeri*: The Dickerman expedition collected four specimens in the Wonegizi Mountains. Bergmans (1990) recorded the species in Ghana, Ivory Coast, and Liberia.

*Scotonycteris ophiodon*: This rare species was recorded in our area only from Ghana and Liberia (Bergmans, 1990).

*Megaloglossus woermanni*: The Dickerman expedition collected 12 specimens from the Wonegizi Mountains; the junior authors two from Hendi and one from Kpatawee Falls. Happold (1987) recorded this species from Ghana, Ivory Coast, Liberia, and Guinea; there is also a specimen from Sierra Leone at USNM.

#### FAMILY EMBALLONURIDAE

*Coleura afra*: Happold (1987) recorded this species from Ghana, Guinea, and Guinea-Bissau.

*Taphozous perforatus*: Happold (1987) recorded this species only from Ghana in our area, but Lopes and Crawford-Cabral (1992) listed specimens from Guinea-Bissau.

*Taphozous mauritanus*: Happold (1987) recorded this species from Ghana and Ivory Coast, but Rosevear (1965) also recorded it from Sierra Leone. There is a skin and attached uncleaned skull (BM 60.2.11.3) from "Bissao Senegambia," which presumably came from Guinea-Bissau.

*Taphozous nudiventris*: Happold (1987) recorded this species in our area only from Ghana. Lopes and Crawford-Cabral (1992) rejected all records of this species from Guinea-Bissau as misidentified *T. perforatus*.

*Saccolaimus peli*: Happold (1987) recorded this species (as *Taphozous peli*) from Ghana, Ivory Coast, and Liberia.

#### FAMILY MEGADERMATIDAE

*Lavia frons*: Happold (1987) recorded this species from Ghana, Sierra Leone, Guinea, and Guinea-Bissau.

#### FAMILY NYCTERIDAE

*Nycteris nana*: Van Cakenberghe and De Vree (1985) recorded this species from Ghana and Ivory Coast.

*Nycteris intermedia*: The Dickerman expedition collected a specimen from the Wonegizi Mountains. Van Cakenberghe and De Vree (1985) recorded the species from Ghana, Ivory Coast, and Liberia. The size of *intermedia* is best shown by the condylocanine length, but females tend to be larger than males. The skull of the single Liberian specimen (a male at 15.2 mm) contrasts with 13.6 mm for a Kenyan male of *N. nana* and 16.7 to 17.8 mm for series of males of *N. arge* from Ghana, Ivory Coast, Liberia, and Sierra Leone (BM, USNM). A male of *intermedia* from Ghana (USNM) has a condylocanine length of 15.3 mm, whereas a female of *nana* from Ghana (USNM) has a condylocanine length of 13.7 mm.

*Nycteris arge*: The Dickerman expedition obtained a specimen from the Wonegizi Mountains. Van Cakenberghe and De Vree (1985) recorded the species from Ghana, Ivory Coast, Liberia, and Sierra Leone.

*Nycteris major*: Van Cakenberghe and De Vree (1985) recorded this species from Ivory Coast and Koopman (1989) from Liberia.

*Nycteris grandis*: The Dickerman expedition collected a specimen from the Wonegizi

Mountains. Van Cakenberghe and DeVree (1993) recorded the species from Ghana, Ivory Coast, Liberia, and Guinea. There is also a specimen from Sierra Leone at USNM.

*Nycteris hispida*: Van Cakenberghe and DeVree (1993) recorded this species from all six countries in our area.

*Nycteris macrotis*: The junior authors collected one specimen from Zorzor and one from Cuttington University College. Van Cakenberghe and DeVree (1985) recorded the species from all six countries in our area.

*Nycteris thebaica*: Van Cakenberghe and DeVree (in press) recorded this species from Ghana, Sierra Leone, and Guinea. The National Museum of Natural History has a few specimens (USNM 454471, 454472, 454509), out of a series of *N. gambiensis* from Ivory Coast, that the senior author would identify as *N. thebaica*.

*Nycteris gambiensis*: Van Cakenberghe and DeVree (in press) record this species from Ghana, Ivory Coast, Sierra Leone, Guinea, and Guinea-Bissau.

#### FAMILY RHINOLOPHIDAE

*Rhinolophus simulator*: The Dickerman expedition collected two specimens from the Wonegizi Mountains, which are the first records from Liberia. This was not unexpected, however, because Brosset (1985) recorded it from the Guinea side of Mt. Nimba. Previously, it had only been known in western Africa from Cameroon and Nigeria. This western African subspecies, *R. s. alticolus*, compared to the eastern and southern African *R. s. simulator*, tends to be somewhat larger, at least as shown by the length of the maxillary tooththrow (6.1–6.9 vs. 6.5–6.9 mm for males; 6.0–6.6 vs. 6.4–6.5 mm for females) based on specimens the senior author has measured, mostly at AMNH, BM, and FMNH from Sudan, Ethiopia, Kenya, Tanzania, Malawi, Zambia, Zimbabwe, Botswana, Cameroon, and Liberia. An extracted male skull from Liberia seems particularly large compared with males from Cameroon (BM, FMNH). Comparative skull measurements are as follows: Condylacanine length (16.9 vs. 16.7–16.8 mm), zygomatic width (9.3 vs. 9.0–9.3 mm), postorbital width (2.6 vs. 2.1–2.4 mm), mastoid width (9.3 vs. 9.1–9.3 mm),

maxillary tooththrow length (6.9 vs. 6.5–6.7 mm).

*Rhinolophus denti*: In western Africa, this species has only been recorded from Guinea (Rosevear, 1965), but there are two specimens so identified (FMNH 105206, 105325) from Ivory Coast. A male skin and skull from Ghana (USNM 414972) is also probably referable to *R. denti*. Measurements are as follows: forearm length (49), condylacanine length (14.4), zygomatic width (9.0), mastoid width (8.6), width across last upper molars (6.1), and maxillary tooththrow length (6.1).

*Rhinolophus clivosus*: The Dickerman expedition collected two specimens from the Wonegizi Mountains of the well-differentiated *R. c. hillorum*, known only from Liberia and Cameroon (see Koopman, 1989). This brings the known specimens of this subspecies to five. Measurements of the two new specimens, a female and male (skull extracted only for the male) are as follows: forearm length (52, 53), condylacanine length (21.8), zygomatic width (13.4), mastoid width (11.2), width across last upper molars (9.4), and maxillary tooththrow length (9.0).

*Rhinolophus alcyone*: Happold (1987) recorded this species from Ghana, Ivory Coast, Liberia, and Sierra Leone.

*Rhinolophus guineensis*: The Dickerman expedition collected 39 specimens from the Wonegizi Mountains. As previously indicated (Koopman, 1989), *guineensis* is clearly specifically distinct from *R. landeri*. The senior author has extracted two skulls (selected to show extremes of size) from the Wonegizi series. These, together with the earlier reported (Koopman, 1989) Liberian skull and nine skulls from Sierra Leone (three males, six females, BM), can be compared with two skulls of *R. l. landeri*, the sympatric subspecies (a male from Ghana and a female from Bioko; also a male from Sierra Leone, a male from Ghana, a male from Nigeria, and a male from Cameroon, BM). There are also specimens of the generally larger eastern *R. l. lobatus* (including *axillaris* and *dobsoni*, following Hayman and Hill, 1971), which the senior author has measured at the Field Museum of Natural History, British Museum (Natural History), Museum of Comparative Zoology, Senckenberg Museum (Frankfurt), Museo Civico di Storia Naturale di Genova, Zool-

ogisches Museum der Humboldt-Universität (Berlin), and American Museum of Natural History. They come from Central African Republic, Sudan, Ethiopia, Somalia, Kenya, and northeastern Zaire. The condylocanine measurements, separated by sex, are as follows (*guineensis* first, *l. landeri* next, *l. lobatus* last): males (17.8–18.2, 15.1–16.0, 15.2–17.0), females (17.3–17.5, 15.1, 15.0–16.2). Besides Liberia, *guineensis* has been recorded from Sierra Leone and Guinea (Rosevear, 1965). This species appears to have a limited range, sympatric with the closely related *R. landeri*, which extends both east and west of it.

*Rhinolophus landeri*: Happold (1987) has recorded this species from Ghana, Sierra Leone, and Guinea. There is also a specimen so identified from Ivory Coast (FMNH 105326).

*Rhinolophus macclaudi*: The Dickerman expedition collected a specimen from the Wonegizi Mountains. This represents the first record for Liberia, but it is not unexpected because the species was described from Guinea and has also been recorded from Nigeria (Happold, 1987). The Liberian specimen (an adult male) seems somewhat smaller than the western African specimens referred to by Smith and Hood (1980). A few selected skull measurements are: condylocanine length (22.9 mm), zygomatic width (12.4 mm), mastoid width (12.3 mm), maxillary toothrow length (8.8 mm), and width across last molar (8.3 mm).

*Rhinolophus fumigatus*: Happold (1987) has recorded this species from Ghana and Ivory Coast, and Rosevear (1965) from Sierra Leone and Guinea.

*Hipposideros jonesi*: The Dickerman expedition collected a specimen from the Wonegizi Mountains. This represents the first record from Liberia, but it is not unexpected because Happold (1987) recorded the species from Ghana, Ivory Coast, Sierra Leone, and Guinea. The senior author has compared the Liberian specimen (a female) with six females from Ghana (AMNH, USNM), because there seems to be a sexual difference, at least in skull size. All three females in the American Museum are in alcohol with one skull from each country having been extracted; the National Museum specimens are skins and skulls. Measurements (in mm) are as follows (the Liberian specimen last): forearm length

(50–53; 47), condylocanine length (16.7–17.2; 15.6). In each case, the Liberian female is clearly smaller. This probably indicates geographical variation, but sample size is inadequate to demonstrate this, especially because the type locality is not in Ghana or Liberia, but in Sierra Leone. Measurements of a series of five intact female skulls from Sierra Leone (BM) give a condylocanine range of 16.0–16.6, which bridges the gap between the Liberian skull and those from Ghana. Incidentally, Rosevear (1965: 238) stated that *H. jonesi* has been found in the “Republic of Sudan,” which would be an enormous range extension. However, the locality (Sikasso) in his gazetteer is indicated as being in Senegal, though the coordinates he gives puts it in Mali.

*Hipposideros marisae*: The Dickerman expedition collected a specimen from the Wonegizi Mountains. Rosevear (1965) has recorded this species from Ivory Coast, Liberia, and Guinea. It should be mentioned, however, that all known localities are in a very restricted area of western Africa. The American Museum Liberian specimen (a male) has a forearm length of 39 mm and a skull length to canines of 15.4 mm, thus making it slightly smaller than the type male from Ivory Coast.

*Hipposideros fuliginosus*: The Dickerman expedition obtained 17 specimens from the Wonegizi Mountains; the type locality is in Ghana. Considerable difficulty has been experienced in separating this species from *H. ruber*. Hill (1963) keyed *fuliginosus* from *H. caffer* (in which he included *ruber*) by “posterior leaf without a transverse supplementary structure developed from its posterior face or with such a structure low, undeveloped and lacking a serrated upper edge” vs. “posterior leaf having a transverse supplementary structure with a serrated upper edge developed from its posterior face.” All western Liberian specimens of *fuliginosus* (including the one previously reported, Koopman, 1989) have this ridge present with a more or less serrated edge, but the degree of its development varies from weak to strong and we have found it of little value in distinguishing the two species. Therefore, it is not surprising that it does not appear in the keys of either Rosevear (1965) or Hayman and Hill (1971). These authors used the presence

(*ruber*) or absence (*fuliginosus*) of the frontal sac, but also used forearm length (59–64 in *fuliginosus* vs. 44–58 in *ruber*). We have found the presence or absence of a frontal sac useful for separating males, but almost useless for separating females, because many female *ruber* resemble *fuliginosus* in either lacking a frontal sac or having it so poorly developed as to be invisible externally. However, knowing that there are indeed two species of males makes it possible to allocate females on the basis of some skull measurements. These mensural data are for western Liberia (table 1). It is obvious that females are less clearly separable than males, but because males can be clearly separated on another character (the frontal sac), females must also fall into two species. On this less than fully satisfactory basis, we have made the above allocations. It should be pointed out, however, that this separation greatly extends the morphometric variation of *fuliginosus* from published measurements (e.g., Rosevear, 1965). Also, there appears to be some geographical variation in *H. fuliginosus* and, in fact, some specimens that the senior author had earlier (Koopman, 1989) assigned to *H. ruber* are here reassigned to *H. fuliginosus*. Besides AMNH and USNM material from East and West Cameroon, Ivory Coast, and eastern Liberia, the senior author has also been able to study Ghana specimens (FMNH, USNM), additional eastern Liberian material (BM), and specimens from Sierra Leone (USNM). The broader picture is shown in table 1. *H. ruber* also shows geographical variation, which in general maintains a gap in measurements between the two species in a given area. As we have delimited *H. fuliginosus*, it is known from Ghana, Ivory Coast, Liberia, and Sierra Leone, but there are no definite records from Guinea or Guinea-Bissau, though Konstantinov (1986) recorded "*H. cf. fuliginosus*" from Guinea. One of the Liberian specimens (from near Zwedru) was previously reported (Koopman, 1989) under the name *H. ruber*.

*Hipposideros ruber*: The Dickerman expedition obtained 57 specimens from the Wonegizi Mountains; the junior authors obtained two from Zorzor. As indicated under the *H. fuliginosus* account, delimitation of *H. ruber* from *H. fuliginosus* has been a problem, though we believe that they can be separated

on the basis of size and (in males) the presence of a frontal sac. Separation from *H. lamottei* will be considered under the following account. Again, in table 1, we can first consider the skull size range in western Liberia and then geographical variation in other parts of western Africa. (These include specimens from the AMNH, FMNH, USNM, and BM). Happold (1987) recorded *H. ruber* from Ghana, Ivory Coast, Liberia, and Sierra Leone. Aellen (1963) recorded this species from Guinea as *Hipposideros caffer guineensis*. We know of no records from Guinea-Bissau.

*Hipposideros lamottei*: The senior author discussed the problem of this species (Koopman, 1989), but, in part, because of paucity of material, no resolution was possible. With acquisition of the large Wonegizi series and at least tentative recognition of the range of measurements of *H. fuliginosus* and *H. ruber*, the problem of *lamottei* has been reinvestigated. When measurements are plotted, it does seem that there is a distinct group of unusually small specimens, which we have tentatively allocated to *H. lamottei*. Two points must be emphasized: first, we know of no nonmensural character that separates *lamottei* from *ruber*, because they both have frontal sacs, at least in males. Second, we have not seen any material from near the type locality of *lamottei* on the north side of Mt. Nimba in Guinea, so we cannot confirm the identity of our small specimens with Brosset's *lamottei* and the measurements we have found most useful are not used by Brosset (1985). Nevertheless, we believe it is highly probable that we are all talking about the same species. It has also become evident that there is a problem in differentiating the small *H. lamottei* from the still smaller *H. caffer*, but we believe that a distinction can be made. In view of the small number of specimens here allocated to *lamottei* (four from Cameroon, four from Ghana, four from Liberia, and three from Sierra Leone) we have pooled both sexes and all localities in our comparisons. It will be evident that only the condylocanine length will really separate the two species. This is shown by the following (*lamottei* first, followed by *ruber*): condylocanine length (15.0–15.5 vs. >15.5); maxillary tooththrow length (6.0–6.6 vs. >6.0); zygomatic width (9.2–10.2 vs. >9.4); width across

TABLE 1  
Skull Measurements of *Hipposideros fuliginosus*  
and *H. ruber*  
(Number of specimens measured  
in parentheses)

	Males	Females
Condyllocanine length		
East Cameroon		
<i>fuliginosus</i>	17.9 (1)	17.9–18.5 (3)
<i>ruber</i>	16.2–16.8 (5)	15.7–16.9 (4)
West Cameroon		
<i>fuliginosus</i>	17.1–18.2 (2)	(0)
<i>ruber</i>	15.8–16.4 (4)	15.7–16.6 (8)
Nigeria		
<i>ruber</i>	15.7–16.7 (9)	16.0–16.9 (13)
Ghana		
<i>fuliginosus</i>	16.8–17.6 (28)	16.7–17.6 (17)
<i>ruber</i>	15.8–16.7 (17)	15.6–16.6 (17)
Ivory Coast		
<i>fuliginosus</i>	(0)	17.0–17.5 (5)
<i>ruber</i>	15.9–16.7 (6)	15.8–16.7 (6)
eastern Liberia		
<i>fuliginosus</i>	17.0–17.7 (7)	17.1–17.7 (6)
<i>ruber</i>	(0)	16.9 (1)
western Liberia		
<i>fuliginosus</i>	17.9–18.0 (2)	17.5–18.7 (7)
<i>ruber</i>	15.8–16.5 (10)	15.9–17.0 (14)
Sierra Leone		
<i>fuliginosus</i>	17.2–18.0 (2)	(0)
<i>ruber</i>	15.6–16.1 (3)	15.7–16.6 (9)
Gambia		
<i>ruber</i>	16.1–16.7 (3)	16.0–16.4 (3)
Maxillary tooththrow length		
East Cameroon		
<i>fuliginosus</i>	7.6 (1)	7.5–7.8 (3)
<i>ruber</i>	6.7–7.1 (5)	6.4–6.9 (5)
West Cameroon		
<i>fuliginosus</i>	6.9–7.6 (2)	(0)
<i>ruber</i>	6.6–6.9 (6)	6.6–6.9 (8)
Nigeria		
<i>ruber</i>	6.6–7.0 (9)	6.7–7.2 (12)
Ghana		
<i>fuliginosus</i>	6.8–7.5 (30)	7.0–7.5 (16)
<i>ruber</i>	6.3–7.0 (18)	6.1–6.7 (17)
Ivory Coast		
<i>fuliginosus</i>	(0)	7.2–7.4 (5)
<i>ruber</i>	6.5–7.1 (7)	6.3–7.0 (7)
eastern Liberia		
<i>fuliginosus</i>	7.0–7.6 (7)	6.9–7.4 (7)
<i>ruber</i>	(0)	7.0 (1)
western Liberia		
<i>fuliginosus</i>	7.5–7.7 (2)	7.1–7.7 (7)
<i>ruber</i>	6.5–7.1 (11)	6.4–7.0 (12)

TABLE 1—(Continued)

	Males	Females
Sierra Leone		
<i>fuliginosus</i>	7.1–7.4 (2)	(0)
<i>ruber</i>	6.4–6.5 (3)	6.2–6.8 (9)
Gambia		
<i>ruber</i>	6.7–7.0 (5)	6.7–6.9 (3)
Zygomatic width		
East Cameroon		
<i>fuliginosus</i>	11.5 (1)	11.3–11.6 (3)
<i>ruber</i>	10.0–10.5 (5)	10.0–10.5 (5)
West Cameroon		
<i>fuliginosus</i>	11.0–11.1 (2)	(0)
<i>ruber</i>	10.3–10.7 (4)	10.2–10.8 (8)
Nigeria		
<i>ruber</i>	10.2–11.1 (9)	10.1–10.8 (13)
Ghana		
<i>fuliginosus</i>	10.5–11.3 (26)	10.5–11.2 (17)
<i>ruber</i>	9.6–10.8 (16)	9.7–10.5 (16)
Ivory Coast		
<i>fuliginosus</i>	(0)	10.3–11.5 (5)
<i>ruber</i>	10.0–10.6 (5)	9.9–10.9 (7)
eastern Liberia		
<i>fuliginosus</i>	10.7–11.3 (7)	10.6–11.1 (7)
<i>ruber</i>	(0)	10.9 (1)
western Liberia		
<i>fuliginosus</i>	11.5–11.7 (2)	11.1–11.5 (7)
<i>ruber</i>	9.9–11.0 (11)	10.0–10.5 (14)
Sierra Leone		
<i>fuliginosus</i>	10.9–11.9 (2)	(0)
<i>ruber</i>	9.6–9.8 (3)	9.5–10.5 (9)
Gambia		
<i>ruber</i>	10.1–10.8 (5)	10.3–10.7 (3)
Width across last molars		
East Cameroon		
<i>fuliginosus</i>	7.8 (1)	7.6–7.8 (3)
<i>ruber</i>	6.7–7.1 (5)	6.9–7.2 (5)
West Cameroon		
<i>fuliginosus</i>	7.1–7.6 (2)	(0)
<i>ruber</i>	6.7–7.1 (5)	6.9–7.2 (8)
Nigeria		
<i>ruber</i>	6.8–7.4 (9)	6.9–7.5 (13)
Ghana		
<i>fuliginosus</i>	7.2–7.8 (30)	7.0–7.7 (16)
<i>ruber</i>	6.3–7.4 (18)	6.3–7.4 (17)
Ivory Coast		
<i>fuliginosus</i>	(0)	7.4–7.7 (5)
<i>ruber</i>	6.5–7.3 (7)	6.5–7.4 (7)
eastern Liberia		
<i>fuliginosus</i>	7.3–7.8 (7)	7.2–7.7 (7)
<i>ruber</i>	(0)	7.2 (1)



TABLE 1—(Continued)

	Males	Females
western Liberia		
<i>fuliginosus</i>	7.5–7.7 (2)	7.3–7.7 (7)
<i>ruber</i>	6.5–7.3 (11)	6.8–7.2 (13)
Sierra Leone		
<i>fuliginosus</i>	7.2–7.5 (2)	(0)
<i>ruber</i>	6.4 (3)	6.3–7.0 (9)
Gambia		
<i>ruber</i>	6.8–7.1 (5)	7.1–7.2 (3)

last molars (6.1–6.7 vs. >6.2). Part of the problem involves the unusually small size of some specimens from Cameroon, Ghana, and Sierra Leone here allocated to *H. ruber*, but it is evident that there is still considerable uncertainty regarding the status of *H. lamottei*. Furthermore, it is possible that *lamottei* is the true representative of *H. ruber* (type locality in Tanzania) and what we have called *ruber* is a separate species, *H. guineensis* (type locality in Gabon), but resolution of this problem is outside the scope of the present paper. As indicated above, we would tentatively allocate specimens from Cameroon (AMNH, BM, FMNH), Ghana (AMNH, BM, USNM), Liberia (AMNH, BM, USNM), Sierra Leone (USNM), and Guinea (Brosset, 1985) to *H. lamottei*. The Liberian specimens include two of the four specimens from Voinjama reported as *H. ruber* by Koopman (1989).

*Hipposideros caffer*: Happold (1987) recorded this species from all six countries with High Forest or Invasive Guinea Woodland. However, in view of the confusion that has existed in the past between this species and its close relatives (*ruber*, *lamottei*, *beatus*), there is considerable doubt about whether true *H. caffer* occurs in Liberia, since this is primarily a savanna species. Specimens at USNM from Liberia reported by Miller (1900) under the name "*Hipposideros caffra*" are a mixture of three species. To quote Miller (p. 647), "Although apparently representing a single species these specimens show remarkable variation in size. In two the forearm measures 52 mm, in two others 49, while in the fifth it barely reaches 42." Actually, the three largest specimens (USNM 83800–

02) are *H. ruber*, USNM 83799 is *H. lamottei*, whereas the smallest one (USNM 83857) is *H. beatus*. Specimens the senior author has allocated to *H. caffer* from Ghana, Ivory Coast, Sierra Leone, and Guinea-Bissau have condylocanine lengths ranging from 13.8 to 14.9 and width across last molars of 5.3–6.3. We have no reason to doubt the occurrence of true *caffer* in any of the countries considered here except Liberia. The junior authors strongly suspect that *caffer* will be found in Liberia.

*Hipposideros beatus*: Happold (1987) recorded this species from Ghana, Ivory Coast, Liberia, Sierra Leone, and Guinea-Bissau, but there seems to be no record from Guinea. Liberian specimens have condylocanine lengths of 14.2–14.6 and width across last molars of 6.4–6.8.

*Hipposideros cyclops*: Happold (1987) recorded this species from Ghana, Ivory Coast, Liberia, Sierra Leone, and Guinea-Bissau, but there seems to be no record from Guinea.

*Hipposideros abae*: Happold (1987) recorded this species from Ghana, Ivory Coast, Sierra Leone, Guinea, and Guinea-Bissau, but there is no record from Liberia. This is not surprising, since *H. abae* is primarily a savanna species, at least in far western Africa.

*Hipposideros commersoni*: The Dickerman expedition collected a specimen from the Wonegizi Mountains. Happold (1987) also recorded this species from Ghana, Ivory Coast, and Guinea-Bissau, Aellen (1956) from Guinea, and there is a specimen from Sierra Leone (USNM).

#### FAMILY VESPERTILIONIDAE

Genus *Kerivoula*: Three species of this genus have been recorded from far western Africa. Hill (1977) has recorded *K. lanosa* (= *muscula*, *bellula*) from Ghana, Ivory Coast, and Liberia; Brosset (1985) from Guinea. Happold (1987) recorded *K. smithi* from Ivory Coast and Liberia. Hayman and Hill (1971) recorded *K. phalaena* from Ghana and Liberia. There is also a skin (but no skull) so identified from Ivory Coast (USNM). A record of *K. cuprosa* from Ghana is in error, specimen (FMNH 55750) having been reidentified as *K. lanosa*.

*Myotis tricolor*: In western Africa, this species is still known only from Liberia (see Koopman, 1989).

*Myotis bocagei*: Happold (1987) recorded this species from Ghana, Ivory Coast, Liberia, and Sierra Leone.

Genus *Pipistrellus*: Hill and Harrison (1987) have considerably enlarged this genus at the expense of *Eptesicus* and we follow them here. By their definition, true *Eptesicus* is not known from the area here delimited, though *E. platyops* probably occurs because it is known from both Nigeria to the east and Senegal to the west. Incidentally, the senior author has compared the type of *platyops* in the British Museum with the three other species of true *Eptesicus* in Africa (*bottae*, *serotinus*, *hottentotus*) and is inclined to agree with Ibañez and Valverde (1985) in considering *platyops* a subspecies of *E. serotinus*. Heller et al. (1994) placed *P. crassulus* and *P. eisenrauti* in a separate genus (*Hypsugo*). However, since there is considerable disagreement concerning the separate status and limits of *Hypsugo* (compare treatment in Hill and Harrison, 1987), we continue to include *crassulus* and *eisenrauti* in *Pipistrellus*.

*Pipistrellus africanus* (= *nanus*): The junior authors obtained two specimens from Robertsport. The senior author (Koopman, 1989) has discussed the use of this name and also the problem of geographical distribution in this species. The forearm length measurements of the two specimens (both males) are 30 and 31 mm and thus fall at the upper end of the variation for Liberian specimens (25–31 mm). Happold (1987) recorded this species from Ghana, Ivory Coast, Liberia, and Sierra Leone; Lopes and Crawford-Cabral (1992) from Guinea-Bissau, but there seems to be no record from Guinea.

*Pipistrellus kuhlii*: Hill's (1982) record from Liberia remains the only one known from our area.

*Pipistrellus rusticus*: In our area, this species has only been recorded from Ghana and Liberia (Hill, 1982). The senior author has studied the skulls of the two specimens that are the basis of these records and has no disagreement with Hill's identification of the one from Ghana. The one from Liberia, however, does not agree with the Ghana specimen in several respects and we are included to treat

it as a small specimen of *P. kuhlii*. Besides comparing it with the two specimens of *kuhlii* from the same locality in Liberia, the senior author has also compared it with the Ghana specimen of *rusticus*, and with the types of *r. marrensis* and *deserti*. Taking the maxillary toothrow length (the only one that can be taken on all four West African skulls), we have the following: two Liberian *kuhlii*, Liberian "*rusticus*," Ghanaian *rusticus* (4.6, 4.5; 4.4; 3.8). On the other hand the width across the last molars of the last two specimens are both 5.2, indicating a considerable difference in the width of the palate relative to its length. We are therefore very skeptical of the occurrence of *Pipistrellus rusticus* in Liberia.

*Pipistrellus inexpectatus*: There are no published records of this species from our area, but there are (USNM) specimens from Ghana and Sierra Leone. Specimens in the American Museum from Kenya (Kwale) and Zaire (Lukolela) previously identified as *P. inexpectatus* turn out, on closer study, to be actually *P. eisenrauti*.

*Pipistrellus eisenrauti*: In our area, this species is known only from Ivory Coast and Liberia (Koopman, 1989). For characters to distinguish this species from *P. inexpectatus*, see De Vree, 1972. Heller et al. (1994) would transfer the far western African subspecies *bellieri* from *P. eisenrauti* to *P. crassulus*. Either allocation implies an apparent gap between Cameroon and Ivory Coast. The senior author has not been able to compare *bellieri* with *crassulus*, but if the Zaire and Kenya specimens are correctly identified as *eisenrauti*, the Liberian specimen (*bellieri*) shows close resemblance to the other two. We don't see the distinctions that Heller et al. (1994) made. Furthermore, they did not mention (though it is shown in their figures) the greater degree of bifid cleavage in the inner upper incisor of *crassulus*, which shows agreement between *eisenrauti* and *bellieri*. Unfortunately the best character distinguishing *crassulus* from *eisenrauti*, namely the much greater size of the penis, cannot be used since *bellieri* is known only by females. Heller et al. (1994) referred to a record by Hill and Harrison (1987) from "South Nimba, Liberia." However, the only species of *Pipistrellus* Hill and Harrison list from South Nimba is *P. nanulus*, not *P. crassulus*.

*Pipistrellus nanulus*: Happold (1987) recorded this species from Ghana, Ivory Coast, Liberia, and Sierra Leone; Roche (1971) recorded it from Guinea.

*Pipistrellus guineensis*: Aellen (1956) recorded this species from both Guinea and Guinea-Bissau as well as Senegal. There are specimens (USNM) from Ghana and Ivory Coast. This and the following five species were all formerly included in *Eptesicus* (see Koopman, 1989).

*Pipistrellus somalicus*: Happold (1987) recorded this species from Ghana, and there are also specimens from Sierra Leone (USNM). Records of "*minutus*" from Liberia (Kuhn, 1965) are probably also referable to *P. somalicus*, but the application of the name "*minutus*" is uncertain. Lopes and Crawford-Cabral (1992) tentatively identified *somalicus* from Guinea-Bissau.

*Pipistrellus capensis*: Happold (1987) recorded this species from Ghana, Ivory Coast, and Liberia and there are also specimens from Sierra Leone (BM). Lamotte (1942) recorded what was presumably this species from Guinea as *Eptesicus grandidieri*.

*Pipistrellus brunneus*: Koopman (1989) recorded this species from Liberia and discussed its taxonomic status. There are specimens from Ghana, Ivory Coast, and Sierra Leone (USNM).

*Pipistrellus tenuipinnis*: The Dickerman expedition collected a specimen from the Wonegizi Mountains. Happold (1987) recorded the species from Ghana, Ivory Coast, Liberia, Sierra Leone, and Guinea.

*Pipistrellus rendalli*: Happold (1987) recorded this species from Ghana, Liberia, and Sierra Leone.

*Mimetillus moloneyi*: Happold (1987) recorded this species from Ghana, Ivory Coast, Liberia, and Sierra Leone.

*Glauconycteris beatrix*: Happold (1987) recorded this species from Ghana, Ivory Coast, and Guinea-Bissau, though we are skeptical of the last country record, which is, perhaps, actually *poensis*.

*Glauconycteris poensis*: The junior authors collected a single immature specimen from Cuttington University College. Koopman (1989) had previously reported this species from two other localities in Liberia. Happold (1987) recorded it from Ghana, Ivory Coast,

and Sierra Leone, as well as Senegal to the northwest of our area.

*Glauconycteris variegata*: In our area, this species is known only from Ghana (Happold, 1987).

*Glauconycteris superba*: This species is known from Ghana (Rosevear, 1965).

*Nycticeinops schlieffeni*: See Koopman (1989), who followed Hill and Harrison (1987) in the use of this name. In our area, this species is only known from Ghana (Happold, 1987).

*Scotoecus albofuscus*: In our area, this species is known only from Ivory Coast and Sierra Leone (Hill, 1974).

*Scotoecus hirundo*: In our area, this species is known only from Ghana and Sierra Leone (Hill, 1974).

Genus *Scotophilus*: As the senior author (Koopman, 1989) has pointed out, two competing arrangements are currently recognized by various authors, with Koopman (1984) recognizing only three species: *borbonicus* (= *viridis*, *nigritellus*), *leucogaster* (= *nucella*, *dinganii*, *colias*, *nux*), and *nigrita* (= *gigas*), whereas Robbins et al. (1985) recognized six. We will follow the Koopman arrangement, but the reader is referred to Robbins et al. (1985) for the alternative. However, because in West Africa two groups of subspecies of *leucogaster* occur sympatrically, thus behaving like separate species (but intergrading in Ethiopia), they will be treated separately. See these two cited papers for locality records of the various species.

*Scotophilus borbonicus*: This species was recorded from Ghana and Ivory Coast. Happold (1987) also recorded *viridis* from Sierra Leone.

*Scotophilus leucogaster* (*leucogaster* group of subspecies, including *nucella*): This group of subspecies was recorded from Ghana, Ivory Coast, Sierra Leone, and Guinea-Bissau.

*Scotophilus leucogaster* (*dinganii* group of subspecies, including *colias* and *nux*): This group of subspecies was recorded from Ghana, Ivory Coast, Liberia (Koopman, 1989), and Sierra Leone. Of two specimens from Guinea-Bissau identified by Veiga-Ferreira (1949) as *Scotophilus nigrita*, one (forearm 49) agrees with the *leucogaster* group, but another (forearm 56) is too big for *l. leucogaster* and agreed much better with the *dinganii*

group. Lopes and Crawford-Cabral (1992) agreed in allocating their specimens to both groups under the names of *leucogaster* and *nigrita* (= *dinganii* of current nomenclature).

*Scotophilus nigrita*: In our area, this species is only recorded from Ghana.

*Miniopterus schreibersi*: The Dickerman expedition collected three specimens from the Wonegizi Mountains. The type locality of the subspecies *villiersi* is from Guinea (see Hayman and Hill, 1971) and there are specimens from Sierra Leone (USNM). These are the first records from Liberia. Though Rosevear (1965) recognized only a single species from West Africa (which he called *inflatus* and in which he included *villiersi*), the Dickerman expedition obtained two species in sympatry. *M. schreibersi* is the smaller species as is shown by the following measurements (three alcoholic specimens, two with extracted skulls) from Liberia. There are followed by a series in the American Museum from Thysville in extreme western Zaire together with specimens from Cameroon and Nigeria (BM) and from Sierra Leone (USNM): forearm length (43–44, 40–46); condylobasal length (15.0–15.2, 13.9–15.3); maxillary toothrow length (6.0–6.1, 5.5–6.1); width across molars (6.4, 5.7–6.6).

*Miniopterus inflatus*: The Dickerman expedition collected a single specimen from the Wonegizi Mountains. The species was also recorded from Liberia by Hill (1982). Happold (1987) also records it from Guinea, but this evidently refers to *M. s. villiersi*. *M. inflatus* is clearly larger than the sympatric *M. schreibersi* as shown by the following measurements (Wonegizi specimen, followed by specimens from Zaire, Cameroon [the holotype], and Liberia [BM]): forearm length (47, 46); condylobasal length (16.3, 15.5–16.5); maxillary toothrow length (6.7, 6.3–6.7); width across molars (6.9, 6.6–6.9).

#### FAMILY MOLOSSIDAE

*Myopterus daubentonii* (= *albatus*): Originally described from Senegal, in our area, this species has only been recorded from Ivory Coast. See Koopman (1989) for a brief discussion of the nomenclature and distribution of this species.

*Myopterus whitleyi*: In our area, Happold

(1987) recorded this species only from Ghana.

*Chaerephon bennellini*: As previously discussed (Koopman, 1989), the Liberian record of this species was regarded as probably erroneous. However, there is a specimen from Sierra Leone (USNM), which supports the validity of the Liberian record.

*Chaerephon nigeriae*: In our area, Happold (1987) recorded this species only from Ghana but there are also specimens (USNM) from Sierra Leone.

*Chaerephon major*: The junior authors collected 41 specimens from Cuttington University College. The species has also been recorded from Ghana (Kumasi; see Rosevear, 1965).

*Chaerephon pumila*: Although Rosevear (1965) recognized several West African species in this assemblage, we follow Hayman and Hill (1971) in putting *gambiana*, *websteri*, and *nigri* in *C. pumila*. Happold (1987) recorded this species from Ghana, Ivory Coast, and Liberia; Monard (1939) from Guinea-Bissau. There are also specimens from Sierra Leone (BM, USNM) but there seem to be no records from Guinea.

*Chaerephon russata*: In our area, this species is only known from Ghana (Fenton and Peterson, 1972).

*Chaerephon aloysiisabaudiae*: In our area, this species is likewise known only from Ghana (Fenton and Peterson, 1972).

*Mops nanulus*: The species was recorded by Happold (1987) from Ghana, Liberia, and Sierra Leone. However, in view of the confusion between this species and *M. spurrelli* (see Koopman, 1989), there was some doubt about these far west African records. A re-examination has been made of all adult skulls of both species in the American Museum, including specimens from Uganda, north-eastern Zaire (including the type of *nanulus*), Cameroon, Ivory Coast, and Liberia. Skulls have also been studied from Cameroon, Nigeria, Ghana, Sierra Leone, and Gambia (BM). These include the types of *calabarensis* and *spurrelli*. Additional skulls have been studied from Zaire, Equatorial Guinea, Benin, Ghana, Ivory Coast, and Sierra Leone (USNM). Males of the two species can almost always be distinguished by the presence (*spurrelli*) or absence (*nanulus*) of contact be-

tween the medial cingula of the two lower canines. Females of *spurrelli* rarely have such contact (present in AMNH 257078 from Liberia and USNM 414392 from Ghana), but can be distinguished from females of *nanulus* by their considerably more prominent anterior cingula on the upper canines. In USNM 424936, a male from Ghana, the lower canines do not quite meet, but the upper canines do have the very prominent cingula characteristic of *M. spurrelli*. On this basis, all specimens from Uganda and Benin, also all but three from Zaire, together with a single male from East Cameroon (AMNH 241086) are here identified as *M. nanulus*, along with all BM material from West Cameroon, Nigeria, Sierra Leone, Gambia, and one specimen from Ghana. The remaining material from Zaire and East Cameroon, as well as all specimens from Equatorial Guinea, Ivory Coast, and Liberia along with three other Ghana specimens are clearly *M. spurrelli*. It is obvious, therefore, that *M. nanulus* does indeed occur throughout the forest belt of West Africa. Furthermore, examination of the two British Museum types shows that the names *calabarensis* (to *nanulus*) and *spurrelli* have been properly applied. On the basis of specimens examined, we would record *M. nanulus* from Ghana and Sierra Leone. The specimens recorded by Verschuren (1977) from Liberia have not been seen, but there is no reason to doubt the record.

*Mops spurrelli*: The junior authors collected 19 specimens from Kpatawee Falls. El-Rayah (1981) recorded this species from Ghana and Ivory Coast. There is also a single male (USNM 545613) from Sierra Leone. Lamotte (1942) recorded this species with some question from Guinea.

*Mops petersoni*: This species was described by El-Rayah (1981) from Cameroon and Ghana. The Royal Ontario Museum also has a specimen identified as *petersoni* from Sierra Leone, which is probably correct since the holotype is deposited there.

*Mops brachypterus*: Happold (1987) recorded this species (under the name *leonis*, see El-Rayah, 1981: 6, for synonymy) from Ghana and Sierra Leone. Koopman (1989) recorded the species from Liberia, and there are specimens from Ivory Coast (USNM).

*Mops thersites*: Happold (1987) recorded

this species from Ghana, Liberia, and Sierra Leone. There are also specimens from Ivory Coast (USNM).

*Mops condylurus*: The junior authors collected seven specimens from Robertsport and one from Cuttington University College. These are the first records from Liberia, but the species was already expected because it is known from several neighboring countries. Happold (1987) recorded it from Ghana, Sierra Leone, and Guinea, but the type locality of *occidentalis*, a specific synonym (see below) is in Guinea-Bissau. There is also a specimen from Ivory Coast (USNM). Aellen (1956) was inclined to refer all West African specimens to *condylurus wonderi*, originally described from Mali, *occidentalis* (the only other valid name referable to this species from West Africa) being in synonymy. Rosevear (1965), however, recognized no subspecies and stated that West African material is indistinguishable from nominate *condylurus*, originally described from Natal, South Africa. Rosevear also listed *angolensis* (Angola) and *osborni* (western Zaire) as synonyms. Other named forms that we would include in the species *Mops condylurus* are *orientis* (Tanzania) and *leucostigma* (Madagascar). However, until the pattern of geographical variation in this species is analyzed and a decision is made whether or not this pattern is best expressed by recognizing subspecies (and if so which ones), we are inclined to follow Aellen (1956) in referring all specimens in our area to *M. c. wonderi*. A few measurements of the Liberian specimens are here compared with material (AMNH, BM, USNM, FMNH) from Ghana, Ivory Coast, Sierra Leone, Guinea-Bissau, Gambia, Senegal, and Mali (including the type of *wonderi*). Because there is considerable sexual dimorphism, males and females are listed separately, the Liberian specimens first, followed by the others: forearm length, males (46–48; 44–50), females (45–48; 44–49); condylobasal length, males (18.5, 18.8; 18.0–19.3), females (17.3, 18.3; 17.3–18.6); zygomatic width, males (12.9, 13.4; 12.3–13.7), females (11.9–12.9; 12.2–12.6); postorbital width, males (4.4, 4.5; 4.0–5.0), females (4.4, 4.5; 4.2–4.6); maxillary toothrow length, males (7.4, 7.7; 7.2–7.7), females (6.9, 7.5; 7.0–7.4);

width across last molars, males (9.1, 9.2; 8.5–9.4), females (8.2, 9.2; 8.4–9.1).

*Mops demonstrator*: We know of no published record of this species from the area here discussed, but the British Museum (Natural History) has a specimen (81.218) from "Kwabanya, Legon," which is near Accra in Ghana (W. H. F. Ansel, in litt.). This is an adult male from which the senior author has taken the following skull measurements: condylobasal length (17.1), zygomatic width (11.8), postorbital width (4.0), maxillary tooththrow length (6.7), width across last molars (8.1). There is also a male (USNM 420088) from Ghana (northern region: Saka-pa) with the following measurements: condylobasal length (19.1), zygomatic width (12.8), postorbital width (4.0), maxillary tooththrow length (8.0), width across last molars (9.6).

*Mops congicus*: Happold (1987) has recorded this species in our area only from Ghana. The specimen (BM 71.877) from which this record was obviously taken, however, is immature and could be *M. trevori* rather than true *congicus*. However, in size of individual molar teeth, the Ghana specimen agrees better with specimens of *congicus* in the British Museum (Natural History) from Sudan than with those of *trevori* from Uganda. This is presumably also the specimen referred to by Jeffrey (1975).

*Otomops martiensseni*: Though this species has an extensive distribution in southern, eastern, and central Africa, there are no published records west of Angola and the Central African Republic. There is, however, a specimen (USNM 420099) from Ghana. This is from Pirisi (10°07'N, 2°27'W) in the Upper Region.

## DISCUSSION

### OVERALL DISTRIBUTION PATTERN

Because overall numbers of species of bats in West Africa decrease from east to west, we may think of species extending in a westwardly direction, even though in some cases movement may have gone in the reverse direction (see table 2). Therefore, starting with Ghana, which is not only farthest east, but also has the greatest range of habitats (High Forest to Sudan savannah), we have 79 of the

total number of 94 species, but only seven species reach their westernmost limits there. Sixty-two species are known from Ivory Coast, of which only two reach their western limits there; however, as discussed above, *Epomops franqueti* has been recorded farther west, though with some doubt. From Liberia, 57 species are definitely known, although, as discussed previously, five additional species (*Epomops franqueti*, *Epomophorus gambianus*, *Hipposideros caffer*, *Pipistrellus rusticus*, and *P. somalicus*) are doubtfully recorded. No less than 16 of these appear to reach their westernmost limits in Liberia. Certain species (*Rhinolophus simulator*, *Hipposideros marisae*, and *Kerivoula lanosa*) are also known from Guinea, but only in its easternmost part, not west of the Liberian records. From Sierra Leone, 57 species are definitely known, *Epomops franqueti* also being doubtfully recorded. Some 14 of these appear to reach their western limits in Sierra Leone. Of these, four have been recorded from Guinea, but *Hipposideros fuliginosus* only doubtfully; *Megaloglossus woermanni*, *Hipposideros lamottei*, and *Pipistrellus nanulus* are known only in extreme eastern Guinea, not west of Sierra Leone. From Guinea, 37 species are definitely known, not counting *Hipposideros fuliginosus*, which has been only doubtfully recorded. Eleven of these appear to reach their western limits in Guinea. From Guinea-Bissau, only 24 species are definitely known, assuming that the *Glauconycteris beatrix* record is valid. Only three of these (including *Coleura afra*, *Hipposideros beatus*, and *Glauconycteris beatrix*) appear to be westernmost records for Guinea-Bissau. Forty species are known to extend beyond Guinea-Bissau to Gambia, Senegal, or Mauritania. Most of these are not primarily forest species, but are predominantly of the savanna or widespread. It should be pointed out that whereas the senior author has studied numerous specimens of bats from Ghana, Ivory Coast, Liberia, and Sierra Leone, few specimens from Guinea or Guinea-Bissau have been available, and most of the records are taken from the literature. Therefore, there has been little opportunity for critical checking of identifications. Consequently, it is possible that study of extant specimens from these two countries would reveal additional species. On the other

hand, west of Sierra Leone, high forest is virtually absent (only tiny remnants remain) so that known records may reflect the true distribution fairly accurately.

It should be pointed out that whereas the great majority of species extend east of the region here discussed, two do not and appear to be confined to far western Africa. These include *Rhinolophus guineensis* and *Hipposideros marisae*.

#### BASIC ECOLOGICAL BREAKDOWN

We have attempted an ecological classification of the 94 species here treated, based on overall distributional pattern (see table 2). Of these, 42 species are treated as basically forest adapted, 18 as basically distributed in savannas, 29 as ecologically widespread, and 5 as "upland." The last are species of restricted distribution found in the vicinity of mountains, though not necessarily at high altitudes. They would thus be comparable to "para-montane" species previously mentioned for South America and Sudan (Koopman, 1983, 1986).

Perhaps the greatest difficulty in this ecological classification based on overall distribution has been separating the forest and savanna species from those we call widespread. In fact, the senior and junior authors are by no means in agreement on the ecological classification of some species. First, some forest species (at least 5 out of the 42 recognized here) extend, presumably in gallery forest along rivers, into areas mapped as savannas. On the other hand, when forests have been cleared by people, an environment is created that, at least in some ways, resembles a savanna and can therefore be invaded by savanna species if they are present in nearby areas. Of the 18 species here classified as savanna inhabitants, at least five (*Nycteris thebaica*, *Rhinolophus fumigatus*, *Hipposideros caffer*, *H. abae*, and *Scotophilus borbonicus*) appear to have invaded cleared areas. In this connection, we have found the maps in Hapgood (1987) very useful, even though they only cover an area (Nigeria) well outside the territory here considered.

We will consider the 57 Liberian species in greater detail in the following section, but the ecological classification as it applies to

this country can be summarized here. Thirty-one species are considered as forest inhabitants, *Pipistrellus kuhlii* (also *Hipposideros caffer*, *P. rusticus*, and *P. somalicus* if they really occur in Liberia) as savanna, 19 as widespread, and 5 (*Rhinolophus simulator*, *R. clivosus*, *R. macclaudi*, *Hipposideros marisae*, and *Myotis tricolor*) as upland species. However, it should be noted that *R. macclaudi* and *H. marisae* are poorly known in western Africa and, as a result, the distributional patterns are uncertain.

#### ECOLOGICAL DISTRIBUTION IN LIBERIA

*Eidolon helvum*: This species has an extensive sub-Saharan range and there are many Liberian records (Bergmans, 1990; Koopman, 1989) in both uplands and lowlands. It is known to be migratory (Thomas, 1983), but unfortunately little is known about the Liberian populations, though Koopman (1989) did record specimens collected in September (Gahnpe in the central uplands) and November (Monrovia in the western lowlands). The National Museum of Natural History has a specimen collected in December at Robertsport, also in the western lowlands. However, it may be expected to turn up almost anywhere in Liberia. Information concerning seasonal occurrence at various localities would be most welcome and should not be too difficult to obtain because *Eidolon* usually roosts in large colonies (Thomas, 1983).

*Rousettus egyptiacus*: Although this species has a widespread (albeit patchy) distribution in sub-Saharan Africa, we know of only two areas in Liberia where it has been obtained: Mount Nimba (Coe, 1975; Verschuren, 1977; Wolton et al., 1983) and Voinjama-Wonegizi (Koopman, 1989; this paper). Both of these are upland areas along the northern border and it remains to be seen whether the species occurs in lowland areas as well.

*Rousettus angolensis*: This species is widespread in sub-Saharan Africa. Its distribution in Liberia is similar to that of *R. egyptiacus* (Coe, 1975; Verschuren, 1977; Wolton et al., 1983; Brosset, 1985; this paper) and the same comments apply to it.

*Myonycteris torquata*: Overall, this species,

TABLE 2  
Distribution by Country with Ecological Classification

	Gh	IC	L	SL	Gu	GB	SGM	EC
<i>Eidolon helvum</i>	+	+	+	+	+	+	+	W
<i>Rousettus egyptiacus</i>	+	+	+	+	+	—	+	W
<i>Rousettus angolensis</i>	+	+	+	+	+	+	+	W
<i>Myonycteris torquata</i>	+	+	+	+	+	—	—	F
<i>Hypsignathus monstrosus</i>	+	+	+	+	—	—	?	F
<i>Epomops franqueti</i>	+	+	?	?	—	—	—	F
<i>Epomops buettikoferi</i>	+	+	+	+	+	—	—	F
<i>Epomophorus gambianus</i>	+	+	?	+	+	+	+	W
<i>Micropteropus pusillus</i>	+	+	+	+	+	+	+	W
<i>Nanonycteris veldkampii</i>	+	+	+	+	+	—	—	F
<i>Scotonycteris zenkeri</i>	+	+	+	—	—	—	—	F
<i>Scotonycteris ophiodon</i>	+	—	+	—	—	—	—	F
<i>Megaloglossus woermanni</i>	+	+	+	+	+	—	—	F
<i>Coleura afra</i>	+	—	—	—	+	+	—	S
<i>Taphozous perforatus</i>	+	—	—	—	—	+	+	S
<i>Taphozous mauritanus</i>	+	+	—	+	—	+	+	W
<i>Taphozous nudiventris</i>	+	—	—	—	—	—	+	S
<i>Saccolaimus peli</i>	+	+	+	—	—	—	—	F
<i>Lavia frons</i>	+	—	—	+	+	+	+	W
<i>Nycteris nana</i>	+	+	—	—	—	—	—	F
<i>Nycteris intermedia</i>	+	+	+	—	—	—	—	F
<i>Nycteris arge</i>	+	+	+	+	—	—	—	F
<i>Nycteris major</i>	—	+	+	—	—	—	—	F
<i>Nycteris grandis</i>	+	+	+	+	+	—	+	F
<i>Nycteris hispidus</i>	+	+	+	+	+	+	+	W
<i>Nycteris macrotis</i>	+	+	+	+	+	+	+	W
<i>Nycteris thebaica</i>	+	+	—	+	+	—	+	S
<i>Nycteris gambiensis</i>	+	+	—	+	+	+	+	S
<i>Rhinolophus simulator</i>	—	—	+	—	+	—	—	U
<i>Rhinolophus denti</i>	+	+	—	—	+	—	—	?S
<i>Rhinolophus clivosus</i>	—	—	+	—	—	—	—	U
<i>Rhinolophus alcyone</i>	+	+	+	+	—	—	+	F
<i>Rhinolophus guineensis</i>	—	—	+	+	+	—	—	F
<i>Rhinolophus landeri</i>	+	+	—	+	+	—	—	W
<i>Rhinolophus macclaudi</i>	—	—	+	—	+	—	—	?U
<i>Rhinolophus fumigatus</i>	+	+	—	+	+	—	+	S
<i>Hipposideros jonesi</i>	+	+	+	+	+	—	—	W
<i>Hipposideros marisae</i>	—	+	+	—	+	—	—	?U
<i>Hipposideros fuliginosus</i>	+	+	+	+	?	—	—	F
<i>Hipposideros ruber</i>	+	+	+	+	+	—	+	W
<i>Hipposideros lamottei</i>	+	—	+	+	+	—	—	F
<i>Hipposideros caffer</i>	+	+	?	+	+	+	+	S
<i>Hipposideros beatus</i>	+	+	+	+	—	+	—	F
<i>Hipposideros cyclops</i>	+	+	+	+	—	+	+	F
<i>Hipposideros abae</i>	+	+	—	+	+	+	—	S
<i>Hipposideros commersoni</i>	+	+	+	+	+	+	+	W
<i>Kerivoula lanosa</i>	+	+	+	—	+	—	—	F
<i>Kerivoula smithi</i>	—	+	+	—	—	—	—	F
<i>Kerivoula phalaena</i>	+	+	+	—	—	—	—	F
<i>Myotis tricolor</i>	—	—	+	—	—	—	—	U
<i>Myotis bocagei</i>	+	+	+	+	—	—	—	W
<i>Pipistrellus africanus</i>	+	+	+	+	—	+	+	W
<i>Pipistrellus kuhlii</i>	—	—	+	—	—	—	—	S



TABLE 2—(Continued)

	Gh	IC	L	SL	Gu	GB	SGM	EC
<i>Pipistrellus rusticus</i>	+	—	?	—	—	—	—	S
<i>Pipistrellus inexpectatus</i>	+	—	—	+	—	—	—	S
<i>Pipistrellus eisentrauti</i>	—	+	+	—	—	—	—	F
<i>Pipistrellus nanulus</i>	+	+	+	+	+	—	—	W
<i>Pipistrellus guineensis</i>	+	+	—	—	+	+	+	W
<i>Pipistrellus somalicus</i>	+	—	?	+	—	+	+	S
<i>Pipistrellus capensis</i>	+	+	+	+	+	—	—	W
<i>Pipistrellus brunneus</i>	+	+	+	+	—	—	—	F
<i>Pipistrellus tenuipinnis</i>	+	+	+	+	+	—	+	F
<i>Pipistrellus rendalli</i>	+	—	+	+	—	—	+	W
<i>Mimetillus moloneyi</i>	+	+	+	+	—	—	—	F
<i>Glauconycteris beatrix</i>	+	+	—	—	—	+	—	F
<i>Glauconycteris poensis</i>	+	+	+	+	—	—	+	F
<i>Glauconycteris variegata</i>	+	—	—	—	—	—	+	S
<i>Glauconycteris superba</i>	+	—	—	—	—	—	—	F
<i>Nycticeinops schlieffeni</i>	+	—	—	—	—	—	+	S
<i>Scotoecus albobfuscus</i>	—	+	—	+	—	—	+	W
<i>Scotoecus hirundo</i>	+	—	—	+	—	—	+	W
<i>Scotophilus borbonicus</i>	+	+	—	+	—	—	+	S
<i>Scotophilus leucogaster (leucogaster)</i>	+	+	—	+	—	+	+	W
<i>Scotophilus leucogaster (dinganii)</i>	+	+	+	+	—	+	+	W
<i>Scotophilus nigrita</i>	+	—	—	—	—	—	+	W
<i>Miniopterus schreibersi</i>	—	—	+	+	+	—	—	W
<i>Miniopterus inflatus</i>	—	—	+	—	—	—	—	F
<i>Myotis daubentonii</i>	—	+	—	—	—	—	+	F
<i>Myotis whitleyi</i>	+	—	—	—	—	—	—	F
<i>Chaerephon bennettii</i>	—	—	+	+	—	—	—	F
<i>Chaerephon nigeriae</i>	+	—	—	+	—	—	—	W
<i>Chaerephon major</i>	+	—	+	—	—	—	—	W
<i>Chaerephon pumila</i>	+	+	+	+	—	+	+	W
<i>Chaerephon russata</i>	+	—	—	—	—	—	—	F
<i>Chaerephon aloysiisabaudiae</i>	+	—	—	—	—	—	—	F
<i>Mops nanulus</i>	+	—	+	+	—	—	+	F
<i>Mops spurrelli</i>	+	+	+	+	+	—	—	F
<i>Mops petersoni</i>	+	—	—	+	—	—	—	F
<i>Mops brachypterus</i>	+	+	+	+	—	—	+	F
<i>Mops thersites</i>	+	+	+	+	—	—	—	F
<i>Mops condylurus</i>	+	+	+	+	+	+	+	W
<i>Mops demonstrator</i>	+	—	—	—	—	—	+	S
<i>Mops congicus</i>	+	—	—	—	—	—	—	F
<i>Otomops martiensseni</i>	+	—	—	—	—	—	—	S

Gh Ghana; IC Ivory Coast; L Liberia; SL Sierra Leone; Gu Guinea; GB Guinea-Bissau; SGM Senegal, Gambia, Mauritania. EC ecological classification (F forest, S savana, W widespread, U upland—see text). + recorded, — not recorded, ? occurrence doubtful.

though migratory (Thomas, 1983), is largely confined to forests in sub-Saharan Africa. In Liberia, it is widely distributed throughout the country (Kuhn, 1965; Coe, 1975; Verschuren, 1977; Wolton et al., 1983; Koopman, 1989; this paper).

*Hypsignathus monstrosus*: This is another species largely confined to forests of sub-Sa-

haran Africa, but fairly widely distributed in Liberia (Bergmans, 1989; this paper) both in uplands and lowlands.

[*Epomops franqueti*]: This basically forest species has been recorded from Liberia by Kuhn, 1965, who regarded *buettikoferi* as conspecific, but, as explained previously, it probably does not extend west of Ivory Coast.

Liberian records probably refer to *Epomops buettikoferi*.

*Epomops buettikoferi*: This species is largely confined to forests from Nigeria to Sierra Leone and Guinea. It is widely distributed in Liberia (Bergmans, 1989; Koopman, 1989; this paper). The junior authors would be inclined to treat this as a savanna species, based on its more frequent occurrence in disturbed agricultural habitats than in rain forest. This view conflicts with the virtual absence of *E. buettikoferi* from savanna areas.

[*Epomophorus gambianus*]: This is a widespread, sub-Saharan species, albeit with major disjunctions in its range. The sole basis for including it in Liberia is a record from Kpeape that Bergmans (1989) doubts. We strongly suspect this record was based on misidentified *Epomops buettikoferi*.

*Micropteropus pusillus*: This is a widespread sub-Saharan species, but according to Bergmans (1989: 100), it is probably absent from undisturbed forest. See Thomas and Marshall (1984) for its savanna occurrence. In this connection, all published Liberian records (Bergmans, 1989; Koopman, 1989; this paper) are coastal, in or near the strip that Rosevear (1965) mapped as coastal scrub. It was conspicuous by its absence in large collections from the rain forest at Wonegizi. However the National Museum has a specimen from "Zigida Village, 25 miles north of Zozor."

*Nanonycteris veldkampii*: This is basically a West African forest species, though it is known to be migratory and occurs in savannas during the wet season (Marshall and McWilliam, 1982; Thomas, 1983; Wolton et al., 1983), ranging from the Central African Republic to Guinea. A good case could be made for regarding this species as ecologically widespread. However, the senior author, but not the junior authors, would stress that everyone seems to agree that *Nanonycteris* shows much greater affinity for rain forest than does *Micropteropus*. While the type locality of the species (Buluma, Fisherman Lake) is near the coast in Liberia, all recently collected Liberian material is from either the Mount Nimba area (Bergmans, 1989) or the northwest (Koopman, 1989; this paper). It is possible that deforestation since 1881 (when

the holotype was collected) has eliminated the species from the coastal area.

*Scotonycteris zenkeri*: This central and western African forest species ranges from eastern Zaire to Liberia. In Liberia, it is widely distributed (Bergmans, 1990; Koopman, 1989; this paper).

*Scotonycteris ophiodon*: This rare west African forest species is only known from the Congo Republic, Cameroon, Ghana, and Liberia. The three known Liberian localities (Bergmans, 1990; Koopman, 1989) are all in the northeastern and north-central upland parts of the country.

*Megaloglossus woermanni*: This is a tropical African forest species with an extensive distribution. It is also widely distributed within Liberia (Kuhn, 1965; Coe, 1975; Verschuren, 1977; Wolton et al., 1983; Koopman, 1989; this paper).

*Saccolaimus peli*: This is another tropical African forest species with an extensive distribution. The relatively few known localities in Liberia (Kuhn, 1965; Coe, 1975; Wolton et al., 1983; Koopman, 1989) indicate an extensive distribution within Liberia.

*Nycteris intermedia*: This forest species has an extensive distribution from Tanzania to Liberia. The few Liberian records (Kuhn, 1965; this paper) suggest a wide distribution in that country.

*Nycteris arge*: This forest species has an extensive distribution from Kenya to Sierra Leone. The relatively few Liberian records (Van Cakenberghe and De Vree, 1985; Koopman, 1989; this paper) indicate an extensive distribution there.

*Nycteris major*: This is a rare forest bat with a spotty distribution (as far as is known) from Zambia to Liberia. The sole Liberian record (Koopman, 1989) is from the uplands in the extreme northwestern part of the country.

*Nycteris grandis*: This basically forest species has an extensive distribution in sub-Saharan Africa. A number of records (Kuhn, 1965; Verschuren, 1977; Wolton et al., 1983; this paper) indicate that it is widespread in Liberia.

*Nycteris hispida*: This species is widespread in sub-Saharan Africa. Liberian records (Kuhn, 1965; Koopman, 1989; Van

Cakenberghe and De Vree, 1993) are few, however, and confined to the lowlands.

*Nycteris macrotis*: This widespread sub-Saharan species is known from relatively few Liberian localities (Van Cakenberghe and De Vree, 1985; Koopman, 1989; this paper). However, these are widely distributed in Liberia from the coast to the uplands.

*Rhinolophus simulator*: This species has an extensive distribution in southern and eastern Africa, but in western Africa is known only from a few upland areas in Cameroon, Nigeria, Liberia, and Guinea. For this reason we would put it in our "upland" category. The only known Liberian locality (this paper) is in the uplands of the northwest.

*Rhinolophus clivosus*: This species has likewise been allocated to the upland category because in western Africa it is known only from upland areas in Cameroon and Liberia. It has an extensive distribution, however, in southern, eastern, and even northern Africa. Liberian records come from upland areas in both central and western portions of the country (Koopman, 1989; this paper).

*Rhinolophus alcyone*: This forest species has an extensive distribution in tropical Africa. However, the only known Liberian record (Verschuren, 1977) is from the uplands of the central part of the country.

*Rhinolophus guineensis*: This forest species has a very restricted range in parts of Liberia, Sierra Leone, and Guinea. The only Liberian records (Koopman, 1989; this paper) are from the uplands of the northwest.

*Rhinolophus maclaudi*: We have tentatively put this species in the upland category. The uncertainty arises from the fact that the holotype was supposedly obtained at Conakry on the coast of Guinea. All other specimens of this species have been collected in upland areas, however, and in view of the relatively early collecting date (1897), it seems possible that the holotype was actually obtained farther inland. As *R. maclaudi* is currently conceived, the distribution is markedly discontinuous, falling into three widely separated areas: Uganda, Rwanda, eastern Zaire; central Nigeria; Liberia and Guinea. The only Liberian record (this paper) is from the northwest uplands.

*Hipposideros jonesi*: This widespread spe-

cies is confined to West Africa, ranging from Nigeria to Guinea and Sierra Leone. The only Liberian record (this paper) is from the northwestern uplands.

*Hipposideros marisae*: We have tentatively considered this an upland species but its known distribution is very limited, being confined to a small area of Ivory Coast, Liberia, and Guinea. The Liberian records (Kuhn, 1965; Hill, 1982; Wolton et al., 1983; this paper) are all from the central and western uplands.

*Hipposideros fuliginosus*: While, as discussed above, there is considerable uncertainty concerning the limits (both morphological and geographical) of this species, it appears to be a forest species with an extensive distribution in tropical central and western Africa. Liberian specimens that we have studied and would allocate to *H. fuliginosus* are from the Zwedru area in the lowlands of eastern Liberia, the Mount Nimba area in the central uplands, and the northwestern uplands (Voinjama and the Ziggida area). We know of no reliable published records.

*Hipposideros ruber*: This widespread species has an extensive distribution in sub-Saharan Africa. Liberian specimens studied by us are widely distributed in that country.

*Hipposideros lamottei*: As we have interpreted this species, it occurs in forests from at least Cameroon to Guinea and Sierra Leone. The four Liberian specimens that we would allocate to this species are from the central uplands (Teayee), eastern lowlands (Mount Coffee), and northwest uplands (Voinjama).

[*Hipposideros caffer*]: This basically savanna species has an extensive sub-Saharan distribution. There are no recent records from Liberia, though the junior authors would expect it in the deforested zone. Kuhn (1965) records this species from the following localities: Junk River, Du Queah River, Mount Coffee, Freemantown, Harbel, Kahnple, Peloken. Of the specimens from these localities, the senior author has seen only those from Mount Coffee (reported by Miller, 1900), which, as explained above, he would allocate to *ruber*, *lamottei*, and *beatus*. Since Kuhn (1965) did not list *H. ruber*, it is almost certain that he included it in his concept of *H.*

*caffer*, as was customary at the time (see Rosevear, 1965). Consequently, there is no sound reason to believe that true *H. caffer* occurs in Liberia, though we would certainly not rule out this possibility.

*Hipposideros beatus*: This forest species has an extensive distribution in central and western Africa. The few Liberian records (Kuhn, 1965; Koopman, 1989; this paper) are in the lowlands.

*Hipposideros cyclops*: This forest species has an extensive distribution in tropical Africa. Liberian records (Kuhn, 1965; Verschuren, 1977; Wolton et al., 1983; Koopman, 1989) are from both lowlands and uplands and suggest a wide distribution within the country.

*Hipposideros commersoni*: This widespread species has an extensive sub-Saharan distribution. The few Liberian records (Kuhn, 1965; Wolton et al., 1983; this paper) are from both lowlands and uplands.

*Kerivoula lanosa*: This forest species has an extensive sub-Saharan distribution. However, there appear to be only two known Liberian localities (Kuhn, 1965; Hill, 1977), both in the lowlands.

*Kerivoula smithi*: This forest species is known from Kenya, Zaire, Cameroon, and Nigeria. Happold's (1987) distribution table indicates its occurrence in Liberia, but we have been unable to trace any actual locality in that country.

*Kerivoula phalaena*: This forest species is confined to central and western Africa. The three known Liberian localities (Kuhn, 1965) are all in the lowlands.

*Myotis tricolor*: This is a widespread eastern and southern African species. The only west African record (Koopman, 1989) is from the northwestern uplands of Liberia. We therefore would consider this in the upland species category.

*Myotis bocagei*: This widespread species has an extensive distribution in sub-Saharan Africa. The only known Liberian record (Kuhn, 1965) is from the western lowlands.

*Pipistrellus africanus* (= *nanus*): This widespread species has an extensive sub-Saharan distribution. From the numerous Liberian records (Kuhn, 1965; Wolton et al., 1983; Koopman, 1989; this paper), it is clear that *P. africanus* is widely distributed in Liberia.

*Pipistrellus kuhlii*: This savanna species has

an extensive distribution over much of Africa, though there are few records from West Africa south of the Sahara. The only Liberian record (Hill, 1982; Wolton et al., 1983) is from the highlands (over 1000 m) of Mount Nimba.

[*Pipistrellus rusticus*]: This savanna species has a fairly extensive, albeit spotty, sub-Saharan distribution. Its only Liberian record is from the same locality as that of *Pipistrellus kuhlii*. As discussed above, we believe that this Mount Nimba specimen, which Hill (1982) identified as *P. rusticus*, is actually a small individual of *P. kuhlii*.

*Pipistrellus eisentrauti*: This forest species has a fairly extensive, albeit spotty, tropical African distribution. The sole Liberian record (Koopman, 1989) is from the northwestern uplands.

*Pipistrellus nanulus*: This widespread species has a fairly extensive tropical African distribution. The three Liberian records of this species (Hill, 1982; Koopman, 1989) are from uplands and lowlands of the eastern and central portions of the country.

[*Pipistrellus somalicus*]: This savanna species has an extensive range in sub-Saharan Africa. Kuhn (1962, 1965) recorded a single specimen from Deaple in the central uplands of Liberia which he originally identified as "*Eptesicus minutus*." This preoccupied name has been used for various small dark-winged African "*Eptesicus*." From Kuhn's (1962) measurements, this specimen agrees best with *P. somalicus*, but in view of the presence of three other similar species in far-western Africa (*guineensis*, *capensis*, *brunneus*), its identity remains uncertain.

*Pipistrellus capensis*: This widespread species has an extensive sub-Saharan distribution. However, the only Liberian records (Verschuren, 1977) are from the eastern lowlands and uplands.

*Pipistrellus brunneus*: This forest species is confined to central and western Africa. The only Liberian record (Koopman, 1989) is from the northwestern uplands.

*Pipistrellus tenuipinnis*: This forest species has an extensive tropical African distribution. Liberian records (Kuhn, 1965; Koopman, 1989; this paper) indicate an extensive distribution in the country, both lowlands and highlands.

*Pipistrellus rendalli*: This widespread spe-

cies has an extensive sub-Saharan distribution. However, the only Liberian record (Kuhn, 1965) appears to be Harbel in the western lowlands.

*Mimetillus moloneyi*: This basically forest species has an extensive tropical African distribution. The few Liberian records (Kuhn, 1965; Koopman, 1989) are from the lowlands and uplands of the western part of the country. However, there is a specimen (USNM) from near Zwedru in the eastern lowlands.

*Glauconycteris poensis*: This basically forest species has an extensive tropical African distribution. Except for the single lowland specimen reported in this paper, the two Liberian records (Koopman, 1989) are from the central and western uplands.

*Scotophilus leucogaster* (*dinganii* group): This widespread group of subspecies (including *colias* and *nux*) has an extensive sub-Saharan distribution. The two Liberian records (Hill, 1982; Koopman, 1989), however are both from the uplands, one central, the other western.

*Miniopterus schreibersi*: This widespread forest species has a very extensive distribution but the only Liberian record (this paper) is from the northwestern uplands.

*Miniopterus inflatus*: This forest species has an extensive tropical African distribution, but the only Liberian records (Hill, 1982; Wolton et al., 1983; this paper) are from the central and western uplands.

*Chaerephon bennettii*: This forest species has an extensive, albeit patchy, distribution across tropical Africa. As mentioned above, however, the precise Liberian locality (if indeed it occurs in Liberia) is unknown. The Sierra Leone record is in Northern province.

*Chaerephon major*: This widespread species has an extensive distribution in tropical Africa. Liberian records (Hill, 1982; Wolton et al., 1983; Koopman, 1989; this paper) suggest that it is widespread in Liberia.

*Chaerephon pumila*: This widespread species has an extensive sub-Saharan distribution. However, the only Liberian record (Verschuren, 1977) is from the central uplands.

*Mops nanulus*: This forest species has an extensive distribution in tropical Africa. However, the only Liberian record (Verschuren, 1977) is from the eastern lowlands.

*Mops spurrelli*: This forest species is prob-

ably confined to western Africa. The two Liberian localities (Koopman, 1989; this paper) are from the lowlands and uplands of the western part of the country.

*Mops brachypterus* (= *leonis*): This forest species has an extensive tropical African distribution. The only Liberian record (Koopman, 1989), however, is from the western lowlands.

*Mops thersites*: This is another forest species with an extensive tropical African distribution. Liberian records (Kuhn, 1965; Verschuren, 1977; Koopman, 1989) are from the western lowlands and from central and western uplands. There is a specimen (USNM) from the eastern lowlands (near Zwedru).

*Mops condylurus*: This widespread species has an extensive distribution. However, the only Liberian records (this paper) are from the western and west-central lowlands.

Summing up, if we subtract the seven species of bats whose occurrence or distribution in Liberia is uncertain, we have nine species known only from the lowlands, 19 known only from the highlands, and 27 from both. It is important to point out that the number of species known from the uplands has greatly increased since Kuhn (1965) listed bats from three upland localities (Deaple, Gapple, Kahnple), all from the central part of the country. Kuhn listed only nine species (*Eidolon helvum*, *Hypsignathus montrosus*, *Epomops buettikoferi*, *Nycteris intermedia*, *Hipposideros marisae*, *H. ? ruber*, *H. cyclops*, *Pipistrellus africanus*, and *P. ? somalicus*) from these three localities. Clearly (because of difficulty of access), most records from before 1965 were from the lowlands, chiefly the western lowlands. Kuhn (1965) listed 26 species from the lowlands (ignoring the problematical *Epomophorus gambianus*, *Scotonycteris ophiodon*, *Pipistrellus somalicus*, and *Chaerephon bennettii*), of which 18 are here considered basically forest species. While records from the lowlands since 1965 have been relatively few (Verschuren, 1977; Koopman, 1989; Bergmans, 1989; Kofron and Chapman, 1994; this paper), they have confirmed the continued occurrence of nine of these species (*Myonycteris torquata*, *Hypsignathus montrosus*, *Epomops buettikoferi*, *Scotonycteris zenkeri*, *Megaloglossus woermanni*, *Saccolaimus peli*, *Hipposideros beatus*, *H. cyclops*, and *Mimetillus moloneyi*). In addition, there are low-

land specimens (USNM) collected since 1965 of two others (*Pipistrellus tenuipinnis*, *Mops thersites*). For the remaining seven (*Nanonycteris veldkampii*, *Nycteris intermedia*, *N. arge*, *N. grandis*, *Hipposideros lamottei*, *Kerivoula lanosa*, and *K. phalaena*), however, we know of no post-1965 lowland records. *Hipposideros lamottei* is listed here because although it was not listed by Kuhn (1965), one of Miller's (1900) "*Hipposideros caffra*: from

Mount Coffee" is actually *H. lamottei*, as mentioned previously. Although the absence of at least some of these seven may well be the results of vagaries of collecting or have simply not been reported in the literature, it is possible that some, as suggested above for *Nanonycteris veldkampii*, have disappeared from the Liberian lowlands as a result of deforestation. In any case, they should be looked for in any remaining lowland forest habitat.

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