

THE BATS OF TIMOR:
SYSTEMATICS AND ECOLOGY

ROBERT E. GOODWIN

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ABSTRACT

A survey of the species of bats occurring on the island of Timor was conducted from February 27 to May 22, 1968. Eleven of the 22 species found are new records for the island, namely: *Eonycteris spelaea*, *Macroglossus lagochilus*, *Taphozous melanopogon*, *Taphozous saccolaimus*, *Rhinolophus borneensis*, *Rhinolophus creaghi*, *Rhinolophus philippinensis*, *Pipistrellus tenuis*, *Miniopterus australis*, *Miniopterus magnater*, and *Miniopterus pusillus*. *Rhinolophus borneensis parvus*, *Rhinolophus creaghi timorensis*, and *Rhinolophus philippinensis montanus* are new subspecies. A study of

the literature and of the important museum collections of bats from Timor indicates that two other species probably occur there also. External structural characteristics and ecological data are given and the taxonomic status on Timor and adjacent islands is discussed for each species. An account of the history of bat study on the island and a discussion of the literature dealing with the bat fauna of Timor is included. An analysis of zoogeographical relationships with adjacent islands and major land masses is discussed and an attempt is made to account for the origin of each species of bat found on Timor.

INTRODUCTION

PHYSICAL GEOGRAPHY OF TIMOR

Timor Island, the largest of the Lesser Sunda Islands, has a length of about 480 km., a maximum width of 95 km., and an area of approximately 35,480 km². It lies from 8 to 10 degrees south of the equator and is oriented in a northeast-southwest position. Less than 40 km. off the north coast is the Indonesian island of Alor, the nearest of a continuous chain of closely spaced islands connecting Timor with Java and ultimately the Malay Peninsula. The Australian mainland lies about 480 km. to the southeast across the Timor Sea.

A complex system of mountains runs the length of the island producing a rugged terrain with altitudes as high as 2955 m. A series of alternate submergences and emergences have provided the igneous core of the ancient island with a thick mantle of sedimentary rock. The combination of limestone, orogenic activity, and monsoonal rains has produced extensive cave systems in parts of the island and the characteristic karst topography is apparent in many areas. Most of the natural caves that were investigated during this study were very irregular in form, having developed in association with complex fault systems. Large chambers and large, regular tunnel-like passageways were uncommon and extensive active formations where deposition was occurring were

found in but a few of the caves. Fissure-type caves were common. The markedly seasonal rainfall and capricious water table, and the extensive orogenic activity which occurred through much of the limestone area could account for these cave characteristics.

The island is under the influence of the Asiatic monsoon from the northwest which brings considerable moisture to parts of the island, and the Australian monsoon from the southeast which is extremely dry. The average annual rainfall ranges from approximately 510 mm. to more than 3050 mm. In eastern Timor the localities with the highest and lowest annual rainfall are only about 130 km. apart. There are many local variations in rainfall, but in general, the north coast and central part of the island have a rainy season from December to May. During this period the climate is hot and humid at low altitudes with a mean temperature of approximately 27° C. In the mountains the temperatures are generally cool and the humidity high. At Maubisse at an altitude of 1520 m. temperatures near freezing have been recorded. The south coast has a rainy period extending from December to July.

The combination of a long dry season, clearing of the land for agriculture, and heavy cutting of the original forests rich in sandalwood and rosewood is responsible for the fact that

much of the island is covered with grassland and scrub. However, contrary to what one may read in the scant literature describing the vegetation, rather extensive forests still exist in areas of higher rainfall. Lush forests are found along the south coast, in parts of the mountainous interior, and along stream and river valleys. Coastal palm forests dominated by species of *Corypha* and *Borassus*, present striking plant communities. Extensive mangrove forests of nearly pure stands of *Rhizophora conjugata* also occur along the coasts. These conditions have offered a considerable amount of ecological diversity to the organisms that have reached the island during its long history.

HISTORY OF BAT STUDY IN TIMOR

The earliest important collections of Timorese bats were made by François Péron, René Maugé, and Charles Lesueur during the French expeditions of 1801 and 1803 under the direction of Captain Nicolas Baudin. Five of the bats collected on these expeditions were subsequently described as new species by Geoffroy (1810, 1813). These records, which thus designated Timor as the type locality, were *Pteropus amplexicaudatus* (= *Rousettus amplexicaudatus*), *Pteropus griseus*, *Pteropus edulis* (= *Pteropus vampyrus*), *Cephalotes peroni* (= *Dobsonia peroni*), and *Hipposideros diadema*. The identity of the nominal species *Vespertilio timoriensis* Geoffroy (1806) has not been definitely established. A specimen in the Paris Museum labeled *Nyctophilus timoriensis*, MHNP 217, is believed to be the type specimen. Rode (1941) gave the type locality as Timor, but Tate (1941b) stated that the type locality is unknown. Since *Nyctophilus* has never been reported outside of the Australo-Papuan region, it is unlikely that it occurs in Timor.

In 1829, Salomon Müller collected specimens of 10 species of bats in Timor, one of which, *Pteropus mackloti* (= *Acerodon mackloti*), was subsequently described as a new species by Temminck (1835-1841). Recorded from Timor for the first time as a result of Müller's work were *Macroglossus minimus*, (probably *M. lagochilus*), *Hipposideros bicolor*,

Scotophilus temmincki (= *S. kuhlii*), and *Miniopterus schreibersi* (probably *M. magnater*). In addition, Müller (1839-1844) listed *Rhinolophus minor* from Timor. It is quite likely that this record referred to *Rhinolophus borneensis*. He collected several specimens of *Pteropus griseus* from Timor and Semau which were later incorrectly identified as *Pteropus temmincki* and served as the basis for many later reports of this species from Timor. The material collected by Müller is located in the Rijksmuseum, Leiden. If Müller actually collected specimens of *Macroglossus minimus* and *Hipposideros bicolor* on Timor, they were subsequently lost, since no such material presently exists.

Seabra (1897, 1898a, 1898b, 1900) listed several species of bats from Timor from specimens in the Museu Bocage, Lisbon. These are referable to *Rousettus amplexicaudatus*, *Pteropus griseus*, *Pteropus vampyrus*, *Acerodon mackloti*, *Hipposideros diadema*, and *Scotophilus kuhlii*. Specimens of all of these species except *Acerodon mackloti* are still in the collection of the Museu Bocage. Seabra's papers contain a complex synonymy due to his interpretation of cases of individual variation and dichromatism, especially in the Pteropodidae. Some of this synonymy is discussed in the Species Accounts.

Andersen (1912) listed nine species of Megachiroptera from Timor: *Rousettus amplexicaudatus*, *Pteropus griseus*, *Pteropus temmincki*, *Pteropus vampyrus edulis*, *Acerodon m. mackloti*, *Dobsonia moluccensis*, *Dobsonia peroni*, *Cynopterus sphinx tithaecheilus*, and *Nyctimene cephalotes*. Uncertain identifications of specimens led Andersen to question the validity of including *Dobsonia moluccensis* and *Cynopterus sphinx tithaecheilus* in this list. The record of *Dobsonia moluccensis* was based on a mounted adult female specimen collected in Semau by Müller and labeled "*Cephalotes peroni*." Andersen noted that this specimen, located in the Rijksmuseum, Leiden, was externally indistinguishable from *Dobsonia moluccensis* and suggested that if the locality was correct, the range of the species probably also included the other islands of the Timor group. Dr. A. M. Husson informed me that this badly faded specimen

(RMNH qq) is mounted with wings spread and skull *in situ*. The forearm length is 135 mm. The identity of this large *Dobsonia* remains to be determined. If *Dobsonia moluccensis* does occur on Timor, it must be uncommon or locally distributed.

The *Nyctimene* record is based on a specimen in the British Museum (Natural History), BMNH 9.1.4.8. The only collecting data on the label is "Timor." The specimen on which the record of *Cynopterus sphinx* is based is an immature female, BMNH 84.4.22.1, collected by Dr. H. O. Forbes in 1883.

The expedition of C. B. Haniel to western Timor in 1911 resulted in a collection of eight species of bats identified by Schwarz (1914) as: *Pteropus griseus*, *Pteropus vampyrus*, *Dobsonia peroni*, *Cynopterus sphinx*, *Rhinolophus simplex* (actually *R. borneensis*), *Rhinolophus canuti* (actually *R. creaghi*), *Hipposideros diadema*, and *Pipistrellus tralatitius* (= *P. tenuis*). Unfortunately, most of Haniel's material, which had been deposited in the Bavarian State Collection, Munich, was destroyed during World War II. Only two specimens are extant, a skull of *Pteropus vampyrus* labeled "*Pteropus celaena* (?)," BSM 2279, from Timor, and a skeleton labeled "*Pteropus temmincki*," BSM 2151, from central Semau. The latter specimen is very young and cannot be positively identified, but the proportions of the skull compare favorably with a slightly older specimen of *Pteropus griseus* in my collection.

In a review of the distribution of bats in the Lesser Sunda Islands, Pohle (1950) listed 20 species from Timor: *Rousettus amplexicaudatus*, *Pteropus hypomelanus*, *Pteropus temmincki*, *Pteropus vampyrus*, *Acerodon mackloti*, *Dobsonia peroni*, *Cynopterus brachyotis*, *Cynopterus sphinx*, *Macroglossus minimus*, *Nyctimene cephalotes*, *Rhinolophus arcuatus*, *Rhinolophus simplex*, *Hipposideros bicolor*, *Hipposideros diadema*, *Hipposideros galeritus*, *Hipposideros speoris*, *Pipistrellus tralatitius*, *Scotophilus temmincki*, *Miniopterus blepotis*, and *Nyctophilus timoriensis*. Since the author did not refer to original records, some of the sources are obscure. Undoubtedly, Pohle's list is based in part on the collection of Georg Stein in the Berlin Museum. I have not had an

opportunity to examine this collection. The record of *Pteropus hypomelanus* probably referred to *Pteropus griseus*, a member of the *hypomelanus* group. The basis for the record of *Cynopterus brachyotis* may have been a misinterpretation of Sody (1940). In that paper, Sody identified the Timorese form of *Cynopterus sphinx* as a new subspecies, *terminus*, and on the following page, he described specimens of *Cynopterus brachyotis* from the islands of Talau in the northern Moluccas, and Bawean between Java and Borneo. The record of *Rhinolophus arcuatus* may have referred to Schwarz's record of *Rhinolophus canuti*, a member of the *arcuatus* group. The *Hipposideros galeritus* record probably referred to Lesueur and Petit (1824) who included in their atlas a plate of *Hipposideros crumeniferus* from Timor. Laurie and Hill (1954) declared *crumeniferus* to be *incertae sedis* but noted that the figures in Lesueur and Petit's plate had characters which would place it in the *galeritus* group. Since there are no other records of the *galeritus* group from Timor and since only a drawing of *crumeniferus* exists, the presence of this form on Timor must be considered doubtful. The source of the record of *Hipposideros speoris* probably goes back to the same illustration. In reference to this problem, Tate (1941) wrote: "It is difficult to determine from Péron's plate the number of lateral leaflets. The 4-celled transverse leaf, the forearm length 53 mm. (on the plate), the frontal sac—all are characters common to males of *speoris* and *cervinus*. Geoffroy's (1813) picture of 'crumeniferus' which clearly shows three lateral leaflets may have been drawn from different material. Péron's figures show a more lightly built bat than *speoris*. Also, Timor is well within the extensive distributional range of the *galeritus* group, whereas, excepting the doubtfully identified *taitiensis*, *speoris* is unknown beyond India and Ceylon some 2000 miles from Timor."

The record of *Miniopterus blepotis* refers back to Müller's record of *M. schreibersi* which is probably *M. magnater*. Thus, of the total of 20 species listed for Timor by Pohle, only 10 represent substantial records.

Laurie and Hill (1954) listed 15 species of

bats from Timor. These were *Rousettus a. amplexicaudatus*, *Pteropus g. griseus*, *Pteropus t. temmincki*, *Pteropus vampyrus edulis*, *Acerodon m. mackloti*, *Dobsonia p. peroni*, *Cynopterus sphinx terminus*, *Nyctimene cephalotes*, *Hipposideros b. bicolor*, *Hipposideros crumeniferus*, *Hipposideros d. diadema*, *Pipistrellus j. javanicus*, *Tylonycteris robustula*, *Scotophilus t. temmincki*, and *Miniopterus schreibersi blepotis*. The record of *Pipistrellus javanicus* referred to Haniel's two specimens which Schwarz (1914) called *Pipistrellus tralatitius* and which are now known to be *Pipistrellus tenuis*. *Tylonycteris robustula* was reported from Timor by Thomas (1915a) on the basis of two specimens in the British Museum (Natural History), BMNH 84.4.22.2 and BMNH 84.4.22.3, collected by H. O. Forbes. According to Mr. John E. Hill (*in litt.*) these specimens are labeled "Timor" and are without further collecting data. Of the 15 forms listed by Laurie and Hill, 11 represent unquestionable records; the occurrence of *Pteropus temmincki* and *Hipposideros crumeniferus* in Timor must be considered doubtful.

The present study was undertaken in an attempt to clarify some of the problems existing in the taxonomy and distribution of bats on Timor. A period of three months (February 27 to May 22, 1968) was spent on the eastern half of the island (then Portuguese Timor) during which time a total of 20 species of bats was collected. As a result of this study, two genera, *Eonycteris* and *Taphozous*, and 11 species were recorded for the first time from Timor: *Eonycteris spelaea*, *Macroglossus lagochilus*, *Taphozous melanopogon*, *Taphozous saccolaimus*, *Rhinolophus borneensis*, *Rhinolophus creaghi*, *Rhinolophus philippinensis*, *Pipistrellus tenuis*, *Miniopterus australis*, *Miniopterus magnater*, and *Miniopterus pusillus*. The collection of *Hipposideros bicolor* verifies a previous report which had not been supported by extant specimens. Finally, as a result of this study, the following forms were described as new subspecies: *Rhinolophus borneensis parvus*, *Rhinolophus creaghi timorensis*, and *Rhinolophus philippinensis montanus*. The entire collection consisting of 88 skins and skulls and 213 alco-

holic specimens is deposited in the American Museum of Natural History in New York City.

In summary, the following species of bats are known to occur in Timor: *Rousettus amplexicaudatus*, *Pteropus griseus*, *Pteropus vampyrus*, *Acerodon mackloti*, *Dobsonia peroni*, *Cynopterus sphinx*, *Eonycteris spelaea*, *Macroglossus lagochilus*, *Taphozous melanopogon*, *Taphozous saccolaimus*, *Rhinolophus borneensis*, *Rhinolophus creaghi*, *Rhinolophus philippinensis*, *Hipposideros bicolor*, *Hipposideros diadema*, *Pipistrellus tenuis*, *Scotophilus kuhlii*, *Miniopterus australis*, *Miniopterus magnater* and *Miniopterus pusillus*.

Although *Nyctimene cephalotes* and *Tylonycteris robustula* were not collected during this study, it is probable that they occur in Timor. Therefore, they are included in the species accounts.

Finally, four species which are known to occur on Flores but have not been reported from Timor might possibly occur there. These are *Taphozous longimanus*, *Myotis mystacinus*, *Murina florium*, and *Kerivoula papillosa*. Since competitive exclusion between *Taphozous longimanus* and *T. melanopogon* might be expected, it would not be surprising to find that *T. longimanus* occurs on Flores, but not on Timor and that *T. melanopogon* occurs on Timor, but not on Flores. Although these two species are not known to occur together on any of the Lesser Sunda Islands, they are sympatric on Borneo, Java, Sumatra, and on the mainland.

ZOOGEOGRAPHY OF TIMOR AND ORIGINS OF THE TIMORESE BAT FAUNA

The zoogeographical importance of Timor as a "stepping stone" between the Lesser Sunda Islands and Australia has been emphasized by Wallace (1869), Stresemann (1939), and Mayr (1944). During the Pleistocene, Timor was separated from Australia by only about 72 km. of sea. Although Rensch (1936) postulated the presence there of a land bridge like that which existed between Australia and New Guinea when the Sahul Shelf was exposed, geological

evidence does not support his theory. Neither does it find support in the zoogeography of the area, a fact first recognized by Wallace when he observed that there were no species of Australian land mammals in Timor. (Actually, *Phalanger orientalis* occurs in Timor and the Cape York Peninsula.) Rensch also claimed that at one time Timor was connected by land to Sumba, Alor, Wetar, and Tanimbar. Whether or not this is true is not really important in accounting for the origins of the Timorese bat fauna. It is most significant, however, that the Lesser Sunda Islands form a continuous chain between Java and Timor with, at most, a 40 km. stretch of water separating the islands. It is not surprising then, to find that the majority of Timorese bats are most closely related to Malaysian, Sumatran, and Javan forms rather than to Australo-Papuan species, and that the colonization of Timor by bats has been predominantly from the west. The bat faunas of the islands in the Lesser Sunda archipelago adjacent to Timor are too poorly known for valid comparisons to be made at this time. However, one would expect the closest faunal affinities to occur between Timor and the Alor, Solor, Flores group, the adjacent chain of islands which forms the main terrestrial approach to Timor from the west.

Mayr noted that of the 137 species of breeding land birds of Timor, 65 came from the west and 64 came from the Australo-Papuan region, the origins of the remaining species being obscure. The bat fauna of Timor exhibits a much weaker Australo-Papuan influence. Of the 22 species known to occur on the island, 16 are clearly of Asiatic origin. These are *Rousettus amplexicaudatus*, *Pteropus vampyrus*, *Cynopterus sphinx*, *Eonycteris spelaea*, *Macroglossus lagochilus*, *Taphozous melanopogon*, *Taphozous saccolaimus*, *Rhinolophus borneensis*, *Hipposideros bicolor*, *Hipposideros diadema*, *Pipistrellus tenuis*, *Tylonycteris robustula*, *Scotophilus kuhlii*, *Miniopterus australis*, *Miniopterus pusillus*, and *Miniopterus magnater*. The four genera *Cynopterus*, *Eonycteris*, *Tylonycteris*, and *Scotophilus* range widely through the Oriental region and the intercontinental islands as far as Timor, but do not reach Australia or New Guinea. *Rousettus* reaches

New Guinea and the Solomon Islands, but not Australia. *Pteropus vampyrus* and *Taphozous melanopogon* do not reach the Australo-Papuan region, but these genera are represented there by other species. The ranges of *Macroglossus lagochilus*, *Hipposideros diadema*, *Miniopterus australis*, *Miniopterus pusillus*, and *Miniopterus magnater* extend from the Oriental region into the Australo-Papuan region or beyond. *Taphozous saccolaimus* should also be included here if one considers the likelihood that *T. nudicluniatatus* is really a subspecies of *T. saccolaimus*.

A second group of Timorese bats consists of intercontinental endemic species. This autochthonous element includes *Pteropus griseus*, *Acerodon mackloti*, *Rhinolophus creaghi*, and *Rhinolophus philippinensis*. *Rhinolophus* entered the islands from the Oriental region and thence spread to New Guinea and Australia. *Acerodon* is an endemic genus derived from *Pteropus*. Although its origin cannot be certainly determined, Celebes is a likely possibility since the species occurring there, *Acerodon celebensis*, has the least specialized dentition and was considered by Andersen (1912) to be the most primitive form. Also, the size, ecological diversity, and isolation of this island have been conducive to the evolution of a number of Megachiropteran genera, e.g., *Neopteryx*, *Boneia*, *Styloctenium*, and probably *Harpionycteris*. The dispersal of *Acerodon* into the Lesser Sunda Islands by way of Flores and into the Philippines through the Sanghir Islands could logically account for the present distribution and relationships of *Acerodon* species.

Finally, two species, *Dobsonia peroni* and *Nyctimene cephalotes*, represent genera which appear to have had an Australo-Papuan origin. *Dobsonia peroni* evolved in the Lesser Sunda Islands, and *Nyctimene cephalotes* probably originated in New Guinea. The present distribution of these genera strongly suggests an origin in New Guinea. The two forms of *Nyctimene* and one of *Dobsonia* that occur in Australia are apparently confined to the Cape York Peninsula and may be derived from relatively recent arrivals from New Guinea.

It is beyond the scope of the present paper to consider the origins of the continental Aus-

tralian bat fauna. The importance of Timor as a "stepping stone" for the colonization of Australia by bats is open to question. It seems that it has been far less important for this group than for birds. It is possible that Timor could have served as a corridor of entry into Australia for *Taphozous*, *Rhinolophus*, *Hipposideros*, *Pipistrellus*, and *Miniopterus*, but relationships would suggest that most genera entered Australia by way of New Guinea. It seems likely that at times dispersal across the Sahul Shelf by bats has also occurred in the opposite direction. There is no evidence to suggest that bats have ever entered the Lesser Sunda Islands from Australia by way of Timor.

Little endemism occurs in Timorese bats. There are no endemic genera or species and presently, only six endemic subspecies are recognized. These are *Cynopterus sphinx terminus*, *Pteropus vampyrus edulis*, *Acerodon mackloti mackloti*, *Rhinolophus borneensis parvus*, *Rhinolophus creaghi timorensis*, and *Rhinolophus philippinensis montanus*. Whether or not *Pteropus vampyrus edulis* and *Acerodon mackloti mackloti* are valid subspecies remains to be determined.

The 137 resident birds of Timor include one endemic genus, 22 endemic species (16%), and 67 endemic subspecies (47.5%) (Mayr, 1944). The small percentage of "old" endemics in the Timorese avifauna is accounted for by the fact that during the early Pleistocene most of Timor was submerged. Also, faunal exchange was facilitated during late Pleistocene by the nearness of adjacent islands and Australia. This exchange tended to inhibit divergence and the development of endemic forms (Mayr, 1944). There is no doubt that these same factors also influenced the character of the Timorese bat fauna.

It is tempting to speculate about the difference in success between birds and bats in colonizing Timor, especially from Australia. Bats are a much smaller and less diverse group. Relatively few bats can be considered strong, straight-course, long-distance flyers. They have not evolved in this direction, their patterns of flight having been refined mainly in the direction of efficiency in chasing down and captur-

ing insects. Migratory patterns have evolved in relatively few species. Bats are primarily nocturnal and most of them have poor vision so that their ability to orient visually on landmarks is limited. All of these factors would seem to be significant in accounting for the fact that bats have generally been less successful than birds in dispersal across water barriers.

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Of those who gave assistance during the field phase of the study in Timor, I am especially grateful to Senhora Suzana Rodrigues de Almeida of the Tourist Bureau, Dili, and Mr. Pao Wen Nien, Chinese Consul in Dili, who were so helpful in making contacts and in paving many rocky roads in Timor; and to Mr. Joseph D'Mello of Dili, who served as my guide, interpreter, and assistant in the collection and preparation of specimens.

Miss Karen Armour, secretary to the Department of Biology at Colgate University, typed the manuscript.

EXPLANATION OF MEASUREMENTS

In the species accounts, descriptions and measurements are of specimens collected on Timor by the author, unless otherwise specified. All measurements are given in millimeters and weights are in grams. Weights and measurements of total length, head-body length, tail length, ear length, and wingspread are field measurements of fresh specimens and serve only as approximations. Skull measurements and most forearm lengths were taken with dial calipers from preserved specimens using standard procedures, and are recorded to the nearest tenth of a millimeter. Since shrinkage occurs on drying, measurements of the forearm of skins and wet specimens are given separately in cases where both types of specimens were used. In series, the average measurement of each structure is given in parentheses following the range of variation.

Because of occasional uncertainty as to how some skull measurements are taken, the following explanation may be in order. The greatest length of skull is the distance between the most anterior point on the front surface of the incisors and the most posterior point on the skull. The condylobasal length is taken by placing one side of the calipers in the notches dorsal to the occipital condyles and measuring to the most anterior point on the premaxilla. The condylocanine length is the greatest distance between the condylar notches and the most anterior point on the canines.

Colors were determined in most cases by comparison of specimens with a color standard. The names of the colors which are capitalized are from Ridgway (1912).

When referring to particular specimens, abbreviations are used to represent the museums in which they are housed, followed by the museum specimen numbers.

ABBREVIATIONS

AMNH, the American Museum of Natural History, New York.

BMNH, British Museum (Natural History), London.
BSM, Bayerische Staatssammlung, Zoologische Abteilung, Munich.

FMNH, Field Museum of Natural History, Chicago.
MB, Museum Bocage, Lisbon.

MHNP, Muséum National d'Histoire Naturelle, Paris.

RMNH, Rijksmuseum van Natuurlijke Historie, Leiden.

LOCATIONS OF COLLECTING SITES IN TIMOR

The names of locations in Timor where specimens were collected are listed below with approximate locations given in degrees and minutes of latitude and longitude. Most of these places are shown on the map (fig. 1), and with the exception of those marked with an asterisk (*) are on the following maps prepared by the United States Army Map Service: Dili (SC51-4), Bobonaro (SC51-8), and Baucau (SC52-1).

The accompanying map was prepared when eastern Timor and the enclave of Ocussi Ambeno were Portuguese colonies. Recently the entire island came under the control of the Republic of Indonesia.

	LATITUDE	LONGITUDE
Ai-Fu	8°44' S	125°22' E
Atsabe	8°56' S	125°23' E
Baucau	8°28' S	126°27' E
Becia*	8°54' S	126°30' E
Bere-Cole	8°35' S	126°22' E
Dili	8°33' S	125°34' E
Ermera	8°45' S	125°23' E
Fatu Bessi	8°46' S	125°18' E
Fatu Cama	8°31' S	125°35' E
Fatu Maca	8°32' S	126°26' E
Hatolia	8°48' S	125°22' E
Hera	8°32' S	125°41' E
Lequi-Mia*	8°47' S	125°23' E
Luca	8°56' S	126°15' E
Mau-Dohi	8°34' S	125°26' E
Metinaro	8°32' S	125°45' E
Nae-Boroc*	8°52' S	126°22' E
Ossu	8°45' S	126°22' E
Ratano	8°52' S	126°19' E
Tutuala	8°23' S	127°15' E
Viqueque	8°51' S	126°21' E

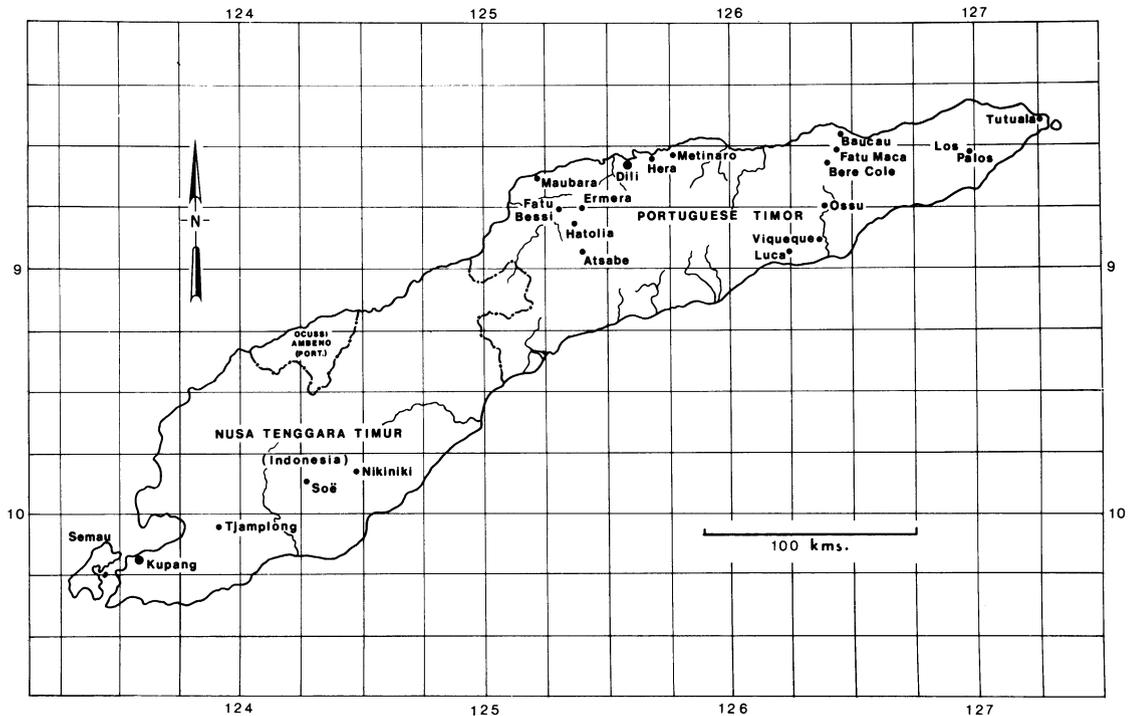


FIG. 1. Map of Timor.

ACCOUNTS OF TAXA

Rousettus amplexicaudatus amplexicaudatus (E. Geoffroy)

Pteropus amplexicaudatus E. Geoffroy, 1810, p. 96.
Cynonycteris bocagei Seabra, 1898a, p. 160.

TYPE LOCALITY: Timor. One specimen of the original series collected by Péron and Lesueur is in the Paris Museum according to Andersen (1912), but Rode (1941) did not list the specimen.

DISTRIBUTION: Andersen gave the range of the typical form as Cambodia, the Philippine Islands, Borneo, Sumatra, Engano, Flores, Savu, Alor, and Timor. Tate (1942) recorded series from Peleng Island, east of Celebes, and from northwest Borneo. In Timor, specimens were collected at Becia, Dili, and Ossu. In addition, the species was seen at Metinaro and Atsabe. It occurred from sea level to an altitude of at least 910 m.

DESCRIPTION: The fur of this species is short and rather sparse. The color of the dorsal surfaces is intermediate between Bister and Warm Sepia. The neck and shoulder region is usually considerably paler approaching Pale Ochraceous-Buff. The hairs of the darker parts, especially across the middle of the back, are pale-tipped which imparts a slight frosted appearance to the fur. Adult males have a tuft of specialized hairs on each side of the neck below the ears. These hairs are short, relatively large in diameter, and bristle-like and their color varies in different individuals from Ochraceous-Buff to a color intermediate between Yellow Ocher and Ochraceous-Orange. The tufts are nearly hidden by the surrounding fur and the bright color can be seen only when the fur is parted with the fingers. The underparts are a lighter shade of the color of the back. There is no significant difference in color

or size between the sexes except that females lack the neck tufts.

Forearm lengths of adult specimens are: six skins, 79.5-83.3 (81.9); 22 alcohol specimens, 77.3-89.5 (82.7). Body measurements of 28 adults are: head-body length 111-132 (121), tail length 15-26 (20), ear length 18-21 (19), wing-spread 503-552 (529), weight 59-94 (75). Skull measurements of six adults are: greatest length 35.5-38.0 (37.0), condylobasal length 34.0-37.1 (35.7), condylocanine length 32.6-35.4 (34.2), maxillary toothrow length 12.5-13.9 (13.1), zygomatic width 20.1-23.0 (21.7), mastoid width 13.6-14.2 (14.0), width of interorbital constriction 7.7-8.4 (8.1), greatest width between outer surfaces of upper canines 6.7-7.7 (7.2), greatest width between outer surfaces of M² 10.0-10.9 (10.4).

TAXONOMIC NOTES: Seabra (1898a) described *Cynonycteris bocagei* from an adult male specimen collected in Dili by F. Newton in 1897. According to Seabra, this specimen differed from *Rousettus amplexicaudatus* in having a greater zygomatic width and a different form and position of certain palatal ridges. This specimen, MB 2634, was examined at the Museu Bocage in Lisbon. It was preserved in alcohol and the skull had been removed and apparently lost. The length of the forearm (85) and tail (17) are within the range of *amplexicaudatus* from Timor. Andersen (1912) pointed out that although Seabra did not give a measurement of the zygomatic width of the type specimen his figure of the skull has a zygomatic width of 23 which is within the range of *R. a. amplexicaudatus*. There is no doubt that *Cynonycteris bocagei* belongs in the synonymy of *R. a. amplexicaudatus*.

HABITAT: In Timor, *Rousettus* was found roosting only in caves, but of the many caves investigated there, it was present in only three. In two of these it occurred in relatively large numbers. Fissure-type caves near Viqueque and Atsabe contained colonies of approximately 800 and 500 animals, respectively. They were concentrated in chambers just inside the entrances, and they hung freely by their toes in masses from the ceilings which were 3 to 6 m. high. At both of these locations they could be clearly seen flying about inside, and their noisy vo-

calizing could be heard as one stood outside of the cave entrances. These caves, both very similar in character, were situated in vertical cliff faces and had to be approached up long, steep talus slopes. They were surrounded by dense forest. A pair of pythons, *Python* sp., was observed at the entrance of each cave. The snakes had an approximate range in length of from 2.4 to 4.5 m. In the cave near Viqueque, it was reported to me that one of the snakes was ingesting a *Rousettus* at the time that it was discovered. It would seem that the presence of snakes at these caves was not merely a coincidence. The entrances were narrow enough to provide the snakes with ample opportunity for ambushing the bats as they made their exit and the chambers in which the bats were roosting had relatively low ceilings and very irregular sides. Therefore, in both situations there were rather large concentrations of bats accessible to the snakes. The cave near Ossu contained approximately 30 *Rousettus* located in a large room near the entrance. As in the other two caves, there was sufficient light in this room to see the bats flying about.

ASSOCIATED SPECIES OF BATS: Other species of bats were not found to be closely associated with *Rousettus* in its roosting areas. The large cave at Ossu was also inhabited by 200 to 300 *Miniopterus*. The cave near Viqueque contained the following species in addition to *Rousettus*: *Taphozous melanopogon*, *Rhinolophus borneensis parvus*, *R. creaghi timorensis*, and three species of *Miniopterus*. No other species were found in the cave near Atsabe. However, a complete search of the deeper parts of that cave was not made.

FOOD: This species could be observed feeding wherever *Muntingia* was in fruit. The berries were eaten in both the green and ripe conditions. Although this is not a native tree, it has been widely planted in Timor, particularly around the larger villages, and it appears to be the preferred food of *Rousettus* at least during the time of the year that the study was made. When *Muntingia* berries were fed to captive *Rousettus*, they were chewed up and the skins and seeds were spit out.

BEHAVIOR: These bats begin feeding about an hour after sunset. It is not unusual to see as

many as 20 individuals feeding on the fruits of a small *Muntingia* tree. If a tree is in heavy fruit, up to 50 bats may be seen circling around it at one time. As the bats circle, they may suddenly swerve in toward a branch and land heavily on top of it, scrambling along until a berry is located. They spend little time in the branches, usually flying off after but a few seconds, presumably to devour the fruit. There is a continuous coming and going of bats around a fruiting tree and at times they appear to arrive and depart in small groups. They are quiet as they feed even when they are present in large numbers. The high frequency clicking sounds which this species is known to produce (Novick, 1958) are apparently not within our auditory range. It is possible to stand within a few feet of a tree in which these bats are feeding without disturbing them. Individuals will fly by so closely that the beat of their wings can be heard. They are quite tolerant of a flashlight beam and they will often continue to circle a tree even when a beam of light is directed upon them. When roosting in caves, these bats are also quite tolerant of disturbances and may be approached within 1.5 m. if done so quietly and slowly and if a flashlight beam is not shown directly upon them. This species is readily captured in rather coarse mist nets which is indicative of the relative inefficiency of its echolocation system.

Although these bats do not produce a strongly scented secretion as do many pteropodids, they do possess a characteristic odor. This is barely noticeable when they are being handled, but it is quite strong at their roosting sites. It is rather like the odor of wet wool.

REPRODUCTIVE DATA: Most of the adult specimens collected in March, April, and May were in breeding condition. The testes of five adult males ranged from 9 by 6 to 12 by 10 mm. Many of the females were pregnant or had recently given birth and were lactating. One female captured in a mist net while flying around a *Muntingia* tree had a naked young with eyes not yet open clinging to it. Measurements of this female and its young are: forearm length 77, 35; head-body length 114, 65; tail length 21, 9; ear length 19, 12; weight 64, 18.

Pteropus griseus griseus E. Geoffroy

Pteropus griseus E. Geoffroy, 1810, p. 94, pl. 6.

TYPE LOCALITY: Timor. The original specimens were collected by Péron and Lesueur. The type specimen is in the Paris Museum (MHNP A.42C.29-759).

DISTRIBUTION: Timor; Semau Island (near Timor); Bonerato, Dyampea, and possibly Saley Island south of Celebes. Other subspecies occur on Celebes, the Philippine Islands, and possibly on the Banda Islands. A total of 12 specimens was collected on Timor at Dili, Hera, and Nae-Boroc. I observed this species commonly near sea level, but never found it above an altitude of approximately 30 m. It does exhibit a preference for lowland forest, but perhaps it may fly into the hills when food is more plentiful there. Schwarz (1914) reported two specimens collected by Haniel at Tjamplong, Timor, at an altitude of 190 m.

DESCRIPTION: There is marked sexual dichromatism, particularly of the head and mantle pelage, in this species. Andersen (1912) described a wide range in color in the series available to him, but he did not relate it to sex. Five adult males from Timor are colored as follows: mantle Russet shading anteriorly on the head and posteriorly on the shoulders, first to Tawny and then to Light Ochraceous- Buff. The Russet continues ventrally around the neck as a complete, but indistinct, collar. There is a strong contrast in color and texture of the pelage between the mantle and back as is usually the case in *Pteropus* species. The back is typically Smoke Gray with varying numbers of Warm Buff and Light Buff hairs mixed in. A buffy cast is especially strong on the rump and legs. In one specimen this area is decidedly darker and browner, the color of the legs approaching Warm Sepia. The underparts posterior to the collar are quite variable. In one specimen this area is Light Buff, in another, Ochraceous- Buff, and in a third, Warm Sepia mixed with some light gray hairs. In four adult females the pale head and mantle color ranges from Pinkish Buff to Cinnamon- Buff. The mantle color tends to be most intense in the neck region. The crown is Light Buff and the

back and undersurfaces are similar to those areas of male specimens. An immature female has the head Mouse Gray, and the back is browner and the undersurfaces darker than in the adult.

The texture of the mantle especially in males is coarse and woolly contrasting strongly with the smooth, silky, closely adpressed pelage of the back. The hairs of the back are straight and all are oriented in an anteroposterior direction. The mantle hairs of females are softer and less woolly than those of males.

This species produces a unique moldlike odor which is particularly strong in the area of the mantle.

Body measurements of seven adults are: forearm length 116.9-122.2 (118.8), total length 168-185 (180), ear length 23-27 (25), wingspread 748-899 (844), weight (5 specimens) 240-296 (270). Skull measurements of one adult male and one adult female are: greatest length 56.9, 56.6; condylobasal length 54.2, 54.5; condylocanine length 50.8, 49.9; maxillary tooththrow length 21.0, 20.3; zygomatic width 33.4, 31.2; mastoid width 19.5, 19.5; width of interorbital constriction 8.4, 9.1; greatest width between outer surfaces of upper canines (male specimen only) 11.5; greatest width between outer surfaces of M¹ 16.4, 16.3. There is no indication of a significant difference in size between the sexes in the small series.

TAXONOMIC NOTES: I have not seen specimens of *P. griseus* from any islands except Timor and Semau. Therefore, I am unable to comment on the validity of the races which have been described from other islands.

There has been considerable confusion involving the taxonomy of this species and *P. temmincki* due to a similarity in appearance between *P. temmincki* and female and immature *P. griseus*. In comparing a series of skins of *P. temmincki* from Amboina in the British Museum (Natural History) with my series of female and immature *P. griseus* from Timor, a basic similarity in pelage color was found to be present. However, there are consistent differences. *Pteropus temmincki* possesses more yellow in the mantle, more brown in the back, and lacks the sharp contrast and abrupt break

between the back and mantle coloration which is present in *P. griseus*. The adult skulls of these two species are easily identified. *Pteropus temmincki* is distinguished by its short, narrow rostrum, its large orbits, and its relatively delicate dentition. It is interesting that *P. griseus* with its larger, heavier skull, exhibits in its immature stages skull characteristics similar to *P. temmincki*.

Andersen (1912) explained that Peters (1867) described *P. temmincki* from Temminck's series of specimens from Amboina. However, Peters included Semau within the range of this species because of Temminck's (1835-1841) record of *P. griseus* for that island even though he had not seen Temminck's material from Semau. Andersen examined these specimens and declared at least some of them to be *P. griseus*. He included Timor in the range of *P. temmincki* mainly on the basis of two specimens in the British Museum. I examined Temminck's material in the Rijksmuseum, Leiden, a series collected by Müller. It consisted of four skins of *P. griseus*, an adult female and an immature male from Timor, and two adult females from Semau. All had been reidentified as *P. temmincki* (probably by Jentink), but later the two specimens from Timor had been correctly identified by Andersen. Those from Semau bore corrected labels, but with no indication of who had revised the nomenclature.

The original record of *P. temmincki* from Timor goes back to Dobson (1878) based on the specimens in the British Museum (Natural History). One of these (BMNH 7.1.1250), an immature male collected by Dr. Alfred Russell Wallace, is so young that identification is difficult. It appears to be *P. griseus* since it compares favorably with young specimens in my collection. The other specimen, BMNH 58.11.18.2, a skin and skull of an adult male is, indeed, *P. temmincki*. The specimen label contains only the information that the specimen was collected in Timor, and that it was purchased from Frank, a dealer in Holland who supplied museums with specimens from the Indo-Australian archipelago. The reliability of locality data accompanying material from that source might be questioned.

Schwarz (1914) reported six specimens of *P. temmincki* from Timor and one from Semau collected by Haniel. He gave no measurements. Only one of these specimens is extant, a skull and trunk skeleton of a very young individual labeled *P. temmincki* collected in central Semau. This specimen, BSM 1911/2151, cannot be certainly identified without comparative skeletal material of comparable age. Since it has skull proportions similar to a specimen of a slightly older individual of *P. griseus* in my collection, I believe it to be this species.

Although there have been many reports of *P. temmincki* from Timor and Semau, with one exception these reports are traceable to misidentifications of specimens of *P. griseus*. The exception is the Frank specimen. *Pteropus temmincki* was not found in Timor during the course of the present study. It is possible, though rather unlikely, that the species does occur there but is either rare or restricted in range to the western part of the island which was not investigated. Also, the range of a species confined to Amboina, Ceram, and Timor (including Semau) represents a rather anomalous distribution pattern. These facts lead me to seriously doubt the presence of *P. temmincki* in Timor.

Seabra (1897) reported *P. pselaphon* from Timor based on a specimen collected by F. Newton in Dili in 1897. This specimen, MB 296, was examined at the Museu Bocage, Lisbon. It was a badly faded skin, mounted on a wooden stand, and lacked a skull. Although positive identification could not be made, the specimen appeared to be an immature *P. griseus*.

HABITAT, FOOD, AND ASSOCIATED SPECIES OF BATS: Camps of this species have not been reported. None were located during the course of this study. Specimens were collected while feeding on the fruits of *Ficus* and *Muntingia*, and an undetermined part of *Borassus* (probably the fruit). Solitary individuals were found hanging well-hidden beneath the leaves of species of *Corypha* and *Borassus* in coastal palm forests at Mau-Dohi and Hera. In Dili an adult male and an immature female were collected at midday while hanging in the branches of a large *Ficus* tree about 24 m. above the ground. No other bats were present in the tree.

Often, two or more species of Megachiroptera could be observed feeding together in apparent harmony at the same fruiting tree. When hostile encounters were observed in such situations, it always involved members of the same species. Interspecific hostility was not seen. Feeding associations between bat species are of course determined mainly by the food habits of the species involved just as roosting associations are determined by the roosting preferences of the species. However, a certain degree of interspecific compatibility must exist if the association is to survive. Thus, such associations are formed over a period of time in much the same way as more complex associations like communities.

Rousettus amplexicaudatus and *Dobsonia peroni* were the most frequently observed feeding associates of this species, but *Cynopterus sphinx*, *Pteropus vampyrus*, and *Acerodon mackloti* were also seen feeding with it. *Cynopterus sphinx* and *Dobsonia peroni* were found roosting in the same palm forests but not in close proximity to *P. griseus*.

REPRODUCTIVE DATA: Three adult males collected in Dili and Nae-Boroc in March and April had testes ranging in size from 18 by 14 to 20 by 14 mm. Two adult females examined did not contain embryos nor were they lactating.

Pteropus vampyrus edulis (E. Geoffroy)

Pteropus edulis E. Geoffroy, 1810, p. 90.

TYPE LOCALITY: Timor. The original description of *edulis* was based on an adult female collected by Péron and Lesueur. The type specimen is mounted with skull *in situ* and is in the Paris Musuem. (MHNP 745-C.I.).

DISTRIBUTION: The species is found from the Malay Peninsula east to Timor and the Philippine Islands. The subspecies *edulis* occurs on Timor and on Savu Island, west of Timor. It was seen only near the coast at sea level on Timor. There were reports from Timorese fisherman near Metinaro that in the evenings the bats often flew into the hills south of that village to feed. Medway (1969) stated that this species is commoner in the coastal areas of Malaya, but that it also occurs inland up to an altitude of 1370 m. Specimens were collected at

Dili, and at a large camp at Niki-Tara, near Metinaro. Schwarz (1914) reported two specimens collected by Haniel at Baung and Kuatnana, western Timor.

DESCRIPTION: The extreme variation in the color of the mantle has been responsible for some taxonomic confusion in this species. Dark-mantled and light-mantled forms are known to occur in four of the six subspecies, *vampyrus*, *pluton*, *edulis*, and *lanensis*. Thus, the division used by Andersen (1912) in his key to subspecies does not hold. He separated supposedly melanistic subspecies (*pluton*, *edulis*, and *lanensis*) from non-melanistic subspecies (*natunae*, *malaccensis*, and *vampyrus*).

Ten specimens from Timor in the present collection include five adult males with light-colored mantles (forearm length 180-196, testes 25 by 20 to 22 by 15), one immature male with light-colored mantle (forearm length 171, testes 9 by 5), two immature males with dark mantles (forearm length 165, 177, testes 8 by 5, 10 by 6), one mature female with dark mantle (forearm length 189), and one immature female with dark mantle (forearm 163). This distribution suggests that color difference is correlated with sex and also with the degree of sexual maturity in males. It appears that the age at which color change occurs in young males may be somewhat variable since one immature male has a light-colored mantle, whereas another with a somewhat longer forearm still retains the dark mantle color. It may be that sexual dichromatism in this subspecies is a trend which is in the process of undergoing evolutionary refinement from non-sex-related dichromatism. If this is true, then one would expect to find the somewhat loose color-age-sex relationship that is exhibited in this series. A definite answer will be found only after a larger series of *edulis* is obtained.

The mantle color of five adult males ranges from Antimony Yellow to Sanford's Brown. Intermediate specimens are Yellow Ocher, Ochraceous-Orange, and Zinc Orange. These colors shade into Chestnut or Auburn laterally and to Mahogany Red or black ventrally on the throat and chest. The belly and abdomen are a shade lighter than the chest. In one specimen the belly and abdomen are nearly black but some of the hairs are white-tipped giving the

area a grizzled appearance. The back is pure black in one specimen, but in the other four there are brown and gray hairs mixed in with black. The head ranges from black to Mahogany Red in five specimens.

An adult female has the mantle Sanford's Brown medially shading to Burnt Sienna laterally and posteriorly and finally to Chestnut on the sides of the neck. The crown is nearly black with white hairs mixed in on the forehead. The occipital region is Carob Brown. The back is black with light gray and brownish hairs mixed in posteriorly. The undersurfaces are nearly black.

The lightest specimen of three immature males has the mantle between Raw Sienna and Antique Brown medially, shading to Amber Brown laterally. The crown is near Amber Brown and the throat and anterior chest are Chestnut Brown. The black hairs of the belly and abdomen have a Buckthorn Brown wash. The specimen with intermediate color has the mantle Hazel medially, shading to Chestnut Brown laterally. The back is black shading to Chestnut Brown on the rump. The undersurfaces are nearly black. The darkest specimen has a Chestnut Brown mantle and the black back has many gray and buff hairs mixed in posteriorly. The undersurfaces are nearly black. An immature female is the darkest of all specimens in the series. It has a mantle color near Auburn and is nearly black elsewhere.

Body measurements of six adults are: forearm length 180-196 (190), total length 271-296 (286), ear length 38-43 (41), wingspread (4 specimens) 1302-1424 (1385), weight (3 specimens) 630-1135 (938). Skull measurements of four adults are: greatest length 76.4-82.6 (78.5), condylobasal length 74.9-76.4 (75.7), condylocanine length 69.3-71.5 (70.6), maxillary toothrow length 28.1-32.4 (30.2), zygomatic width 38.6-46.2 (42.7), mastoid width (3 specimens) 24.6-25.5 (25.0), width of interorbital constriction 9.0-10.4 (9.5), greatest width between outer surfaces of upper canines 13.9-14.5 (14.3), greatest width between outer surfaces of M¹ 18.6-20.5 (19.9)

TAXONOMIC NOTES: A reassessment of the present systematic arrangement of this species would seem to be in order. Large series of individuals of comparable age from the various

islands are needed. It would appear from the situation in *edulis* that little if any taxonomic importance can be given to melanism versus non-melanism at the subspecies level. Since a range of color variation correlated with sex and age similar to that which occurs in the material from Timor might be expected in the other subspecies, it will be necessary to determine that range for each population before color will be useful on a comparative basis.

HABITAT: The spectacular colony observed near Metinaro consisted of approximately 2000 bats. It was located in a section of a dense mangrove forest which extended along the coast for a distance of about 8 km. Between the time that the colony was first seen and a return visit one month later, it had shifted its location a distance of about 400 m. The first location was along the outer edge of the forest facing the sea. At low tide the mangroves were separated from the sea by a barrier beach and a shallow lagoon between the beach and the edge of the mangroves. Later, the bats occupied a section of the seaward side of the forest where at high tide many small bays and a complex network of channels broke up the forest into a series of irregular islands and peninsulas. The bats were spread out over an area of about 2 hectares.

ASSOCIATED SPECIES OF BATS: There were no other species of bats in the camp near Metinaro. When feeding, *T. vampyrus* was often observed to be loosely associated with *P. griseus*, *Acerodon mackloti*, and *Dobsonia peroni*.

FOOD: During the period from March through May, this species was observed to feed only on the fruit of *Ficus*. A resident of Dili reported that it feeds extensively on mangoes in July and August and that it is considered a pest because it is so destructive to this fruit.

BEHAVIOR: In the camp near Metinaro, the bats roosted along the branches mainly toward the tops of the mangroves from 6 to 9 m. above the water. They were disturbed only slightly when a person entered the colony by boat, and they could be approached as closely as 9 m. without taking flight. However, when individuals in one part of the colony were disturbed from their resting places and circled

about uttering harsh squawks the excitement spread quickly throughout the colony. On both occasions when the camp was entered, most of the bats were preoccupied with fanning, their great, partly folded wings acting as air circulators and radiators as they were slowly flapped. Even when the colony was apparently undisturbed, individuals would leave their roosts from time to time, circle about briefly and then return to alight at or near the original resting place. As bats returned to rest they were often threatened by bats hanging nearby. Hostile behavior could be readily observed in such a colony. Adjacent individuals often sparred with each other using their thumbs and wrists, or made passes with open jaws and uttered raucous vocalizations. The result of this behavior was to space out the roosting bats regularly so that most individuals were separated just beyond reach of one another.

REPRODUCTIVE DATA: Two adult males collected on May 8, 1968 had testes measuring 25 by 20 and 22 by 15. The colony observed was composed of adults and immatures of both sexes.

Acerodon mackloti mackloti (Temminck)

Pteropus macklotii Temminck, 1835-1841, p. 69, pl. 35, fig. 5, pl. 36, figs. 4, 5, 6.

TYPE LOCALITY: Timor. Five mounted cotypes with skulls *in situ*, and the skull of a sixth specimen collected by Müller and Macklot are in the Rijksmuseum, Leiden. One mounted cotype with skull is in the Berlin Museum.

DISTRIBUTION: The species has been reported from Timor, Sumba, Alor, Flores, Sumbawa, and Lombok. In Timor this is a common and well-known bat. Specimens were collected from a few feet above sea level to an altitude of about 450 m., at Dili, Fatu Maca, Mau-Dohi, Nae-Boroc, and Ossu.

DESCRIPTION: The series of 10 adults from Timor exhibit distinct sexual dichromatism. This is particularly noticeable in the mantle, neck, and crown pelage. A typical adult male has the anteromedial part of the mantle Antimony Yellow shading to Raw Sienna on the sides of the neck where the neck tufts are

located. The bases of the hairs of these tufts are mostly hidden and are Amber Brown. The crown and posterior part of the mantle are Warm Buff, the dark brown bases of the hairs showing through slightly. The sides of the head are a shade darker than the crown. The back is Cinnamon with silvery hairs interspersed especially posteriorly on the rump. The undersurfaces are Mikado Brown, the hairs having silver tips which give a strong grizzled effect to the entire ventral pelage. The female pelage is generally lighter in color. The head and mantle are Cream Buff becoming silvery toward the posterior border of the mantle. The neck tufts are but slightly developed and are indicated by a small patch of Honey Yellow hairs with Dresden Brown bases. The back, rump, and undersurfaces are similar to those areas of the male but the color is paler and more silvery. Immature individuals of both sexes have a pale pelage resembling that of the adult female. Adults exhibit some variation in color, especially of the anterior part of the mantle, the neck tufts of the male, and the undersurfaces. The darkest female in the series is still much lighter than the lightest male. All specimens exhibit the typical pteropid pelage texture. The hairs of the mantle are coarse and undulating, producing a somewhat woolly effect; those of the rump and thighs are soft and wavy and lack the luster of the mantle and back hairs. The hairs of the back are contrastingly straight, closely adpressed to the skin, and oriented in an anteroposterior direction.

The iris of both sexes is light yellow-brown which gives these bats a unique expression. The oil secretion that saturates the neck tufts in males has a penetrating sweet odor something like a combination of musk and Red Delicious apples, if such a mixture can be imagined. Females give off only a trace of this odor.

Body measurements of 10 adults are: forearm length 139.5-148.6 (143.0), total length (8 specimens) 220-238 (227), ear length 32-34 (33), wingspread 937-1070 (1020), weight (8 specimens) 450-565 (518). Skull measurements of five adults are: greatest length 67.7-68.5 (68.1), condylobasal length (4 specimens) 61.3-62.3 (61.8), condylocanine length (4 specimens) 57.1-58.2 (57.6), maxillary toothrow

length 27.4-28.0 (27.7), zygomatic width 36.2-40.4 (37.9), mastoid width 21.7-22.8 (22.2), width of interorbital constriction 8.1-9.7 (8.8), greatest width between outer surfaces of upper canines (4 specimens) 13.1-13.5 (13.3), greatest width between outer surfaces of M¹ (4 specimens) 20.8-21.6 (21.2).

TAXONOMIC NOTES: Each insular population of this species except the one from Sumbawa, has been given subspecific status, *mackloti* from Timor, *gilvus* from Sumba, *alorensis* from Alor, *floresi* from Flores and Sumbawa, and *prajae* from Lombok. These taxa are all based on slight differences in color and/or size of single specimens. It is known that there is considerable variation in color and size of adults in the population on Timor. The type specimen of *floresi*, BMNH 63.12.26.11, falls within the range of color and size variation of the series from Timor. Although I have not seen *gilvus* or *alorensis*, measurements of the types given by Andersen (1912) are very close to specimens from Timor. Dammerman (1928) in describing a specimen of *gilvus*, which up till that time had been considered a full species (Andersen, 1909b), stated: "Our specimen comes very near as to colour and measurements to *P. mackloti floresi* Gray and we may safely consider the Sumba form a subspecies of *mackloti Temm.*"

Sody (1936) in describing *prajae* as a new subspecies stated that it resembled *floresi* but that there were some differences in body proportions. Measurements of the type specimen as given by Sody fall within the range of the series from Timor.

Until more specimens from the different islands become available, it cannot be determined if these populations represent valid subspecies. Although the evidence is meager, it seems improbable that they are distinct.

HABITAT: Two colonies of this species were observed on Timor, one at Baucau, and one at Fatu Maca, about 8 km. apart. At both sites, the bats were spread out over a large portion of the crowns of large fig trees on the edge of open forest. The roosting areas were largely defoliated suggesting that the trees had been occupied for an extended period of time and that the same portions of the crown had been

consistently used. Neither of the trees was in fruit. Both colonies were within view of human dwellings. The camp at Fatu Maca was situated about 90 m. from a group of huts on the edge of the village. There were 300 to 350 bats in each colony.

ASSOCIATED SPECIES OF BATS: This species was observed feeding at fruiting fig trees with *Pteropus griseus*, *P. vampyrus*, and *Dobsonia peroni*. No other species of bats occurred in their camps.

FOOD: The staple food in March, April, and May consists of the fruit of at least two species of fig. These bats also feed on some undetermined part of the coconut palm, probably the young fruit. The intestines of some specimens which were collected were so engorged with material that feces were reflexly extruded in large amounts after they were killed. The color and texture of this material was very much like fresh fig pulp and seeds, but somewhat drier in consistency. Also, each of the seeds was covered by a thick, transparent, gelatinous layer apparently resulting from the action of the digestive secretions of the bat on the seed coat. It seems that the food must pass through the digestive tract very quickly and with relatively little bacterial action for it to be eliminated in such apparently fresh and relatively unmodified condition. Probably most of the nutrition is obtained from the juice of the fruit.

BEHAVIOR: As the sun disappears below the horizon, while it is still rather light, these bats begin leaving their roosts to make the rounds of fruiting trees. On many occasions I watched their activities in Baucau in the early evening. They flew in a straight course toward the center of the village from their camp located about one mile to the west. Usually they traveled in small, well-spaced groups of two to six individuals, one behind the other, rarely flying closer together than 10 or 12 m. The flight was slow with deep, deliberate wingbeats rather like the flight of a heron of comparable size. On one occasion a bat was seen chasing another in rapid, swerving flight proving that these bats are strong, maneuverable fliers even though their usual flight appears to be cumbersome and labored. This impression is partly due to the

fact that they rarely glide, flapping flight continuing even as they grab for a branch when alighting. In the village of Baucau their main activity was flying in and out of the crowns of coconut palms where, presumably, they were feeding on young fruit. They approached the crowns at a level below the fruiting area and then swerved upward and alighted near the fruit. As many as three bats were observed to alight in the same palm, but usually more than one bat in a tree resulted in much squabbling, a dominant individual eventually driving the others away. In such situations the bats were very noisy, emitting harsh, grating screeches, but in flight they were quiet. On a few occasions bats were observed to land on the convex upper surfaces of coconut leaves. Copulation was believed to have occurred on one occasion in such a location. When feeding at fig trees, they circle the tree, alight, and clamber through the branches eating fruit as they proceed.

One can approach quietly and stand beneath a roosting colony in a tall tree without causing the bats to leave. They become uneasy, however, if the disturbance continues, and they begin to move about in the branches, some eventually taking flight. At the colony at Fatu Maca, I watched a Timorese hunter kill a roosting bat with a blowgun, a very quiet operation. The sight of the falling bat was disturbing to the colony and most of the bats took flight and circled the tree for several minutes. The flight in this case was different from distance flight in that the wingbeats were more rapid and shallow. Two bats were observed to perform short glides, equivalent to the distance covered during two or three wingbeats. Gliding appears to be an uncommon practice in the larger species of Megachiroptera. Eventually, one by one, the bats returned to the branches where some clambered about before settling down.

REPRODUCTIVE DATA: Two adult males collected at Dili on March 15, 1968 had well developed testes measuring 25 by 17 and 22 by 17. A female collected at Mau-Dohi on March 19, 1968 had an embryo 7 mm. long in the right uterine horn. A female collected in Dili on May 5, 1968 had an embryo measuring 25 mm. (crown-rump) in the left uterine horn.

Dobsonia peroni peroni (E. Geoffroy)

Cephalotes peroni E. Geoffroy, 1810, p. 104, pl. 7.

TYPE LOCALITY: Timor. An adult holotype, MHNP A.118.-786, and a juvenile paratype, MHNP A.119-786, collected by Péron and Lesueur are in the Paris Museum.

RANGE: The species has been reported from Timor, Babar, Sumba, Wetar, Alor, Flores, Komodo, Sumbawa, and Nusa Penida (near Bali). In Timor it was found to be common and widely distributed. Specimens were collected at Atsabe, Bere-Cole, Dili, Fatu Bessi, Hera, Mau-Dohi, Ossu, Tutuala, and Viqueque, ranging from sea level up to an altitude of 1220 m. A specimen was collected at Tjamplong, Timor, by Haniel (Schwarz, 1914).

DESCRIPTION: In life, the adults of this species exhibit an unusual olive-green color. It is brightest in adult males on the sides and ventral surfaces of the lower neck and chest. The dorsal surfaces of the neck and shoulders are a deeper shade of the same color and the top of the head is olive-brown. On the posterior shoulders, the color shades to a narrow band of dusky olive-brown bordering the wing membranes. The skin of the nose, ears, wing membranes, and feet are dark olive-brown to nearly black. The green color fades rapidly in specimens prepared as skins and those preserved in formalin or alcohol. By the time that a skin has dried completely, much fading has occurred. The dry skins of three adult males exhibit the following coloration: head Brownish Olive, neck and shoulders varying in different specimens from Old Gold to Buffy Citrine, ventral surfaces Buffy Citrine to Buffy Olive. Three dry skins of adult females are colored as follows: head Brownish Olive, mantle varying in different specimens from Isabella Color to Light Brownish Olive, ventral surfaces Light Brownish Olive. Immature animals usually show some olive-green color, but this is rather dull. As individuals approach maturity the color intensifies. In a series of 15 live adults, the brightest olive-green color occurred in an old male with extreme tooth wear.

Like many other species of Megachiroptera, this bat has a very strong, unique odor. It is

musky, but otherwise so unusual that it is impossible to compare to any other scent. The odor is strongest in the hair of the neck and chest, the same areas where the green color is most intense. Also, the odor is strongest in adult males, which are highly colored. This would suggest that modified sebaceous glands associated with the green hairs produce the secretion. When the axillary glands are cut open, the odor can be detected, but it is much weaker than that given off from the neck and chest fur. The secretion readily adheres to the fingers when rubbed through the fur, and although it cannot be seen, it can be smelled for a long time afterward. Both sexes produce the musky odor, but like the green color, it is less intense in females.

Body measurements of 14 adults are: forearm length 108.6-118.8 (114.5), head-body length 154-186 (171), tail length 21-31 (27), ear length 26-29 (27), wingspread (12 specimens) 747-827 (788), weight (10 specimens) 164-340 (224). Skull measurements of seven adults are: greatest length 47.5-50.9 (49.6), condylobasal length (6 specimens) 43.7-45.8 (44.4), condylocanine length (6 specimens) 43.2-46.0 (44.1), maxillary toothrow length 19.3-21.6 (20.4), zygomatic width 27.8-32.1 (29.7), mastoid width 17.6-19.2 (18.3), width of interorbital constriction 18.0-19.3 (18.3), greatest width between outer surfaces of upper canines 8.9-10.1 (9.0), greatest width between outer surfaces of M¹ 14.4-16.4 (15.3). A significant difference in size between the sexes was not indicated in this series of nine males and five females.

TAXONOMIC NOTES: Until recently, only two subspecies of *D. peroni* had been described. Besides the typical form *D. p. sumbana* was originally described as a new species by Andersen (1909a) from a specimen from Sumba. Dammerman (1928) noted that although he had not collected the Sumba form, it must be referred to *peroni* because the difference in size from the typical form was not great enough to warrant species status. The question now arises as to whether or not the population from Sumba deserves subspecies status. Apparently, the holotype is the only specimen available

from this population. Although this specimen is 2.6 mm. shorter in forearm and 1 mm. shorter in skull than the smallest adult in the series from Timor, the difference is inconclusive and series from the two islands must be compared before the degree of relationship of these populations can be determined. Recently, Bergmans (1978) described a third subspecies (*D. p. grandis*) from the western Lesser Sunda Islands.

HABITAT: Limestone caves, fissures, crevices, and ledges are used as roosts by colonies of *D. peroni* on Timor. The largest colonies were located in large chambers of caves. Smaller groups composed mainly of subadult individuals were found in smaller enclosures. The preferred roosting sites were rooms in caves near the entrances where human eyes could perceive little more than dim light when looking toward the entrance. The species was not found deep in the darker reaches of caves. At times, the bats occupied very confined situations. At Atsabe a group of eight individuals, six of which were immature though nearly adult size, were found roosting at the end of a crevice 45 m. long in the side of a cliff. This fault was 1 m. wide and varied in height from 15 to 25 m. With a wing span of about 0.8 m., there was very little clearance as the bats flew through the crevice. As they did so, it was possible to hear their wings slapping against the sides of the narrow passageway. Far back in the crevice, the sides converged overhead forming a cavelike enclosure. It was there that the bats roosted in sufficient light so their indistinct forms could be seen hanging from the ceiling.

The most atypical roosting site was observed near Fatu Bessi where a colony of about 20 bats was located near the bottom of a deep, wooded gorge. The area was extremely rugged and beautiful, and the plant community was as close to a typical rain forest association (including terrestrial leeches) as could be found in Timor. At the bottom of this gorge, a torrential river had scoured a narrow, smooth-sided channel through granitic rock to a depth of 15 m. Undercutting had produced ledges on both sides at the top of the channel. The bats were hanging from the underside of these ledges where they were exposed to the deafening roar and the fine spray from the river below. Although

there was subdued light beneath the ledges, the bats could be clearly seen. This site was known to have been continuously occupied for at least four years.

Occasionally, during the day, individuals could be found resting beneath the large fan-shaped leaves of *Corypha* and *Borassus*. These sites seemed to have been temporary roosts in feeding areas where some bats may have remained after a night of foraging rather than returning to the main colony. In such situations the bats were usually well hidden by overlapping leaves.

ASSOCIATED SPECIES OF BATS: In only one of several roosting situations was *Dobsonia* found to be associated with another species of bat. In Leneara Cave near Tutuala, a colony of 300 *D. peroni* shared a large chamber with approximately 100 *Taphozous melanopogon*. The center of the dome-shaped ceiling was about 24 m. high and it was toward the center that *Dobsonia* was concentrated. *Taphozous* occupied the peripheral parts of the chamber and a short, blind tunnel on the opposite side of the chamber from the entrance. When disturbed, *Taphozous* flew swiftly along the walls at relatively low elevations, whereas *Dobsonia* remained in the highest parts of the dome and fluttered about there. Rarely did individuals of the two species come into close contact.

When feeding, this species may be associated with any of the other fruit-eating bats. The most common feeding associates were *Rousettus amplexicaudatus* and *Pteropus griseus*.

FOOD: During March, April, and May, *Dobsonia* was observed feeding most commonly on the fruits of *Borassus*, *Muntingia*, and at least two species of *Ficus*. It is quite likely that other fruits are eaten as they ripen and become available at other times of the year.

BEHAVIOR: Feeding was never observed to begin before dark. It was usual for these bats to first appear around 7:30 P.M. and they were found to remain active as late as 2:00 A.M. Apparently they will feed at any time during the period of darkness. They were not easily disturbed in either feeding or roosting situations. Often they would continue to circle a fruiting tree even though a flashlight beam was played upon them at a distance of only 6 m. In

a cave or other roosting place they would sometimes allow a person to approach within 8 to 10 m. before taking flight. Whether feeding or roosting, this species usually occurred in groups. The number of individuals in roosting colonies varied from five to 300 bats.

When roosting, they hung freely by the feet from a horizontal surface. In Leneara Cave they collected in groups of three to 20 in shallow cavities in the ceilings. The individuals in these groups roosted so close together that they appeared to be in contact with one another. A few bats were seen resting horizontally on the upper surfaces of rock ledges which were sparingly distributed around the ceiling, and they actively walked about there.

After observing the kinds of roosting sites used by *Dobsonia* and the aerial maneuverability required to gain access to them, the functional advantage of the unique insertion of the wing membranes in this genus becomes completely clear. The mid-dorsal rather than lateral attachment of the membranes undoubtedly gives a greater amount of buoyancy and lift making it possible for these large bats to climb nearly vertically in the virtual absence of assisting air currents to reach the heights typical of their roosting sites. Horizontal distance in these areas is usually severely limited. It is interesting to note that a similar anatomical specialization is present in *Notopteris macdonaldi*, which is also a cave-dwelling pteropodid, though smaller than any species of *Dobsonia*. I observed a colony of *Notopteris* in Kalabu Cave near Suva, Viti Levu, Fiji Islands, where it roosts at the tops of high, narrow passageways, vertical crevices, and chimney-like formations, similar to the kinds of roosting places often occupied by *Dobsonia* and requiring the same kind of flight capability for gaining access to these areas.

Two different vocalizations were heard from *Dobsonia peroni*. At times they emitted a loud, harsh, grating screech similar to sounds made by *Pteropus* species. This vocalization was heard during hostile encounters or, rarely, when a bat was handled. When disturbed at a roost, the bats uttered a series of muffled grunts as they circled about.

When a specimen was removed from a mist

net it was usually rather passive. However, if one's hand was carelessly brought within reach, it became apparent that the bat was not only very responsive but also that it was capable of moving very quickly and biting viciously.

REPRODUCTIVE DATA: Five adult males collected in March and April in Dili and Tutuala were in breeding condition. Testis size ranged from 10 by 13 to 16 by 22 with an average of 13 by 18. A female collected in Mau-Dohi on March 20 while feeding on the fruits of *Borassus* contained a fetus weighing 48 g. and having the following measurements: forearm length 51, head-body length 80, tail length 14, ear length 16, wingspread 325.

The population in Leneara Cave was composed of adults and young adults of both sexes. Some of the smaller colonies observed were made up mostly or entirely of immature individuals.

Cynopterus sphinx terminus Sody

Cynopterus sphinx terminus Sody, 1940, p. 404.

TYPE LOCALITY: Timor. Sody's material consisted of six specimens collected at Nikiniki, Timor, on April 3, 1929, by Mrs. M. E. Walsh. These specimens are in the Zoological Museum at Bogor, Java.

DISTRIBUTION: This species occurs from India to Timor, but it has yet to be reported from the islands between Lombok and Timor. It is widely distributed on Timor occurring from sea level to an altitude of 1220 m. Specimens were collected at Ermera, Hera, Nae-Boroc, Ossu, and Tutuala. Schwarz (1914) listed a specimen collected by Haniel at Kupang.

DESCRIPTION: When Sody described *terminus* as a new subspecies, he compared it with *C. s. titthaechelus* from Java noting that the size and color were the same, but that the skull was considerably shorter. Six of my skins of *terminus* were compared with five skins of *titthaechelus* from Bali in the American Museum of Natural History. The two forms are similar in color and size except that there is a striking difference in the color of the neck tufts. Those of the Balinese males are near Sanford's Brown, whereas those of *terminus* males are Yellow Ocher. The pelage color of two adult

males in breeding condition from Timor is Brownish Olive mixed with hairs of Yellow Ocher across the shoulders and back shading to Clove Brown posteriorly. The top of the head is Olive Brown to Clove Brown, and the dorsal surface of the neck is suffused with Yellow Ocher which intensifies laterally reaching its brightest color in the lateral neck tufts. This color continues ventrally around the neck and becomes duller along the sides of the chest. Medially, the chest, belly, and abdomen are Light Grayish Olive to Grayish Olive. The hairs of the neck tufts are longer and coarser than the rest of the pelage, but they are not as specialized as are those of the neck tufts of *Rousettus amplexicaudatus*. The color of females tends to be duller than that of males, but bright female variants are indistinguishable from dull male variants. Neck tufts are present in females though they are not as well developed or as bright in color. Dorsally, females and immature individuals appear to be grayer than males.

The skull of *terminus* is compact and has a very short, stout rostrum as Sody (1940) noted.

Forearm lengths of adult specimens are: six skins, 75.2-78.4 (76.3); five alcohol specimens, 76.9-80.5 (78.0). Body measurements of eleven adults are: head-body length 98-113 (104), tail length 6-13 (8), ear length 17-21 (20), wingspread 470-523 (508), weight 42-69 (52). Skull measurements of six adults are: greatest length 31.5-33.2 (32.5), condylobasal length 30.2-31.9 (31.3), condylocanine length 29.8-31.3 (30.6), maxillary toothrow length 10.9-11.8 (11.1), zygomatic width (4 specimens) 20.0-21.3 (20.6), mastoid width (5 specimens) 12.9-13.2 (13.1), width of interorbital constriction 6.4-6.8 (6.6), greatest width between outer surfaces of upper canines 6.8-7.3 (7.1), greatest width between outer surfaces of M¹ 9.5-10.5 (10.0). There is no significant difference in size between the sexes in this series of five males and six females.

TAXONOMIC NOTES: Andersen (1912) referred to an immature female specimen in the British Museum (Natural History), BMNH 84.4.22.1, collected by Dr. H. O. Forbes in Timor, as agreeing with *C. s. titthaechelus* in the size of the teeth, but since he was uncertain about the identity of this specimen he ques-

tioned the presence of this subspecies on Timor. The true identity of the Timorese population remained in question until Sody pointed out its unique rostral size and described it as a new subspecies, *terminus*.

HABITAT: At low altitudes these bats are found in forests of *Corypha* palms where they roost in shelters which they construct from the large fan-shaped leaves. These shelters can be easily found because of their unique appearance. They are usually located along the edges of clearings where they are more accessible to the bats. The shelters are built from 2.4 to 6 m. above the ground. The fact that many unoccupied shelters may be found in a stand of palms suggests that these bats do much moving around, continually changing their roosting location. In some cases shelters are abandoned before they are completed. At higher altitudes where *Corypha* does not occur, cavities in large trees, usually *Ficus*, are used as roosting sites. At three such locations, the openings were from 6 to 15 m. above the ground and all were less than 250 mm. in diameter. At Ossu an adult male was found hanging on a small branch of bamboo next to the main stem about 9 m. above the ground. It was well hidden in a cluster of leaves.

ASSOCIATED SPECIES OF BATS: Scattered individuals of *Dobsonia peroni* and *Pteropus griseus* were occasionally found roosting in palm forests in which *Cynopterus* occurred. They were never observed to occupy shelters of *Cynopterus*.

FOOD: This species was collected only while roosting during the day so it was not possible to obtain data on its food habits. In flight it could easily be confused with *Rousettus* and *Eonycteris* so positive sight identifications could not be made. Individuals believed to be this species were observed flying in and out of the crowns of *Borassus* with *Pteropus griseus* and *Dobsonia peroni*. It could not be determined whether they were feeding on the flowers, fruits, or sap of these trees. At least some of the trees visited were in the process of being tapped so that open containers of sap would have been available to the bats for drinking. A beverage called toddy is made from the juice by the Timorese people. Andersen (1912) mentioned that *Pteropus giganteus* in India is

attracted to coconut palms during the season that those trees are tapped for the same purpose.

Cynopterus was never captured in mist nets set up near fruiting trees of *Ficus* and *Muntingia*.

BEHAVIOR: Without exception *Cynopterus* was found to be very wary and easily disturbed at its roosts. Even though extreme care was taken to approach their shelters quietly, rarely could one come within 6 m. without flushing the bats. They were especially sensitive if they were in a position to see someone approaching. When roosting in hollow trees they were less easily disturbed, but usually they could be made to leave by tossing a stone through the opening. When disturbed at their roosts, seldom did they fly farther than 30 m. before settling down temporarily in the crown of a tree or tall shrub. If they were then disturbed again, they would often fly back to the original roost. During such movements the bats tended to remain in a group. However, with repeated disturbance the flocking movements became disorganized and the individuals became widely scattered. Their flight was extremely rapid and they maneuvered with such great agility that it was very difficult to follow them visually as they flew through a wooded area. They left their roosts with incredible speed and disappeared almost immediately. From one to 20 bats were found roosting in a single palm leaf shelter but the usual number varied from three to eight. Groups of two, five, and approximately 12 individuals were found in hollow trees in the mountains.

The bats construct their palm leaf shelters by chewing through the veins of the leaf, circumscribing a characteristic flask-shaped pattern within the blade, or palman. This results in the collapse of a wide marginal area which folds down to form the sides of the shelter. The bats roost within by clinging to the veins of the "roof" with their toes. They prefer to hang against the sides of the enclosure rather than toward the center probably because they are able to grasp more easily the rough edges of the leaf where the veins have been chewed. Also, the bats are more completely hidden from below in this part of the shelter.

REPRODUCTIVE DATA: Specimens of both

sexes collected in March, April, and May were found to be in breeding condition. Of five adult females examined, one contained a 5 mm. embryo, one had two large corpora lutea in its ovaries, and one gave birth to two young in captivity, about 20 hours after capture. The testes of two adult males measured 10 by 8 and 8 by 6.

Eonycteris spelaea (Dobson)

Macroglossus spelaeus Dobson, 1871, pp. 105, 106.

TYPE LOCALITY: The original description is based on a specimen collected in Farm Caves, Moulmein, Burma by Dr. Stolicza. Andersen (1912) stated that the type specimen was located in the Indian Museum, Calcutta.

DISTRIBUTION: The species has been reported from Tonkin and Burma to Java, Bali, Sumba, Borneo, and the Philippine Islands. In Timor, one adult female, AMNH 237709, and one immature female, AMNH 237710, were collected at Dili. These are the first records of this species from Timor.

DESCRIPTION: The resemblance of these two skins to *Rousettus amplexicaudatus* is striking. It is interesting that such distantly related forms should bear such a marked superficial similarity. The absence of a claw on the second digit and the darker wing membranes of *Eonycteris* are the best characters for distinguishing skins of the two species. The skulls are very different and are immediately separable.

The color of the adult female specimen is as follows: crown, shoulders, and back Bister; neck, sides of head and throat Pale Ochraceous-Buff; chest, belly, and abdomen Hair Brown.

Measurements of the adult female are: forearm length 73.7, head-body length 114, tail length 22, ear length 20, wingspread 507, greatest length of skull 36.9, condylobasal length 35.5, condylocanine length 33.2, maxillary toothrow length 12.4, zygomatic width 20.9, mastoid width 14.1, width of interorbital constriction 7.2, greatest width between outer surfaces of upper canines 7.4, greatest width between outer surfaces of M¹ 9.4.

TAXONOMIC NOTES: The lack of sufficient material from the intercontinental region is responsible for some taxonomic uncertainty in

this genus. Tate (1942) offered a diagnosis which recognized two species, *spelaea* and *major*. He restricted the nominate subspecies to populations ranging from Burma and Tonkin to Java and possibly Borneo, and he recognized an eastern race, *glandifera*, in the Philippine Islands, Bali, perhaps eastern Java, and probably Borneo. The latter subspecies is characterized by the rufous throat of the male. In describing *glandifera*, Lawrence (1939) observed that in a series from the Philippine Islands the intensity of the throat color in the males varied with age.

A series of specimens from Sumatra in the American Museum of Natural History exhibits generally lighter coloration in both pelage and membranes than a series from Bali. The throat pelage of adult males from Sumatra is Buckthorn Brown, whereas in the Balinese specimens the same area varies in different specimens from Cinnamon-Rufous to Kaiser Brown. The only specimen from Java that I have seen is a female. The dorsal pelage color and the color of the membranes of this specimen are intermediate between specimens from Sumatra and Bali. A male from the Philippine Islands is closest in color to the series from Bali except that the throat pelage is less red and near Buckthorn Brown in color. This may be due to the fact that the specimen was originally preserved in alcohol and was later prepared as a skin. The difference in color between the Sumatran and Balinese material is striking and consistent and would seem to warrant subspecific distinction.

The adult female from Timor is dark like specimens from Bali and the Philippine Islands. It remains to be determined if males from Timor possess the rufescent throat color typical of *glandifera*. This should be expected on the basis of the similarity of the adult female specimen to *glandifera*, and because of the geographical position of Timor. The specimen from Timor has a larger forearm than any specimen in a series in the British Museum (Natural History) of 15 adult males (62.7-71.1, average 67.1) and 10 adult females (58.4-71.0, average 66.5) from Burma, Thailand, the Malay Peninsula, and Sumatra. Forearm length of 14 adult specimens from Sumatra in the American Mu-

seum of Natural History are 63.8-71.2 (68.5); forearm lengths of 15 adults from Bali are 64.7-74.0 (70.7).

FOOD: The two specimens from Timor were captured in a mist net which was set up near a *Muntingia* tree. Several specimens of *Rousettus amplexicaudatus* were collected at the same time.

Macroglossus lagochilus lagochilus Matschie
Macroglossus lagochilus Matschie, 1899, pp. 96-97.

TYPE LOCALITY: According to Andersen (1912) the type specimen from Buru is in the Berlin Museum.

DISTRIBUTION: Four subspecies of *M. lagochilus* are presently recognized. The typical race occurs from the Malay Peninsula and Sumatra through Borneo and Celebes east to Ceram and the Banda Islands. The range of *M. l. nanus* includes New Guinea, Kai Islands, Aru Islands, Bismarck Archipelago, and Admiralty Islands. *Macroglossus lagochilus microtus* is restricted to the Solomon Islands, and *M. l. pygmaeus* occurs on the Murray Islands in the Torres Straits and on the Cape York Peninsula.

Temminck (1827) listed a specimen of *M. minimus* from Timor but there is no specimen of *Macroglossus* from Timor in the Rijksmuseum, Leiden. Dr. A. M. Husson (*in litt.*) believed that Temminck may have been informed of the occurrence of *Macroglossus* there by Müller and that actually he may not have examined material from the island.

A single specimen of *M. l. lagochilus*, AMNH 237711, was collected at Taibesse, a settlement on the south side of Dili, on March 8, 1968. In October 1973, four specimens were collected in Soe and Panite, western Timor by members of NAMRU-2 and were subsequently deposited in the collection of the American Museum of Natural History. These five specimens verify Temminck's original record of that genus on Timor and establish a range extension for the species.

DESCRIPTION: The specimen from Taibesse was a lactating female which contained an embryo with a crown-rump measurement of 11 mm. The skin of the extended wing of the living specimen, the ears, feet, and nose were a

rich light brown quite close to the color of the back pelage. In the dried skin the color of the dorsal pelage is between Sayal Brown and Tawny-Olive. The ventral pelage is Avellaneous shading to Wood Brown posteriorly. The color of the wing membrane is Verona Brown.

Measurements of five specimens (2 males, 3 females) from Timor are: forearm length 40.0-41.3 (40.8), greatest length of skull 24.2-25.2 (24.7), condylobasal length 21.0-23.6 (22.2), condylocanine length 20.0-22.3 (21.0), mastoid width 9.2-9.5 (9.4), width of interorbital constriction 4.1-4.8 (4.6), greatest width between outer surfaces of upper canines 4.6-4.9 (4.8).

TAXONOMIC NOTES: The distribution of the genus is such that one might expect to find *minimus* rather than *lagochilus* on Timor. The range of *minimus* extends eastward through Java at least as far as Bali, while *lagochilus* has not been recorded previously from the Lesser Sunda Islands. The affinity of the population on Timor with the Celebes-Moluccan form rather than with the Javan species represents a zoogeographical anomaly.

In addition to size the most useful characters for separating *lagochilus* and *minimus* are differences in the form of the external nares and the medial area between the nares and the edge of the upper lip. Andersen (1912) used the direction which the external nares face and the presence or absence of a median vertical groove on the upper lip to differentiate between these two species. In comparing alcoholic specimens of *M. minimus sobrinus* from Malaya, *M. l. lagochilus* from Malaya and Celebes, and *M. l. microtus* from the Solomon Islands a difference in the direction which the nares face could not be observed. However, there is an obvious difference in the form of the nares between *lagochilus* and *minimus*. In *lagochilus* the margins of the nares are raised showing a tendency toward the development of incipient tubes as in *Cynopterus* and *Dobsonia*. A median vertical groove extends from the area between the nares to the edge of the upper lip. In *minimus* the margins of the nares are not raised, but the upper lip is swollen medially below the nares. This bulge can be seen espe-

cially well when the head is viewed from above. In most specimens of *minimus* the vertical groove between the nares does not extend downward across the bulge to the edge of the lip, but in one specimen (AMNH 216778) there is a shallow groove crossing this area. These facial characters are best seen in alcoholic specimens. Usually, they are not preserved well enough in dried skins to be useful.

Measurements of the skull and the length of the forearm of the specimen from Timor compare favorably with specimens of *M. l. lagochilus* from Celebes, Borneo, and Ceram. There is so much individual variation in the dental characters of *M. lagochilus* that the teeth have no taxonomic value at the subspecies level. Since the five specimens from Timor are prepared as skins, the facial characters are not well preserved.

FOOD: The specimen from Taibesse was captured at night in a mist net which was attached at one end to a *Muntingia* tree. This tree bore an abundance of flowers and fruit. *Rousettus amplexicaudatus* and *Dobsonia peroni* were captured at the same time.

Nyctimene cephalotes (Pallas)

Vespertilio cephalotes Pallas, 1767, p. 10, pl. 1, 2.

TYPE LOCALITY: "Moluccas." Andersen (1912) restricted the type locality to Amboina.

DISTRIBUTION: The typical form has been recorded from Celebes, Timor, Tanimbar, Amboina, Buru, Ceram, and northwestern New Guinea. Thomas (1914) described *N. c. vizcaccia* from Ruk (= Umbui), off the north coast of New Guinea.

The present status of this species in Timor is not known. It was not collected during the course of this study even though considerable time was spent searching for it in likely habitats across the eastern half of the island. Numerous inquiries were made, also, but the Portuguese and Timorese residents who were questioned had never seen this distinctive bat. The only known record of this species from Timor up till this time is that of Andersen (1912). This record was based on a specimen in the British Museum (Natural History), BMNH 9.1.4.8, labeled "Timor."

Taphozous melanopogon Temminck

Taphozous melanopogon Temminck, 1835-1841, pp. 287-288, pl. 60, figs. 8, 9.

TYPE LOCALITY: Java. Three cotypes from Bantam, west Java, are in the Rijksmuseum, Leiden.

DISTRIBUTION: *Taphozous melanopogon* is widely distributed on the mainland of southeast Asia from India and southern China south through the Malay Peninsula. It is known to occur on the islands of Sumatra, Borneo, Java, Bali, Sumbawa, Timor, Savu (west of Timor), and the Philippine Islands. It has not yet been reported from Lombok, Flores, nor the chain of islands east of Flores, but it should be expected on at least some of these islands. Although not previously reported from Timor it was found to be widely distributed and rather common there. Collections were made at Becia, Fatu Cama, and Tutuala.

DESCRIPTION: The color of the dorsal pelage in the series of adult specimens varies in different individuals from Warm Sepia to Bone Brown with paler areas on the neck and head. This pale pelage varies from Natal Brown to Snuff Brown. There is a small pale patch on the forehead and the bases of all the dorsal hairs are nearly white. The pelage of the ventral surfaces varies from Wood Brown to Natal Brown in different individuals. The specialized throat patches of adult males consist of long, closely adpressed black or brown hairs. Upon close examination the black patches are composed of mostly black hairs with many dark brown hairs mixed in. The color difference of the throat of adult males is not correlated with age as indicated by tooth wear, but instead it is simply a matter of individual variation. According to Brosset, (1962) the black patch does not appear until the age of five or six months. Of 10 adult males in the series from Timor, two had black patches and eight had brown.

Forearm lengths of adult specimens are: five skins 62.7-65.2 (63.9), 30 alcohol specimens 61.4-66.9 (64.1). Body measurements of 30 adults are: head-body length 76-86 (81), tail length 22-29 (26), ear length 18-23 (21). Skull measurements of five adults are: greatest length 20.9-22.8 (21.9), condylobasal length 19.7-20.9

(20.5), codylocanine length 19.7-21.8 (20.6), maxillary tooththrow length 8.9-9.5 (9.1), zygomatic width 12.4-13.3 (12.8), mastoid width 11.2-11.6 (11.4), width of interorbital constriction 6.0-6.7 (6.3), greatest width between outer surfaces of upper canines 4.0-4.2 (4.1), greatest width between outer surfaces of upper posterior molars 8.7-9.1 (8.9).

TAXONOMIC NOTES: I can find no appreciable differences between the populations of *T. melanopogon* from Bali, Savu Island, and Timor. A series of 17 adults from Bali in the American Museum of Natural History have forearm lengths ranging from 61.1 to 66.5 (average 63.8). Two adult females, one of which is the type specimen of *T. m. aches*, collected by A. Everett on Savu Island (approximately 190 km. west of Timor) have the following measurements: forearm length 62.2, 63.9; greatest length of skull 21.8, 22.0; maxillary tooththrow length 9.7, 9.6; zygomatic width 13.1, 13.2; mastoid width 11.3, 11.3. These measurements are within the range of variation of the Timor population. Specimens from these three islands are so close in body measurements, size and character of the skull, and color, that they should be considered consubspecific.

I have not examined specimens from Java, but Dr. A. M. Husson informed me that the forearm lengths of the three cotypes in the Rijksmuseum, Leiden, are 61.5, 62.0 and 59.0. The specimens are very old, faded, and mounted with wings spread. On the basis of these measurements it seems that the populations from Bali, Savu, and Timor should be considered to belong to the typical subspecies. A large series of topotypical material must be examined before this can be determined for certain. In describing the Savu Island population as a new species, Thomas (1915b) remarked on the small size of the forearm (59 mm.) of Temminck's specimen from Java. He did not have any Javan material to compare with the specimens from Savu Island and apparently was not aware of the larger size of the other Javan cotypes. It seems doubtful that *aches* is a valid subspecies, but this, too, will depend on the determination of the true character of the typical race.

HABITAT: This species was found in solution caves and cavelike crevices on or near the coast. Fatu Cracat Cave at Becia and Leneara Cave near Tutuala were within a few hundred meters of the sea. At Fatu Cama there were two large, irregular fissures in a sea cliff in which the bats roosted only 5 m. above high tide level.

ASSOCIATED SPECIES OF BATS: In Fatu Cracat Cave, Becia, the bats roosted in the same or adjacent chambers with *Rousettus amplexicaudatus*, *Rhinolophus borneensis parvus*, *Rhinolophus creaghi timorensis*, *Miniopterus australis*, *Miniopterus magnater*, and *Miniopterus pusillus*. At Leneara Cave, *T. melanopogon* roosted around the periphery of a large domed room the center of which was occupied by *Dobsonia peroni*. No other species were present in the roosting areas at Fatu Cama.

BEHAVIOR: This species prefers to roost in subdued light rather than in the darker, deeper parts of caves. At Fatu Cama several roosts, only two of which were occupied at the time observed, were located in relatively exposed situations on the undersides of rock ledges in wide crevices in a sea cliff. During the day there was enough light present so that the bats could be clearly seen while roosting. When the bats were disturbed they would fly farther back in the fissures. In a few minutes they would gradually reappear at their original exposed location.

Besides occupying a large dome-shaped room near the entrance of Leneara Cave, bats of this species were found in a narrow, low passageway farther back in the cave where there was no light visible. They roosted in irregular cavities and crevices in the ceilings and usually gathered in groups of five to ten individuals. When disturbed they were very active and scurried about continually over the rough rock surfaces, sometimes crawling into small cracks or pockets. After disappearing momentarily they usually returned to peek out from their retreat. These bats were never observed to hang freely by their feet when roosting. They always used their wings to assist in support as they roosted against vertical or near-vertical surfaces. Captive bats were able to

hang freely by their toes from horizontal surfaces when forced to do so, but when given a choice of situations they always settled where their wings could be used as props.

REPRODUCTIVE DATA: The testes of three adult males collected at Fatu Cama on March 14, 1968, ranged in size from 4 by 2 to 5 by 3 mm. The reproductive tracts of three females from the same collection were examined grossly. The right uterine horn of one specimen was slightly enlarged, but if implantation had occurred, it had been so recent that no embryo could be seen with the naked eye. A second female had enlarged mammary glands and was lactating but showed no enlargement of the uterus. Medway (1969) stated that in Malaya the highest frequency of pregnancy is in January. In India, the young are carried for the first 30 days after birth and then roost independently of the adults and do not emerge from the roost until they are weaned (Brosset, 1962). Nursery roosts were not located in Timor during March, April, and May, nor were any juveniles collected during that period.

Taphozous saccolaimus Temminck

Taphozous saccolaimus Temminck, 1835-1841, pp. 285-286, pl. 60, figs. 1-6.

TYPE LOCALITY: Temminck's description was based on specimens collected by Kuhlz and Hasselt in Java. Three cotypes are in the Rijksmuseum, Leiden.

DISTRIBUTION: The subgenus *Saccolaimus* occurs through the Oriental and Australian regions. The species relationships in this group are incompletely understood at present and are in need of careful study. It seems that *T. saccolaimus*, a strong flier, is a widespread species exhibiting as much individual variation in structure and color in a particular island population as it may show over a wide geographical range. Until larger local series are available and a more complete sample through the entire range is obtained it seems undesirable to attempt to divide the species into subspecies.

One specimen, an adult male, AMNH 237750, was collected near Becia on April 5, 1968. This represents the first record of the species for the Lesser Sunda Islands.

DESCRIPTION: The color of the dorsal pelage of this specimen is Bone Brown shading to Verona Brown in the neck region and to Mikado Brown around the shoulders and sides of the neck. There are a few small, irregular white flecks on the crown and back, and the basal halves of the hairs on the dorsal surfaces are nearly white. The ventral pelage is Drab-gray medially shading to Pale Pinkish Buff laterally. These hairs are slightly pale-tipped which gives the undersurfaces a somewhat frosted appearance. A gular pocket is present.

Measurements of this specimen are: forearm length 73.9, head-body length 93, tail length 24, ear length 21, greatest length of skull 26.9, condylobasal length 24.9, condylocanine length 25.6, maxillary toothrow length 11.8, zygomatic width 17.6, mastoid width 14.8, width of interorbital constriction 9.0, greatest width between outer surfaces of upper canines 5.5, greatest width between outer surfaces of upper posterior molars 11.5.

TAXONOMIC NOTES: This specimen was compared with the three cotypes, with specimens from India and Java in the British Museum (Natural History) and with a series from Java in the American Museum of Natural History. It differed significantly from the type specimens only in the color of the ventral pelage. In the types, this area was medium yellow-brown. This same color with only slight variation also occurred in a series of seven specimens from Java in the American Museum of Natural History and three specimens from Java in the British Museum (Natural History). However, one specimen in the latter series, BMNH 7.1.1.570, was much paler and less yellow ventrally than any other specimens from Java. It approached the color of the specimen from Timor but it was slightly darker. Two specimens from India exhibited an even greater intensity of yellow in the ventral pelage than the typical Javan specimens.

An alcohol specimen of *T. nudicluniatus* from Queensland, AMNH 66144, is very close to the specimen from Timor. The color of the undersurface is paler than the typical Javan color and it lacks the yellow suffusion, possibly due to its long period of preservation in alcohol. It is not as pale as the specimen from

Timor. Measurements of this specimen of *T. nudicluniatus* and those given for the species by DeVis (1905) and by Troughton (1925) are very close to the specimen from Timor. Troughton in describing *T. nudicluniatus* mentioned that it was different from *saccolaimus*, *flaviventris*, and *mixtus* in lacking a deep groove in the posterior floor of the mesopterygoid fossa and by a peculiarity of the tragus. The specimen of *nudicluniatus* in the American Museum of Natural History also lacks the mesopterygoid groove, whereas the specimen of *saccolaimus* from Timor has a very deep groove. In checking this character in the series of *saccolaimus* from Java at the American Museum of Natural History it was discovered that five specimens had a groove, and five lacked it. The differences of the tragus described by Troughton could not be seen when the specimen of *nudicluniatus* was compared with alcohol specimens of *saccolaimus* from India. It seems then, that *nudicluniatus* and *saccolaimus* are conspecific. One might even question the justification for giving *nudicluniatus* subspecific status without having more comparative material.

HABITAT: The specimen from Timor was reported by a Timorese boy to have been captured in Fatu Cracat Cave near Becia, but since this is not normally a cave-dwelling bat in other parts of its range, the accuracy of this report might be questioned.

Rhinolophus borneensis parvus, new
subspecies

TYPE SPECIMENS: The holotype is the skin and skull of an adult male, AMNH 237766, collected in Lia Hoo Cave near the village of Fatu Maca, 7 miles (11 km.) south of Baucau, Timor, at an altitude of approximately 550 m., on March 27, 1968. Two paratypes have been designated. One is the skin and skull of an adult male, AMNH 237777, collected in Fatu Cracat Cave near the village of Becia, 10 miles (16 km.) east of Viqueque, on April 5, 1968. This specimen was chosen as a paratype because of the perfectly preserved skull. The second paratype is an adult male preserved in alcohol with the skull *in situ*, AMNH 237753,

collected at the same location and on the same date as the holotype. Since the facial features are of such great taxonomic value in this group, it seems advisable to include an alcohol paratype with skull *in situ* and with the facial specializations in as undistorted condition as possible, whenever new taxa are described.

In addition to the type specimens, a series of three skins with skulls, and 22 specimens preserved in alcohol have been deposited in the American Museum of Natural History.

ETYMOLOGY: The subspecific epithet is a Latin adjective meaning small.

DIAGNOSIS: This subspecies can be distinguished from other subspecies of *Rhinolophus borneensis* by the following characters: smaller size, pale hair bases and a greater admixture of pale hairs in the dorsal pelage, pale patches of fur behind the bases of the ears, horseshoe narrower relative to height, elevation of connecting process located more posteriorly, posterior slope of nasal swellings slightly convex.

DESCRIPTION: This is a very small *Rhinolophus* of the *borneensis* groups, closest to *javanicus* and *celebensis*, but generally smaller in size. The texture and color of the pelage are similar to the other members of the *borneensis* group but there is a more distinct bicolored appearance when the fur is parted due to paler hair bases. The color of *parvus* is near that of the type specimen of *javanicus* except that it is paler beneath and has unique pale patches of fur behind the bases of the anterior edges of the ears. Dorsally, there are more pale hairs mixed in with the darker ones than in any of the other closely related forms. This condition is particularly noticeable on the sides of the neck and head. The dorsal pelage is near Wood Brown. In one specimen it approaches Drab. The ventral pelage varies in the series from Wood Brown to Drab and Light Olive.

The facial features (fig. 2) are basically similar to those of the other members of the *borneensis* group. Compared with the type specimen of *celebensis*, the sella is very similar, the connecting process has its elevation farther posterior from the tip of the sella, and the horseshoe has a slightly different shape, being a bit narrower relative to its height. The sizes and proportions of the sella, lancet, and

horseshoe appear to be correlated with sex, males tending to have broader horseshoes than females (table 1). Although there was only a difference of 0.1 mm. between the average forearm lengths of a series of 11 males and 11 females, the average of the horseshoe widths, a relatively small measurement, differed 0.5 mm.

In most species of *Rhinolophus*, the sella normally curves forward, distally. In order to obtain as accurate a representation as possible of the shape of the sella in the three illustrations of facial features (figs. 2, 3, and 4), the sella of each alcohol specimen was flattened so that in lateral view it assumed a position more or less parallel to the lancet and the canine.

The most useful taxonomic characters of the skull of the *borneensis* group are the size and shape of the antero-medial (dorsal) nasal swellings or bullae, the width of the interorbital constriction, and the position of the junction of the supraorbital crests. Although these characters are subject to a slight amount of individual variation, significant differences occur between subspecies. In most characteristics the skull of *parvus* is most similar to *javanicus*. The size of the antero-medial swellings is proportionately larger in *borneensis* than in any of the other members of this group. The distance between the junction of the supraorbital crests and the anterior edge of the nasal bones is shortest in *parvus*, slightly longer in *javanicus* and *celebensis*, and longest in *borneensis*. The

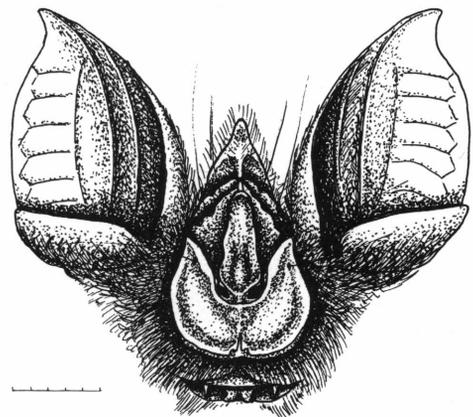


FIG. 2. Facial features of *Rhinolophus borneensis parvus*. Scale represents 5 mm.

width of the interorbital constriction is narrowest in *parvus*, wider in *javanicus* and *celebensis*, and widest in *borneensis*.

In lateral view, the shape of the skull is most similar to *javanicus*, but this aspect is very similar in all of the forms. The only difference that could be detected between *parvus* and *javanicus* was that the posterior slope of the nasal swellings was straight in *javanicus* and slightly convex in *parvus*. This minor difference might be within the limits of normal variation within a population even though this did not prove to be the case in the available sample. This view of the skull shows *borneensis* to be the most different of the four forms with its more bulbous occipital area and more strongly arching frontoparietal area. No significant differences in the form of the dentition could be found between any of the members of the group which were examined.

The measurements given in table 1 show that *parvus* is smaller than any of the forms except in length of tail and length of ear. Since these two measurements are subject to considerable error they are of limited use in comparing closely related taxa, especially when the measurements are not all taken by the same investigator.

DISTRIBUTION: This species was collected in the two caves listed as the type localities, Lia Hoo Cave near Fatu Maca, and Fatu Cracat Cave near Becia. Schwarz (1914) identified a specimen collected by Haniel at Kupang as *R. simplex*. Although this specimen no longer exists, it is clear from the skull measurements given by Schwarz that it was *P. b. parvus*. The species ranges widely across the island from sea level to an altitude of at least 550 m.

TAXONOMIC NOTES: The similarities between this new *Rhinolophus* and the three forms with which it has been compared leave no doubt that they are all very closely related and that they belong to the same species. Since "*borneensis*" has priority as a specific name, it is proposed that the forms be recognized as *R. b. borneensis*, *R. b. celebensis*, *R. b. javanicus*, and *R. b. parvus*.

Four species which are fairly closely related and are geographically adjacent to *R. borneensis parvus* are *R. affinis*, *R. keyensis*, *R. mega-*

phyllus, and *R. simplex*. Of these, *affinis* is the least closely related. It differs from *borneensis* in being a larger species with more specialized dentition and wing structure. In addition, the sella is strongly constricted at the middle (pandurate), the nasal bullae are longer, and the interorbital constriction is narrower.

In *keyensis*, *megaphyllus*, and *simplex* the supraorbital crests join at a point posterior to the middle of the orbital cavity rather than anterior to it as in *borneensis*. In *keyensis* the nasal bullae are more prominent and longer (nearly round when viewed dorsally), the sella is much higher and somewhat narrower, and the connecting process is not as prominent. Both *megaphyllus* and *simplex* are larger than *R. borneensis parvus*, and their dentition is somewhat more primitive. The vestigial premolars in both upper and lower jaws are generally not as crowded, but there is some individual variation in this condition. The nasal bullae of *megaphyllus* are slightly more prominent and longer, and there are differences in the shape of the sella and connecting process. The sella of *simplex* is slightly constricted and the connecting process is not as prominent.

The relationship of *borneensis* to *virgo*, *madurensis*, and *malayanus*, remains to be determined.

COMPARATIVE MATERIAL EXAMINED: *Rhinolophus affinis affinis*, AMNH 103240, skin and skull, Mentawai Islands; *R. borneensis borneensis*, BMNH 11.1.18.5, alcohol, skull removed, Borneo; *R. b. borneensis*, AMNH 106844, skin and skull, Borneo; *R. b. celebensis*, BMNH 97.1.3.19, type, alcohol, skull removed, Celebes; *R. b. celebensis*, AMNH 102246, skin and skull, Celebes; *R. b. javanicus*, BMNH 9.1.5.174, type, skin and skull, Java; *R. b. javanicus*, AMNH 107888, skin and skull, Bali; *R. keyensis keyensis*, BMNH 10.3.1.73, alcohol, skull removed, Kai Islands; *R. k. annectens*, RMNH 21721, type, alcohol, skull removed, Wetar; *R. k. nanus*, BMNH 61.12.11.10, type, alcohol, skull removed, Goram (=Gorong) Island; *R. k. truncatus*, BMNH 70.2516, alcohol, Ceram; *R. malayanus*, BMNH 3.2.6.83, type, alcohol, skull removed, Malaya; *R. megaphyllus*, AMNH 154592, skin and skull, Cape York, Australia;

R. simplex BMNH 97.4.18.14, type, alcohol, skull removed, Lombok.

HABITAT: Lia Hoo Cave is a relatively small solution cave located on the edge of open forest. It has a complex entrance and a network of small, irregular passageways. A colony of approximately 100 *R. b. parvus* and 50 *R. creaghi timorensis* occupied two small, irregular, relatively dry chambers with low ceilings (approximately 1.5 to 2.5 m. high) located about 90 m. from the entrance well within the dark zone of the cave. Fatu Cracat is a somewhat smaller cave, but of similar character. The same two species were associated there and showed the same preference for small, craggy rooms far back in the dark, deeper parts of the cave.

ASSOCIATED SPECIES OF BATS: Besides the two species of *Rhinolophus*, five other species of bats occurred in Fatu Cracat Cave. These were: *Rousettus amplexicaudatus*, *Taphozous melanopogon*, and three species of *Minioterus*. Of these, the closest associates were the two *Rhinolophus* species. They roosted in the same areas of the cave, usually widely scattered and not closely spaced nor associated in species groups. It was not determined if this was the typical roosting pattern of these two species or if the disturbance of my presence had caused abnormal behavior. The only other species in Lia Hoo Cave was *R. creaghi*. As in Fatu Cracat Cave, the two species were randomly scattered and widely spaced across the roosting area.

BEHAVIOR: All three species of *Rhinolophus* on Timor exhibit similar roosting preferences and similar roosting behavior. They hang freely by their toes from relatively low ceilings in small caves. Colonies tend to be small and the individuals widely spaced through the roosting chambers. In each of the four caves where this genus was found, two species were present and randomly distributed. In Lia Hoo Cave and Fatu Cracat Cave, *R. b. parvus* and *R. c. timorensis* were closely associated. In the two Quoto Lou Caves, *R. c. timorensis* and *R. philippinensis montanus* were freely interspersed in the roosting areas. It seemed as if *R. p. montanus* might be filling the niche of *R. b. parvus* in these caves.

I found it impossible to identify the three species in caves on the basis of behavioral characteristics. All were quite responsive to disturbances and left their resting places readily when approached. When a flashlight beam was directed upon them, they gaped, squeaked, and flew off to circle around the room and eventually return to their original resting place, or to some new location. If the disturbance continued they would fly to other parts of the cave. Sometimes they would enter passageways almost too small for a person to crawl through, but this occurred rather rarely. *Rhinolophus borneensis parvus* tended to be more active and more easily flushed from its resting places than *R. c. timorensis*. Like *Hipposideros bicolor*, the Timorese species of *Rhinolophus* possess very sensitive and effective echolocation systems, and are, thus, difficult to capture in mist nets. They are usually able to avoid even the finest denier nets when placed across the passageways of caves. This ability also improves with experience. The usual behavioral sequence through which the position of a net is learned begins with a bat coming into contact or near contact with the net without becoming entangled. It then flutters back and forth several times along the entire length of the net and close to the surface in an attempt to find an opening. After a bat has had an opportunity to "study" the position of a net in this way, it becomes extremely difficult to capture and must be virtually driven into the net.

REPRODUCTIVE DATA: The sizes of testes in two adult males collected in Lia Hoo Cave on March 27, 1968, were 4 by 3 (holotype), and 3 by 2 mm. An adult female from the same locality and collected on the same date contained a 2 mm. embryo.

The sex ratios present in the two collections of this species are: Lia Hoo Cave, seven males to nine females; Fatu Cracat Cave, seven males to four females.

Rhinolophus creaghi timorensis, new subspecies

TYPE SPECIMEN: The holotype is a skin and skull of an adult male, AMNH 237783, collected in Lia Hoo Cave near the village of Fatu

TABLE 1
Measurements of *Rhinolophus borneensis parvus*, New Subspecies, and Related Forms
 (For series, mean and range are given.)

	Forearm Length	Head-body Length	Tail Length	Ear Length	Sella Height	Sella Width	Horseshoe Width	Locality
<i>R. b. parvus</i>								
AMNH 237766, Type, skin and skull	39.2	43	22	19	—	—	—	Timor
AMNH 237777, Paratype, skin and skull	41.6	43	26	19	—	—	—	Timor
AMNH 237753, Paratype, alcohol	40.7	43	25	18	4.9	1.9	7.9	Timor
AMNH 237767, skin and skull	39.9	43	24	20	—	—	—	Timor
AMNH 237759, skin and skull	39.2	41	25	18	—	—	—	Timor
AMNH 237760, skin and skull	38.7	42	23	18	—	—	—	Timor
AMNH Series of 11 adults in alcohol	38.9-41.2 40.1	40-47 43	20-27 24	17-20 18	4.4-5.3 4.8	1.6-2.2 1.9	7.4-8.4 8.0	Timor
AMNH Series of 11 adults in alcohol	38.6-41.7 40.0	41-46 44	21-26 23	17-19 18	4.3-4.9 4.6	1.5-2.0 1.8	7.1-7.7 7.5	Timor
<i>R. b. javanicus</i>								
BMNH 9.1.5.174, Type, skin and skull	42.0	48	21	18	—	—	—	Java
<i>R. b. celebensis</i>								
BMNH 97.1.3.19, Type, alcohol	42.7	—	21	16	4.7	1.8	7.9	Celebes
<i>R. b. borneensis</i>								
AMNH 106844, skin and skull	44.8	—	—	—	—	—	—	Borneo

TABLE 1 — (Continued)

	Condylo- canine Length	Maxillary Toothrow Length	Zygo- matic Width	Mas- toid Width	Interorbital Constriction Width	Width		Distance Between Apex Supraorbital Crest and Anterior Edge of Nasal	Dimensions Median Nasal Swellings
						Between Outer Surfaces Upper Molars	Between Outer Surfaces Upper Canines		
<i>R. b. parvus</i> AMNH 237766, Type, skin and skull	17.3	6.7	8.4	8.2	2.1	4.4	6.2	4.8	3.4 × 1.9
AMNH 237777, Paratype, skin and skull	17.5	6.6	8.6	8.3	2.0	4.5	6.2	4.7	3.3 × 2.0
AMNH 237767, skin and skull	17.4	6.7	8.4	8.1	2.1	4.3	6.3	4.9	3.4 × 2.1
AMNH 237759, skin and skull	16.6	6.3	8.2	7.9	2.1	4.1	6.2	4.4	3.1 × 1.8
AMNH 237760, skin and skull	17.0	6.3	8.2	7.9	2.0	4.4	5.9	4.7	3.3 × 2.0
<i>R. b. javanicus</i> BMNH 9.1.5.174, Type, skin and skull	17.7	6.8	8.8	8.4	2.4	—	—	5.0	3.3 × 1.8
<i>R. b. celebensis</i> BMNH 97.1.3.19, Type, alcohol	17.8	6.8	8.8	8.6	2.2	—	—	5.1	3.3 × 1.5
<i>R. b. borneensis</i> BMNH 11.1.18.5 skull AMNH 106844, skin and skull	18.0	6.9	9.0	8.9	2.7	—	—	5.2	3.5 × 2.1
	18.3	7.2	9.0	—	2.8	—	—	5.2	3.8 × 2.1

Maca, 7 miles (11 km.) south of Baucau, Timor, at an altitude of approximately 550 m., on March 27, 1968. One paratype has been designated, an adult male preserved in alcohol with skull *in situ*, AMNH 237792, collected in Quoto Lou Caves near the village of Lequimia, 5 miles (8 km.) south of Ermera, Timor, at an altitude of approximately 1220 m., on April 23, 1968.

In addition to the type specimens, a series of six skins with skulls and 23 specimens preserved in alcohol have been deposited in the American Museum of Natural History.

ETYMOLOGY: The subspecific epithet is a Latinized adjectival form of Timor.

DIAGNOSIS: This subspecies can be distinguished from other subspecies of *Rhinolophus creaghi* by the following characters: skull relatively narrow (zygomatic width, mastoid width, and interorbital constriction width); tuft of hairs between sella and posterior nose leaf relatively diffuse, sparse, and unspecialized; connecting process relatively well developed; sella neither inflated nor with its anterior face pubescent.

DESCRIPTION: This is a medium-sized *Rhinolophus* most closely related to *R. creaghi canuti*. The texture of the pelage is similar to other members of the species; the hair is long, straight, and fine, and it tends to stand out straight from the body giving the fur a soft, fluffy appearance.

There are two rather distinct color forms which are not correlated with sex or age. In the brighter form, the dorsal pelage varies in different individuals from Sayal Brown to Snuff Brown and the ventral pelage from Avellaneous to Wood Brown. The dorsal pelage of the duller form varies from Wood Brown to Army Brown and the ventral pelage from Light Drab to Drab. In all specimens the hairs of the dorsal surfaces are paler basally when the fur is parted. These colors are different from the type specimens of the other subspecies of *R. creaghi*; three specimens of *canuti* including the type are redder and darker, *pilosus* is more yellowish brown, and *creaghi* is grayer and darker. It is possible, however, that *creaghi*, *canuti*, and *pilosus* may exhibit considerable variation in color and that when long series are compared some of the variants may prove to

approach more closely colors within the range of variation of *timorensis*. Such series have not been available for study.

The facial characteristics (fig. 3) are most similar to those of *canuti*, the greatest differences occurring in the shape of the connecting process and in the arrangement, quantity, and color of the hairs forming the tuft between the sella and posterior nose leaf. In *timorensis* the tuft is formed largely by fine, somewhat bristly hairs on the posterior nose leaf at the base of the lancet. Most of these hairs are directed upward and slightly forward, and there is a tendency for them to curve medially. There is a fringe of hairs along the edge of the connecting process, and there are long hairs on both the anterior and posterior surfaces of the lancet. The sella is naked except for a short pubescence on the basal half of the anterior surface. The sella, like that of *canuti*, does not show a tendency to be inflated as do those of *creaghi* and *pilosus*. To the unaided eye the color of the tuft appears quite like the rest of the dorsal pelage, but with a good light source and some magnification, the hairs take on a contrastingly lustrous reddish brown color. In *canuti*, the tuft is a much more striking structure because of the greater abundance of hair comprising it and because of its color. The arrangement of the

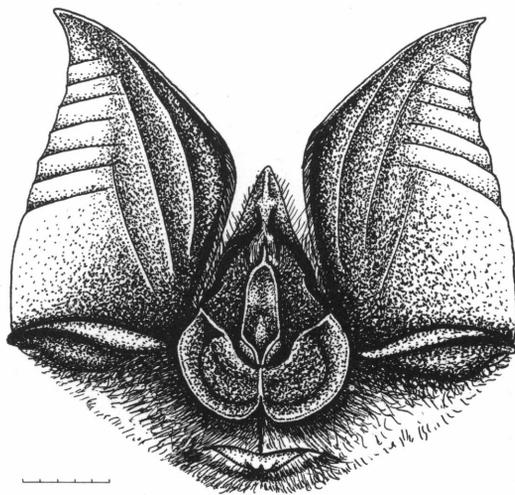


FIG. 3. Facial features of *Rhinolophus creaghi timorensis*. Scale represents 5 mm.

hair is similar to that of *timorensis* except that there are supplementary tufts on the posterior surface of the sella about midway between the base and the tip, one lying on each side of the connecting process. Unlike *timorensis*, the anterior face of the sella is sparsely clothed with long hairs and the color of the tuft is straw yellow. The tuft stands out in strong contrast to the rest of the pelage.

The connecting process of *timorensis* represents the greatest development that this structure attains in the *creaghi* complex. There is an interesting inverse correlation between the degree of specialization of the facial tuft and the degree of development of the connecting process in this species. In *creaghi* and *pilosus* there is a highly specialized tuft in which the long hairs are gathered into a dense conical mass. In *pilosus* the hairs themselves are strangely modified by having their distal halves flattened and expanded in bladelike fashion. Both of these subspecies are virtually without connecting processes. There is a very slight frenum behind the sella of *creaghi*. Considerably less specialized is the condition in *canuti*, which possesses a profusion of hairs, making up the rather diffuse tuft. A connecting process is present, though not well developed. Finally, in *timorensis* the tuft is least specialized and the connecting process is relatively well developed.

The ears of *timorensis* are large and generally of the same form and relative size as those of the other subspecies. They are more pointed and the outer margins are more falcate below the tip than in *creaghi*.

A comparison of the measurements of the body and skull indicates that all subspecies are quite close in size (table 2). In all measurements taken of the body and skull *timorensis* tended to run somewhat smaller than *canuti*, but the proportions of these two subspecies are very similar. The occipital area of the sagittal crest generally tends to be more pronounced than in *canuti*. The latter character is quite variable, however. The dentition is exactly as in *canuti*. The premolar behind the canine is included in the upper toothrow but shows a tendency to be crowded slightly out of line. It is in contact with both the canine and the premolar behind it, and it separates those two

teeth by a distance of about 0.5 mm. The diameter of the tooth is approximately 0.75 mm. In the mandible the second premolar behind the canine has been crowded completely out of the toothrow so that the cingula of the premolars in front and behind are in contact. The diameter of the vestigial premolar is approximately 0.5 mm.

DISTRIBUTION: In addition to the localities of the type specimens, this species was also collected in Fatu Cracat Cave near the village of Becia, 16 km. east of Viqueque. Thus, the species has a wide range through Timor and it occurs from near sea level to an altitude of at least 1220 m. Schwarz (1914) identified a specimen collected by Haniel in Bonleo as *R. canuti*. Although this specimen has been lost, measurements of the skull given by Schwarz indicate that it was *R. creaghi timorensis*.

TAXONOMIC NOTES: The close relationship of *R. creaghi* and *R. arcuatus* has long been recognized (Andersen, 1905a). Now the morphological gap between these two species is further narrowed by the intermediate character of *timorensis*. The facial characteristics of *timorensis* and *R. arcuatus* are different enough, however, to warrant separation into two species. Similarly, the somewhat closely related *R. euryotis* lacks the unique modifications of the connecting process of the *creaghi* complex. It seems very likely that *creaghi* represents an offshoot of *arcuatus* in which there has been a trend toward the loss of the connecting process and filling of the space thus formed by a specialized tuft of hairs.

COMPARATIVE MATERIAL EXAMINED: *R. arcuatus arcuatus*, AMNH 187137, skin and skull, Luzon; *R. a. exiguus*, AMNH 206737, alcohol, Negros; *R. creaghi creaghi*, BMNH 96.7.30.1, type, alcohol, skull removed, Sabah; *R. c. creaghi*, AMNH 202249, alcohol, Sabah. *R. c. pilosus*, BMNH 10.4.7.5, type, skin and skull, Madura; *R. creaghi canuti*, BMNH 9.1.5.183, type, skin and skull, Java; *R. c. canuti*, BMNH 9.1.5.184, skin and skull, Java; *R. c. canuti*, BMNH 9.1.5.185, skin and skull, Java; *R. euryotis euryotis*, AMNH 54432, alcohol, Amboina; *R. euryotis timidus*, AMNH 101941, skin and skull, New Guinea; *R. euryotis ssp.*, AMNH 196475, skin and skull,

TABLE 2
Measurements of *Rhinolophus creaghi timorensis*, New Subspecies, and Related Forms
 (For series, range and mean are given.)

	Forearm Length	Head-body Length	Tail Length	Ear Length	Locality
<i>R. c. timorensis</i>					
AMNH 237783, Type, skin and skull	49.2	54	22	22	Timor
AMNH 237792, Paratype, alcohol	49.6	55	24	23	Timor
AMNH 237784, skin and skull	48.5	54	22	23	Timor
AMNH 237787, skin and skull	47.6	51	19	23	Timor
AMNH 237801, skin and skull	49.9	60	23	23	Timor
AMNH Series of 24 adults, in alcohol	47.2-51.2 49.3	51-62 55.8	19-23 20.9	21-23 22.2	Timor
<i>R. c. creaghi</i>					
BMNH 96.7.30.1, Type, alcohol	47.5	—	—	—	Sabah
<i>R. c. pilosus</i>					
BMNH 10.4.7.5, Type, skin and skull	49.4	—	—	—	Madura
<i>R. c. canuti</i>					
BMNH 9.1.5.183, Type, skin and skull	49.9	—	—	—	Java
BMNH 9.1.5.184, skin and skull	50.3	—	—	—	Java
BMNH 9.1.5.185, skin and skull	50.5	—	—	—	Java

TABLE 2 — (Continued)

	Condylocanine Length	Maxillary Toothrow Length	Zygomatic Width	Mastoid Width	Interorbital Constriction Width	Width Between Outer Surfaces Upper Canines	Width Between Outer Surfaces Upper Posterior Molars
<i>R. c. timorensis</i>							
AMNH 237783, Type, skin and skull	19.0	8.5	10.4	10.0	1.8	6.2	8.2
AMNH 237784, skin and skull	18.5	8.4	10.1	9.6	1.7	5.9	7.9
AMNH 237787, skin and skull	18.5	8.5	10.0	9.8	2.0	5.8	7.9
AMNH 237801, skin and skull	19.1	8.7	10.3	10.1	1.8	6.0	8.1
<i>R. c. creaghtii</i> ^a							
BMNH 96.7.30.1, Type, alcohol	18.7	8.2	10.6	10.3	2.3	—	—
<i>R. c. pilosus</i> ^a							
BMNH 10.4.7.5, Type, skin and skull	19.4	8.7	—	10.7	2.5	—	—
<i>R. c. canuti</i> ^a							
BMNH 9.1.5.183, Type, skin and skull	20.2	9.0	—	10.4	2.45	—	—
BMNH 9.1.5.184, skin and skull	19.8	8.7	10.6	10.3	2.15	—	—
BMNH 9.1.5.185, skin and skull	19.3	8.6	10.7	10.3	2.3	—	—

^aMeasurements from Hill (1958).

Celebes; *R. euryotis* ssp., AMNH 195249, alcohol, New Britain.

ASSOCIATED SPECIES OF BATS: Loosely associated with this species in Quoto Lou Caves were *R. philippinensis montanus*, *Miniopterus magnater*, and *M. pusillus*. In Fatu Cracat Cave, six other species of bats occurred: *Rousettus amplexicaudatus*, *Taphozous melanopogon*, *Rhinolophus borneensis parvus*, and three species of *Miniopterus*. The only other species of bat in Lia Hoo Cave was *Rhinolophus borneensis parvus*.

REPRODUCTIVE DATA: The testes of adult males collected in March, April, and May varied in size from 2 by 1 to 5 by 3 mm. Four female specimens were examined and none were found to be pregnant.

The sex ratios in the three collections from different cave systems are: Lia Hoo Cave, three males to five females; Fatu Cracat Cave, one male to three females; Quoto Lou Caves, 13 males to 4 females.

Rhinolophus philippinensis montanus, new subspecies

TYPE SPECIMEN: The holotype is the skin and skull of an adult female, AMNH 237814. The specimen was collected in Quoto Lou Caves near the village of Lequi-Mia, 5 miles (8 km.) south of Ermera, Timor, at an altitude of approximately 1220 m., on April 23, 1968. An adult male preserved in alcohol with skull *in situ*, AMNH 237811, collected on the same date and in the same cave as the holotype, has been designated a paratype.

Two other specimens deposited in the American Museum of Natural History, adult males, preserved in alcohol, one with skull removed, complete the series.

ETYMOLOGY: The subspecific epithet is a Latin adjective meaning montane, since this bat was found at an altitude of about 1220 m.

DIAGNOSIS: This subspecies can be distinguished from other subspecies of *Rhinolophus philippinensis* by the following characters: smaller size, sella broad at base and gradually tapering to a truncate tip, cup at base of sella relatively narrow and unspecialized, base of lancet nearly as long as either of its sides,

connecting process high and pointed, dorsal nasal swellings of skull more pronounced, upper premolar behind canine relatively crowded and in contact with canine, lower middle premolar crowded slightly out of line and partially rotated.

DESCRIPTION: This is a small grayish *Rhinolophus* with very large ears. Of all the subspecies of *philippinensis* it is most closely related to *R. p. philippinensis*. The pelage has a somewhat woolly texture and a slight variegated or grizzled appearance due to a scattering of pale hairs. There is a marked similarity in the texture and color of the pelage to that of *R. p. maros*, a large subspecies from Celebes. The color of the dorsal surface is Fuscous shading to Hair Brown in the neck region. Most of the individual hairs are dark throughout so that there is no bicolored effect when the fur is parted. The ventral surface is somewhat paler and most of the hairs have pale tips. The ventral color is Hair Brown.

In life, the skin of the nose leaves is pale flesh color contrasting with the somewhat darker skin of these structures in the other two species of Timorese *Rhinolophus*. The nose leaves (fig. 4) are basically similar in form to those of *R. p. philippinensis*, but there are distinct differences in the shape of the sella, lancet and connecting process. The sella is

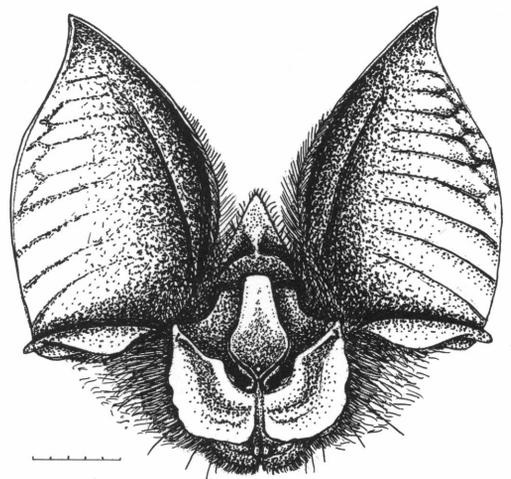


FIG. 4. Facial features of *Rhinolophus philippinensis montanus*. Scale represents 5 mm.

broad at the base and forms a cuplike structure there. The sides of the sella gradually taper to a truncate tip. The cup is relatively broader in *philippinensis* and the sides of the sella above the cup are nearly parallel. The lancet of *montanus* is broad at its base, the breadth being only slightly shorter than either of the two sides so that the structure is nearly an equilateral triangle. The base of the lancet in *philippinensis* is only about half as long as the sides so that in contrast to *montanus* the lancet appears to be narrow and high. The connecting process is higher and more pointed in *montanus*.

Measurements of the body and skull show that this subspecies is smaller than *philippinensis* and *sanborni* but the proportions are similar (table 3). The large ears, a characteristic of the *philippinensis* group, are in about the same ratio to forearm length in all three subspecies. The three subspecies, *achilles* from the Kai Islands, *maros* from Celebes, and *robertsi* from Queensland are much larger than *montanus* measuring about 10 mm. longer in forearm. There are also significant differences in facial characters among *montanus*, *maros*, and *robertsi*. I have not seen *achilles*.

When the skull is viewed laterally, the dorsal nasal swellings are more pronounced and slope off more abruptly posteriorly than either *philippinensis* or *sanborni*. The condition of the premolar behind the canine in the maxillary tooththrow is similar to that of *philippinensis* and *sanborni* except that the tooth is somewhat more crowded. It is in contact with the canine, but separated from the premolar behind it by a slight space. In *philippinensis* and *sanborni* it is not in contact with either the canine or the premolar behind. In the mandible, the middle premolar is in contact, or nearly so, with both the anterior and posterior premolars, and it is crowded slightly out of line and rotated about 30 degrees. Neither *philippinensis* nor *sanborni* have as crowded a condition, the middle premolar retaining its position in the tooththrow. This would suggest a greater degree of specialization in the dentition of *montanus*, which at the same time possesses a more primitive facial form.

COMPARATIVE MATERIAL EXAMINED: *Rhinolophus philippinensis philippinensis*, BMNH

55.12.26.270, type, alcohol, skull removed, Philippine Islands; *R. p. philippinensis*, AMNH 206736, alcohol, Philippine Islands; *R. p. maros*, AMNH 102351, paratype, skin and skull, Celebes; *R. p. robertsi*, AMNH 157056, alcohol, Queensland; *R. p. sanborni* BMNH 67.1427, alcohol, skull removed, Sarawak.

DISTRIBUTION: This species was found only in Quoto Lou Caves near Lequi-Mia. Eventually, it may be found to be more widely distributed in Timor.

HABITAT: Quoto Lou Caves are two shallow earth caves which were excavated by the Japanese during their occupation of the island. Their partly overgrown entrances are in the side of a steep, heavily forested slope, and are about 15 m. apart. The cave which this species occupied consisted of a tunnel about 21 m. long and 1.5 m. high. A chamber 15 m. square and 2.4 m. high extended off the left side of the end of the tunnel. The irregular sides and ceiling were composed of a mixture of rock and soil and minor cave-ins had occurred in several places. The humidity was high in the cave, but the soil was not wet. The chamber was very dark, and light from the entrance could not be seen.

ASSOCIATED SPECIES OF BATS: Small numbers of *Rhinolophus creaghi timorensis*, *Miniopterus magnater*, and *M. pusillus* were occupying the cave with this species.

BEHAVIOR: It is believed that no more than six or seven individuals of this species were inhabiting Quoto Lou Caves. Like the other two *Rhinolophus* species in Timor, individuals preferred to hang from the ceiling in exposed situations well spaced out from each other. They were quick to take flight when approached or if a flashlight beam was shone upon them.

Of four specimens collected, three were adult males and one an adult female.

Hipposideros bicolor (Temminck)

Rhinolophus bicolor Temminck, 1834, p. 19, pl. 1, fig. 3.

TYPE LOCALITY: The range of this species was originally given by Temminck (1835-1841) as Java, Amboina, and Timor. Since Tem-

TABLE 3
Measurements of *Rhinolophus philippinensis montanus*, New Subspecies, and Related Forms

	Forearm Length	Head-body Length	Tail Length	Ear Length	Width of Nasal Cup	Width of Sella Above Nasal Cup	Locality
<i>R. p. montanus</i>							
AMNH 237814, Type, skin and skull	45.3	49	27	25	—	—	Timor
AMNH 237811, Paratype, alcohol	44.0	48	25	27	3.8	2.7	Timor
AMNH 237812, alcohol	45.8	50	28	25	3.5	2.6	Timor
AMNH 237813, alcohol	45.3	50	31	26	3.6	2.8	Timor
<i>R. p. philippinensis</i>							
BMNH 55.12.26.270, Type, alcohol	47.5	—	—	—	4.6	2.8	Philippine Islands
<i>R. p. sanborni</i>							
BMNH 67.1427, alcohol	49.6	—	—	—	5.0	2.7	Sarawak

minck's series included two distinct forms, Tate (1941a) restricted the species by naming a lectotype from the Anjer Coast of northwest Java from the original series.

DISTRIBUTION: The species as presently conceived by Hill (1963) ranges from India to the Philippine Islands and Timor. Three specimens were collected at Tutuala, Timor, and bats believed to be this species were observed at Baucau and Dili. These appear to be the only specimens of this species in existence from the Lesser Sunda Islands. Probably the species will eventually be found on the islands between Java and Timor.

DESCRIPTION: The color of the dorsal pelage is between Verona Brown and Warm Sepia shading lighter toward the head. The basal three-quarters of the hairs is Tilleul Buff. These pale bases are very apparent where the fur has been disarranged.

Forearm lengths of an adult male prepared as a skin, AMNH 237815, and two adult females preserved in alcohol, AMNH 237816 and AMNH 237817, are respectively, 45.3, 44.8, and 43.4. Body measurements of these specimens are: head-body length 52, 49, 50; tail length 34, 27, 32; ear length 22, 22, 21; wing-spread 292, 285, 277. Skull measurements of

these specimens are: greatest length of skull 18.6, 18.6, 18.5; condylobasal length 16.0, 16.2, 16.1; condylocanine length 15.9, 16.1, 16.0; width of interorbital constriction 2.8, 2.8, 2.8; zygomatic width 9.2, 8.9, 9.0; mastoid width 9.3, 9.3, 9.2; maxillary toothrow length 6.3, 6.4, 6.3; greatest width between outer surfaces of upper canines 3.9, 3.8, 4.0; greatest width between outer surfaces of upper posterior molars 6.0, 5.9, 5.9.

TAXONOMIC NOTES: After a preliminary examination of specimens of both *H. bicolor* and *H. ater* in the American Museum of Natural History and in the British Museum (Natural History), it appears that they are very closely related. The form from Timor seems clearly ascribable to *bicolor* in that the internarial septum is narrow and uninflated and it is a larger bat than any of the subspecies of *ater*. It compared quite closely with three specimens of the slightly darker, grayer race, *H. b. major*, from the Mentawai Islands off the western coast of Sumatra (AMNH 103237, 103239, 103323). *Hipposideros bicolor macrobullatus*, a slightly smaller race from Celebes is distinctive with its large ears and auditory bullae. Also, the color of the dorsal pelage is grayer than specimens from Timor.

TABLE 3 — (Continued)

	Maxillary Toothrow Length	Zygomatic Width	Mastoid Width	Interorbital Constriction Width	Width Between Outer Surfaces Upper Canines	Width Between Outer Surfaces Upper Posterior Molars
<i>R. p. montanus</i>						
AMNH 237814, Type, skin and skull	6.5	8.0	8.9	2.3	4.0	5.8
AMNH 237812, alcohol	6.5	8.1	9.2	2.2	4.1	5.6
<i>R. p. philippinensis</i>						
BMNH 55.12.26.270, Type, alcohol	7.1	9.0	9.7	—	—	—
<i>R. p. sanborni</i>						
BMNH 67.1427, alcohol	7.9	9.0	9.9	—	—	—

Since I have not seen specimens of *bicolor* from Java it is not possible at this time to assign the material from Timor to subspecies. Measurements of the lectotype given by Tate (1941a) are slightly larger than those of any of the specimens from Timor, yet they are close enough to be within the expected range of individual variation. It remains to be determined if the Timorese population is close enough to the Javan form to be assigned to the typical race, or if, instead, it should be given subspecific status.

HABITAT AND BEHAVIOR: The specimens were collected after dark as they were flying around the dimly lighted rooms of a house. Repeated attempts to catch this species in the finest denier mist nets were unsuccessful even when they were placed across regularly used flyways. In spite of their rapid, straight flight, the bats were always able to veer off their courses at the last moment and avoid the nets. They are strongly attracted to artificial lights and the insects which usually abound there, and are often seen flying singly or in pairs along lighted verandas, patios, and in rooms of dwellings.

Although this species is known to be a cave-dwelling bat in other parts of its range, it was not found in any caves in Timor. One evening at least one individual was observed to repeatedly enter and leave the attic of a building through a space between the outer wall and the

corrugated metal roof. It could not be determined if this was a permanent roost used also during the day or if it was merely a temporary resting place used only while feeding.

Hipposideros diadema diadema (E. Geoffroy)

Rhinolophus diadema E. Geoffroy, 1813, p. 263.

TYPE LOCALITY: Timor. The type specimen collected by Péron and Lesueur is a skin with skull *in situ* in the Paris Museum (MHNP 918).

DISTRIBUTION: This species has a wide range extending from Burma and Indo-China through Malaya, the Philippine Islands, and the Indo-Australian archipelago, to New Guinea, the Solomon Islands, and northern Australia. The range of the typical subspecies remains to be determined. It probably extends from Timor westward through the entire Lesser Sunda chain and may be found to include Java, also. Two specimens were collected on Timor, one from Ratano, 4 miles (6.4 km.) west of Viqueque, AMNH 237818, and one from Viqueque, AMNH 237819. Schwarz (1914) listed a specimen collected by Haniel at Kupang, Timor.

DESCRIPTION: The color of the dorsal pelage of the specimen from Ratano varies from Natal Brown to Avellaneous, shading to Tilleul Buff on the sides, neck, and head. There is a distinct tricolor effect when the fur of these areas is parted, the hairs having dark bases and tips with very pale median areas. The chest, belly,

and abdomen are Wood Brown shading to Avellaneous and Tilleul Buff on the sides, throat, and chin. The fur bordering the membranes on the sides is nearly white both above and below the membranes, and a small patch of white is present on each shoulder.

Body measurements of two adult males are: forearm length 82.3 (specimen prepared as a skin), 86.2 (specimen preserved in alcohol); head-body length 81, 95; tail length 55, 54; ear length 30, 31; wingspread of specimen prepared as a skin 489. Skull measurements of the specimen prepared as a skin are: greatest length of skull 31.2, condylobasal length 27.8, condylocanine length 27.2, maxillary toothrow length 11.7, zygomatic width 16.5, mastoid width 14.6, width of interorbital constriction 3.6, greatest width between outer surfaces of upper canines 7.5, greatest width between outer surfaces of upper posterior molars 10.9.

TAXONOMIC NOTES: There has been some uncertainty regarding the size of the typical subspecies from Timor. Andersen (1905b) gave the range of the typical form as Java and Timor, and the forearm length as 84.5 and 91. He referred to a skin from Timor in the British Museum (Natural History) with a forearm length of 84.5 which closely agreed with Geoffroy's original figure and description, and to a series of five skins from Java with forearm lengths of 85 to 91. He suggested that if in a large series Javan specimens should prove to average larger than those from Timor then the name *nobilis* which was described by Horsfield (1824a) would have to be retained for the Javan subspecies.

My two specimens from Timor have forearm lengths of 82.3 and 86.2, and two skins from Timor in the Museu Bocage, MB 542a and 542b, have forearm lengths of 83 and 89. Two cotypes of *nobilis* in the British Museum (Natural History), BMNH 79.11.21.83 and BMNH 79.11.21.84, both skins, have forearm lengths of 87 and 82 (Tate, 1941a). A skin of a male specimen from Java in the American Museum of Natural History, AMNH 106736, has a forearm length of 87.9. Seven adult males from Bali in the same museum have forearm lengths of 87.5-93.0 (90.3). I have compared skulls of specimens from Timor and Java and can find

no significant differences between them. Larger series of specimens from Java and Timor must be compared before it can be determined whether or not the populations on those islands are consubspecific. I am inclined to believe that they are consubspecific and to agree with Hill (1963) that the name "*nobilis*" should be retired to the synonymy of *diadema*.

HABITAT AND BEHAVIOR: The two specimens were collected in similar situations about 5 miles apart. The specimen from Ratano was first observed flying in a forested area at dusk. The flight was straight and swift and the bat flew about 2.4 m. above the ground. It made several passes back and forth along a 90 m. stretch of road and then alighted on a dead branch overhanging the road. It repeated this pattern several times, always returning to the same position on the same branch to rest. The second specimen, captured just outside the village of Viqueque, behaved in a similar manner and flew back and forth along a path through a dense forest. This individual also returned repeatedly to alight on a dead branch. The species was observed in flight at Ermera and Atsabe, but specimens were not collected at those locations.

Pipistrellus tenuis (Temminck)

Vespertilio tenuis Temminck, 1835-1841, pp. 229-230, pl. 57, figs. 5-7.

TYPE LOCALITY: Sumatra.

DISTRIBUTION: The species as presently conceived by Koopman (1973) ranges widely through the Indo-Australian archipelago from Sumatra to Timor, the Molucca Islands, New Guinea and the Solomon Islands. One specimen, AMNH 237820, was collected in Timor at Taibesse, on the south side of Dili. This specimen serves to link the ranges of *sewelanus* (Lombok) and *papuanus* (New Guinea).

DESCRIPTION: Because the specimen was preserved in alcohol, the fur of the back and belly had to be dried and the colors then matched against Ridgway's standards. It is believed that the amount of fading of the pigments which had occurred as a result of being preserved in alcohol was at most very slight. The pelage has a marked bicolor appearance,

dark basally and paler distally. The hairs of the dorsal surfaces have bases near Bister with Snuff Brown tips. Ventrally the bases are Bister and the tips are Pinkish Buff.

Measurements of the specimen, an adult male, are: forearm length 29.8, head-body length 38, tail length 30, ear length 9, wing-spread 199, greatest length of skull 12.1, condylobasal length 11.1, condylocanine length 11.0, maxillary toothrow length 4.0, zygomatic width 7.7, mastoid width 6.9, width of interorbital constriction 3.2, greatest width between outer surfaces of upper canines 3.9, greatest width between outer surfaces of upper posterior molars 5.2.

Measurements of four adult males from Tjamplong, Timor, collected by Georg Stein in January 1932 are: forearm length (3 specimens) all 29, condylocanine length 11.2-11.5 (11.4), maxillary toothrow length 3.9-4.1 (4.0), width between outer alveoli of upper posterior molars 4.9-5.2 (5.1). These measurements were taken by Dr. Karl Koopman from specimens in the collection of the Zoological Museum, Bogor, Java, presently on loan to the Rijksmuseum, Leiden.

TAXONOMIC NOTES: Dr. Koopman, who has been working on the systematics of *Pipistrellus* of the Indo-Australian region examined the specimen, which I collected in Timor, and identified it as *P. tenuis*. He considered *ponceleti*, *angulatus*, *collinus*, *papuanus*, *sewelanus*, *nitidus*, *tenuis*, *sublidens*, and *murrayi* to be conspecific. The name "*tenuis*" has priority. Designation of the Timorese subspecies will be postponed pending the completion of a paper by Dr. Koopman dealing with the subspecies of *P. tenuis*.

Schwarz (1914) identified two specimens probably of this species collected by Haniel in Lelogama and Bonleo, Timor, as *P. tralatitius* (Horsfield).

BEHAVIOR: Although only one specimen was collected during the course of this study, the species was observed on a number of occasions flying about some of the larger villages. At Dili it appeared quite regularly flying in small groups usually with *Scotophilus kuhlii*. It first appeared at dusk and flew at low altitudes, usually 3 to 6 m. above the ground. The flight

was swift and erratic. The species was not found in any caves and it seemed, generally, to be rather uncommon.

The specimen was collected in the early evening as it was flying within a large dimly lighted hut with a high-peaked thatched roof.

Tylonycteris robustula Thomas

Tylonycteris robustula Thomas, 1915a, p. 227.

TYPE LOCALITY: Sarawak.

DISTRIBUTION: Yunnan, Indo-China, Malay Peninsula, Sumatra, Borneo, Celebes, Peleng Island, Java, Bali, and Timor.

Thomas (1915a) reported this species from Timor on the basis of two specimens in the British Museum (Natural History), BMNH 84.4.22.2 and BMNH 84.4.22.3. The labels on these specimens bear only the locality, Timor, and the name of the collector, H. O. Forbes. No other specimens from Timor are known to exist.

I did not find this species in Timor. Every opportunity was taken to search for it in old bamboo canes, but without success. Inquiries were made in every part of the island visited, but no one had ever seen bats entering or exiting through cracks in bamboo canes. It is quite conceivable, however, that such a small and secretive species could go unnoticed even when it was living in close proximity to people. If this species does occur in Timor it must be rather uncommon and locally distributed.

Scotophilus kuhlii temminckii (Horsfield)

Vespertilio temminckii Horsfield, 1824b, p. 20, pl. 9.

TYPE LOCALITY: Java.

DISTRIBUTION: This species occurs from India to the Philippine Islands, the Greater Sunda Islands, the Lesser Sunda Islands, Banda Islands, and Aru Islands. The actual range of the subspecies cannot be delimited at this time because there is a need to examine and reassess the validity of some of the closely related forms which have been described. At the present time it is known that *S. k. temminckii* occurs in Java, Bali, Flores, Sumba, and Timor, and with further investigation it will undoubtedly be found on other islands between Bali

and Timor. Two adult males were collected in a mist net in Dili, Timor, on April 4, 1968, AMNH 237821, and on May 17, 1968, AMNH 237822.

DESCRIPTION: The color of the two specimens, both prepared as skins, is identical. The dorsal pelage is Cinnamon-Brown and the belly and abdomen are Buffy Brown shading to Warm Buff on the sides, throat, and chin. The fur is short, closely adpressed to the skin, and lustrous.

Measurements of these specimens are: forearm length 47.8, 47.2; head-body length 68, 75; tail length 46, 45; ear length 13, 14; wing-spread 345, 332; greatest length of skull 19.5, 19.5; condylobasal length 17.1, 17.0; condylocanine length 17.5, 17.4; maxillary tooth-row length 6.5, 6.2; zygomatic width 13.3, 13.1; mastoid width 11.4, 11.2; width of interorbital constriction 4.9, 4.7; greatest width between outer surfaces of upper canines 6.4, 6.1; greatest width between outer surfaces of upper posterior molars 8.6, 8.0.

TAXONOMIC NOTES: This species has been subjected to much taxonomic splitting some of which does not appear to be valid. The two skins and skulls from Timor were compared with series from Java and Bali in the American Museum of Natural History and were found to be identical with them. The forearms of 14 adults from Bali range from 47.3 to 54.0 (average 49.8). Ten adults from Java have forearm lengths of 46.0 to 52.4 (average 48.6). Forearms of males in both series average about 2 mm. shorter than females.

Peterson (1968) and Hill and Thonglongya (1972) discussed the nomenclatural problems present in Asian *Scotophilus* and offer a rationale for replacing the specific name *temminckii* with *kuhlii*.

HABITAT: Walker (1964) described members of this genus as house-roosting bats. Many inquiries were made in an attempt to locate bat infested buildings in Timor, but none were found. The fact that *S. k. temminckii* was observed and collected only in the city of Dili would suggest that it may roost in buildings there. Since the residents of Dili were not generally aware of the presence of bats in buildings, apparently they do not congregate in numbers large enough to attract attention.

ASSOCIATED SPECIES OF BATS, FOOD, AND BEHAVIOR: *Scotophilus kuhli temminckii* begins feeding in small, loose groups of two to five individuals at dusk. These bats are most frequently seen hawking insects in the company of *Pipistrellus tenuis*. The flight of *Scotophilus* is characteristic and easily recognized; a relatively straight course and constant elevation are maintained. It prefers to feed in open areas within the town, over vacant lots, parks, and along streams and ditches. At one feeding area, which was checked quite regularly each day, the bats followed a consistent schedule, arriving at dusk and feeding continually for one-half hour until it was nearly dark. After that time little activity was observed. There was an occasional brief return of one or two individuals. It was determined that such limited activity continued at least until near midnight.

MINIOPTERUS BONAPARTE

The genus *Miniopterus* has been difficult to treat taxonomically, and it has been badly in need of revision. Though widely distributed, it is remarkably homogeneous. Divergence has resulted in differences in size and in relative proportions of certain skeletal elements. These differences are sometimes very minor between species. When such apparently minor differences separate sympatric species, it is tempting to suspect that there may exist a greater degree of divergence involving characteristics which cannot be observed or are difficult to study such as differences in glandular secretions and behavior. Olfactory cues or tactile precopulatory behavior patterns may be important in species recognition. Perhaps physiological differences effecting reproductive cycles are present and the resulting behavior patterns and olfactory stimuli could be responsible for eliminating copulatory attempts between species. Such possibilities are rendered even more likely or more necessary in situations where at least three species of *Miniopterus* may occupy the same chamber in a cave and where the greatest apparent difference may be a variation in forearm length of adults of only 2 mm. One must also consider the possibility that there might be discreet breeding seasons rather limited in extent and that during these periods a tendency

for the species to segregate into breeding populations should be expected. The colonies might remain effectively isolated in different caves or different parts of the same cave. Even if this does occur, one cannot overlook the possible efficiency of olfactory cues in preventing copulatory mistakes.

Three distinct but similar populations occur on Timor, a small, a medium, and a large species. On many other islands of the Indo-Australian region two or more distinct sympatric populations occur. Six taxa have been reported from Java (Peterson, *in litt.*). Although there may be rather slight apparent differences between species, there is relatively little individual variation within each population. Therefore, the populations fall into distinct groups which are usually easily separable.

Dr. Randolph Peterson, Curator-in-Charge, Royal Ontario Museum, Toronto, is presently completing a taxonomic revision of the genus. He has found that the major differences between species involve skull proportions. The relative length and width of skulls and the size and shape of the rostrum and braincase are the most useful taxonomic characters. Dr. Peterson has been kind enough to compare my data from the populations on Timor with his findings. He has concluded that the three species occurring on Timor are *Miniopterus australis*, *M. pusillus*, and *M. magnater*.

The populations from Timor show some degree of divergence in certain characters from adjacent island populations but the subspecific status of these populations has not yet been determined.

These three species have similar habitat requirements at least during the period that they were observed. Their roosting behavior is also very similar as far as could be determined from limited observations in caves. They occur together in mixed colonies. Like *Rhinolophus* species, they usually occupy the deeper parts of caves where light does not penetrate. At Luca, however, *M. magnater* was found roosting near the entrance of a cavelike fissure in subdued light. Unlike *Rhinolophus* species, they seem to prefer less exposed roosting positions. At times they were found hanging against the vertical surfaces of chamber walls and in slight depressions in cave ceilings. They also hid within

deeper crevices in the ceilings in the highest parts of chambers. When disturbed by noise or flashlights, bats hanging in more exposed locations quickly scurried into such protected situations. They usually roosted in small groups of two to six individuals.

The only bat inhabitants of the cave near Atsabe were the three species of *Miniopterus*. Fatu Cracat Cave, Becia, was inhabited by the three species of *Miniopterus*, *Rousettus amplexicaudatus*, *Taphozous melanopogon*, *Rhinolophus borneensis parvus*, and *R. creaghi timorensis*. At Quoto Lou Caves, small numbers of *Miniopterus pusillus* and *M. magnater* were occupying narrow passageways and chambers with low ceilings with *Rhinolophus creaghi timorensis* and *R. philippinensis montanus*.

Color in *Miniopterus* has relatively little taxonomic value. With few exceptions the color differences between species are not great enough to offer a reliable means of distinguishing individuals of one species from another. The presence of seasonal color phases in many populations of *Miniopterus* and the tendency for pigments to fade with time in museum specimens further complicates matters. Molting *Miniopterus* often exhibit a bicolored pattern of dark brown and reddish brown. Such intermediate pelages may be so consistent and symmetrical in a series of specimens taken from a population that the condition might be mistaken for that of a normal, permanent pelage. Johnson (1964) has described the progression of the molt in *M. schreibersi* from Australia.

There are only minor differences in color in the three species of *Miniopterus* occurring on Timor. The color of *M. pusillus* and *M. magnater* is almost identical, whereas that of *M. australis* is slightly darker. Each of the six specimens of *M. australis* collected in Timor in April and May exhibits a similar bicolored condition. The colors in all of these specimens are exactly the same and the distribution of the colors shows but slight variation. The top of the head is Moss Brown and the dorsal surface of the body is deep Blackish Brown. The undersurfaces are Fuscous shading to Blackish Brown on the throat. In one specimen the hairs of the chin and throat are tipped with Moss Brown.

Five specimens in the series of six skins of *M. pusillus* are in the dark phase. The dorsal surfaces are a little darker than Seal Brown and the undersurfaces are Fuscous. The color of the throat is slightly darker. One specimen, AMNH 237831, exhibits a transitional molt pattern in which the head, neck, and shoulders are Prout's Brown, whereas the remaining pelage is the same color as the other five specimens.

The three specimens of *M. magnater* collected during the months of April and May were in the dark brown color phase. Like *M. pusillus* collected during the same period, the dorsal surfaces are Seal Brown and the ventral surfaces are Fuscous. There is a tendency for the anterior part of the back and the shoulders to be a slightly lighter shade than the posterior half of the back.

The population of *M. australis* on Timor is close to *M. a. shorridgei* of Java but averages slightly larger in forearm and certain other measurements. The ranges and averages of measurements of five skins and skulls of adult *M. australis* from Timor (AMNH 237823-237827) are: forearm length 35.4-38.0 (37.3), tibia length 16-17 (16.2), greatest length of skull 13.3-13.7 (13.5), condylobasal length 12.5-12.8 (12.6), condylocanine length 11.8-12.2 (11.9), maxillary toothrow length 4.8-5.1 (4.9), zygomatic width 7.1-7.3 (7.2), mastoid width 7.0-7.5 (7.3), interorbital constriction width 3.2-3.5 (3.4), width between outer surfaces of upper canines 3.7-3.8 (3.8), width between outer surfaces of upper posterior molars 5.2-5.3 (5.3).

The population of *M. pusillus* on Timor is characterized by its small skull relative to forearm length. Ranges and averages of forearm

lengths of six adult skins from Timor (AMNH 237829-237833) are 41.5-43.1 (41.8), and 52 adults preserved in alcohol are 41.2-44.1 (42.5). Ranges and averages of skull measurements of six adult specimens are: greatest length of skull 13.3-13.5 (13.4), condylobasal length 12.6-12.9 (12.8), condylocanine length 12.1-12.4 (12.3), maxillary toothrow length 5.0-5.1 (5.1), zygomatic width 7.4-7.7 (7.5), mastoid width 7.6-7.8 (7.7), interorbital constriction width 3.5-3.8 (3.6), width between outer surfaces of upper canines 3.9-4.1 (4.0), width between outer surfaces of upper posterior molars 5.4-5.6 (5.5).

Specimens of *M. magnater* from Timor are similar to those from New Guinea but are smaller. This is the largest of the three species on Timor. The skull is relatively large with well-developed sagittal and lambdoidal crests. The sagittal crest is especially high on the frontal curve. The canines are long and slender and the upper premolar behind the canine is relatively large and crowded. Ranges and averages of forearm lengths of three adult skins from Timor (AMNH 237888-237890) are 46.6-48.3 (47.4), and 17 adults preserved in alcohol are 47.1-49.7 (48.6). Ranges and averages of skull measurements of three adult specimens are: greatest length of skull 16.2-16.4 (16.3), condylobasal length 15.5-15.8 (15.6), condylocanine length 15.0-15.1 (15.0), maxillary toothrow length 6.5-6.7 (6.6), zygomatic width 9.1-9.4 (9.3), mastoid width 8.8-9.0 (8.9), interorbital constriction width 3.8-3.9 (3.9), width between outer surfaces of upper canines 5.3 (5.3), width between outer surfaces of upper posterior molars 7.2-7.3 (7.3).

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