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BATS OF VIETNAM
AND ADJACENT TERRITORIES

An identification manual

by Alex V. Borissenko and Sergei V. Kruskop

Prepared within the framework of the research program «Tropical Ecology», facilitated by the Joint Russian-Vietnamese Science and Technological Tropical Centre.

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БИОРАЗНООБРАЗИЕ ВЬЕТНАМА

РУКОКРЫЛЫЕ ВЬЕТНАМА
И ПРИЛЕЖАЩИХ ТЕРРИТОРИЙ

Руководство по определению

А. В. Борисенко, С. В. Крускоп

Москва — 2003

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Справочное издание по рукокрылым (Chiroptera, Mammalia) из серии «Биоразнообразие Вьетнама». Приведен полный таксономический список рукокрылых Вьетнама, определительные ключи для семейств, родов и видов, важные для диагностики особенности внешнего строения, краткая информация по распространению, систематике и биологии всех известных с территории Вьетнама видов рукокрылых, их вьетнамские, английские и русские названия. Издание содержит иллюстрации основных диагностически важных признаков, оригинальные изображения черепов и фотографии отдельных представителей вьетнамских рукокрылых. Изложены основные методики полевого изучения этой группы. Справочник снабжен указателями научных и тривиальных названий.

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Предисловие

Настоящее руководство по определению рукокрылых продолжает серию публикаций, представляющих результаты изучения биологического разнообразия Вьетнама. Это итог многолетнего плодотворного сотрудничества ученых Московского университета и Российско-Вьетнамского Тропического центра, основанного в 1987 г. на территории СРВ. Создание и развитие Центра неразрывно связано с именем академика Владимира Евгеньевича Соколова (1928–1998). Семидесяти пятилетний юбилей этого выдающегося ученого символическим образом совпал с пятнадцатилетием Тропического центра. Этим замечательным датам авторы посвящают настоящую книгу.

Стремительно накапливающиеся сведения по биологическому разнообразию постоянно приносят новые зоогеографические и таксономические открытия, что создает необходимость периодического обновления региональных списков и определителей и включение в них таксонов, новых для данной территории или для науки. Это касается даже таких хорошо изученных животных как наземные позвоночные. Среди них в качестве ключевых объектов при экологическим мониторинге сообществ служат группы, наиболее удобные для прямого полевого наблюдения, определения и отлова.

Рукокрылых до недавнего времени не включали в подобные исследования, прежде всего из-за трудностей надежного определения некоторых представителей не только в полевых, но и в камеральных условиях. Кроме того, совершенно понятные сложности создает скрытный ночной образ жизни этих животных. Отмеченные обстоятельства усугубляются в малоизученных районах с высоким уровнем таксономического разнообразия, и особенно в условиях тропического леса. Здесь изучение рукокрылых требует от исследователя специфических навыков полевой работы.

Тем не менее, эколого-фаунистическое обследование ряда охраняемых территорий, проведенное во Вьетнаме за последнее десятилетие, показало, что рукокрылые составляют важную часть тропических наземных экосистем и могут служить хорошим индикатором их состояния. Поэтому, на наш взгляд, рукокрылые должны занять достойное место среди объектов, заслуживающих глубокого изучения с позиций экологиеи и мониторинга тропических сообществ. Первым шагом к широкомасштабному вовлечению рукокрылых в подобные исследования должно послужить издание регионального определителя. К сожалению, существующие определители либо охватывают всю Юго-Восточную Азию (например, Corbet, Hill, 1992), а потому переусложнены и неточ-

ны, либо не охватывают территорию Индокитая (например, Harrison, 1966; Lekagul, McNeely, 1977; Medway, 1978). Единственный региональный определитель млекопитающих (Van Peenen et al., 1969) на практике оказался непригодным для диагностики рукокрылых. И, конечно, ни одна из этих работ не учитывает последних таксономических новаций.

В настоящем издании авторы постарались заполнить этот пробел, поставив своей главной задачей составление руководства по определению рукокрылых Вьетнама, предназначенного для широкого круга заинтересованных исследователей (как профессионалов, так и любителей). В первую очередь, предлагаемая книга ориентирована на специалистов широкого профиля, знакомых лишь с общими принципами использования определительных ключей. Ради расширения круга пользователей определителя, было решено подготовить первое издание на английском языке.

Для читателя, не знакомого с биологией рукокрылых в определитель включены главы, содержащие общеизвестные сведения по строению, биологии, систематике и наиболее общеупотребимым методам исследования этих животных. Авторы также постарались привести основные сведения по обитающим во Вьетнаме видам, уделив особое внимание данным, собранным в ходе экспедиций Совместного Российско-Вьетнамского Тропического центра. Эти материалы содержат важные, ранее не опубликованные сведения по распространению вьетнамских рукокрылых.

Авторы не ставили задачу компиляции всех данных по коллекциям рукокрылых Индокитая, а также публикаций и многочисленных неопубликованных отчетов, подготовленных исследователями, проводившими эколого-фаунистическое обследование в различных районах Вьетнама. Работа такого плана невозможна без широкомасштабного сотрудничества исследователей из разных стран. Учитывая современное состояние изученности фауны рукокрылых Вьетнама, а также обилие исследовательских проектов, выполняемых на территории этой страны, создание подобной обширной сводки, вероятно, станет предметом ближайшего будущего.

Настоящее издание следует считать предварительным. Учитывая скорость накопления новых сведений по рукокрылым Вьетнама, любая книга, обобщающая даже самые последние данные, рискует устареть сразу после публикации. Поэтому в определительные ключи внесены и виды с прилежащих территорий Индокитая, до сих пор во Вьетнаме не найденные. Несомненно, в течение ближайших лет существующий таксономический список будет расширен за счет видов, новых для страны

и, возможно, для науки, а сведения по распространению уже известных видов будут существенно дополнены.

В заключение выражаем надежду, что глубокое и плодотворное сотрудничество вьетнамских и российских ученых внесет ценный вклад в познание фауны этой прекрасной страны.

Л. П. Корзун,
М. В. Калякин

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PREFACE

This identification manual for Chiroptera continues the series of publications devoted to the study of biodiversity of Vietnam. This is a result of a continuous and fruitful collaboration of researchers of Moscow State University and the Russian-Vietnamese Tropical Centre, founded in 1987 due to the efforts of academician V. E. Sokolov (1928–1998). His 75th anniversary coincided with the 15th anniversary of the Tropical Centre. The present issue it dedicated to these two important dates.

The rapidly accumulating data on tropical biodiversity constantly yields new zoogeographic and taxonomical findings and thus provides for the necessity of constantly updating the available regional identification guides to include taxa new to a given territory and even to science. This is true even for terrestrial vertebrates, despite that most of the species have been described. Among the latter a number of groups are known to have particular value from the standpoint of ecological monitoring, primarily because they are relatively easy to observe and recognize (e. g., birds). Bats have traditionally been overlooked in such studies due to their cryptic habits, requiring specific efforts and skills from the researcher to assess their diversity. First of all, this is due to the difficulties involved in their observing and capture, secondly, usually only large taxonomic groups of bats (i. e., families and genera) are more or less readily recognizable, whereas identification to the species level requires considerable experience and sometimes comparative collection material.

However, surveys conducted during the last decade in a number of protected territories have shown bats to be an important component of tropical ecosystems, and a good indicator of the state of local natural communities in Vietnam. This implies that bats as a study object possess considerable interest not only to specialists in this particular taxonomic group, but to all students involved in ecological monitoring and nature conservation. The minimal requirements for launching such work on a larger scale would be to have a concise and updated regional identification guide. Unfortunately, currently available guides are either too «generalized» and thus complex to use (e. g., Corbet, Hill, 1992) or too «extralimital» (e. g., Harrison, 1966; Lekagul, McNeely, 1977; Medway, 1978). The only available identification manual for at least part of Vietnam (Van Peenen et al., 1969) proved to be of little use in identifying bats. Neither of these works reflect the recent important taxonomical and zoogeographical findings, contained in the papers published thereafter.

Herein authors have tried to fill this gap, designating the main goal of this book as providing a general-purpose regional identification manual for students of Vietnamese bats (both professionals and volunteers). It is intended

particularly for people not specialized in bats, however familiar with the basic principles of field identification of animals; to make it available to as many people doing research in Vietnam as possible it was chosen to prepare the texts and identification keys in English and to include chapters containing general and commonly known information on bats, their morphological structure, biology and study methods.

Authors also tried to provide minimal information on these animals available to date, with particular emphasis on the data accumulated during the expeditions of the Joint Russian-Vietnamese Tropical Centre. These materials, deposited in various institutions of Russia and Vietnam (predominantly the Zoological Museum of Moscow University), contain important data on the distribution records of Vietnamese bats, which has not been published for various reasons.

Authors did not, however, intend to compile all possible data either on bat collections from Indochina deposited worldwide or from all publications and unpublished reports prepared by bat researchers or ecological survey workers studying bats in Vietnam. A work like that would be impossible without extensive international collaboration of all researchers working in Vietnam. Considering the present state of knowledge of the Vietnamese bat fauna and the numerous survey projects underway, the compilation of such an ultimate monograph seems somewhat premature at this moment.

The present guide should be considered as preliminary. Given the rapid accumulation of data on Vietnamese Chiroptera, any book summarizing even the most recent findings faces inevitable risk of being outdated the day it becomes published. This notion urged us to include in the identification keys extralimital taxa reported from adjacent territories of Indochina. There is no doubt that within the next few years in the course of ecological survey work throughout the country new species and genera of bats will be found (perhaps, some new taxa will be described) and known distribution ranges of already found species would be considerably extended. We should like to express hope that the fruitful collaboration of Vietnamese and Russian researchers would make further important contributions to our knowledge in bats of this beautiful country.

L. P. Korsoun,
M. V. Kalyakin

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INTRODUCTION

BASIC PATTERNS OF BAT DISTRIBUTION IN VIETNAM

The order of bats (Chiroptera) is the second largest order of mammals containing over 1000 species and having nearly worldwide distribution. The bulk of the diversity of bats is confined to the tropics, where they play a tremendous role in ecological communities, generally as consumers of insect and plant biomass, as pollinators and an important food resource for a variety of predators. This role, however, is apparently underestimated, due to the lack of knowledge on most regional tropical bat faunas. The bat fauna of the Indochinese biogeographical division (following Koopman, 1989; Corbet, Hill, 1992) contains ca. 150 bat species, nearly $^2/_3$ of which occur in Vietnam.

A detailed zoogeographical account is not the intention of this book, hence we shall restrict ourselves to providing a concise overview of the basic distributional patterns of bats (and mammals in general) in Vietnam, outlined by G. V. Kuznetsov (2000; 2001). Bats, together with rodents and carnivores, constitute the bulk of the mammalian fauna of Vietnam forming ca. 73% of the estimated overall mammalian species diversity of the country (ibid.)

According to G. V. Kuznetsov there are two basic factors sustaining the unusually high biodiversity level in general and that of mammals in particular. These are: a) significant latitudinal extension of the country which forms a continuous gradient of climatic conditions along the meridional direction and b) altitudinal zoning of ecosystems imposed by the numerous mountain ridges covering ca. 30% of the country. In addition to vertical stratification of natural communities, mountain systems facilitate the southward penetration of Chinese and Himalayan faunas and form complex natural barriers variously delimiting and/or blending climatic influences of the Pacific and continental Indochina, thus contributing to further sustention of the highly mosaic landscapes and patchiness of habitats. The unique geographical position of Vietnam results in mammal assemblages in different regions of the country being influenced by different faunal complexes. Thus northern Vietnam is heavily influenced by the so-called Southern-Chinese and montane Indo-Burmese faunal complexes and even a number of Palaearctic forms penetrate here. On the other hand, southern parts of the country are more affected by Malayan elements. Certainly a number of trans-Indomalayan species are distributed throughout the whole country.

Despite the high diversity of Vietnamese mammal fauna, its level endemism appears rather low. G. V. Kuznetsov (ibid.) indicates six endemic mammal species, which include but one bat (*Paracoelops megalotis*), hitherto known only from the type specimen. Another recently described species of

bat is *Myotis annamiticus* (Kruskop, Tsytsulina, 2001). Despite that it has not yet been reported from elsewhere in Indochina, it seems unlikely that this species closely resembling its allies from the Himalayas and Central Asia is endemic to Vietnam. Still it is quite possible, that the mosaic habitats of Vietnam house a number of endemic bat forms, which remain to be described.

AIM AND STRUCTURE OF THE BOOK

Principally, the book consists of three major parts. The first part is a brief overview of the methods usually employed in bat investigation, with emphasis on the commonly used procedures of capturing, handling and collecting them for research purposes. The second part is a complete taxonomic list of Vitnamese Chiroptera, containing only taxa whose presence in Vietnam is confirmed by examined collection materials or by reference to exact capture sites in recent works. The third (main) part contains identification keys and short characteristics of each taxon up to the species level.

Most keys have a typical dichotomic manner with the antithesis located right after the respective thesis, each of them terminating either with the number of the next thesis or the name of the taxon sought (and the page number of its description). For certain especially complex groups («*affinis*» and «*lepidus*» groups of *Rhinolophus*) character matrices were provided instead. As mentioned in the Preface, the keys also include extralimital Indochinese taxa whose presence in Vietnam is not confirmed, however, may be expected, based on general considerations (e. g., taxa with wide northern Indomalayan distribution or those found in neighboring countries close to the Vietnamese border). These taxa are marked in the keys by asterisks (*) or footnotes.When possible, keys based on external and cranial characters are provided separately. If both external and cranial characters are possible to examine in the specimen being identified, the reader is advised to follow both keys to verify the accuracy of identification. It is also recommended to check the respective species account, drawings and tables of measurements.

The description of each taxon is titled with the currently valid taxonomic name and author(s). Since this book is not a taxonomic revision, synonyms are not provided (for synonyms the reader is referred to special works, e. g., Corbet, Hill, 1992; Koopman, 1993; Pavlinov et al., 1995). If there is certain taxonomical ambiguity or complexity (especially relevant to problems in identification) or possibility of confusion due to nomenclatoral reasons, this is specified in the text under Taxonomical remarks.

Considering the importance of promoting bats as a popular study object, we found it necessary to provide common names (in Vietnamese, Russian

and English) of bat species, in addition to scientific names. In some cases when a trivial name was absent or considered (arbitrarily) inconvenient for common use, we suggested a more appropriate one (this refers almost exclusively to Russian names).

The section Material studied contains data on the number of specimens of each species available to the authors and includes both collection material and live individuals examined and subsequently released by the authors during field expeditions.

For reasons stated above we also refrained from providing exhaustive and overwhelming diagnoses and tried to outline only the most vital and readily visible characters (to the extent this could be made in taxonomically complex groups) and the basic distinguishing characteristics from similar taxa. The data on measurements provided in the descriptions of each taxon is compiled from both literature and original materials. The tables of measurements contained in the appendix at the end of the book is original and retrieved from live animals or post-mortem and is thus may be more comparable with the measurements available to the reader possesseing only alive individuals.

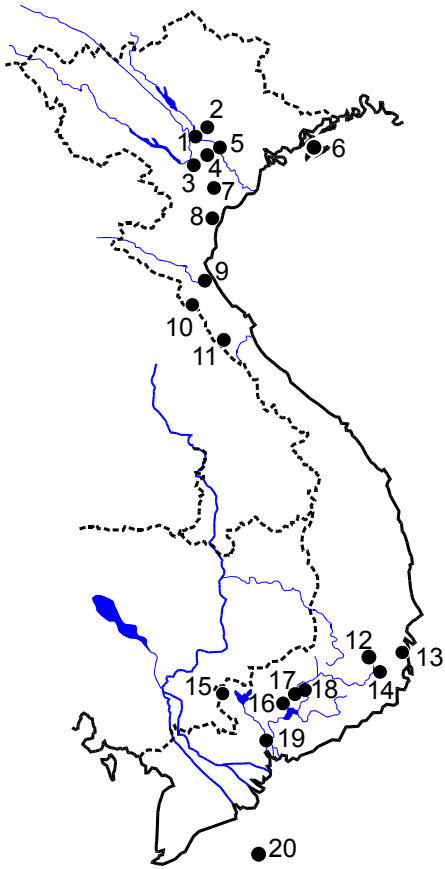
The Comments on natural history are usually limited to outlining the basic features of habitat preference, foraging and roosting behavior, which may aid in field identification and/or capture. This information was intentionally detailed in cases when no published data on the biology of a given species in Vietnam was found, however, original materials were available.

THE EXPERIENCE OF BAT RESEARCH IN INDOCHINA

Until recently Vietnam remained one of the least studied areas of the Indomalayan Region in terms of chiropteran diversity. Recent extensive surveys of a number of protected areas undertaken by several researchers from different countries have yielded a number of interesting zoogeographical findings and even taxonomical innovations. Nevertheless, much of our knowledge of Vietnamese bats is limited to faunal lists compiled for relatively small territories. A detailed historical account of zoological research in Indochina is provided by V. V. Rozhnov (2001). Hence here we shall restrict ourselves to emphasizing the role of the Russian-Vietnamese Tropical Centre in the study of Vietnamese Chiroptera.

During the expeditions of the Tropical Centre bats were collected in 20 localities, mostly confined to the north, north-central and southern parts of the country (see map on Fig. 1). However, the representation of chiropteran diversity is uneven.

Before 1997 during the expeditions of the Tropical Centre no specific bat surveys were undertaken. However, material on bats was collected as a by-



EXPLANATIONS OF LOCALITIES:

1. Ba Vi
2. Tam Dao
3. Kim Boi
4. Quoc Oai
5. Hanoi City and surroundings
6. Phuong Vong I.
7. Cuc Phuong
8. Thanh Hoa
9. Vinh
10. Vu Quang
11. Ke Bang
12. Bi Doup
13. Nha Trang 14. Cong Troi
15. Lo Go Xa Mat
16. Ma Da 17. Nam Cat Tien
18. Cat Loc
19. Ho Chi Minh City and surroundings
20. Con Dao Is.

Localities 1, 2, 3, 4, 6, 7, 8, 9, 13, 14, 20 were surveyed by G. V. Kuznetsov.

Fig. 1. Map of the various sites in Vietnam where bat survey and/or capture has been undertaken by the expeditions of the Russian-Vietnamese Tropical Centre.

product of mammalogical and ornithological surveys and part of it was subsequently deposited in the Zoological Museum of Moscow University (Moscow, Russia). Most bats from this period deposited in the ZMMU collections were donated by German V. Kuznetsov and Mikhail V. Kalyakin, either captured in bird mist nets, or taken inside day roosts. A number of interesting specimens collected before this period was kindly donated to the Zoological Museum by Dr. Dao Van Tien. Most of the specimens collected represented common and abundant species, however, a number of new zoogeographical records were made, e. g., the Himalayan fruit bat, *Sphaerias blanfordi*, was found in Tam Dao Province by G. V. Kuznetsov.

The absence of chiropterological surveys as a separate goal resulted in relatively poor representation of the diversity of bats in each of the surveyed sites. These works resulted in a number of mammalian faunal lists (Sokolov et al., 1986) and a general mammalogical survey (Huynh et al., 1994). Unfortunately, some of the information contained in these lists and surveys is based on unverified citations of earlier works and hence requires reevaluation. It is worthy to note, however, that the occurrence in Vietnam of a number of bat species (e. g., *Saccolaimus saccolaimus, Rhinolophus acuminatus, Myotis chinensis*) was predicted by Sokolov et al. (1986).

During the last six expeditions facilitated by the Tropical Centre (Vu Quang 1997, Ke Bang 1999, Lo Go Xa Mat 2001, Cat Tien 2001, Da Lat 2002, Ma Da 2002) particular attention was paid to surveying bats. As a result this order was represented much better, which enabled to compile more or less comprehensive faunal lists of the studied areas. Additional to the standard method of capturing bats in mist nets, ultrasound detectors were employed, and the original method of capturing bats with mobile traps (Borissenko, 1999) was extensively used, which enabled to collect data on behavioral patterns of certain bat species.

The list of bat species collected in Vietnam during the expeditions of the Tropical Centre contains 57 species, of the ca. 95 hitherto reported from this country. Among them are species which have not been previously listed in available publications and unpublished reports (e. g., *Sphaerias blanfordi*, *Saccolaimus saccolaimus*, *Rhinolophus acuminatus*, *Arielulus circumdatus*). This includes a small mouse-eared bat representing a new species — *Myotis annamiticus* (Kruskop, Tsytsulina, 2001). The complete taxonomic list of bat species collected in Vietnam during the expeditions of the Tropical Centre is not yet published. However, annotated lists are available for the last two expeditions (Kruskop, 2000; Kuznetsov et al., 2001).

Particular focus on bats during the last six expeditions of the Tropical Centre enabled to start the accumulation of data on ecology and natural history of bats during the surveys. These include an eco-morphological assessment of the structure of the bat community of Vu Quang (Borissenko et al., 2001), observations on cave dwelling bats of Phong Nha — Ke Bang (Kruskop, 2000b), and studies on parasitic flies of bats (Farafonova, Borissenko, 2001; Farafonova, Kruskop, 2001).

Ecological assessments of the state of local bat communities are of especial importance, as they are indicative of the state of the ecosystems in general. Thus it is proposed that aside from the necessary faunistic reconnaissance studies resulting in species lists, extensive ecological monitoring of bats should be introduced in surveyed areas. The should form a good basis for elaborating site-specific conservation activities.

METHODS OF BAT INVESTIGATION

Here we intend to give a brief overview of the methods of bat investigation employed in the studies of tropical Chiroptera in general and those used in our studies in Vietnam in particular. Comprehensive and nearly exhaustive compendia have recently been published on various study and capture methods (e. g., Kunz (ed.), 1990; Wilson et al. (eds.), 1996), and we should like to refer the reader to the above works for detailed information. Below we shall only provide a synopsis of the most common methods used to collect material for faunistic works and baseline ecological surveys.

In many well-surveyed areas with more or less known faunal composition (e. g., temperate Europe or North America) ecological studies are often limited to field observations of free-ranging bats, however this is hardly applicable in tropical areas where bat communities are much more diverse and often contain species which are extremely difficult to identify even in the laboratory and those with unknown ecological and behavioral peculiarities. Therefore, with few exceptions, even ecological studies must involve, at least at a preliminary stage, direct encounters of the observer with its objects of study in form of capture and handling and eventually sacrifice of selected individuals to serve as reference collection specimens.

Aside from the difficulties involved in catching bats, this implies that the investigator constantly faces the problem of making an acceptable compromise between collecting necessary data and causing minimal harm to local bat populations, additionally complexified by his/her own possible health hazards. In Vietnam it is also imperative for the worker to receive permission to conduct research and to collect reference material from both the State and local authorities. Ethic and administrative aspects of catching, handling and collecting bats, however, are beyond the scope of this book.

CAPTURE METHODS

General considerations

The capture of bats is an immanent part of any faunal survey work and one of its most challenging and fascinating stages, requiring, except for the most abundant species, special skills, good knowledge of bat biology and considerable innovative thinking from the researcher. It is impossible to be prepared for all situations one may encounter while catching bats, however, a synopsis of the most commonly employed methods and certain useful hints are provided below. For detailed information we should refer the reader to special works (Tuttle, 1974; Tideman, Woodside, 1978; Kunz, Kurta, 1990;

Jones et al., 1996; Borissenko, 1999; Snitko, 2001; Strelkov, Shaimardanov, 2001).

Special devices

The most vital equipment needed to perform any nighttime work in the tropics are light sources. Our experience shows that three types of light sources are useful when observing or catching bats. A general purpose head lamp is useful in most situations; additionally, a powerful hand torch is indispensable for lighting out remote dark corners of large roosts and various distant landmarks; a small flashlight may be used to find bats roosting in narrow crevices. Other equipment useful to detect bat activity includes ultrasound detectors. We have used narrowband heterodyning ultrasound detectors of the D-series (D–100 and D–120, Pettersson Elektronik AB, Sweden) to monitor the activity of bats and also to aid in the identification of certain genera and species in flight.

Capture methods for flying bats

Mist nets

Mist nets are the most «traditional» way of catching bats and are probably the most widely and extensively used means to assess chiropteran diversity, particularly in the tropics (e. g., Kunz, Kurta, 1990; Jones et al., 1996).

The type of net and the principle manner of erecting it is essentially similar to what is used to capture birds. Usually the finest types of nylon net with a mesh of 16 to 20 mm are used and the most widely used size types are 2 m in height and 7 to 12 m in width. The nets must contain 3–5 shelves and form «pockets» (see Fig. 2c) necessary to ensure the entanglement of bats.

Mist nets are set up in presumed flyways of bats, preferably in places where they transit to or from their foraging grounds and are not as alert to possible new obstacles as when hunting. The echolocation system of most microchiropteran bats is sensitive enough to detect even the finest types of nets, which makes the efficiency of capture highly dependant on the selection of the place to set them up. Megachiropteran bats which rely on vision when flying are much more likely to plunge into the net, hence to catch fruit bats it is more appropriate to set them near fruiting or flowering trees.

When erected the nets must be attended constantly or at least visited regularly throughout the dark period (ca. every few minutes to every few hours, depending on bat activity) and should not be left opened during the day, unless catching birds is also part of the survey.

It should be kept in mind, that, despite the numerous advantages of mist nets as tools for capturing bats, their efficiency is highly dependant on the

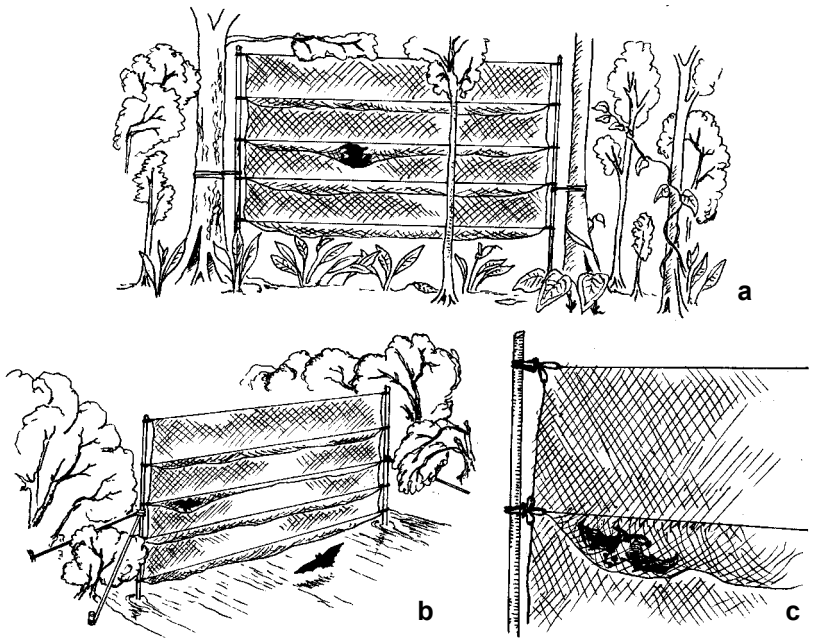


Fig. 2. The use of mist nets for catching bats: «typical» ways of setting up mist nets to catch bats a) in a forest opening and b) across a narrow stream; c) details of attachment of a mist net to a pole.

choice of the places where they are set up and the amount of sampling effort and/or plain luck. Certain groups of bats with high flight maneuverability and sensitive echolocation (e. g., *Myotis*, *Pipistrellus*, *Rhinolophus*, *Hipposideros*, etc.) tend to be largely overlooked in some situations (e. g., at their foraging grounds), as compared to others (e. g., pteropodids). Hence it is important that in the course of a survey other methods of capture are also employed. It should also be emphasized that mist nets are not suitable for sampling bats in places where large aggregations reside.

Harp traps

A harp trap is an «automatic» bat catching device composed of a frame with vertical lines or wires used to stop the flight of a bat and a bag to collect the bats which slide down along the lines of the frame (e. g., Tideman, Woodside, 1978; Kunz, Kurta, 1990; Kunz et al., 1996). The most widely used type (the so-called «Tuttle trap»), first suggested by Tuttle (1974) contains two banks of vertical lines; this enables to collect individuals which

manage to pass through the first row of lines.* In the «standard» construction the frame is some 2 m high and 1,6 m wide, the distance between frames is 5 cm and the lines (thin wires of monofilament fishing lines) are fastened 2,5 cm apart, their consecutive rows displaced by ca. 1.25 cm (Tideman, Woodside, 1978). The bag should be made of thick cloth and should have internal plastic flaps to keep bats from flying or crawling out.

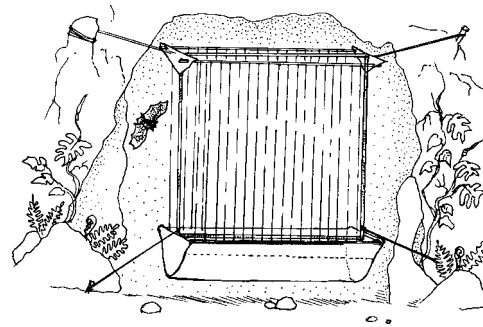


Fig. 3. Schematic representation of a harp trap set up at a cave entrance.

Harp traps are the most preferable mean of catching bats in situations when many individuals pass in relatively short time periods through rather narrow flyways; a typical example is an emergence route from a roost housing a large bat colony (e. g., cave entrance). However, it was shown to be quite effective in many other situations, and sometimes an adequate replacement for mist nets (e. g., Tideman, Woodside, 1978; Kunz, Kurta, 1990; Kunz et al., 1996). During the last decade it has been used quite extensively in Vietnam and Cambodia when conducting baseline ecological surveys (B. Hayes, J. L. Walston, pers. comm.), mostly near cave entrances.

One of the drawbacks of this method is that bats of different size classes, and behavioral patterns (including foraging habits and aggressiveness) are becoming packed together in one small volume with restrained ability to flee, which adds extra stress to the situation. The results of such encounters could be especially dramatic if a carnivorous species (*Megaderma lyra*) falls into the bag (J. L. Walston, pers. comm.)

Mobile traps

The mobile trap, or «flap trap» (Borissenko, 1999) is an alternative method of catching active bats when they «fly around» but stably avoid being caught into stationary catching devices (e. g., at their foraging sites) or when the population density is so low and the amount of nets available is so few that the probability of catching bats in mist nets is vanishingly small.

* Many of the Indochinese bats, such as rhinolophoids, may pass through several consecutive banks of lines, hence the traps with four rows of lines give even better catching results (J. L. Walston, pers. comm.)

Principally the mobile trap is composed of a piece of fine (0.1–0.17 mm thread/ or line diameter) fishing net ca. 2,5×3 m in size with a mesh of 14–18 mm armored with a frame of rope or fishing line (0.5–1 mm thick) which is attached to two poles (carbon fishing rods are ideal for this) ca. 4–5 m in length, to form a trapezium-shaped shallow scoop ca. 2–2.5 m wide and 2 m high, with four loops at the angles (Borissenko, 1999).

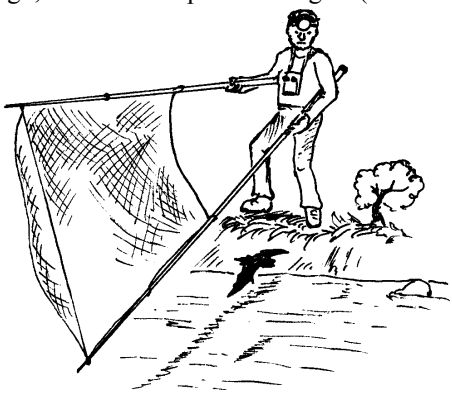


Fig. 4. Using a mobile trap to catch bats in flight.

The poles are held by the catcher under the arms (Fig. 4) and the bats passing within range are scooped by sidewise movements of the net. Head torches and heterodyning ultrasound detectors are most useful in aiding the catcher to be aware of approaching bats and in tracing their flights paths. When captured the bat should be handled in a manner similar to extracting then from mist nets, with similar precautions.

The trap proved to be quite effective in capturing a number of low-flying bat species, particularly, pipistrelles, mouse-eared bats, and small rhinolophoids in habitats where the probability of capturing them in mist-nets was low. In our studies it proved to be most helpful in conducting transect surveys along forest paths and roads, when bat activity was monitored simultaneously with capturing reference individuals. The major drawbacks of this method are the somewhat higher risk of injury both to the catcher and/or assistant (e. g., falling due to awkward movement or accidental damage to the assistant's eye by the tips of poles) and to the bat (e. g., damage to the wings caused by hits of the poles), which are, however, minimized with due practice, if elementary safety precautions are followed. When using mobile traps made of carbon rods (possessing high electroconductivity), special care should be taken to avoid proximity with high-voltage power lines.

Since the time of its introduction the mobile trap has been used in Indochina (Vietnam and Cambodia) by several researchers (V. A. Matveev, pers. comm., our studies) and proved to yield species which were not sampled by other means (neither in the studies nor during the same surveys), including taxa new to the countries. The efficiency and ease of using, together with the possibility to make captures parallel to conducting field observations of chiropteran flight behavior makes the mobile trap a useful addition to the «traditional» methods of capturing bats in flight.

Capture methods for roosting bats

Finding bat roosts is an alternative to catching and/or observing bats while they forage or commute to foraging grounds. The roosts could be traced by observing bats as they emerge in the evening or return before dawn or by searching through all potentially suitable places. The many bat species inhabiting Indochina use a wide variety of roosts, an exhaustive list of which is impossible to provide. However, a number of places are more likely to be used than others and we should try to list them in brief. The most typical daytime shelters used by bats are: caves, caverns, artificial mines, hollow trees (large hollow segments of trunks, such as *Lagerstroemia* and *Ficus*, or closed hollows), crevices and niches in rocky walls and trees, human buildings simulating the conditions of the above natural shelters, tree canopy, bamboo internodes, banana leaves, etc. Different capture techniques should be employed, depending on the type of roost and the researcher's goals (Kunz, Kurta, 1990; Jones et al., 1996). Special equipment (e. g., listed in previous or following chapters) may aid in these situations.

Nets

Pieces of fishing or bird net of various sizes may be quite helpful, especially when catching bats in closed spaces, e. g., roosts in hollow trees, attics, small caverns, etc. These nets are usually mounted to cover the presumed exits of fleeing bats, upon which the animals are startled. The nets should preferably be of fine nylon thread (pieces of old mist nets would serve good). When sealing a flyway with such a net, one should leave a small pocket below to ensure the entanglement of animals, however, this should be avoided in roosts housing large numbers of bats, to prevent from getting too many of them entangled simultaneously. Under such circumstances using a harp trap (see above) is the better choice.

Extracting devices

When bats are roosting in crevices inaccessible for human hands, various devices may be used to aid in their extraction. The most simple way is to use any long thin object, such as stick or pole, however, if the extracted bats are not dormant, this may cause them to move deeper into their shelter or to fly away. In many cases long forceps are quite useful for reaching such individuals. Measures should be taken to avoid injuring the animals which are being extracted and especially those which are their most proximal neighbors. The ends of the forceps must be covered with rubber sockets which ensure better grip and preclude damage to the soft tissues of the bat. The best way is to grip the animal by the fur at the side of the neck — this prevents the bat from trying to turn around within the crevice and ensures that no bones are broken

and no organs damaged if the pressure is too hard. For particularly long crevices specifically designed long-handled grips (Snitko, 2001; Strelkov, Shaimardanov, 2001) may be applicable.

Smoke

In situations when the shelter of bats cannot be accessed directly and the animals inside cannot be extracted or forced to leave without severely damaging the roost (e. g., in the case of a closed tree hollow with one or few small entrances), they could be smoked out. The most simple way is to blow in smoke from a tobacco-pipe, holding the mouthpiece towards the exit of the roost, which must be sealed with a piece of net beforehand. Smoke should not be too dense, to prevent the suffocation of bats. This technique should not be practiced during the bat reproducing season (which in Vietnam is usually confined to the end of spring and the beginning of summer), to avoid killing non-volant juveniles. Also it should be kept in mind that, although the roost remains more or less intact after this procedure, it will be abandoned for considerable time even if some bats remain inside after smoking terminates.

HANDLING BATS

To maintain bats for several days, specially designed cages or carrying containers are necessary (e. g., Kunz, Kurta, 1990), however, for situations when the animals are kept only for several hours, cloth bags are sufficient. Bags (small cloth sacks) should be at least ca. 17×25 cm and should be made of strong material but allow good ventilation. They should possess a tape or lace to tie the exit when a bat is inside. When holding bats they should preferably be hung in a cool, moist and ventilated place. If such conditions could not be provided, they must be moistened with water every few hours, to prevent the animals from dehydrating. If bats are kept for long time periods (e. g., over the day to collect feces) it is also recommended that they be offered water whenever handled. Avoid keeping specimens of different species (especially of different sizes) in one container. Several conspecific bats (provided that they are naturally colonial and not especially aggressive) may be maintained together in one bag. There should be enough space left for them to move more or less freely. Usually 2–4 individuals of small size is the optimum for a 17×25 cm bag. Solitary or carnivorous species should be kept individually or in mother-and-infant groups[*].

[*] Unless there is particular necessity imposed by the design of the study, females with non-volant young (or pregnant ones) should not be captured or handled, since this may terminate lactation (gestation) and cause death to the young (fetuses).

When handled (e. g., during disentanglement from mist nets, harp traps or mobile traps, external examination, taking measurements and/or searching for ectoparasites), bats have to be adequately restrained in order to exclude possible injury of the animal on the one hand, and to minimize the risk to one's own health (see below) on the other. The general rule is hold the bat right under the chin to preclude biting. Wearing protective gloves made of thick skin (e. g., those used for rodeo) may be advisable, however, this considerably reduces manipulative precision (especially important when working with small individuals) and any awkward movement may harm the animal.

When taken for general external examination (e. g., preliminary identification of taxonomic position or reproductive state) the bat should be held from the back by the elbows, leaving the belly exposed. One should be aware that the neck of bats, especially rhinolophoids, is extremely flexible, therefore to avoid bites free hands must be kept away from the head. In some cases it is profitable to grasp the animal by the nape right behind the occiput, this could be helpful when examining dentition and/or gular pouch (when present). Remember that certain bats, e. g., large rhinolophoids are quite aggressive when handled, but very sensitive to injury resulting from constriction. Usually they demonstrate considerable loyalty when held upside down by the hind feet, their body concealed inside the palm of the hand. This posture, however, is usually inconvenient for the person and requires wearing protective gloves.

Cases of severe entanglement of bats in nets require considerable self-control from the catcher, in order to make the extrication procedure as fast as possible; in some difficult cases the net has to be sacrificed to ensure that the bat remains intact. One has to keep in mind, however, that stress caused by disentanglement and the preceding time during which the bat was in the net may be as fatal to the animal as physical injury.

One of the difficult parts in handling bats is removing them from and placing back into bags, especially if the bag contains several individuals. To get a convenient grasp one should first locate the bat's head through the sack cloth and restrain it during the extraction procedure. The animal may then be taken by the elbows. When putting the animal back it is convenient to turn the bag inside out, take the bat's forequarters through the bag and roll it back on over the animal.

A useful way of temporarily immobilizing bats (especially medium-sized aggressive individuals) for weighing and collecting ectoparasites it to put them (separately) into cloth bags and to place them subsequently into a jar containing a piece of cotton soaked with chloroform. The bat has to be watched carefully and removed from the jar immediately after the first signs of inactivity. The time spent in the vapors of chloroform is sufficient to inactivate (however, not to kill!) most ectoparasites (flies, fleas, bugs, unattached

mites), which could be readily brushed off the bat's fur and membranes and from the cloth on the inside of the bag and subsequently collected. On the other hand, the time required for the bat to recover is usually sufficient for weighing, taking basic measurements and/or tissue samples and external examination, without stessing or putting special efforts to restraining the animal. After processing the bat may be left to recover in a cage, clean cloth bag or any suitable perch for subsequent releasing or maintaining in captivity.

Determining the reproductive condition

Determining the reproductive condition is one of the most important parts in examining bats, since considerable shifts in roosting and foraging ecology or even habitat preference, migratory activity and ultimately geographical distribution may be imposed by sex and/or reproductive state. Much of this information could (and should) be obtained by external examination and palpation of live individuals or other *in vivo* methods (e. g., X-ray, taking vaginal smears, etc.) However, certain precise data on ovulation, pregnancy, spermatogenesis, postcopoulatory reactions, etc., require dissection and subsequent microscopic studies[*]. For more detailed information on these procedures we should refer the reader to special works (Racey, 1990; Borissenko, 2000)

Sexing and aging

Sexing bats occurring in Indochina is quite easy, since males possess a prominent penis, and females have a characteristic transverse vulvar opening. Primary sex characters are somewhat obscured in subadult pteropodid bats, but could still be distinguished with due experience. In fact, sexing may be done with high precision even on skeletal material (e. g., in cave deposits): in males the pubic symphysis is well-developed, firmly binding the halves of the pelvis, whereas in females it is not ossified and decomposes leaving the contralateral pubic bones detached (Borissenko, 2000).

Juvenile and *subadult* individuals (before and after weaning, respectively) may be identified by the layers of relatively transparent cartilage at the epiphysal ends of wing bones, which shrink with age and finally disappear as growth of the bones terminates. In reproducing individuals other sex charac-

[*] It is imperative to remember that sacrifice of reproducing individuals (especially females) is most harmful to bat populations and thus should be done with extreme caution and good substantiation of the reasons. However, the most vital information relevant to our knowledge of population state, ecological and conservation requirements concerns reproduction and this data is limited (if at all available) for most tropical (particularly, Indochinese) bat species.

ters become apparent, such as testes in sexually active males and mammary glands and nipples in pregnant, lactating and postlactating females.

Females

Nulliparous females could be identified by the shape of their nipples, which are small, concealed by fur and essentially resemble those of males; in *parous* females they are enlarged, usually flattened or otherwise deformed and the surrounding area is more or less hairless. *Pregnant* females at late stages of pregnancy possess a conspicuously distended abdomen and somewhat swollen mammary glands; sometimes it is possible to locate the transversely located forearm of the foetus via palpation. In insectivorous bats these cases may be confused with recently fed individuals which may consume up to $^1/_3$ of the body weight, so that the stomach remains inflated for several hours. In *lactating* females the mammary glands are much inflated, the nipples are large and usually pigmented, surrounded by large hairless areas; milk could be obtained from the mammary glands by gently squeezing the nipples (this may not work with females who had just recently suckled their young). Postlactation in females is usually manifested by the gradual involution of nipples and mammary glands and the beginning of postlactational molt.

Males

In males sexual activity could be seen by the enlargement of testes as spermatogenesis progresses and subsequent distension of the epididymes where the spermatozoa are deposited. In some cases secondary sex characters develop and/or become prominent (such as gular sacks, frontal glands, etc.) and characteristic demonstrative (e. g., lek) behavior is displayed.

Weighing and measuring bats

The standard treatment procedure involves, besides external examination, taking measurements and weighing. Ideal for **weighing** bats are small spring balances (e. g., Pesola) or electronic balances with the precision of 0,1–0,5 g. Live individuals may be restrained in a small bag, wrapped with a piece of cloth or temporarily immobilized with chloroform (see above); apparently in the first two cases tare has to be deduced from weighing results. Weight is a good indicator of the overall condition of an individual, including maturity, reproductive state, amount of fat deposits, etc. Despite the high intracpesific variability, it could also be used for preliminary discrimination of related (even «sibling») species, under some circumstances.

External measurements (Fig. 5) are also an important source of information and could be used to verify the accuracy of identification based on quali-

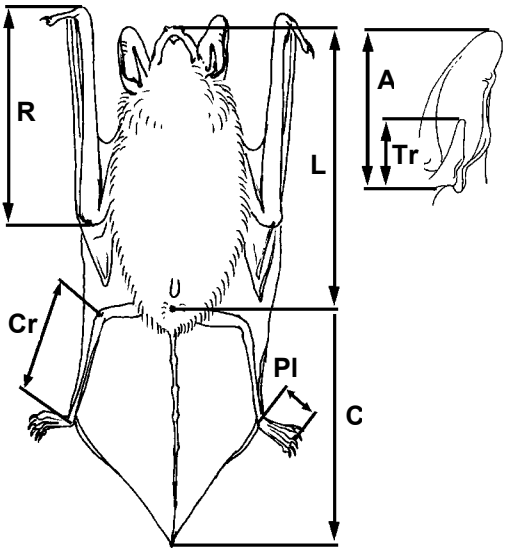


Fig. 5. Schematic representation of the standard measurements of a bat. See text for explanations.

tative characters; they could be taken with calipers (vernier, dial or electronic) to the nearest 0.1 mm, or, less preferably, with a ruler. The most vital measurement reflecting overall size of a bat is **forearm length** (usually abbreviated as FA or R — *radius*, the latter not an absolutely accurate definition), which is measured on a folded wing from the elbow to the outermost extremity of the wrist. Other measurements (their commonly used abbreviations given in parentheses) could be taken *in vivo* from temporarily immobilized bats or post-mortem from recently sacrificed animals intended for collecting. These are: **Head and body length** (H&B or L — *longitudo*) — from the tip of the nose to the anal opening; **Tail length** (T or C — *cauda*) — from the anal opening to the tip of the tail; **Ear length** (E or A — *auris*) — from the inferior emarginaiton to the tip of the pinna; **Tragus length** (Tr) — from the inferior emarginaiton to the tip of the tragus; **Hind foot** (HF or Pl — *planta*) — from the tarsal joint to the outermost part of the claw of the longest finger; Additionally, **Wingspan** (WS, distance between the tips of fully spread wings) and particularly in rhinolophoids the width of horseshoe, or anterior leaf (HS) could be measured.

Other measurements are made from skeletal elements (e. g., length of tibia, or crus (Cr), first wing digit, metacarpals and phalanges of the remainder wing digits). This could be done subsequently on fixed or dried collection specimens. It is important to remember, that measurements of live animals are not always accurate, whereas post-mortem measurements differ significantly from the same parameters taken in collection specimens, due to the shrinking of tissues during fixation or drying of study skins. Most published measurements (including those provided in identification guides) are usually taken in collection specimens, unless the opposite is specifically stated.

For certain purposes (e. g., identification of complex taxonomic groups) cranial measurements are also useful. These measurements are to be taken on

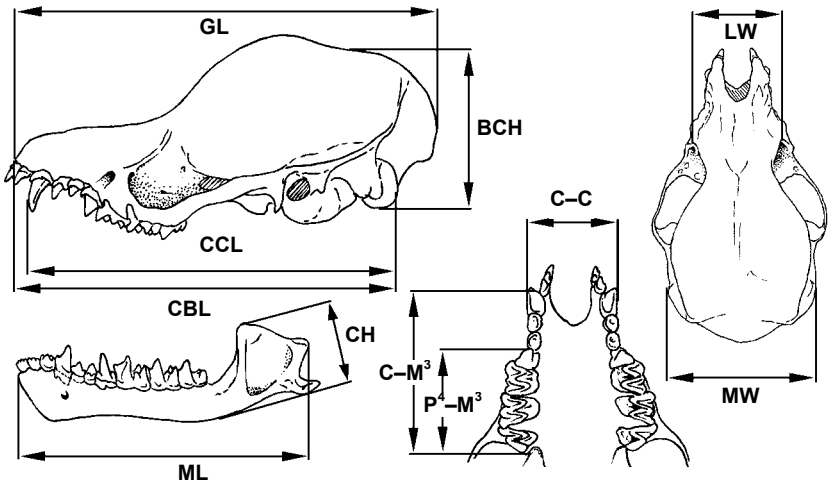


Fig. 6. Schematic representation of the basic cranial measurements of a bat (*Kerivoula*). See text for explanations.

cleared skulls with calipers or ocular-micrometers. From the variety of cranial measurements, few which are most easily and commonly taken may be considered as «standard» (see Fig. 6). These are:

Condylobasal length (CBL) — distance from the occipital condyles to the anterior border of the premaxilla; **Condylocanine length** (CCL) — distance from the occipital condyles to the anterior border of the of the upper canines; **Greatest length of skull** (GL) — distance between the most anterior part of the premaxilla to the posterior part of the skull (usually its occipital area); **Braincase height** (BCH) — height of the braincase, posterior to the auditory bullae from the basioccipital to the sagittal crest; **Mastoid width** (MW) — maximal width of the posterior part of the skull between the mastoid processes; **Lacrymal width** (LW) — distance between contralateral borders of the anterior rim of orbit, measured at the level of lacrymal foramina; **Mandible length** (ML) — length of the lower jaw branch from the outermost part of the symphysis to the articulary process; **Coronoid height** (CH) — height of the coronoid process of the lower jaw measured from its tip to the inferior plane of the proximal part of the jaw; **Upper toothrow length** (C–M^3) — distance from the anterior edge of the upper canine to the posterior edge of the last molar; **Upper molariform toothrow length** (P^4–M^3) — distance from the anterior edge of the large upper premolar to the posterior edge of the last molar; **Canine width** (C–C) — distance between the outermost extremities of the cinguli of upper canines.

Preparing collection specimens

Collecting reference materials is an immanent part of any faunistical survey, especially when one deals with a taxonomically complex group, whose members may need to be examined under laboratory conditions. Even if the species is quite common, a limited number of reference specimens from each locality provides valuable data on the geographic distribution, variability, diagnostic characters and other information which may be verified by subsequent reexamination of collection specimens by the same or other researchers. It is especially important to collect bats which are being sacrificed anyway (e. g., for medical necropsy) or which die accidentally in the course of catching, handling or maintenance. In some cases this prevents deliberate killing of bats specifically for collecting. Certainly such collections must be preserved in well-known and specialized depositories (e. g., leading museums and institutions), where they will be properly maintained, cataloged and available for study to all interested persons; this particularly concerns type specimens. To retain the scientific value of collection material a number of fairly simple rules must be followed by the collector.

Fluid preservation is the easiest (and optimal for most purposes) way of preparing bats as collection specimens. Total carcasses of freshly sacrificed animals are placed into 70–75% alcohol (ethanol) or 4% formaldehyde (10% formalin). Before fixation the ventral wall of the body of the specimen should be dissected to allow better diffusion of fixative and the mouth should be spread open with cotton or a short stick to make the dentition and palatal ridges readily visible for future diagnostics.

In general formalin is a better fixative and alcohol is a better preservative, therefore specimens fixed in formalin must be transferred to alcohol after several days/months of fixation (Handley, 1990). Although being a worse fixative than formalin, alcohol has the advantage that specimens after alcohol fixation are readily available for extraction and clearing of the skull or other skeletal elements, taking tissue samples for DNA extraction and even subsequent preparation of study skins. However, provided that al the above items have been taken care of, fixation in formalin may be preferable. If specimens or parts thereof are intended for histological sectioning, selected pieces should be fixed in special reagents, such as Bouin's fluid, mixture of formalin, alcohol and acetic acid, etc.

Skin and skull is an alternative commonly used form of preservation. For certain purposes it is useful to prepare dried study skins; the main advantage of this form of preparation is that it retains the initial coloration of pelage and parts with exposed skin (ears, muzzle, membranes); dried specimens are also somewhat more easily handled. However, preparing such specimens (e. g.,

Kuzyakin, 1980) is relatively time- and labor-consuming, demanding special materials and skills from the collector. Also dried collections require specific insecticide (or arsenic) treatment during preparation and regular attention and fumigation during maintenance, especially in the tropics where they face great risk of being attacked by various pests (dermestids, ants, roaches and moths) and fungi. When preparing dried study skins it is imperative to retain the interior parts or a least the skull (or skull and skeleton) and label them appropriately (see below) to ensure that they could be recognized as belonging to the same specimen. Skeletal elements may be cleared with dermestids or special chemical reagents. usually this is done subsequently in museums where the collections are deposited. The main task of the collector therefore is to provide dried or alcohol-preserved carcasses suitable fo clearing.

Labeling is the key item of any collecting procedure, and an appropriately filled label contains data as valuable as the specimen itself. The label should be made in good handwriting (or typed) on high-quality tracing paper, oil cloth or similarly strong material with water and alcohol-resistant ink and attached (tied) firmly to the specimen, to ensure that it is not lost during shipment. Each collection specimen should be accompanied with data on its exact collecting locality (country, state, province, district, nearest large settlement, position relative to nearest conspicuous landmark, altitude, preferably also coordinates), habitat characteristics, collecting/capture date, conditions of capture and name of the collector. It is also preferable (imperative for skulls and dried specimens) to indicate preliminary identification, sex, reproductive state, weight and basic measurements (see above), although most of this information could be retrieved subsequently from fluid-preserved material. It is highly desirable that each specimen possesses its unique collection number (it may include the collector's initials or other coding), especially if it is represented by several separately stored forms of preparation (skin, skull, skeleton, internal organs, tissue samples, ectoparasites, etc.) In this case individual labels may be limited to field collection numbers with relevant full data contained in a collecting protocol, journal or diary, provided that this data always accopmanies respective collection materials.

SAFETY PRECAUTIONS

In preparing this chapter we did not intend to create an impression of bats as a particularly dangerous study object, especially since this notion continuously persists in popular literature, much of the information presented therein being dramatically overestimated. We should, however, remind the reader that field work in the tropics in general and that with wild animals in particular is never absolutely safe, and this has to be kept in mind constantly.

Working with bats poses certain specific risks for the researcher, which may or may not be similar to those facing someone working with other small mammals. We have tentatively classified these threats into two major groups, the former of them not posed by the bats themselves, however, indirectly connected with the specificity of bats as a study object.

Hazards from working conditions

Catching bats and monitoring their activity usually implies working during night hours. Therefore it is imperative that prior to the beginning of work the study site (especially if it is a montane area) is well familiarized with during the daytime. Still the deficit of natural lighting often obscures the daytime impression from the terrain and, provided that one's attention is focused on other objectives, important reference points may be lost and obstacles may be overlooked. One should be aware that, in addition to poor lighting conditions, there is higher risk of unpleasant encounters with nocturnal animals, such as venomous arthropods, mosquitoes from the genus *Anopheles* (the transmitters of malaria), snakes and, to a much lesser extent, large mammals. Thus planning such work requires obtaining adequate equipment (clothing, light sources) and medication.

Large dark roosts, particularly caves, are especially dangerous to unprepared people for various reasons (e. g., see below), and students planning to work therein are encouraged to pass at least basic training courses in caving, purchase the necessary equipment and acquire all available preliminary information on the structure and microclimatic conditions in the cave(s) where they propose to conduct studies.

Huge aggregations of bats can sufficiently alter the microclimate and chemical content of the air in their roosts (particularly caves), mostly due to their excretions and respiratory activity; the concentrations of atmospheric gases in poorly ventilated roosts may be suitable for the bats themselves, but dangerously high or even fatal to humans (Constantine, 1990). It is quite probable that populated roosts will have increased concentrations of the following gases (ibid.) Carbon dioxide (CO_2) accumulates due respiration of bats. It is heavier than air and thus its concentrations are bound to be higher near the floor, i. e., it may be higher around the researcher than where bats perch. Usually increased concentrations of CO_2 are accompanied by decreased concentrations of free oxygen (O_2). Ammonia (NH_4) is released from bat urine, decomposing guano and dead bats. This gas is highly toxic to the human respiratory system, and strong odor of ammonia is indicative of possible danger. In addition, other poisonous gases of non-organic origin may be present in caves (see Constantine, 1990), requiring investigators to be alert.

Hazards from bats

The bats themselves pose a minor threat to humans, as compared to many other mammals (both large and small). On the one hand, they cannot inflict serious damage with defensive bites (although in the tropics even a small wound may become infected); on the other hand, bat parasites are generally highly specialized and (with very few exceptions) would not attack humans, and, even less probably, transmit diseases. However, when dealing with live or dead bats, one should remember that several types of health hazards caused to persons working with bats by direct or indirect impact of these animals have been described in literature. The most important of them are bat-transmitted diseases, which are briefly considered below. For more detailed information we should like to refer the reader to special works on the subject (Kulik, Kucheruk, 1989; Constantine, 1990; Kunz et al., 1996).

Histoplasmosis

This is by far the only bat-transmitted human disease reported from Vietnam (Constantine, 1990). It is caused by a dimorphic fungus *Histoplasma capsulatum* developing as a saprophyte on various organic matter, particularly on bat feces and carcasses deposited in roosts and may be transmitted with airborne spores (ibid.), affecting the respiratory system. At present there is no indication for Indochina that it is a major risk for people working in bat caves or attics with large guano deposits, however, it is wise to wear respirators when visiting such places and be alert to possible signs of illness, such as respiratory symptoms, chest pains and dry cough.

Rabies and rabies-like diseases

This extremely dangerous viral disease caused by various strains of *Lissavirus* is widely distributed throughout the World, but is common among bats mostly in the Americas (Kulik, Kucheruk, 1989; Constantine, 1990; Kunz et al., 1996; Botvinkin, 2001). Severely affecting the nervous system, this virus is also deposited in the saliva and is most commonly transmitted through bites, although cases of transfer through the digestive tract, respiratory system and mucous membranes are also reported (Constantine, 1990). In Asia this virus has been isolated from bats sporadically (e. g., Botvinkin, 2001) and for Indochina there are no indications of it being transmitted from bats to humans. Hitherto there appears to be no necessity for preventive immunization (especially considering that there is no special vaccine against bat rabies strains), however it is wise to take all possible measures preventing the bats from biting and their excretions from contaminating skin and mucous parts of the researcher. Wearing latex gloves and respirators when dissecting bats and sterilization of instruments, containers and working space may be

recommended. It is also reasonable to constantly monitor captive individuals (if maintaining them is part of the study) and watch for any signs of illness or inadequate bahavior.

Other diseases

Aside from the diseases considered above, bats have been shown to carry certain types *arboviruses* and *morbilliviruses* (the most proximal reports of the latter reported are from Cambodia and Malaya), and there are several cases of human and domestic animal infestation reported worldwide (e. g., Kulik, Kucheruk, 1989; Botvinkin, 2001). These viruses are known to be transmitted through infested tick (predominantly Argasidae) bites, with food contaminated by bat feces and possibly also via airborne infection. General safety precautions (see above) seem adequate to preclude infection in the course of handling bats.

TAXONOMIC LIST OF VIETNAMESE BATS

This list contains only records confirmed by collection material available to the authors or those listed in latest publications and containing precise information on capture localities and specimens examined. The taxonomic arrangement is based on Pavlinov et al. (1995) and McKenna and Bell (1997).

ORDER CHIROPTERA DOBSON, 1872

SUBORDER MEGACHIROPTERA DOBSON, 1875

FAMILY PTEROPODIDAE GRAY, 1821

SUBFAMILY PTEROPODINAE

TRIBE PTEROPODINI

Genus *Pteropus* Erxleben, 1777

«*v a m p y r u s*» g r o u p

Pteropus lylei K. Andersen, 1908

Pteropus vampyrus (Linnaeus, 1758)

«*s u b n i g e r*» g r o u p

Pteropus hypomelanus Temminck, 1853

TRIBE ROUSETTINI KOOPMAN, JONES, 1970

Genus *Rousettus* Gray, 1821

Rousettus amplexicaudatus (E. Geoffroy, 1810)

Rousettus leschenaulti (Desmarest, 1820)

TRIBE CYNOPTERINI KOOPMAN, JONES, 1970

Genus *Cynopterus* F. Cuvier, 1824

Cynopterus sphinx (Vahl, 1797)

Cynopterus brachyotis (Mueller, 1838)

Genus *Sphaerias* Miller, 1906

Sphaerias blanfordi (Thomas, 1891)

Genus *Megaerops* Peters, 1865

Megaerops niphanae Yenburta, Felten, 1983

SUBFAMILY MACROGLOSSINAE GRAY, 1866

Genus *Eonycteris* Dobson, 1873

Eonycteris spelaea (Dobson, 1871)

Genus *Macroglossus* F. Cuvier, 1824

Macroglossus sobrinus K. Andersen, 1911
Macroglossus minimus (E. Geoffroy, 1810)

SUBORDER MICROCHIROPTERA DOBSON, 1875

INFRAORDER YINOCHIROPTERA KOOPMAN, 1985

SUPERFAMILY EMBALLONUROIDEA

FAMILY EMBALLONURIDAE GERVAIS, 1856

SUBFAMILY THAPHOZOINAE JERDON, 1877

Genus *Taphozous* E. Geoffroy, 1818

Taphozous melanopogon Temminck, 1841
Taphozous theobaldi Dobson, 1872

Genus *Saccolaimus* Temminck, 1838

Saccolaimus saccolaimus (Temminck, 1838)

SUPERFAMILY RHINOLOPHOIDEA

FAMILY MEGADERMATIDAE ALLEN, 1864

Genus *Megaderma* E. Geoffroy, 1810

Subgenus *Megaderma*
Megaderma spasma (Linnaeus, 1758)

Subgenus *Lyroderma* Peters, 1872
Megaderma lyra E. Geoffroy, 1810

FAMILY RHINONYCTERIDAE GRAY, 1866

TRIBE RHINONYCTERINI

SUBTRIBE HIPPOSIDERINA FLOWER, LYDEKKER, 1891

Genus *Aselliscus*, Tate 1941

Aselliscus stoliezkanus (Dobson, 1871)

Genus *Hipposideros* Gray, 1831

Subgenus *Chrysonycteris* Gray, 1866
Hipposideros pomona K. Andersen, 1918
Hipposideros cineraceus Blyth, 1853

Hipposideros ater Templeton, 1848

Subgenus *Ptychorhina* Peters, 1871
Hipposideros galeritus Cantor, 1846

Subgenus *Hipposideros*
Hipposideros larvatus (Horsfield, 1823)

Subgenus *Gloionycteris* Gray, 1866

«*armiger*» group
Hipposideros armiger (Hodgson, 1835)
Hipposideros turpis Bangs, 1901

«*pratti*» group
Hipposideros pratti (Thomas, 1891)
Hipposideros lylei Thomas, 1913

«*diadema*» group
Hipposideros diadema (E. Geoffroy, 1813)

TRIBE COELOPSINI TATE, 1941

Genus *Coelops* Blyth, 1848
Coelops frithii Blyth, 1848

Genus *Paracoelops* Dorst, 1947
Paracoelops megalotis Dorst, 1947

FAMILY RHINOLOPHIDAE GRAY, 1825

Genus *Rhinolophus* Lacepede, 1799

«*affinis*» group
Rhinolophus affinis Horsfield, 1823
Rhinolophus borneensis Peters, 1861
Rhinolophus malayanus Bonhote, 1903
Rhinolophus stheno Andersen, 1905
Rhinolophus cf. *rouxii* Temminck, 1835
Rhinolophus thomasi Andersen, 1905

«*lepidus*» group
Rhinolophus subbadius Blyth, 1844
Rhinolophus pusillus Temminck, 1834
Rhinolophus lepidus Blyth, 1844
Rhinolophus acuminatus Peters, 1871

«*pearsoni*» group
Rhinolophus pearsoni Horsfield, 1851
?*Rhinolophus yunnanensis* Dobson, 1872

«*arcuatus*» group
?*Rhinolophus shameli* Tate, 1943

«*philippinensis*» group
Rhinolophus macrotis Blyth, 1944
Rhinolophus luctus Temminck, 1835
Rhinolophus paradoxolophus (Bourret, 1951)
Rhinolophus marshalli Thonglongya, 1973

INFRAORDER YINOCHIROPTERA KOOPMAN, 1985

SUPERFAMILY VESPERTILIONOIDEA

FAMILY VESPERTILIONIDAE GRAY, 1821

SUBFAMILY KERIVOULINAE MILLER, 1907

Genus *Kerivoula* Gray, 1842
Kerivoula hardwickii (Horsfield, 1824)
Kerivoula papillosa Temminck, 1840
Kerivoula picta (Pallas, 1767)
?*Kerivoula whiteheadi* Thomas, 1894

SUBFAMILY VESPERTILIONINAE

TRIBE MYOTINI TATE, 1942

Genus *Myotis* Kaup, 1829

Subgenus *Myotis*
Myotis chinensis (Tomes, 1857)

Subgenus *Selysius* Bonaparte, 1841

«*montivagus*» group
Myotis montivagus Dobson, 1874

«*mystacinus*» group
Myotis siligorensis (Horsfield, 1855)
Myotis muricola (Gray, 1846)
Myotis ater (Peters, 1866)

«*rosseti*» group
Myotis rosetti (Oey, 1951)

Subgenus *Leuconoe* Boie, 1830
Myotis annamiticus Kruskop, Tsytsulina, 2001
Myotis cf. daubentonii (Kuhl, 1817)
Myotis horsfieldii (Temminck, 1840)

Myotis hasseltii (Temminck, 1840)

Subgenus *Rickettia* Bianchi, 1917
Myotis ricketti (Thomas, 1894)

Genus *Eudiscopus* Consbee, 1953
Eudiscopus denticulus (Osgood, 1932)

TRIBE VESPERTILIONINI S. LATO.

SUBTRIBE PIPISTRELLINA TATE, 1942

Genus *Pipistrellus* Kaup, 1829
Pipistrellus ceylonicus (Kelaart, 1852)
Pipistrellus coromandra (Gray, 1838)
Pipistrellus javanicus (Gray, 1838)
Pipistrellus abramus Temminck, 1840
Pipistrellus tenuis (Temminck, 1840)
Pipistrellus paterculus Thomas, 1915

Genus *Glischropus* Dodson, 1875
Glischropus tylopus (Dobson, 1875)

Genus *Nyctalus* Bowdich, 1825
Nyctalus cf. noctula (Schreber, 1774)

SUBTRIBE VESPERTILIONINA

Genus *Hypsugo* Kolenati, 1856
Hypsugo pulveratus (Peters, 1871)
Hypsugo cadornae Thomas, 1916

Genus *Eptesicus* Rafinesque, 1820
?*Eptesicus serotinus* Schreber, 1774

Genus *Ia* Thomas, 1902
Ia io Thomas, 1902

Genus *Arielulus* Hill, Harrison, 1987
Arielulus cf. circumdatus (Temminck, 1840)
Arielulus aureocollaris (Kock, Storch, 1996)

Genus *Tylonycteris* Peters, 1872
Tylonycteris pachypus (Temminck, 1840)
Tylonycteris robustula Thomas, 1915

Genus *Hesperoptenus* Peters, 1868

Subgenus *Milithronycteris* Hill, 1976
Hesperoptenus tikkeli (Blyth, 1851)

Hesperoptenus blanfordi (Dobson, 1877)

Genus *Scotomanes* Dobson, 1875

Scotomanes ornatus (Blyth, 1851)

Genus *Scotophilus* Leach, 1821

Scotophilus heathi Horsfield, 1831
Scotophilus kuhli Leach, 1821

SUBFAMILY MURININAE MILLER, 1907

Genus *Murina* Gray, 1842

«*cyclotis*» group
Murina cyclotis Dobson, 1872
Murina huttoni (Peters, 1872)

«*suilla*» group
Murina tubinaris (Scully, 1881)
Murina leucogaster Milne-Edwards, 1872
Murina aurata Minle-Edwards, 1872

Genus *Harpiocephalus* Gray, 1842

Harpiocephalus harpia (Temminck, 1840)
(including *H. mordax*)

SUBFAMILY MINIOPTERINAE DOBSON, 1875

Genus *Miniopterus* Bonaparte, 1837

Miniopterus schreibersi (Kuhl, 1817)
Miniopterus pusillus Dobson, 1876
Miniopterus magnater Sanborn, 1931

SUPERFAMILY MOLOSSOIDEA

FAMILY MOLOSSIDAE GERVAIS, 1856

SUBFAMILY TADARIDINAE LEGENDRE, 1984

Genus *Tadarida* Rafinesque, 1814

?*Tadarida teniotis*

Genus *Chaerephon* Dobson, 1874

Chaerephon plicata (Buchanan, 1800)

SYSTEMATIC ACCOUNTS: ORDER CHIROPTERA

GENERAL CHARACTERISTICS. One of the most diverse and widespread order and the only group of mammals capable of true flight.

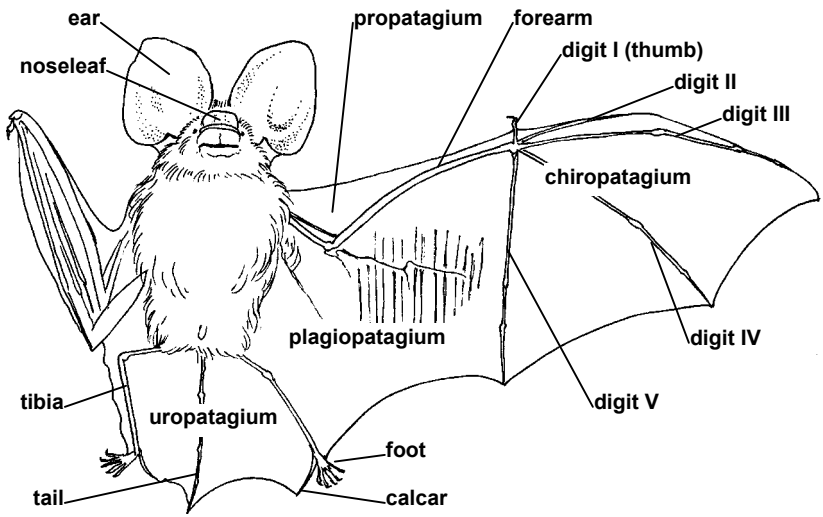


Fig. 7. Schematic representation of the external appearance of a «typical» bat (exemplified by *Hipposideros*).

DIAGNOSIS. External appearance most variable, but with a number of distinct characteristic features not found among other mammals (Fig. 7). Front limbs developed into wings formed by elongated arm and elements of 2nd—5th digits. The wing elements and the lower limb are enclosed into the flight membrane (essentially a fold developed from the skin of the limbs, with one common layer of *corium*) divided into the so-called *chiropatagium* (hand-wing), *plagiopatagium* (arm-wing), *propatagium* (anterior edge of wing) and *uropatagium* (interfemoral, or tail membrane). The latter is usually supported by accessory partially cartilaginous calcar, attached to the hind limb.

The shoulder-girdle and thoracic region are hypertrophied, with powerful musculature facilitating active flapping flight; in larger species the sternum possesses a prominent ventral keel (although not as prominent as in birds) to attach the most powerful pectoral muscle responsible for downstroke. The first digit is only partially (basally) enclosed within the membrane, opposed to the remainder fingers and always with a well-developed claw, facilitating

effective movement over vertical surfaces. The second digit is clawless in Microchiroptera and, with few exceptions, has a well-developed claw in Megachiroptera.

Hind limbs rather small, but also very peculiar with the knee joints turned sidewards and dorsally and toes facing outwards, with very sharp claws. Such arrangement of hind limbs also facilitates effective movement over vertical surfaces. There is a special tendinous mechanism constricting the toes when the limb is stretched, enabling to grasp the substrate when the bat is at rest.

Muzzle of various shape and appearance (Fig. 9), often with complex outgrowths, sometimes leaf-like. Ears also of various shape and size (Fig. 9), from simple to complex, with supplementary structures (tragus, antitragus). Eyes from large (in Megachiroptera) to medium or small (in Microchiroptera), corresponding to the role of vision in flight.

There is usually one pair of thoracic (axillary) nipples, in several families an additional pair of false pubic nipples (used only for attachment of young) is also present. Many bats possess specific scent glands located in the buccal area, on the throat, forehead or wing membrane. The fur is usually dense and soft, vibrissae poorly developed. Pelage of various color.

Skull (see Figures in the Appendix) with enlarged braincase, sutures between bones soon become obliterated, except for premaxillae, which in some families remain separate from maxillary bones. Teeth of various shape, dental formula* $I^{1-2}/_{1-3}$, $C^{1}/_{1}$, $P^{1-3}/_{2-3}$, $M^{1-3}/_{1-3}$ $\times 2 = 20–38$. The digestive tract is short, the stomach is simple. Cheek teeth of microchiropterans usually possess the so-called tribosphenic dental cusp pattern, typical of primitive mammalian orders. This pattern is rather complex, basically quite uniform and moderately variable within this suborder, making dental structure an especially valuable character complex for diagnostics of taxa at various levels.

Upper molars (Fig. 8) possess three main cusps, connected via sharp ridges: the internal **protocone** and two external cusps: anterior **paracone** and posterior **metacone**. These are connected via sharp ridges (crists): anterior preprotocrista and posterior postprotocrista, forming a variously pronounced (sometimes obscured) V-shaped structure. The preprotocrista in some (e. g., *Myotis*) species may possess a small notch-like structure — the **paraconule**.

Posterior and internal to the trigon lies the fourth cusp — **hypocone**. Usually it is not as prominent, in some taxa it is visible as a short ridge coming from the protocone. In certain families (e. g., Rhinolophidae) the part of the cingulum adjacent to the hypocone is expanded and forms a prominent **hypo-**

* The dental formula indicates the number of teeth (I — incisors, C — canines, P — premolars, M — molars) in one half of the $^{upper}/_{lower}$ jaw; number after the equation mark shows the total number of teeth.

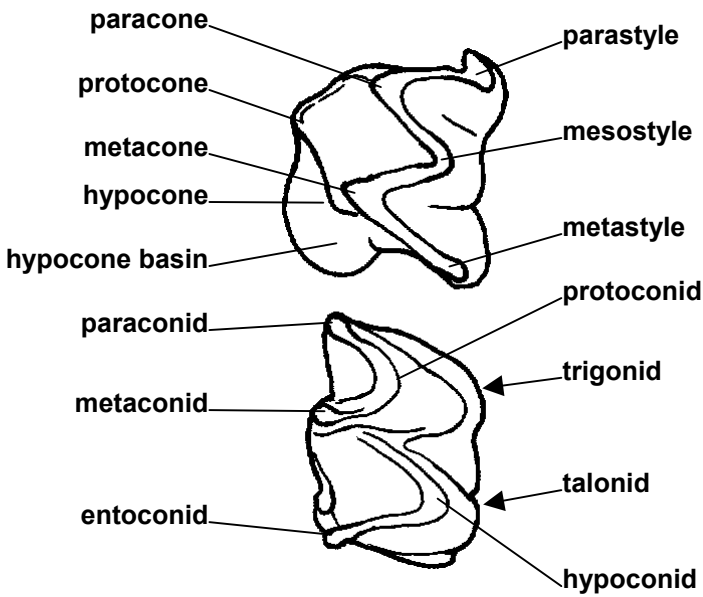


Fig. 8. Structure of a typical tribosphenic teeth (left upper and right lower second molars (M^2 and M_2) of *Rhinolophus*). Note the W-shaped ectoloph of upper molar.

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cone basin, or talon. External to the trigon are three additional cusps forming the stylar shelf: **parastyle**, **mesostyle** and **metastyle**, connected to the paracone and metacone by four ridges: pre- and postparacrista, and pre- and potsmetacrista. These four ridges are usually especially well-pronounced and together they form the characteristic W-shaped **ectoloph**. The last (fourth) upper premolar (P^4) takes part in occlusion and retains the sharp cusp and transverse ridge, thus being in shape somewhat intermediate between the canine and molars, together with the latter it forms an occlusive row of **molariform teeth**. The posterior portion of the last molar is usually variously reduced, eventually only the preparacrista and premetacrista and, respectively, parastyle, paracone and reduced protocone remaining.

The lower molar has an inverse tribosphenic pattern: the **protoconid** is positioned externally to the **paraconid** and **metaconid**, forming a **trigonid**. The **hypoconid** is well-developed, positioned externally; opposing it is an internal equally-developed cusp — **entoconid**; often an additional small cusp is present just posterior to the latter — **hypoconulid**. The ridge connecting the two posterior cusps of the lower molar is called **postcristid**.

In some primitive Vespertilionidae two additional small upper (P^2 and P^3) and lower (P_2 and P_3) premolars are retained. They fill the gap between the canine and molariform premolar and, unlike the other teeth, do not usually (except Murininae) occlude when the jaws are closed. In this case the gap housing small premolars is called pseudodiastem. In most bats, however, only one small premolar is retained in either jaw (most commonly P^3/P_3), and this is often minute and displaced from the toothrow either inwards (intruded) or outwards (extruded), thus the pseudodiastem disappears.

In all pteropodids this dental structure is completely deteriorated, the molars becoming simple in shape, usually with a ridge along the external margin of the tooth. In some Vespertilionidae (e. g., *Scotophilus* and *Harpiocephalus*) the tribosphenic cusp pattern in obscured, due to various reduction of the stylar shelf and/or some of its supporting cusps.

DISTRIBUTION. Distributed worldwide, except for the Arctic and Antarctic and some most remote oceanic islands, inhabiting a wide variety of landscapes and climatic zones, however ca. 90% of the taxonomic diversity is confined to the tropics.

NATURAL HISTORY. Despite that active flight is the predominant mode of locomotion, many bats are well capable at running on horizontal surfaces or «walking» on the ceiling with hind limbs; some can swim and take off from water surface. The normal resting posture is upside down, toes clinging on to the ceiling or walls of the roost, branches, bark, underside of large leaves; some bats may crawl into crevices, including horizontal ones.

A wide variety of natural history patterns is displayed by bats. In Southeast Asia all frugivorous niches are occupied by Megachiroptera, while all microchiropteran bats are animalivorous and, with the exception of one family, almost exclusively insectivorous. The latter usually forage in open air, however, some are known to use perches and take pray from various substrates — a foraging pattern called gleaning. They all exhibit a nocturnal way of life, spending the day hours in various roosts (tree hollows or canopies, caves, rock crevices, human buildings, etc.).

Some bats are solitary, however, most are more or less gregarious, forming monospecific or mixed colonies of up to many thousand individuals.

A variety of seasonal cycles is displayed: birth usually takes place once (most insectivorous species) or twice (most fruit- and nectar-feeding bats) a year, eventually year-round (in some Vespertilionidae). Many species use specific physiological mechanisms for adjusting the periods of mating, birth and lactation to seasons with optimal feeding conditions (sperm conservation in the female reproductive tract, delayed implantation, retarded development and post-partum oestrus). Gestation lasts 1,5 to 9 months; the young are born hairless and blind, however relatively large (ca. 15–30% of female weight).

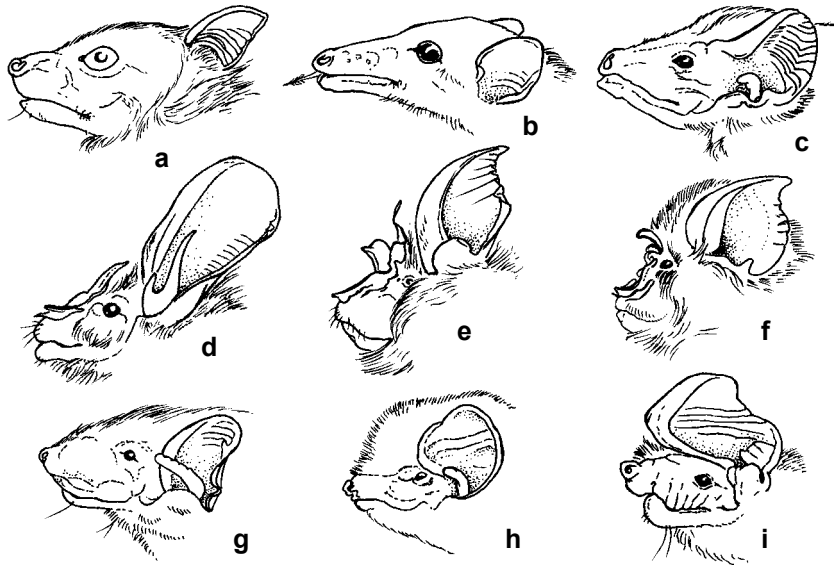

Fig. 9. Variation in the shape of muzzle and ears in Indochinese Chiroptera: a) Pteropodidae (*Cynopterus*); b) Pteropodidae (*Macroglossus*); c) Emballonuridae (*Taphozous*); d) Megadermatidae (*Megaderma*); e) Rhinolophidae (*Rhinolophus*); f) Rhinonycteridae (*Hipposideros*); g) Vespertilionidae (*Scotophilus*); h) Vespertilionidae (*Miniopterus*); i) Molossidae (*Chaerephon*).

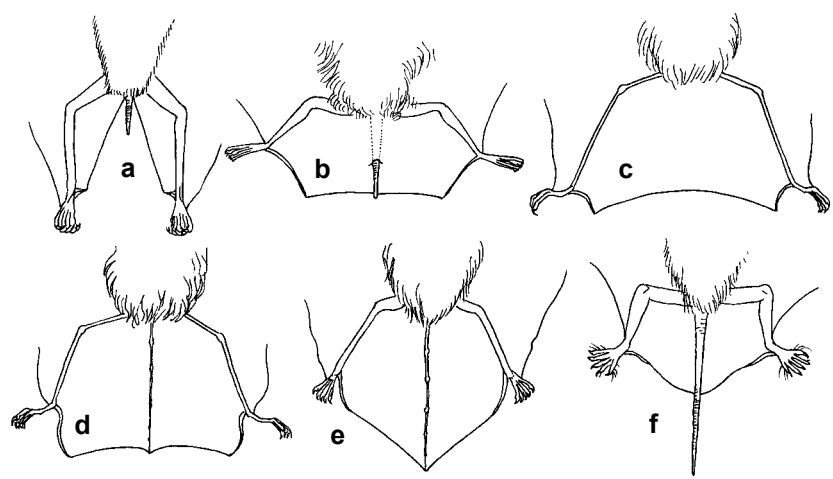

Fig. 10. Structure of the interfemoral membrane (uropatagium) in Vietnamese bats (dorsal view). a) Pteropodidae (*Eonycteris*); b) Emballonuridae (*Taphozous*); c) Megadermatidae (*Megaderma*); d) Rhinolophidae (*Rhinolophus*); e) Vespertilionidae (*Scotomanes*); f) Molossidae (*Chaerephon*).

Usually a single young is born, however, twins are common in certain Vespertilionidae. They are normally left in the roost, while the female forages. Volancy is attained at ca. 0.5–1.5 months and weaning takes place ca. 1–3 months after birth. The relatively low reproductive rate of bats, as compared to other mammals and birds, makes their populations susceptible to direct elimination. This is an important conservation issue, since many tropical species are being extensively harvested for food.

Certain species were shown to be migratory in areas with changing climate, however no such data is available for Vietnam. Despite the apparent shifts in faunal composition of bats in the same locality during our subsequent surveys at different seasons, the patterns and affecting factors of migratory activity in Vietnamese bats are not known.

The maximum reported lifespan for bats is 34 years, such data for Indochinese species is not available.

TAXONOMICAL REMARKS. Taxonomical structure very complex and contradictory. Two major suborders are usually recognized: Megachiroptera (only one family Pteropodidae) and Microchiroptera (the remainder families). An alternative view is that the two taxa are paraphyletic and should be regarded as separate orders. Includes 18 families, over 180 genera and over 1000 species.

Key to the families of Chiroptera, found in Indochina*

External characters

1 Eyes large (over 4 mm in diameter); muzzle elongated or somewhat doglike; ear pinna simple, without tragus and antitragus (small notches may be present in their places; Fig. 9ab). Second digit of wing with well developed phalanges; usually (with one exception for Vietnam) bearing a claw. Tail, if present, shorter than $^1/_2$ of tibia; interfemoral membrane reduced or virtually absent (Fig. 10a)..... **Pteropodidae** (p. 52)

— Eyes medium to small (less than 3 mm); muzzle of various shape, but not doglike; ear pinna with distinctive tragus or/and antitragus. Second digit of wing usually with reduced phalanges and no claw. Tail, if present, longer, than $^1/_2$ of tibia; interfemoral membrane moderate to wide.....**2**

2 Muzzle simple, without conspicuous coriaceous structures (nostrils sometimes prominent; Fig. 9cghi) **6**

— Muzzle with distinctive coriaceous, usually leaflike structures (Fig. 9def) **3**

* This key includes two families (Craseonycteridae and Nycteridae) extralimital to Vietnam, which are, however, found in Myanmar and Thailand. See also comments at the end of this section.

3 Noseleaf complex, consisting of a horseshoe (or anterior leaf), surrounding the nostrils, posterior leaf and variable set of supplementary structures. Tragus absent, antitragal lobe conspicuous (Fig. 9ef) **5**

— Noseleaf structure different. Tragus always present and conspicuous, antitragal lobe not developed (Fig. 9d).....**4**

4 Tragus bifid. Ear pinnae large (nearly equal to forearm length), fused at bases. Coriaceous structures on muzzle in form of an erect leaf behind nostrils and a heart-shaped leaf surrounding nostrils. Tail absent..... .....**Megadermatidae** (p. 72)

— Tragus not bifid (simple). Ear pinnae large (nearly equal to forearm length), but distinctly separated at bases. Coriaceous structures on muzzle complex, but not leaf-like, surrounding a slit-like groove passing along the muzzle. Tail long, with a cartilaginous T-shaped tip.....**Nycteridae***

5 Intermediate nasal leaf erect and relatively narrow, consisting of sella and connecting process; posterior leaf (lancet) more or less triangular in frontal view, often pointed (Fig. 18) .....**Rhinolophidae** (p. 92)

— Intermediate noseleaf low and wide, in shape of a transverse dermal ridge; posterior leaf low and flattened (Fig. 12) .....**Rhinonycteridae** (p. 75)

6 Muzzle with thickened narial pad, nostrils directed frontward. Tail and calcar virtually absent. Size extremely small (forearm length, 22–26 mm) . .....**Craseonycteridae***

— Muzzle without narial pad, nostrils directed more or less outward. Tail and calcars well developed. Size variable, sometimes very small, but usually larger than in the previous case **7**

7 Ears thick and fleshy, conjoined above the muzzle or, at least, connected by a ridge of skin. Tail projects beyond the posterior margin of the interfemoral mambrane for over half of its length (Fig. 10f)..... .....**Molossidae** (p. 166)

— Ears not noticeably thick and fleshy, not conjoined (at least in Vietnamese species). Tail completely (for more than $^3/_4$) enclosed within interfemoral membrane or protrudes from its upper surface.....**8**

8 Tail always longer than $^1/_2$ of body length, extends to the posterior margin of interfemoral membrane (sometimes projects several mm, beyond it; Fig. 10e), tail vertebrae flex ventrally .....**Vespertilionidae** (p. 108)

— Tail shorter than $^1/_2$ of body length, protrudes dorsally from the interfemoral membrane near its mid-point (Fig. 10b) and continues along its upper surface, tail vertebrae flex dorsally ..... **Emballonuridae** (p. 68)

Cranial characters

1 Cheek teeth simple, molars without a W-shaped ridge pattern. Postorbital processes well developed, long and relatively thick. Tympanic bullae not ossified, only a narrow tympanic ring is present ..... **Pteropodidae** (p. 52)

— Cheek teeth with transverse ridges, making W-like structure (sometimes obscure). Postorbital processes usually lacking, if present, thick and short, or very thin, easily damaged in collection specimens. Tympanic bullae almost completely ossified **2**

2 Premaxillae with developed palatal and reduced nasal branches, connected with maxillae only below nasal opening or absent (may be broken off in collection specimens). Upper incisors detached from upper canines, never sharply pointed, minute or absent **3**

— Premaxillae with well-developed nasal branches and variously reduced palatal branches, connected with maxillae also or only lateral to the nasal opening. Upper incisors well developed (at least one pair), more or less sharply pointed, usually adjacent to ipsilateral upper canines **5**

3 Premaxillae entirely cartilaginous, usually absent in collection specimens; no upper incisors (Fig. 34). Upper canine with one main and two supplementary (anterior and internal) cusps. Small upper premolar present and displaced inwards from toothrow, sagittal crest well-developed ..... **Megadermatidae** (p. 72)

— Premaxillae ossified, with upper incisors (sometimes minute), however, may be broken off in collection specimens. Upper canine with no supplementary, otherwise sagittal crest poorly developed. Small upper premolar, if present, lies within or displaced outwards from toothrow **4**

4 Two poorly developed upper incisors. More or less developed rostral inflations are present behind nasal opening **5**

— Four well-developed upper incisors conjoined into one row. Rostral part of skull with prominent concavity behind nasal opening, surrounded by ridge-like outgrowths of the frontal bone ..... **Nycteridae***

5 Rostral inflations relatively low. Lateral branches of premaxillae usually in contact with maxillae. Only two premolars (five cheek teeth) in each side of lower jaw. Posterior margin of palate lies at the level of posterior upper molars (Fig. 35) ..... **Rhinonycteridae** (p. 75)

— Rostral inflations commonly well developed and bulbous. Lateral branches of premaxillae usually not in contact with maxillae (this feature could be seen only on a well-cleared skull). Second small lower premolar (p_3) commonly present, however, as a rule, not functional and extruded

from toothrow (six cheek teeth in each side of lower jaw). Posterior margin of palate reaches only the level of second upper molars (Fig. 37) .... **Rhinolophidae** (p. 92)

6 Postorbital processes well-developed, long and thin. Premaxillae sutured to maxillae (Fig. 33) ..... **Emballonuridae** (p. 68)

— Postorbital processes absent. Premaxillae in adults (with one exception) completely fused with maxillae **7**

7 Contralateral premaxillae fused both under and over nasal opening and sutured to maxillae ..... **Craseonycteridae***

— Contralateral premaxillae not fused or not in contact at all, in adults completely fused with maxillae **8**

8 Premaxillae in contact or divided by narrow interspace (Fig. 49). Posterior margin of palate lies at the level of posterior borders of last upper molars, or slightly behind ..... **Molossidae** (p. 166)

— Premaxillae not in contact, palate widely emarginated anteriorly (Fig. 39). Posterior margin of palate extends distinctly behind the level of last upper molars ..... **Vespertilionidae** (p. 108)

Comments

The family Nycteridae, represented by the species *Nycteris tragata* is widely distributed throughout peninsular Malaysia, penetrating into Indochina (Myanmar and Thailand). Thus we cannot completely exclude the possibility of finding it elsewhere in previously unsurveyed primary forests.

The single known species of Craseonycteridae, *Craseonycteris thonglongai*, was until recently regarded as an endemic of western Thailand (Hill, Smith, 1981). However, this species was subsequently found in Myanmar (Bates et al., 2001), beyond its previously known range. Thus, it may prove that hog-nosed bats have a wider distribution in limestone areas of Indochina, than previously thought, possibly including Vietnam.

SUBORDER MEGACHIROPTERA DOBSON, 1875

TAXONOMICAL REMARKS. This is a monotypic suborder, which is sometimes being given the status of a separate order.

FAMILY PTEROPODIDAE GRAY, 1821

COMMON NAMES. Họ dơi quạ; Old World fruit bats; Крылановые.

GENERAL CHARACTERISTICS. Representatives of this family exhibit a large number of shared-primitive anatomical traits, characteristic of non-volant mammals, with the exception of direct adaptations for flight and perching on or beneath vertical substrate using hind legs. Unlike the remainder Chiroptera, these bats rely exclusively (or in one case — predominantly) on vision and scent while foraging and, as a rule, do not use echolocation. A number of peculiarities (such as dentition and digestive system) show strong adaptations towards frugivory and/or nectarivory.

DIAGNOSIS. The eyes are relatively large. Neck usually long and conspicuous. External ear simple, its margin forming a complete more or less even ring around the external auditory meatus. The face is of various shape (from short to long or dog-like), with no supplementary structures behind or around the nostrils. Tail short, eventually absent externally, only rudimentary vertabrae remaining in the skeleton. When present, it usually extends beyond the edge of the interfemoral membrane. Interfemoral membrane poorly developed, usually as a rather narrow line along the medial sides of hind limbs, sometimes obscure. Calcar short, its base attached to the distal part of tibia (not to ankle as in microchiropteran bats). Terminal phalanx of second digit possessing a well-developed claw (with one exception for Vietnam).

Skull with well-developed postorbital processes (in *Pteropus* they form a complete ring with the zygoma), small tympanic bones forming merely a tympanic ring and peculiar molars with reduced tribosphenic crown pattern. Teeth rather loosely positioned within toothrow.

DISTRIBUTION. Widely distributed throughout the Old World tropics, eventually reaching subtropical areas.

NATURAL HISTORY. Using fruit, nectar and pollen (more rarely — flowers and leaves) for food, these bats may be found in a variety of primary and disturbed habitats. Unlike *Tupaia* and primates, which usually consume the entire soft contents of fruit, leaving only the covers and seeds, fruit bats consume mostly fruit juices, leaving characteristic squashed pieces of fruit under their feeding perches. Such squashed fruit are often piled under such perches, manifesting the presence of pteropodid bats. Most of pteropodids normally

use tree canopies for roosting (sometimes quite exposed), however, a number of cave-dwelling species are present. Adult females give birth to one infant once or twice a year.

TAXONOMICAL REMARKS. A very distinctive taxon referred to a separate suborder (or even an order) **Megachiroptera**.

Key to the species of Vietnamese Pteropodidae

External characters

1 Second digit of the wing lacks a claw (claw present only on thumb), tail relatively long, ca. equal to hind foot length ..... *Eonycteris spelaea* (p. 64)

— Claws present on both thumb and second digit of the wing. Tail usually shorter than hind foot or obscure **2**

2 Forearm length more than 120 mm (in adult individuals) **3**

— Forearm less than 100 mm **5**

3 Ears moderate in length, bluntly rounded. Forearm length less than 150 mm ..... *Pteropus hypomelanus* (p. 57)

— Ears relatively long, more or less pointed. Forearm commonly longer than 150 mm (always longer than 140) **4**

4 Forearm 145–160 mm ..... *Pteropus lylei* (p. 56)

— Forearm 170–210 mm ..... *Pteropus vampyrus* (p. 57)

5 External tail extremely short or absent (5 mm or less) **6**

— Tail present, commonly longer than 10 mm (occasionally may be rudimentary in some *Cynopterus*) **9**

6 Muzzle narrow and elongate, slightly curved downwards. Tongue very long and slender, papillae on its distal part elongated, forming a brush-like structure. Wing membrane attached to the dorsal side of foot, over the gap between third and forth finger. Forearm length commonly less than 50 mm **7**

— Muzzle not especially narrow or elongate, not curved downwards. Tongue of moderate length, without brush on distal part. Wing membrane attached to the outer side of foot or to outmost digit. Forearm commonly longer than 50 mm **8**

7 Forearm longer than 44 mm. Continuation of internarial groove on the upper lip obliterated ..... *Macroglossus sobrinus* (p. 65)

— Forearm less than 44 mm. Distinct internarial groove noticeably extending across the upper lip ..... *Macroglossus minimus* (p. 66)

8 Muzzle very short and broad; distance between eye and nostril less than that between eye and ear (auditory meatus). Ears without any white margins. Interfemoral membrane visible, not entirely concealed by fur .... *Megaerops niphanae* (p. 63)

— Muzzle moderate; distance between eye and nostril equal to that between eye and ear. Ears with thin white margins. Hind limbs are covered with dense and long fur, rudimentary interfemoral membrane entirely concealed under it ..... *Sphaerias blanfordi* (p. 62)

9 Muzzle short and relatively broad. Ears with conspicuous white margins. Forearm usually less than 75 mm **10**

— Muzzle moderate in length and breadth. Ears without any white margins. Forearm not less than 75 mm ..... *Rousettus* spp. (p. 58)

10 Body weight (in adults) more than 35 g. Forearm commonly less than 67 mm ..... *Cynopterus sphinx* (p. 60)

— Body weight less than 35 g. Forearm commonly more than 66 mm..... ..... *Cynopterus brachyotis* (p. 61)

Cranial characters

1 Condylobasal length of skull not less than 56 mm **2**

— Condylobasal length of skull less than 40 mm..... **4**

2 Top of coronoid process rounded. Inner cusp on first and second upper molars divided into antero-lingual and posterio-lingual cusps..... ..... *Pteropus hypomelanus* (p. 57)

— Top of coronoid process subangular. Only one inner (lingual) cusp present on each of first and second upper molars **3**

3 Greatest length of skull more than 70 mm. Width of posterior palatal emargination ca. $^{2}/_{3}$ of palate width between posterior molars..... ..... *Pteropus vampyrus* (p. 57)

— Greatest length of skull less than 70 mm. Width of posterior palatal emargination ca. $^{1}/_{2}$ of palate width between posterior molars..... ..... *Pteropus lylei* (p. 56)

4 Only one pair of lower incisors ..... *Megaerops niphanae* (p. 63)

— Two pairs of lower incisors..... **5**

5 Five upper and six lower cheek teeth in each side. Occipital region of skull curved downwards: virtual line, traced (in lateral view) through the alveoli of upper cheek teeth, continues above the occipital process **6**

— Four upper and five lower cheek teeth in each side. Occipital region of skull not displaced downwards: line, traced through the alveoli of upper cheek teeth, continues beneath or through the occipital process **10**

6 Greatest length of skull less than 30 mm. Its facial part slender and long: coronoid height of lower jaw ca. $^1/_3$ of its length. Cheek teeth much reduced **7**

— Greatest length of skull more than 30 mm. Its facial part moderate: coronoid height of lower jaw not less than $^2/_5$ of its length. Cheek teeth not reduced **8**

7 Upper toothrow ($C–M^2$) commonly longer than 9 mm. Anterior extremity of mandible projecting forward beyond the incisors, forming a definite subangular chin .....*Macroglossus sobrinus* (p. 65)

— $C–M^2$ commonly shorter than 9 mm (maximum 9,2). Anterior extremity of mandible slopes forward, not forming a definite chin..... .....*Macroglossus minimus* (p. 66)

8 Upper incisors small, peg-like. Visible gap present between first and second lower premolars, longer than the crown length of the first premolar ....*Eonycteris spelaea* (p. 64)

— Upper incisors conical in shape. No definite gap between first and second lower cheek teeth.....**9**

9 Last lower molars elliptical, their length ranges from 1,5 to 2 times their width..... *Rousettus leschenaulti* (p. 59)

— Last lower molars subcircular, their length and width are subequal .... *Rousettus amplexicaudatus* (p. 59)

10 Upper toothrow ($C–M^1$) less than 9 mm. Upper incisors situated in a bow-like row. Upper canine with distinctive antero-median groove. No foramen at the base of postorbital process..... *Sphaerias blanfordi* (p. 62)

— $C–M^1$ usually over 9 mm. Upper incisors forming a straight transverse row. Upper canine with no antero-median groove. Large foramen present at the base of postorbital process.....**11**

11 Condylobasal length more than 28 mm. $C–M^1$ longer than 10 mm .... *Cynopterus sphinx* (p. 60)

— Condylobasal length usually less than 28 mm (maximum ca. 29). $C–M^1$ usually less than 10 mm (maximum 10.7)....*Cynopterus brachyotis* (p. 61)

Genus *Pteropus* Erxleben, 1777

GENERAL CHARACTERISTICS. Largest of all Indochinese Chiroptera: weight up to 1 kg, forearm up to 220 mm.

DIAGNOSIS. Dental formula: $I^2/_2$ $C^1/_1$ $P^3/_3$ $M^2/_3$ ×2 = 34. Anterior upper premolar reduced, eventually absent. Outer lower incisor ca. 10 times smaller than the inner one. Premaxillae not fused (in contact). Postorbital process in contact with zygoma, completely enclosing the orbit. Muzzle long and characteristically doglike. Second digit always with a well developed claw. External tail absent.

DISTRIBUTION. Throughout the islands of the Indian Ocean and Western Pacific and also on mainland in the Indomalayan Region and coastal Australia. Distribution in Vietnam is sporadic.

ECOLOGICAL REMARKS. When present these large bats are usually quite conspicuous forming huge exposed colonies in tree canopy. Diet consists of various soft fruit. All members of the genus are listed in CITES Appendix II.

TAXONOMICAL REMARKS. A very complex genus; taxonomical status of many named forms is contradictory, and diagnostic characters for many of them are not clear. Ca. 57 species currently recognized (Koopman, 1994), three of which occur in Vietnam.

Pteropus lylei K. Andersen, 1908

COMMON NAMES. Dơi ngựa Thái Lan; Lyle's flying fox; Летучая лисица Лиля.

MATERIAL STUDIED. Two skins, one skull and one live specimen from Cambodia.

IDENTIFICATION. A large pteropodid (weight ca. 390–480 g.; forearm ca. 145–160 mm; CBL ca. 57.3 mm). Ears black, distinctly pointed, relatively long, when laid forward they reach the midpoint of the eye. Legs, wings and tip of nose also black. Fur short, up to 14 mm long on mantle. Pelage over most of the body is dark brown, sprinkled with black on underparts and sometimes slightly tipped with silver on back. Mantle, neck, throat, crown and interocular space are ochraceous, while muzzle and skin around eyes are black, making an impression of black «spectacles» in most individuals. Skull with relatively thin postorbital processes, wide and bulbous braincase almost lacking sagittal crest. Width of posterior palatal emargination ca. $^2/_3$ of palatal width at the level of posterior molars. Coronoid process somewhat turned backwards, with angular top.

Amongst Vietnamese bats this species is quite similar to *P. hypomelanus*, from which it differs by somewhat larger size, bicuspid upper molars, shape of coronoid process, pointed ear pinna and, probably, by lighter coloration of mantle.

DISTRIBUTION AND COLLECTING SITES. Distribution restricted to lowlands of south Thailand, Cambodia and likely south Vietnam (Corbet, Hill, 1992). Reported from Vietnam (Ho Chi Minh City) by Huynh et al. (1994).

COMMENTS ON NATURAL HISTORY. Huge colonies are formed in tree canopy, sometimes inside large and heavily populated human settlements areas (V. A. Matveev, pers. comm.). Natural history poorly known.

Pteropus vampyrus (Linnaeus, 1758)

COMMON NAMES. Dơi ngựa lớn; Giant flying fox; Гигантская летучая лисица, Калонг.

MATERIAL STUDIED. One specimen from unknown locality (extralimital to Vietnam).

IDENTIFICATION. A very large fruit bat, one of the largest bats in the World (weight ca. 1 kg.; forearm ca. 179–220 mm; CBL ca. 84 mm). In general characters similar to previous species. Fur dense and soft; its coloration in the Indochinese subspecies *P. v. malaccensis* is mainly black or blackish-brown, conspicuously sprinkled with grayish-white or cinnamon. Chin and lower jaw dark-brown or blackish, throat dark chestnut with blackish tinge. Mantle and neck ochraceous, crown chestnut-brown (Andersen, 1912). Skull with large postorbital processes and relatively narrow braincase. Dentition robust. Sagittal crest of moderate height, but conspicuous, connected with well-developed lambdoid crests. Width of posterior palatal emargination $^1/_2$ palatal width at the level of posterior molars, or less. Lower jaw with relatively massive chin. Coronoid process somewhat turned backward, with angular top.

From the other two *Pteropus* species, inhabiting the region, *P. vampyrus* is well distinguished by conspicuously larger size.

DISTRIBUTION AND COLLECTING SITES. Malayan and Sunda species, inhabiting southern parts of Burma, most of Indochina, Malacca, Great and Lesser Sunda, Andaman and Philippine islands (Corbet, Hill, 1992). In Vietnam it was found in Hue and on islands off the southern coast of the country, including Phu Quoc and Con Dao (Kuznetsov, An', 1992; Huynh et al., 1994).

COMMENTS ON NATURAL HISTORY. Canopy-dweller, living in colonies which usually exceed 100 individuals. Feeds on flowers and fruit, and may cause damage to selected orchard cultures (Lekagul, McNeely, 1977; Medway, 1978; Bates, Harrison, 1997).

Pteropus hypomelanus Temminck, 1853

COMMON NAMES. Dơi ngựa bé; Lesser flying fox; Летучая лисица малая.

MATERIAL STUDIED. One specimen from unknown locality, supposedly originating from Vietnam.

IDENTIFICATION. A large fruit bat (weight ca. 425–450 g, forearm ca. 121–148 mm, in Vietnam, probably, ca. 135, CBL ca. 59–64 mm; after Bates, Harrison, 1997). Ears relatively short, broadly blunt on tips, black. Pelage short and smooth. Pelage coloration in the southern Indochinese subspecies *P. h. condorensis* is dark grayish-brown on back and rump and hazel-brown on ventral part. Mantle blackish chestnut with lighter hair roots, head chestnut-brown, lighter on crown (Andersen, 1912). Other geographic races are highly variable in color, and may also have a light-colored mantle, similar to that of *P. lylei*. Skull with relatively wide and rounded braincase, possessing a low, but well-developed sagittal crest. Width of posterior palatal emargination ca. $^{2}/_{3}$ of palatal width at the level of posterior molars. Coronoid process more erected than in *P. lylei*, with rounded top. Upper molars with distinct anterolingual cusp (Ingle, Heaney, 1992).

This species differs from the similar *P. lylei* by smaller size, rounded coronoid process, tricuspid upper molars, short and blunt ears, and, at least specimens from Con Dao — by dark mantle and neck.

DISTRIBUTION AND COLLECTING SITES. Malayan and Sunda species, commonly inhabiting small islands. Distributed from the Maldives through coastal territories of Burma, Thailand, Great Sunda to the Philippine Islands (Corbet, Hill, 1992). In Vietnam known from Con Dao (Con Son) Island, from which a distinct subspecies was described (see: Anderson, 1912), and also from some other islands off the southern shores of the country (Kuznetsov, An', 1992). From the mainland it was reported from Hue (Central Vietnam) by Huynh et al. (1994).

COMMENTS ON NATURAL HISTORY. Feeds on various fruit, mainly *Mangifera* and *Pouteria*; lives in colonies up to several hundred individuals, preferring disturbed forests, orchards and coconut plantations (Mickleburgh et al., 1992; Bates, Harrison, 1997). Mainly confined to islands and coastal areas (Medway, 1978).

Genus *Rousettus* Gray, 1821

GENERAL CHARACTERISTICS. Medium-sized fruit bats (forearm ca. 65–102 mm). The only members of Pteropodidae known to use echolocation (its mechanism though is different from that of Microchiroptera).

DIAGNOSIS. Dental formula: $I^{2}/_{2}\ C^{1}/_{1}\ P^{3}/_{3}\ M^{2}/_{3} \times 2 = 34$. First upper premolar reduced (not exceeding upper incisors in diameter). Length of the first upper molar less than combined length of second and third. Premaxillae in contact or fused in front. Short tail always present.

DISTRIBUTION AND ECOLOGICAL REMARKS. Most of Africa eastward to the Philippines, New Guinea and Solomon Islands. Sporadically throughout

Indochina. These bats are usually associated with caves, where they may form large colonies, often mixed with other bat species.

TAXONOMICAL REMARKS. Seven species currently recognized (Koopman, 1994), two of which have been reported in Vietnam.

Rousettus leschenaulti (Desmarest, 1820)

COMMON NAMES. Dơi ngựa nâu; Fulvous fruit bat; Летучая собака Лешенолта.

MATERIAL STUDIED. One immature specimen from unknown locality in Vietnam; one adult female from Nepal.

IDENTIFICATION. A medium-sized fruit bat (weight ca. 60–108 g, forearm 75–86 mm, CBL ca. 33–38 mm.) Muzzle of moderate length and width, in general appearance somewhat similar to that of *Eonycteris*. External tail present and well-visible. Pelage soft and not very thick, pale grayish brown on the upperparts, somewhat more gray on belly. Muzzle and ears poorly pigmented, pale pinkish-gray. Membranes gray. Dentition relatively massive, posterior lower molar elliptical in proportions.

This bat differs from *Eonycteris spelaea* by distinctly larger size and presence of claw on the second digit; from the very similar *R. amplexicaudatus* — by somewhat larger average size and more robust dentition, especially posterior molars.

DISTRIBUTION AND COLLECTING SITES. Indo-Malayan species, whose distribution extends from Pakistan and Sri Lanka to south China, Vietnam and Sunda Islands. Huynh et al. (1994) reported this species in Vietnam from Bac Thai, Hoa Binh, Ha Tay, Ninh Binh, Quang Nam — Da Nang, Lam Dong and Khanh Hoa provinces and from Hanoi City. However, the slight difference between this species and *R. amplexicaudetus* precludes from unambiguously allocating most of the Indochinese records of *Rousettus* to *R. leschenaulti*.

COMMENTS ON NATURAL HISTORY. Feeds on fruit and flowers; lives in small groups or colonies up to several thousand individuals, mainly in caves and deserted buildings (Bates, Harrison, 1997).

Rousettus amplexicaudatus (E. Geoffroy, 1810)

COMMON NAMES. Dơi ngựa đuôi lớn; Geoffroy's fruit bat; Летучая собака Жоффруа.

MATERIAL STUDIED. Five specimens, provisionally referred to this species, from Ha Shon Binh Province , collected by Dr. G. V. Kuznetsov.

IDENTIFICATION. A medium-sized fruit bat (weight ca. 54–75 g, forearm 77–87 mm, CBL ca. 34–39 mm), in all features essentially similar to *R. leschenaulti*, from which it differs by relatively smaller skull and tibia,

howevwr, having similar forearm length. Ears seem to be somewhat narrower. Posterior lower molar small and rounded in shape.

Specimens in ZMMU collection from North Vietnam where initially identified as *R. leschenaulti*. However, they all have skulls distinctly smaller, than those of adult *R, leschenaulti* from Nepal, and better corresponding to the measurements of *R. amplexicaudatus*, as provided by Andersen (1912). Four of these specimens possess characteristic subcircular posterior lower molars.

DISTRIBUTION AND COLLECTING SITES. Sunda-Malayan species, inhabiting Indochina, Malacca peninsula, Great and Lesser Sunda Islands and the Philippines (Corbet, Hill, 1992). Not reported from Vietnam by these authors, however, included in Vietnamese fauna by Cao Van Shung (1976), who reported it for Quang Binh Province, and also by Hayes and Howard (1998) for Nghe An Province. Specimens in ZMMU collection, provisionally referred to this species, came from Ha Shon Binh Province, Northern Vietnam.

COMMENTS ON NATURAL HISTORY. Cave-dweller (Cao Van Shung, 1976), essentially similar in biology to *R. leschenaulti* (Medway, 1978).

Genus *Cynopterus* F. Cuvier, 1824

GENERAL CHARACTERISTICS. Small to medium-sized bats (forearm ca. 60–75 mm) with short muzzle (Fig. 9a), characteristic white margins of ears and pale colored wing digits.

DIAGNOSIS. Dental formula: $I^2/_2\ C^1/_1\ P^3/_3\ M^1/_2 \times 2 = 30$. Upper canine with a secondary cusp at its inner edge. Rostrum shortened (its length not exceeding lacrymal width). Postorbital foramen (through the base of the postorbital process) large. Premaxillae in simple contact anteriorly. Wing membrane attaches to the first toe. A short tail is always present.

DISTRIBUTION AND ECOLOGICAL REMARKS. Indomalayan Region eastward to the Solomon Islands and northeastern Australia. Essentially common throughout agricultural and heavily disturbed landscapes throughout Indochina.

TAXONOMICAL REMARKS. Five species currently recognized (Koopman, 1994), two of which occur in Vietnam.

Cynopterus sphinx (Vahl, 1797)

COMMON NAMES. Dơi chó Ấn; Common short-nosed fruit bat; Индийский короткомордый крылан.

MATERIAL STUDIED. Seventy six specimens from Ma Da (Dong Nai Province), Lo Go Xa Mat (Tay Ninh Province), Cat Loc (Lam Dong Province), Vu Quang (Ha Tinh Province), Ke Bang (Quang Binh Province) and Hanoi City; two additional specimens from Cambodia.

IDENTIFICATION. A small to medium-sized fruit bat (weight ca. 35–57 g; forearm ca. 65–75 mm; CBL ca. 28.4–33.3 mm; Table 4) of characteristic appearance. External tail is always present, slightly protrudes from the interfemoral membrane, which is narrow, but well-pronounced. The pelage is short, grayish (in juveniles) to russet-brown (in adults) with grayer belly and darker (grayish or even greenish) mantle, especially in adult males. The ears, muzzle and membranes are brown, well-pigmented, however, the margins of ears (especially the anterior one) are distinctly whitish. Limbs and especially digits are not pigmented, whitish, particularly conspicuous when the bat is at resting posture.

Differs from all similar-sized bats from other genera in coloration pattern, from *Megaerops* also in size, from *Sphaerias* also in longer tail and better development of the interfemoral membrane. From *C. brachyotis* it is distinguished predominantly by larger size and heavier weight.

DISTRIBUTION AND COLLECTING SITES. Indomalayan species, distributed throughout the entire region, from east Pakistan to south-east China and Sulawesi. Widely distributed and very common throughout Indochina, including Vietnam, particularly common in disturbed and agricultural landscapes.

COMMENTS ON NATURAL HISTORY. Mainly tree canopy-dweller, using as day shelters undersides of palm leafs, crevices in banyans and some other trees, palm fruit clusters (Bhat, Kunz, 1995; Bates Harrison, 1997). Occasionally uses buildings and caves (V. A. Matveev, pers. comm.). Usually it forms small groups of 4–25 individuals; adult males may live solitarily. This species feeds on various types of fruit, including bananas, lichies, mango, guavas, figs, fruit of the *Phoenix* palm, etc. Diet preferences change from season to season. These bats inhabit variably disturbed and forested areas, often occurring nearby settlements and even in large cities, e. g. Ho Chi Minh. Numerous pieces of squashed fruit were found in the building of Tropical Center, dropped from the perches short-nosed fruit bats. Foraging activity was observed after dusk. Simultaneous presence of both subadults and pregnant females in the beginning of autumn in Vu Quang Reserve indicate bimodal polyoestrus reproductive cycles of this species.

Cynopterus brachyotis (Mueller, 1838)

COMMON NAMES. Dơi chó tai ngắn; Lesser short-nosed fruit bat; Короткомордый крылан малайский.

MATERIAL STUDIED. Thirty three specimens from Ma Da (Dong Nai Province), Lo Go Xa Mat (Tay Ninh Province) and Da Lat Plateau (Lam Dong Province); eight additional specimens from Cambodia.

IDENTIFICATION. A small-sized fruit bat (weight ca. 21–35 g; forearm ca. 59–68 mm; CBL ca. 26–28,8 mm; Table 3), essentially resembling *C. sphinx*.

External characters and coloration pattern most similar to the latter species, differing predominantly in smaller size and weight, and slightly in a somewhat shorter muzzle.

DISTRIBUTION AND COLLECTING SITES. Indomalayan species, widely distributed from southern India and Sri Lanka to southern China, Vietnam, Sunda and Philippine Islands. Reported from Lao Cai, Hoa Binh, Quang Tri, Quang Nam — Da Nang, Kon Tum, Dac Lac, Lam Dong, Khanh Hoa, Ninh Thuan and Tay Ninh Provinces (Huynh et al., 1994), however, part of these records, especially from Northern Vietnam, could be referred to misidentified immature *C. sphinx*. We found this species only in the southern part of the country, in Tay Ninh, Lam Dong and Dong Nai Provinces. Supposedly widely distributed throughout the Southern Vietnam in the same habitats, as previous species, and sometimes may be more abundant.

COMMENTS ON NATURAL HISTORY. Natural history essentially similar to that of *C. sphinx*. Roosts in canopies, palm leafs, also in buildings and twilight zone of caves (Medway, 1978). Diet consists, wild figs, bananas and some other fruit, pollen, and also of small amount of insects (probably consumed together with fruit; ibid.) In Southern Vietnam this bat inhabits the same habitats as *C. sphinx*; in Ma Da and Tay Ninh it seems to be more abundant than the latter.

Genus *Sphaerias* Miller, 1906

GENERAL CHARACTERISTICS. A monotypic genus (see comments under species below) of predominantly extralimital distribution, not characteristic for Indochina.

DIAGNOSIS. Dental formula: $I^2/_2\ C^1/_1\ P^3/_3\ M^1/_2 \times 2 = 30$. Postorbital foramen absent (see diagnosis of *Cynopterus*). Cheek teeth conspicuously narrowed.

Sphaerias blanfordi (Thomas, 1891)

COMMON NAMES. Dơi quả núi; Himalayan fruit bat; Крылан Бланфорда.

MATERIAL STUDIED. Two specimens: from Tam Dao (collected by Dr. G. V. Kuznetsov) and from Vu Quang.

IDENTIFICATION. A small fruit bat (weight ca. 25 g.; forearm ca. 51–60 mm; CBL ca. 26 mm), externally somewhat resembling a small *Cynopterus*. The calcar and external tail are absent, the interfemoral membrane is greatly reduced and, together with the tibiae, covered with dense wooly hair, similar to *Macroglossus*. Pelage is dense and long, dark brownish-gray above and below. Membranes, ears and muzzle are dark blackish gray; wing digits and margins of ears are whitish.

White ear margins and digits give this species certain similarity with *Cynopterus*, from which it is distinguished by darker color, absent tail and hairy uropatagium. From *Macroglossus* it differs by considerably shorter muzzle and also darker color.

DISTRIBUTION AND COLLECTING SITES. Extralimitally it is known from mountain massifs of northern India, Bhutan, south-west Tibet, Myanmar, northern Thailand and south-western China (Bates, Harrison, 1997). Tam Dao and Vu Quang are the only two known localities of *S. blanfordi* in Vietnam, however, it may be found elsewhere along the Truong Son mountain range.

COMMENTS ON NATURAL HISTORY. Little is known on the biology of this bat in Vietnam. Supposedly it is confined to montane primary forest formations. The specimen from Tam Dao was captured in mist net set across a stream (G. V. Kuznetsov, pers. comm.), the specimen from Vu Quang was captured in a mist net set at canopy level in a montane *Fokienia* forest at 1300 m a. s. l.

Genus *Megaerops* Peters, 1865

GENERAL CHARACTERISTICS. Small fruit bats (forearm ca. 45–60 mm) with shortened muzzle and light pelage coloration.

DIAGNOSIS. Skull on Fig. 31. Dental formula: $I^2/_1\ C^1/_1\ P^3/_3\ M^1/_2 \times 2 = 28$. Upper canine with reduced or absent secondary cusp. Premaxillae in simple contact anteriorly. Postorbital foramen large. External tail virtually absent.

DISTRIBUTION. Northeastern India to the Philippines; sporadically distributed throughout Indochina.

TAXONOMICAL REMARKS. Four species currently recognized, one of which occurs in Vietnam.

Megaerops niphanae Yenburta, Felten, 1983

COMMON NAMES. Dơi quả cụt đuôi; Tail-less fruit bat; Крылан бесхвостый.

MATERIAL STUDIED. One female from Ma Da (Dong Nai Province), five specimens from Vu Quang, Ha Tinh Province; three additional specimens from Phnom Bokor, Cambodia.

IDENTIFICATION. A small fruit bat (weight ca. 22–28 g; forearm ca. 52–63 mm; CBL ca. 25.6–26.7 mm; Table 5). External tail is absent, the interfemoral membrane is reduced, not as hairy as in *Sphaerias*. Pelage is fine and soft, light brownish gray above and below. Membranes are light gray; limbs, ears and muzzle are pale brownish pink, not well pigmented.

From *M. ecaudatus*, several times mistakenly reported from Indochina (Kock, 2000), this species differs by rostrum shape, which is trapezoidal in

lateral view (not parallel-sided). From both *Cynopterus* and *Sphaerias*, *Megaerops may* be distinguished by paler and more grayish coloration and absence of white margins on ears, from the former — also by absence of tail and lacking any rufous tinges on mantle and back, from the latter — by less conspicuous fur on interfemoral membrane.

DISTRIBUTION AND COLLECTING SITES. Indochinese species of middle elevations. Distributed from east India to Vietnam. In Vietnam it was reported (as *M. ecaudatus*) from Vinh Phu, Kon Tum, Lam Dong and Ninh Thuan Provinces (Huynh et al., 1994). Also found in Ma Da (Dong Nai Province) and Vu Quang (Ha Tinh Province).

COMMENTS ON NATURAL HISTORY. Natural history poorly investigated. Probably, a tree-dweller, inhabiting mainly forested areas and cultivated land with orchards. Seems to be distributed throughout a wider spectrum of altitudes, than *Cynopterus*; found in Thailand at elevations from 138 to 2092 m a. s. l (Bates, Harrison, 1997), in Vu Quang — from ca. 100 to 1300 m a. s. l. (Kuznetsov et al., 2001). Animals maintained in captivity in Vu Quang did not show any strong preference to any of the fruit offered.

Genus *Eonycteris* Dobson, 1873

GENERAL CHARACTERISTICS. Medium-sized fruit bats, somewhat similar in general appearance and roosting habits to *Rousettus*.

DIAGNOSIS. Dental formula: $I^2/_2\ C^1/_1\ P^3/_3\ M^2/_3 \times 2 = 34$ (last lower premolar occasionally lost). Premaxillae separated anteriorly. Teeth sharp, not especially reduced. Second digit of wing without a claw. Tail relatively long.

DISTRIBUTION. Range extending through most of the Indomalayan Region. Sporadically distributed in Indochina.

TAXONOMICAL REMARKS. Two species recognized, one of which occurs in Vietnam.

Eonycteris spelaea (Dobson, 1871)

COMMON NAMES. Dơi quả lưỡi dài; Dawn bat; Пещерный крылан.

MATERIAL STUDIED. Three specimens from Vu Quang, six individuals from Ke Bang.

IDENTIFICATION. A medium-sized fruit bat (weight ca. 49–55 g; forearm ca. 66–78 mm; CBL ca. 31.7–36.3 mm; Table 6), externally somewhat resembling a small *Rousettus*. There is no claw on the second digit of the wing. The muzzle is somewhat elongated, however not as in *Macroglossus*; the tail is rather long for a fruit bat (ca. 15–25 mm). Wing membranes attach close to the spine of the back, leaving a short stripe of dorsal pelage. The fur is short and soft, not extending to the tibiae; its color uniform dark grayish brown

above and somewhat paler below. Membranes, ears and muzzle uniform dark brown, without white markings.

This bat readily differs from the remainder Vietnamese Pteropodidae by the absence of the claw on the second digit of the wing.

DISTRIBUTION AND COLLECTING SITES. This species is distributed throughout the Indomalayan region from south-western India to Vietnam, Sunda and Philippine Islands (Corbet, Hill, 1992). In Vietnam it was reported from Lai Chau, Quang Binh, Quang Trai and Lam Dong Provinces (Huynh et al., 1994). We found this species in Vu Quang (Ha Tinh Province) and Ke Bang (Quang Binh Province).

COMMENTS ON NATURAL HISTORY. This is an almost exclusively cave-dwelling species (e. g., Hill, Harrison, 1997), however, not showing specific preference for surrounding habitats. Probably it could be found throughout Vietnam in areas with available roosting sites. Its resemblance with macroglossine bats suggests nectarivorous habits, however observations of captive individuals and feces of bats, captured in the wild, suggest that fruit and, possibly, other plant material are also included in the natural diet.

Bimodal polyestry type of reproduction was supposed for Vietnam, with peaks of births in spring and in the end of summer (Kuznetsov et al., 2001). Lactating females were captured in September (in Vu Quang) and in April (in Ke Bang). However, individuals, captured in Ke Bang, gave births in captivity in winter time (from November to February).

Genus *Macroglossus* F. Cuvier, 1824

GENERAL CHARACTERISTICS. Small nectarivorous bats (forearm ca. 36–51 mm) with characteristically elongated muzzle (Fig. 9b).

DIAGNOSIS. Skull on Fig. 32. Dental formula: $I^2/_2\ C^1/_1\ P^3/_3\ M^2/_3 \times 2 = 34$. Upper incisors minute; premolars and molars reduced in size. Premaxillae solidly fused together. Rostrum long, slender and conspicuously deflected against braincase (Fig. 9b). External tail virtually absent.

DISTRIBUTION. Throughout Indochina to Solomon Islands and northern Australia.

NATURAL HISTORY. Specialized nectar-feeders inhabiting both primary and variously disturbed habitats.

TAXONOMICAL REMARKS. Two species currently recognized, both of which have been reported from Vietnam.

Macroglossus sobrinus K. Andersen, 1911

COMMON NAMES. Dơi ăn mật hoa; Hill long-tongued bat; Большой длинноязыкий крылан.

MATERIAL STUDIED. Four specimens from Vu Quang, Ha Tinh Province, ten specimens from Ke Bang, Quang Binh Province, and two specimens from Cat Tien National Park, Lam Dong Province (collected by A. V. Zinoviev).

IDENTIFICATION. A small fruit bat (weight ca. 18–28 g; forearm ca. 45–50 mm; CBL ca. 26.6–27.0 mm; Table 7) of characteristic appearance. The muzzle is greatly elongated and slender, conspicuously curved downward; tongue very long with a papillary brush at the end. External tail is virtually absent; interfemoral membrane greatly reduced, covered, together with tibiae, with dense fur. The pelage is dense and wooly, uniformly light brown above, somewhat paler below. Membranes, ears and muzzle are also light brown.

Distinguishable from *M. minimus* by larger size and shape of the internarial groove, which does not extend to the upper lip.

DISTRIBUTION AND COLLECTING SITES. Malayan species, distributed from the north-easternmost India and Myanmar to Vietnam and western Great Sunda islands. Reported from Vietnam by Huynh et al. (1994) as *M. minimus sobrinus* for Lam Dong, Vung Tau and Ho Chi Minh City. We found this species in Vu Quang, Ke Bang and Cat Loc (Ha Tinh, Quang Binh and Lam Dong Provinces, respectively). Supposedly, it inhabits forested landscapes (both primary and secondary) troughout South and Central Vietnam.

COMMENTS ON NATURAL HISTORY. The habits of this bat in Vietnam are poorly known. Extralimitally it is reported to be confined to forests of various types, feeding on nectar and pollen of banana trees and roosting in the canopy of palms and banana trees (e. g., Lekagul, McNeeley, 1977; Nowak, 1994, Bates, Harrison, 1997). Two specimens were captured in Cat Loc (Cat Tien National Park) in a mist net set on a hill covered with cashew plantations. In Vu Quang it was observed flying around flowering *Macaranga* trees (one specimen captured with mobile traps) and captured in mist nets set within vegetation (predominantly *Musa*, *Macaranga* and *Ficus*). In Ke Bang these bats were captured over a stream or near flowering bananas, in secondary plant formations. In all these sites droppings of this species indicated the presence of pollen. Reproduction cycle is, probably, bimodal polyestry; pregnant females were captured in August (in Vu Quang) and in March — April (in Ke Bang).

Macroglossus minimus (E. Geoffroy, 1810)

COMMON NAMES. Lesser long-tongued bat; Малый длинноязыкий крылан.

MATERIAL STUDIED. No material from Vietnam was seen; two specimens from the Philippine Islands were examined.

DIAGNOSIS. A small fruit bat (weight ca. 15–20 g; forearm ca. 41–45 mm; CBL ca. 24.5–26.5 mm). In general appearance it greatly resembles *M. so-*

brinus, from which it differs, besides smaller size, by internarial groove, distinctly extending to upper lip, and less prominent chin on the anterior extremity of mandible.

DISTRIBUTION AND COLLECTING SITES. This species is distributed through southern Indochina, on the Moluccas, Java and Philippines. However, records from Cambodia (Hendrichsen et al., 2001) and, probably, Vietnam are sometimes thought to be misidentifications of *M. sobrinus*. Nevertheless, both *Macroglossus* species were reported from Pu Mat Nature Reserve (Nghe An Province; Hayes, Howard, 1998).

COMMENTS ON NATURAL HISTORY. Natural history supposedly similar to that of *M. sobrinus*. This species mainly confined to coastal areas, predominantly mangroves (Medway, 1978), however, see above.

SUBORDER MICROCHIROPTERA DOBSON, 1875

GENERAL CHARACTERISTICS. Comprised by forms with adaptations towards using echolocation. Southeast Asian forms exclusively animalivorous (predominantly insectivorous).

DIAGNOSIS. The bats comprising this suborder are very diverse in external appearance and morphology, however possess a number of common traits, distinguishing them from the Megachiroptera, many of which reflect the use of vocal echolocation as the primary mean of orientation in flight. The eyes are small to medium-sized, evidently reduced in some forms. The ears are rather complex with well-pronounced tragi and/or antitragal lobes, their size varying from rather small to ca. forearm length. There are often peculiar coriaceous structures on the muzzle facilitating the emission of echolocation signals through the nostrils.

The tympanic bones are enlarged, their medial portions extending towards the basioccipital bone to enclose the enlarged and complex cochleae and forming the characteristic inflated tympanic bullae. Consequently the basioccipital bone is narrowed leaving room for the enlarged auditory apparatus.

The interfemoral membrane is variously developed, however, never rudimentary. Distal phalanges on the second digit of the wing are variously reduced, but always lacking a claw.

DISTRIBUTION. Distributed nearly worldwide, the range resembling that of the whole order, except for few remote oceanic islands.

TAXONOMICAL REMARKS. Taxonomical composition and even rank of this suborder is very complex and constantly undergoing revision. At present 16 families are recognized, which are being grouped into 4–7 superfamilies. Koopman (1985) suggested dividing this suborder into two infraorders, based on the degree of fusion of the premaxilla and the maxilla.

The infraorder **Yinochiroptera** Koopman, 1985 contains forms with premaxillae not fused with maxillaries. It is divided into 2–3 superfamilies, two of them occurring in Vietnam:

1. **Emballonuroidea** (palatal branch of premaxilla reduced, nasal branch well developed, last cervical vertebra not fused with first thoracic, no accessory structures present on muzzle, no false pubic nipples), represented in Vietnam by the family Emballonuridae.

2. **Rhinolophoidea** (nasal branch of premaxilla absent, palatal branch well-developed or absent, last cervical vertebra at least partly fused with the first thoracic, more or less complex coriaceous structures are present on muzzle, false pubic nipples usually present in females), represented in Vietnam by the families Megadermatidae, Rhinonycteridae and Rhinolophidae.

The infraorder **Yangochiroptera** Koopman, 1985 comprises forms with premaxillae completely fused with maxillaries, with no sutures remaining in adults. It is divided into 4–6 superfamilies, of which two (as accepted here) occur in Vietnam:

3. **Vespertilionoidea** (tail completely or almost completely enclosed within interfemoral membrane, palate extending posteriorly far beyond third upper molars, basioccipital pits shallow when present), represented in Vietnam by the family Vespertilionidae.

4. **Molossoidea** (tail conspicuously protruding from interfemoral membrane, palate almost never extending beyond third upper molars, basioccipital pits very deep), represented in Vietnam by the family Molossidae.

FAMILY EMBALLONURIDAE GERVAIS, 1856

COMMON NAMES. Họ dơi bao, Sheath-tailed bats; Футлярохвостые.

GENERAL CHARACTERISTICS. Small to medium-sized bats (forearm 35–95 mm), considered amongst the most primitive Microchiroptera in postcranial morphology.

DIAGNOSIS. Premaxillae with developed nasal and reduced palatal branch, separated from each other and not completely fused with maxillae. Postorbital process well-developed, in Indochinese species — long and slender (may be broken off in collection specimens). Ears with a well-developed tragus and poorly pronounced antitragal lobes. No supplementary outgrowths on muzzle. Uropatagium and calcar well-developed. Tail protruding from the upper surface of the interfemoral membrane about at its midpoint, its tip usually does not reach the edge of the interfemoral membrane; tail vertebrae flex dorsally. Second digit of wing lacking phalanges. Third digit of wing extremely elongated, when at resting posture its phalanges are flexed dorsally in a Z-like manner.

DISTRIBUTION. Widely distributed throughout the Old World and New World tropics, also on many islands of the Pacific and the Caribbean and in Australia.

NATURAL HISTORY. In Indochina the representatives of this family are specialized high-altitude aerial foragers with characteristically strong echolocation signals, sometimes audible to a human ear. They may be found in various habitats, in southern Indochina particularly abundant in cities (e. g., Ho Chi Minh City) and agricultural landscapes. At rest they usually cling on to vertical surfaces, often in open situations.

TAXONOMICAL REMARKS. Includes ca. 15 genera and nearly 50 species, divided into 3 subfamilies (Koopman, 1994; Pavlinov et al., 1995), of which two genera and four species from the subfamily Taphozoinae have been hitherto reported from Vietnam.

Key to the species of Vietnamese Emballonuridae

External characters

1 Gular sac well-developed; no beard-like patch on chin and throat; wing membrane attaches to ankle **2**

— Gular sac absent; dark or rufous beard-like patch of fur often present (mainly in males) on throat, wing membrane attaches to distal portion of tibia..... **3**

2 Forearm length more than 62 mm. Radio-metacarpal wing pouch absent. Dorsal pelage blackish brown with whitish patches..... ..... *Saccolaimus saccolaimus* (p. 72)

— Forearm length less than 62 mm. Radio-metacarpal wing pouch distinctive. Dorsal pelage brown without whitish patches..... ..... *Taphozous longimanus**

3 Forearm 60–68 mm ..... *Taphozous melanopogon* (p. 70)

— Forearm 70–76 mm..... *Taphozous theobaldi* (p. 71)

Cranial characters

1 Well-developed sagittal crest highly projects posteriorly beyond the occiput. Frontal region of skull not distinctly concave. Anterior upper premolar relatively large, ca. $^1/_2$ in crown area of posterior premolar..... ..... *Saccolaimus saccolaimus* (p. 72)

— Sagittal crest poorly developed, almost not projecting beyond occiput. Frontal region of the skull deeply concave. Anterior upper premolar reduced, considerably less than $^1/_3$ of crown area of posterior premolar..... **2**

2 Condylocanine length not less than 21.9 mm; C–M^3 not less than 9.4 mm . .....*Taphozous theobaldi* (p. 71)

— Condylocanine length not more than 21.6 mm; C–M^3 less than 9.2 mm..... .....*Taphozous melanopogon* (p. 70), *Taphozous longimanus**

Genus *Taphozous* E. Geoffroy, 1818

DIAGNOSIS. Skull on Fig. 33. Dental formula: $I^1/_2$ $C^1/_1$ $P^2/_2$ $M^3/_3$ ×2 = 30. P^2 reduced, considerably less than $^1/_3$ of crown area of P^4. Rostrum short, conspicuously narrowed anteriorly, its dorsal side flattened; frontal region of skull strongly concave. Ventral side of dentary concave anteriorly. Tympanic bullae incomplete medially, not connected with the basioccipital. Wing with a well-developed radio-metacarpal pouch. Gular sac absent.

DISTRIBUTION. Widely distributed throughout most of Africa, the Indomalayan Region and Australia, marginal in New Guinea. Sporadically throughout Indochina.

TAXONOMICAL REMARKS. Thirteen species are recognized, two of which have been reported from Vietnam, and an additional one (*T. longimanus*) was found in adjacent territories of Cambodia.

Taphozous melanopogon Temminck, 1841

COMMON NAMES. Dơi bao đuôi nâu đen; Black-bearded tomb bat; Чернобородый мешкокрыл.

MATERIAL STUDIED. Twelve specimens from Ho Chi Minh City.

IDENTIFICATION. A medium-sized emballonurid bat (weight ca. 23–30 g; forearm ca. 64–66 [60–68] mm; CCL ca. 19.5–21.5 mm; Table 9). Gular sac lacking in both sexes. Usually a patch of dark hair is present on the chin and throat, more prominent in males. Wing membrane attaches to the distal portion of tibia. Pelage brown to almost black dorsally, somewhat paler on underparts, with pale hair bases. Muzzle and ears blackish-brown. Membranes dark gray, with somewhat depigmented posterior margins; limbs poorly pigmented.

This species differs from similar-sized *T. longimanus* by the absence of gular sac and pattern of wing membrane attachment; from *T. theobaldi* by distinctly shorter forearm and furred basal parts of membranes; from *Chaerephon* (and also other molossids) — by characteristic emballonurid tail and interfemoral membrane shape.

DISTRIBUTION AND COLLECTING SITES. Trans Indomalayan species with distribution ranging from eastern Pakistan to Vietnam, Malacca, Sunda and Philippine islands (Corbet, Hill, 1992). In Vietnam it was reported from Quang Ninh, Nam Ha, Nghe An and Quang Nam — Da Nang Provinces (Huynh et al., 1994), also from Con Dao (Con Son) and Cat Ba Islands

(Kuznetsov, An', 1992). We found this species to be numerous in Ho Chi Minh City (this survey).

COMMENTS ON NATURAL HISTORY. Cave or house-dwellers, forming colonies from tens to several thousand individuals (Bates, Harrison, 1997). Fast-flying aerial insectivores. In Ho Chi Minh City small colonies of these bats inhabit crevices in buildings and attics. Newborns and pregnant females were found in the beginning of May.

Taphozous theobaldi Dobson, 1872

COMMON NAMES. Dơi bao đuôi đen; Theobald's tomb bat; Мешкокрыл Теобальда.

MATERIAL STUDIED. Two specimens from Cambodia; no material from Vietnam was studied.

IDENTIFICATION. A large emballonurid species (weight ca. 31 g.; forearm ca. 71–76 mm; CCL ca. 22–23.5 mm), on the whole resembling *T. melanopogon*, except for distinctly larger size. No gular sac, but glandular area present on throat in both sexes, covered in males by a patch of brown hairs. Wing membrane attached to the tibia. Pelage brown-brown dorsally and brown ventrally, with pale hair bases. Membranes uniform dark brown.

This species may be easily distinguished from all similar Indochinese bats by distinctly larger size. From *T. melanopogon* it furthermore differs by absence of fur on membranes, and from *Saccolaimus* — by coloration and the absence of a gular sac.

DISTRIBUTION AND COLLECTING SITES. Indo-Malayan species, distributed in central India, Indochina (from E. Burma to Vietnam), also on Java, Borneo and Sulawesi islands. Within Vietnam reported from Hoa Binh and Quang Nam — Da Nang provinces (Huynh et al., 1994). Animals, attributable to this species, were visually observed by us in Ho Chi Minh City.

COMMENTS ON NATURAL HISTORY. Fast-flying aerial insectivore. Natural history essentially similar to that of *T. melanopogon*.

Genus *Saccolaimus* Temminck, 1838

GENERAL CHARACTERISTICS. Bats somewhat resembling Taphozous in appearance, but with coloration pattern (black with small white spots).

DIAGNOSIS. Dental formula: $I^1/_2\ C^1/_1\ P^2/_2\ M^3/_3 \times 2 = 30$. P^2 relatively large, ca. $^1/_2$ in crown area of P^4. Rostrum short, conspicuously narrowed anteriorly, its dorsal side flattened; frontal reign of skull strongly concave. Ventral side of dentary convex anteriorly. Tympanic bullae extending medially and joined with the basioccipital. Radio-metacarpal pouch on the wing reduced. Well developed gular sac (Fig. 11).

DISTRIBUTION AND ECOLOGICAL REMARKS. From tropical Africa through most of the Indomalayan Region (mostly southern parts of the mainland) to the Solomon Islands and Australia. Predominantly confined to forested or poorly forested lowlands.

TAXONOMICAL REMARKS. Five species recognized, one of them recently found in Vietnam.

Saccolaimus saccolaimus (Temminck, 1838)

COMMON NAMES. Pouch-bearing tomb bat; Мешкогорлый мешкокрыл.

MATERIAL STUDIED. Four specimens from Tay Ninh Province.

IDENTIFICATION. A medium to large emballonurid (weight ca. 31–37 g; forearm ca. 66–69 mm; CCL ca. 21.7–24.6 mm; Table 8). Gular sac present in both sexes, more prominent in males. Radio-metacarpal pouch on the wing is almost absent. Wing membrane attached to the ankle. Pelage dark brown or black dorsally, commonly marbled with white patches, and uniform dark brown on the belly. Muzzle, ears, limbs and membranes are dark gray, wing membranes commonly edged with white.

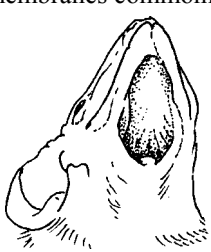

Fig. 11. The throat of a male *Saccolaimus saccolaimus* showing gular sac.

From other Vietnamese emballonurids *Saccolaimus* may be distinguished by coloration and absence of the radio-metacarpal pouch; from all molossids — by the typical emballonurid tail and interfemoral membrane.

DISTRIBUTION AND COLLECTING SITES. An Australasian species, distributed from India and Sri Lanka to Great Sunda and Solomon Islands, New Guinea and north-eastern Australia (Bates, Harrison, 1997). In Vietnam it was found in Lo Go Xa Mat (Tay Ninh Province), near the Cambodian border (our study).

COMMENTS ON NATURAL HISTORY. Fast-flying aerial foragers, hunting on various flying insects (including termites and beetles) at the height of 100 meters and more (Bates, Harrison, 1997). Roosts are found mainly in hollow trees, more rarely — in rock crevices (Lekagul, McNeely, 1977). In Tay Ninh solitary males were observed in October demonstrating lek behavior, perching on individual trees and emitting social calls.

FAMILY MEGADERMATIDAE ALLEN, 1864

COMMON NAMES. Họ dơi ma, Old World false vampires; Лжевампиры.

GENERAL CHARACTERISTICS. A morphologically distinctive family containing specialized gleaners with variously pronounced preference for insec-

tivory and carnivory (feeding on small vertebrates); the only bats in Vietnam known to hunt on small vertebrates.

DIAGNOSIS. Premaxilla greatly reduced, its palatal branch lost and nasal branch nearly obliterated, cartilaginous, not retained in collection specimens, consequently, upper incisors are absent. Nasals also somewhat reduced. Ears exceptionally large, about the length of head&body, their inner margins fused at bases; tragus long, slender, and unevenly bifid (Fig. 9d). Wings large and broad; uropatagium also broad. External tail absent.

DISTRIBUTION. Widely distributed from tropical Africa throughout the Indomalayan Region southward to tropical Australia, in various habitats.

NATURAL HISTORY. Ground and foliage gleaners and essentially perch–hunters, detecting their prey by passive location. Some species are specialized carnivores, feeding on small vertebrates.

TAXONOMICAL REMARKS. Taxonomical position somewhat uncertain; either assigned to or excluded from Rhinolophoidea. Four currently recognized genera, one of which occurs in Vietnam.

Key to the species of Vietnamese Megadermatidae

1 Vertical noseleaf relatively short, ca. 6–7 mm, approximately equal in height to horizontal noseleaf, with rounded apex and distinctly convex sides; its median ridge with wide heart-shaped base. Inner margins of ears fused at about 15% or less of their height. Lacrymal width of skull greater than distance from orbit to canine. Coronoid process distinctly higher than lower canine, with steep posterior margin.....*Megaderma spasma* (p. 74)

— Vertical noseleaf relatively long, ca. 10 mm, conspicuously higher than horizontal noseleaf, with straight top and slightly convex sides; its median ridge with relatively narrow rounded base. Inner margins of ears fused at about 30% of their height. Lacrymal width of skull less than distance from orbit to canine. Coronoid process equal or less in height than lower canine, with shallow posterior margin..... *Megaderma lyra* (p. 75)

Genus *Megaderma* E. Geoffroy, 1810

GENERAL CHARACTERISTICS. General appearance (Fig. 9d, Fig. 10c) and natural history patterns typical of the family.

DIAGNOSIS. Skull on Fig. 34. Dental formula: $I^0/_2\ C^1/_1\ P^2/_2\ M^3/_3 \times 2 = 28$. Upper canines strong, projecting forward beyond the anterior part of skull, with large supplementary posterior cusp, and small supplementary cusp on the anterior part of cingulum. Small upper premolar much reduced and intruded, entirely hidden behind the crown of large premolar. Mesostyles of upper molars reduced. Skull with almost entirely reduced premaxillae and greatly reduced nasals. Sagittal crest well-developed.

DISTRIBUTION. From the Indian subcontinent through southeastern Asia to the Philippines and Moluccas; occurring throughout Indochina, but never abundant.

TAXONOMICAL REMARKS. Contains two species, usually referred to separate subgenera (*M. lyra* belonging to the subgenus *Lyroderma* Peters, 1872), both occurring in Vietnam.

Megaderma spasma (Linnaeus, 1758)

COMMON NAMES. Dơi ma nam; Lesser false vampire; Малайский лжевампир.

MATERIAL STUDIED. Three specimens from Ma Da (Dong Nai Province; collected by M. V. Kalyakin, A. N. Kuznetsov), one specimen from Lo Go Xa Mat (Tai Ninh Province); also five specimens from the Philippine Islands.

IDENTIFICATION. Small to medium-sized megadermatid (weight ca. 13–28 g; forearm ca. 52–62 mm; CCL ca. 21.9–23.6 mm) of characteristic appearance. Ears very large (ca. $^1/_2$ of head&body length or longer) with a long bifid tragus.

The presence of a well-developed tragus readily distinguishes this bat from all other leafnosed bat families. Essentially similar to *M. lyra*, differing in smaller size, shorter and more convex-sided vertical noseleaf, ears being joined along ca. 30–50% of their length.

DISTRIBUTION AND COLLECTING SITES. Widely distributed throughout the Indomalayan region, from western India to Vietnam, Philippine and Sunda Islands (Corbet, Hill, 1992). In Vietnam it was reported mainly from the southern part of the country: Dac Lac, Tay Ninh and Dong Nai Provinces, Con Dao Island (Huynh et al., 1994), Thom and Phu Quoc Islands (Kuznetsov, Pham Trong An', 1992). We found this species in Lo Go Xa Mat, Tay Ninh Province (this survey) and also in Ma Da (Dong Nai Province, specimens collected by A. Kuznetsov and M. Kalyakin). This species seems to be common and widespread in lowland woodlands of southern Vietnam.

COMMENTS ON NATURAL HISTORY. Specialized gleaner, probably — perch-hunter, taking its prey from the ground, tree branches and trunks and also in the air by slow but very maneuverable hawking, or by short spurts from the perch. Roosts are usually found in hollow trees, local houses and caves (Bates, Harrison, 1997; V. A. Matveev, pers. comm.; our survey). Diet reported to be composed of variable large flying and flightless insects, but not of vertebrates (Phillips, 1980). However, a captive individual in Tay Ninh was maintained for several weeks on a diet of insects, and lizards (*Hemidactylus frenatus*, *Mabuya sp.*), thus showing a tendency towards carnivory.

Megaderma lyra E. Geoffroy, 1810

COMMON NAMES. Dơi ma bắc; Great false vampire; Индийский лжевампир.

MATERIAL STUDIED. No material from Vietnam was seen; one specimen from India was examined.

IDENTIFICATION. A medium to large megadermatid (weight ca. 35–60 g; forearm ca. 56–72 mm; CCL ca. 24.5–28 mm), in general shape somewhat similar to *Hipposideros* (even in resting posture). Body short and solidly built. Ears large, only slightly less than half of head and body length. Ear pinna broadly rounded on top. Tragus ca. $^1/_3$ of ear length, characteristically bifid, with its main (posterior) tip pointed and slightly lopsided anteriorly. Wings large and wide, dark brownish gray in color. The noseleaf is erect, ca. 10 mm in length, with straight top and relatively low convex sides, in comparison with previous species. Its base rounded, simple in shape. Pelage mouse-gray on dorsum and somewhat lighter on underparts, tipped with white on throat and belly; juveniles are darker than adults.

The presence of a well-developed tragus readily distinguishes this bat from all other leafnosed bat families. Essentially similar to *M. spasma*, differing in larger size, longer and more convex-sided vertical noseleaf, ears being joined along ca. 10–15% of their length.

DISTRIBUTION AND COLLECTING SITES. Trans Indomalayan species. Widely distributed from Pakistan to Thailand and eastern China. In Vietnam it was reported from Hoa Binh Province (Huyinh et al, 1994) and from Phong Nha — Ke Bang National Park (Timmins et al., 1999; Kruskop, 2000b, visual observations only).

COMMENTS ON NATURAL HISTORY. Specialized ground-gleaner, probably, perch-hunter, taking prey from ground, water surface, walls and ceilings of caves. Feeds on large insects and arachnids and also on small vertebrates, including other bats (Advani, 1981; Csorba et al., 1999). Cave-dweller; in Ke Bang a group of 3 individuals was observed inside a cave, inhabited also by three *Hipposideros* species.

FAMILY RHINONYCTERIDAE GRAY, 1847

COMMON NAMES. Họ dơi mũi, Old World leafnosed bats; False horseshoe bats, Листоносы, Подковогубы, Ложные подковоносы.

GENERAL CHARACTERISTICS. Includes bats of variable appearance but with strong adaptations towards perching on ceilings of roosts and «walking» below them using only hind feet. Complex noseleaf structures facilitate the emission of narrow-band constant frequency echolocation signals, enabling

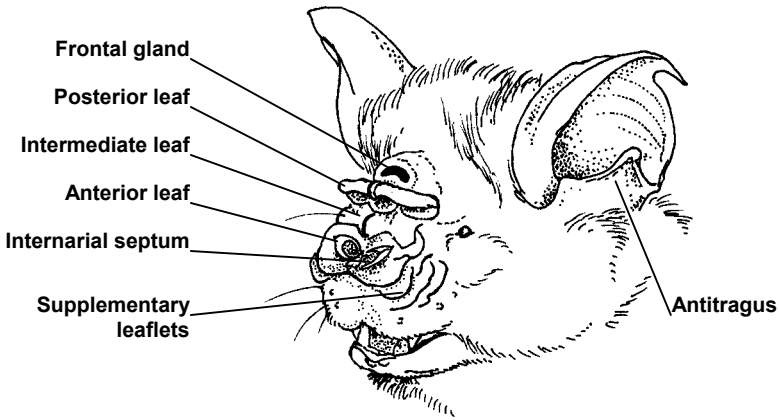

Fig. 12. Head of *Hipposideros larvatus*, demonstrating rhinonycterid noseleaf structure.

to detect fluttering prey against background clutter, using Doppler-shifted echoes.

DIAGNOSIS. Skull with slender premaxillae sutured only to the palate with no nasal branch (eventually broken off in collection specimens) and pronounced nasal inflations. One pair of reduced upper incisors and one pair of small lower premolars present. Noseleaf of complex structure (Fig. 12), with a well-developed anterior leaf (horseshoe) and variously shaped (and developed) intermediate and posterior leafs, the former with no connecting process and the latter with no well-defined dorsal process (lancet). Ear with no tragus and variously developed (usually prominent) antitragal lobe. Tail vertebrae flex dorsally. Toes with two phalanges each.

DISTRIBUTION. Widely distributed in the Old World tropics from western Africa eastward through the Indomalayan Region to Australia, penetrating into subtropical areas of Africa and Asia. Very common and sometimes abundant throughout Indochina.

NATURAL HISTORY. Specialized insectivores, mostly aerial foragers, however, a number of gleaners are known; perches are often usecd to detect and consume prey. Quite common in various primary and disturbed landscapes, especially abundant in areas with caves, where they may form huge colonies, often mixed with other bat species. They require more or less exposed roosting sites (e. g., large tree hollows, caves, attics, etc.), where they could hang freely from the ceiling.

TAXONOMICAL REMARKS. Formerly referred to as Hipposideridae Lydekker, 1891, however, Rhinonycteridae is the senior synonym (McKenna, Bell, 1997). Sometimes regarded as a subfamily within Rhinolophidae (e. g., Koopman, 1994).

Key to the genera of Vietnamese Rhinonycteridae

External characters

1 Tail rudimentary, not longer than 2 mm.....**2**

— External tail well-developed **3**

2 Anterior noseleaf deeply emarginated anteriorly, supplemented by two forwardly projecting lappets. Interfemoral membrane much reduced, narrow .....*Coelops* (p. 90)

— Anterior noseleaf horseshoe-shaped, surmounted by a rounded leaf with radial striations. Interfemoral membrane wide, supported by very long calcar bones.....*Paracoelops* (p. 91)

3 Posterior leaf divided into three lobes, amongst which the median is tallest and pointed. Tail definitely projects beyond the posterior margin of interfemoral membrane .....*Aselliscus* (p. 77)

— Posterior leaf has shape of a transverse skin ridge, without distinct lobes. Tail not projected beyond posterior margin of membrane .... *Hipposideros* (p. 78)

Cranial characters[*]

1 Upper canine with two supplementary cusps (Fig. 15b) **2**

— Upper canine without distinct supplementary cusps ... *Hipposideros* (p. 78)

2 Posterior supplementary cusp of upper canine small, more than twice lower than large premolar. Posterior palatal emargination deep, at the level of anterior border of last upper molars. Small lower premolar subcircular in occlusial view.....*Aselliscus* (p. 77)

— Posterior supplementary cusp of upper canine large, equal in height to large premolar. Posterior palatal emargination shallow, almost at the level of posterior border of last upper molars. Small lower premolar elliptical in occlusial view.....*Coelops* (p. 90)

Genus *Aselliscus* Tate, 1941

GENERAL CHARACTERISTICS. Small leafnosed bats with tricuspid posterior noseleaf. Probably the most primitive representatives of their tribe.

DIAGNOSIS. Dental formula: $I^1/_2\ C^1/_1\ P^2/_2\ M^3/_3 \times 2 = 30$. Premaxillae diverging anteriorly. Rostrum greatly inflated. Sagittal crest poorly developed. Edge of posterior noseleaf with three pointed processes. Tail well-developed, extends beyond the posterior margin of interfemoral membrane.

[*] *Paracoelops* was omitted from this identification key, due to lack of reliable data on its cranial characters.

DISTRIBUTION. Two isolated areas: Burma and southern China south to Malaya and the Moluccas.

NATURAL HISTORY. Virtually unknown.

TAXONOMICAL REMARKS. Two species recognized, one found in Vietnam.

Aselliscus stoliezkanus (Dobson, 1871)

COMMON NAMES. Dơi mũi ba lá; Stoliezka's trident bat; Южноазиатский трезубценос.

MATERIAL STUDIED. One damaged specimen from Hanoi collected by Dr. Dao Van Tien. Description below follows Medway (1978), Lekagul and McNeely (1977), Nowak (1991).

IDENTIFICATION. A small leafnosed bat (weight ca. 6–8 g; forearm ca. 39–44 mm, CCL 26–26.5 mm), somewhat resembling a small *Hipposideros*. Anterior noseleaf narrow, with two pairs of supplementary leaflets. Posterior noseleaf terminating with three moderate and rather bluntly pointed processes. Intermediate noseleaf distinctly narrower than anterior and posterior noseleafs. Frontal sac is present in both sexes. Tail slightly extends beyond interfemoral membrane. Ears broad with acutely pointed tips.

Readily distinguishable from the remainder Vietnamese leafnosed bats by its characteristic tricuspid posterior leaf.

DISTRIBUTION AND COLLECTING SITES. Distributed sporadically from Myanmar and southern China south to Malaya. A rare bat, with limited distribution in North and Central Vietnam. Reported by Huynh et al. (1994) from Lao Cai, Lai Chau, Lang Son, Hoa Binh, Ninh Binh and Quang Binh provinces, found in Phong Na by D. Hendrichsen (Timmins et al., 1999). Specimen in ZMMU collection probably came from Hanoi (according to label data).

COMMENTS ON NATURAL HISTORY. Natural history poorly known. Probably, a cave-dweller (Bates et al., 2000).

Genus *Hipposideros* Gray, 1831

GENERAL CHARACTERISTICS. Small to fairly large bats (forearm ca. 32–115 mm) with morphological characteristics typical of the family.

DIAGNOSIS. Skull on Fig. 35. Dental formula: $I^1/_2\ C^1/_1\ P^2/_2\ M^3/_3 \times 2 = 30$. Upper canine simple, without supplementary cusps (Fig. 15a). Sagittal crest not developed in the immediate postorbital region. Extra phalanges of foot completely fused (i. e., all toes with two phalanges). Posterior noseleaf lacking any well-defined dorsal process. Tail well-developed, not extending beyond interfemoral membrane.

DISTRIBUTION. Widely distributed throughout the Old World tropics, south to Australia. Very common throughout Indochina.

NATURAL HISTORY. Particularly common in limestone areas and places with artificial caverns, however, some may use human buildings or hollow trees as shelter. Several species form large colonies in caves, often together with other bats. Most species are aerial insectivores, few perch-hunters and, probably, gleaners are also known.

TAXONOMICAL REMARKS. A very diverse and taxonomically complex genus with at least 55 recognized species. In recent works this diversity is commonly reflected in a system of species groups all incorporated within the single extant nominative subgenus (the only other used subgeneric name *Pseudorhinolophus* Schlosser, 1887 includes only fossil forms). However, a more or less hierarchical structure of morphoecological diversity may be traced within *Hipposideros*, and a number of morphologically distinct and commonly accepted species groups correspond to previously proposed genus-group names (e. g., those of Peters, 1871 and Tate, 1941). Hence we find it appropriate to tentatively reestablish some of these names in subgeneric rank, until a more reliable phylogenetically substantiated hierarchical structure is proposed. For Indochinese (and South Asian) fauna four such subgenera may be suggested.

Subgenus *Gloionycteris* Gray, 1866 (type species *Rhinolophus armiger* Hodgson) — very large slow-flying aerial foragers with

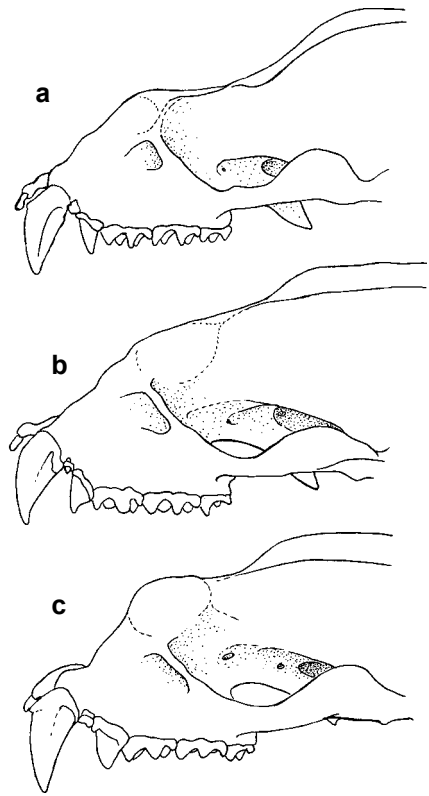

Fig. 13. Rostral profiles of *Hipposideros*: a) *H. lylei*; b) *H. armiger*; c) *H. diadema*

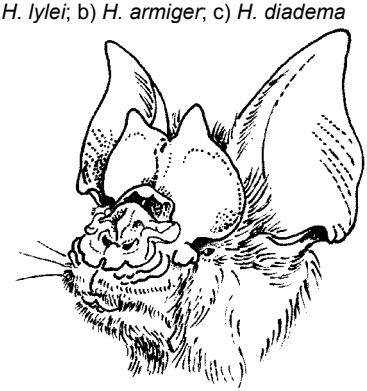

Fig. 14. Head of a male *Hipposideros lylei*, demonstrating facial «shield».

robust skulls and dentition, highly complex noseleaf structure and 3–4 pairs supplementary leaflets of horseshoe. This subgenus corresponds to the following species groups: «*armiger*», «*pratti*» and «*diadema*».

Subgenus *Chrysonycteris* Gray, 1866 (type species *H. fulvus* Gray) — small-sized slow-flying aerial foragers of cluttered spaces and perch-hunters with slender skulls and weak dentition, enlarged rounded ears and relatively simple noseleaf structure with one or no supplementary leaflets. This subgenus corresponds to the «*bicolor*» species group, excluding *H. galeritus* and its extralimital allies.

Subgenus *Hipposideros* Gray 1931 (type species *Vespertilio speoris* Schneider) — medium-sized fast-flying aerial foragers with robust skulls and dentition, moderately complex noseleaf structure with 2–3 supplementary leaflets. This subgenus corresponds to the «*speoris*» species group.

Subgenus *Ptychorhina* Peters, 1871 (Type species *Rhinolophus caffer* Sundevall 1846) — small-sized fast-flying aerial foragers with slender skulls and weak dentition, small pointed ears and moderately complex noseleaf structure with 2–3 supplementary leaflets. This subgenus corresponds to the «*galeritus*» species group of Tate (1941), i. e., including *H. galeritus*, *H. cervinus* and their extralimital allies.

Key to Vietnamese *Hipposideros*

1 Larger: FA longer than 65 mm, condylocanine length usually more than 21.5 mm **2**

— Smaller: FA less than 65 mm, condylocanine length less than 21.5 mm ... **6**

2 Buffy white or yellowish spot present on each shoulder. No fleshy outgrowths behind posterior leaf or even protuberances before eyes. Posterior leaf conspicuously wider than intermediate, and strongly curved forward..... *H. diadema* (p. 89)

— No buffy spots on shoulders. Fleshy outgrowths present behind posterior leaf, at least in the form of small protuberances before the eyes. Posterior leaf not distinctly wider than intermediate (commonly narrower), not strongly curved forward **3**

3 Condylocanine length less than 25 mm, upper toothrow 10.2 mm or less. Outgrowths behind the posterior leaf less conspicuous, represented only by protuberances between noseleaf and eyes. Posterior noseleaf equal in width to intermediate leaf or slightly larger ..... *H. turpis* (p. 87)

— Condylocanine length more than 25 mm, upper toothrow more than 10 mm. Outgrowths behind the posterior leaf conspicuous, especially in males. Posterior noseleaf narrower than intermediate leaf..... **4**

4 Outgrowths behind noseleafs small, equal in height to posterior noseleaf, not forming erected bilobed structure. Pelage coloration dark brown to black. Upper profile of rostrum slopes gradually from anterior end of sagittal crest, forming an acute angle with palatinum (Fig. 13b)..... ..... *H. armiger* (p. 86)

— Outgrowths distinctly higher, than posterior noseleaf, forming in males erect bilobed «shield» (Fig. 14). Pelage coloration pale brown. Upper profile of rostrum almost parallel to palatinum, abruptly concave at the anterior part of sagittal crest (Fig. 13a).....**5**

5 Larger: forearm not less than 81 mm. Only medial emargination present on the anterior noseleaf ..... *H. pratti* (p. 88)

— Smaller: forearm not more than 81 mm. One medial and two lateral emarginations on the anterior noseleaf..... *H. lylei* (p. 89)

6 Anterior noseleaf with two or three pairs of supplementary leaflets. Ears relatively short, not reaching the end of muzzle when laid forward.....**7**

— Anterior noseleaf with one pair or no supplementary leaflets. Ears large, extending to or beyond the end of muzzle when laid forward.....**8**

7 Anterior noseleaf with three pairs of supplementary leaflets. Larger: forearm more than 51 mm, condylocanine length not less than 20 mm ....*H. larvatus* (p. 85)

— Anterior noseleaf with two pairs of supplementary leaflets. Smaller: forearm not longer than 51 mm, condylocanine length less than 16 mm ....*H. galeritus* (p. 84)

8 Larger: FA over 46 mm, CCL over 16.5 mm. Internarial septum expanded into a disk-like structure. Anterior noseleaf with a medial emargination and pair of supplementary leaflets..... *H. rotalis*

— Smaller: FA less than 44 mm, CCL less than 16 mm. Internarial septum not forming a disk-like structure. Anterior noseleaf lacking a medial emargination and supplementary leaflets **9**

9 Smaller: forearm less than 37 mm (usually less than 35 mm); upper toothrow shorter than 5.3 mm .....*H. cineraceus* (p. 83)

— Larger: forearm more than 35 mm (usually more than 38 mm); upper toothrow more than 5.5 mm **10**

10 Ears shorter than 20 mm, when laid forward reaching, but not extending beyond the end of muzzle.....*H. ater* (p. 83)

— Ears longer (over 20 mm) when laid forward extending beyond muzzle..... ..... *H. pomona* (p. 82)

Hipposideros pomona K. Andersen, 1918

COMMON NAMES. Dơi mũi xinh; Andersen's leafnosed bat; Большеухий листонос.

MATERIAL STUDIED. Three specimens from unknown locality (collected by Dr. Dao Van Tien), two specimens from Phuong Vong Isle (collected by Dr. G. V. Kuznetsov), two specimens from Vu Quang (Ha Tinh Province) and six specimens from Ke Bang (Quang Binh Province); three additional specimens from Cambodia were examined.

IDENTIFICATION. A small leafnosed bat (weight ca. 5.5–8 g; forearm ca. 39–43 mm; CCL ca. 14.2–14.6 mm; Bates, Harrison, 1997; Table 10). Ears relatively enlarged, with broadly rounded tips. Noseleaf structure relatively simple. Anterior leaf without supplementary lateral leaflets and lacks a median emargination. Intermediate leaf also simple, with slightly convex upper border. Posterior leaf slightly wider than anterior and median leafs; it is slightly convex and possesses three poorly developed septa, dividing it into four cells. The pelage is grayish or brownish above and pale white below; dorsal hairs with conspicuously pale bases and glossy silvery tips, giving the dorsal surface a smoky appearance. Muzzle and bases of ears pale, poorly pigmented; ear tips, posterior leaf and membranes dark.

Differs from *H. galeritus* by larger ears and absence of supplementary leaflets, from similar-sized *H. ater* it could be distinguished by longer ears and slender internarial septum; from *H. cineraceus* also by larger size.

Specimens from Vietnam are usually referred to the larger subspecies *H. p. gentilis* Andersen, 1918 (type locality in Myanmar).

DISTRIBUTION AND COLLECTING SITES. Distributed from easternmost India to south-eastern China and peninsular Thailand (Corbet, Hill, 1992). The older records of *H. bicolor* and *H. fulvus* from Vietnam (e. g., Huynh et al., 1994) are probably erroneous, based on misidentified *H. pomona* (see Hill et al., 1986 for status and distribution range of the former two species). Taking into account these records, *H. pomona* was reported from Son La, Hoa Binh, Ha Noi, Quang Nam — Da Nang and Lam Dong Provinces; also from several coastal islands, including Con Dao and Phu Quoc (Kuznetsov, Pham Trong An, 1992). However, part of these records, reported as *H. bicolor*, should probably be assigned to *H. ater*.

COMMENTS ON NATURAL HISTORY. Natural history poorly known; probably a perch-hunter (gleaning or aerial). Roosts in caves; in Ke Bang a colony of ca. 50 individuals inhabited a small limestone cave together with *H. armiger*, partly in mixed aggregations (Kruskop, 2000a). In northern India it was found from 462 m a. s. l. to 1631 m (Bates, Harrison, 1997).

Hipposideros cineraceus Blyth, 1853

COMMON NAMES. Dơi mũi bé; Least leafnosed bat; Малый листонос.

MATERIAL STUDIED. Five specimens from Vu Quang, two specimens from Ke Bang; one additional specimen from Cambodia.

IDENTIFICATION. A very small-sized leafnosed bat (weight ca. 3.7–4.9 g; forearm ca. 33–35.5 mm; CCL ca. 12.6–13.9 mm; Corbet, Hill 1992; Table 11). Externally this bat essentially resembles *H. pomona*, except for distinctly smaller size and shorter ears. Noseleaf structure relatively simplex and shows no principal differences from that of *H. pomona*, except that the internarial septum is inflated and bulbous. Coloration pattern also essentially similar to the latter species.

Differs from all other Vietnamese *Hipposideros* by smaller size, from *H. pomona* also by shorter ears and inflated internarial septum.

DISTRIBUTION AND COLLECTING SITES. Malayan species, distributed sporadically in northern Pakistan and India, from easternmost India to Vietnam and peninsular Thailand, on Sumatra, Kangean, Borneo and Luzon Islands (Corbet, Hill, 1992). Huynh et al. (1994) reported it from Ha Noi and Ha Nam Provinces. We found this bat in Vu Quang Nature Reserve (Kuznetsov et al., 2001), Phong Nha — Ke Bang (Kruskop, 2000b) and in Cat Tien National Park (Cat Loc, Lam Dong Province; our surveys).

COMMENTS ON NATURAL HISTORY. Natural history poorly known. Probably perch-hunter and gleaner. This species displays relatively cryptic behavior. It was mainly observed when flying within and out of the vegetation, one individual was observed perching on a low thin branch about 1.5 m from the ground. A colony of ca. 15 individuals was found in Ke Bang in a limestone cave, inhabited also by other bat species. Animals used small cavities and holes in the distant part of cave as roosts and passes, which made their capture rather difficult. Such behavior may have been a response to the presence of *Megaderma lyra*. When megaderms left the roost, *H. cineraceus* began to use open space more frequently (Kruskop, 2000a).

Hipposideros ater Templeton, 1848

COMMON NAMES. Dơi mũi tro; Dusky leafnosed bat; Сумеречный листонос.

MATERIAL STUDIED. No collection material was seen. The diagnosis below follows Bates and Harrison (1997).

IDENTIFICATION. A small leafnosed bat (weight ca. 8 g; forearm ca. 35–42 mm; CCL ca. 13–15 mm). Noseleaf structure relatively simplex and essentially similar to that of *H. cineraceus*. Coloration pattern essentially similar to *H. pomona*.

Externally similar to *H. pomona* and *H. cineraceus*, differing from the former by shorter ears and inflated internarial septum, and from the latter by larger overall size.

DISTRIBUTION AND COLLECTING SITES. Widely distributed from western India to Indochina, Malacca Peninsula, Great Sunda Islands, the Philippines and the Moluccas (Corbet, Hill, 1992). Previously reported from Thanh Hoa Prov (Huynh et al., 1994).

COMMENTS ON NATURAL HISTORY. Natural history in Vietnam not known. In the Philippines it was found from sea level to 1200 m a. s. l., mainly in forested areas. Roosts reported in caves (Heaney et al., 1998).

Hipposideros galeritus Cantor, 1846

COMMON NAMES. Dơi mũi Galê; Fawn leafnosed bat; Хохлатый листонос.

MATERIAL STUDIED. Three specimens from Vietnam: one from Lo Go Xa Mat and two from Cat Tien; four additional specimens from Cambodia.

IDENTIFICATION. A small to medium-sized leafnosed bat (weight ca. 7 g; forearm ca. 45–51 mm; CCL ca. 14.6–15.8 mm). The noseleaf structure is more complex than that of *H. pomona*. Anterior leaf without a medial emargination, but with two well developed supplementary leaflets, the proximal leaflets are expanded and fused to form one impaired structure surrounding the anterior leaf and considerably exceeding it in width. The intermediate leaf is simple, equal to or wider than posterior leaf. The latter is subdivided by septa into four cells, similar to *H. pomona*. Males possess a frontal gland behind posterior leaf. Ears triangularly pointed; antitragal lobe subangular, ca. $^1/_3$ of ear length. Pelage is thick and soft, dark to reddish brown, paler on the underparts; hairs with pale bases. Muzzle and ears variously pigmented, membranes dark.

This species differs from all small-sized leafnosed bats in the presence of characteristic antitragal lobes and two supplementary leaflets of horseshoe. From *H. larvatus* it differs in smaller overall size and shape of antitragus and noseleafs.

Another leafnosed bat of the same size, the extralimital *H. rotalis* Frncis, Kock, Habersetzer, 1999, recently described from Laos, may be easily distinguished from *H. galeritus* by anterior noseleaf with disc-like internarial septum and one pair of supplementary leaflets and by larger ears (Francis et al., 1999).

DISTRIBUTION AND COLLECTING SITES. This species has a disrupted range consisting of three areas: India and Sri Lanka; Thailand and Malaya; Java and Borneo. In Vietnam it was first recorded from Cat Tien National Park, Dong Nai Province (B. Hayes, in: Pham Nhat et al., 2001).

COMMENTS ON NATURAL HISTORY. Aerial insectivore, hunting supposedly along forest roads and trails and forest edges, predominantly in fairly open habitats. In Tay Ninh and Cat Loc these bats were observed flying along roads and above grassland, ca. 2 or 2.5 meters from the ground; flight is relatively fast and maneuverable. Reported to be a cave-dweller, living solitarily, in small aggregations of up to 25 individuals or in families consisting of a male, female and young (Bates, Harrison, 1997).

Hipposideros larvatus (Horsfield, 1823)

COMMON NAMES. Dơi mũi xám; Horsfield's leafnosed bat; Листонос Хорсфилда.

MATERIAL STUDIED. A total of 84 specimens from Con Dao and Phuong Vong Islands (collected by Dr. G. V. Kuznetsov), Ke Bang (Quang Binh Province) and Cat Loc (Lam Dong Province); also 21 specimens from Cambodia were examined.

IDENTIFICATION. A medium-sized leafnosed bat (weight ca. 12.5–17.5 g; forearm ca. 51.5–63 mm; CCL ca. 20.8–21.4 mm; Table 12). Noseleaf structure relatively complex. Anterior leaf with three supplementary leaflets, with a pronounced medial emargination. Intermediate leaf with one medial and a pair of lateral inflations. Posterior noseleaf is subdivided into four cells by three well-developed septa. Adult males possess a well-developed pale-whitish frontal gland just behind posterior noseleaf (Fig. 12). Pelage is short and soft, russet brown above, ochraceous brown below; dorsal hairs with conspicuously lighter bases, darker midparts and paler extreme tips, giving dorsal fur a glossy appearance. Immature individuals are more grayish than adults. Ears and membranes are well-pigmented, dark. Muzzle pale, anterior and posterior leafs and supplementary leaflets gray.

Differs from *H. galeritus* by larger size and larger number of supplementary leaflets. From small specimens of *H. turpis* and *H. lylei* differs in the absence of fleshy outgrowths behind posterior leaf and by the presence of the medial emargination on the anterior noseleaf.

Two separate subspecies were reported from Indochina, including Vietnam: *H. l. grandis* Allen, 1936 and *H. l. alongensis* Bourret, 1942, from the northern and southern parts, respectively (Corbet, Hill, 1992; Koopman, 1994). Both forms were reported as the largest among this species. However, the size of the specimen collected in Central Vietnam (Ke Bang) stands close to the minimal limit for the species.

DISTRIBUTION AND COLLECTING SITES. One of the most widespread and abundant rhinonycterid species in the eastern half of the Indomalayan region, from north-eastern India to Hainan Island and Malacca, also extending on Sunda Islands, probably east to Timor (Corbet, Hill, 1992). From Vietnam it

was reported sporadically throughout the territory, including most of the coastal islands (Kuznetsov, An', 1992; Huynh et al., 1994; Kuznetsov, 2000). We found this species in Ke Bang (Qung Binh Province; Kruskop, 2000b) and Cat Loc (Lam Dong Province; this study).

COMMENTS ON NATURAL HISTORY. Aerial insectivore. Usually a highly gregarious cave-dweller, also inhabiting temples and old mines. A large colony of this species, associated with *Miniopterus* spp., was observed in a cave in Cat Loc. In the same locality bats commuting to their foraging grounds were observed and captured, demonstrating relatively fast flight with low maneuverability; however, hunting behavior was not seen. Echolocation signal is of fairly low intensity, CF component at ca. 90 kHz.

Hipposideros armiger (Hodgson, 1835)

COMMON NAMES. Dơi mũi quạ; Himalayan leafnosed bat; Гималайский листонос.

MATERIAL STUDIED. Two specimens from Vu Quang and Huong Son (Ha Tinh Province), ten specimens from Ke Bang (Quang Binh Province).

IDENTIFICATION. A large leafnosed bat (weight ca. 37–51 g; forearm ca. 86–92.5 mm; CCL ca. 25.6–29.2 mm; Table 13). Ears moderate, broadly triangular. Noseleaf with four pairs of supplementary leaflets (outer pair may be greatly reduced). Anterior leaf lacking a median emargination. Intermediate leaf with a well-defined median process. Posterior leaf narrower than anterior leaf, with three septa and four cells. Frontal gland well-developed in males. As opposed to *H. pratti*, this species lacks a «shield» behind the posterior leaf, but possesses a pair of conspicuous fleshy elevations (outgrowths) above each eye. Fur dark gray-brown to black dorsally, slightly paler dark gray on underparts. Muzzle, tips of ears and membranes dark gray-brown. Skull with a large sagittal crest. Upper profile of rostrum slopes gradually from anterior end of sagittal crest (Fig. 13b).

H. armiger differs from all other *Hipposideros* of similar size by uniform dark coloration and noseleaf proportions.

DISTRIBUTION AND COLLECTING SITES. Indomalayan species, widely distributed from Nepal to Taiwan and Malacca. In Vietnam it was reported (Huynh et al., 1994) from several localities of North Vietnam, and also from Quang Nam — Da Nang and Lam Dong provinces; also found on most of the coastal islets, in both northern (Tonkin Gulf) and southern parts of Vietnam (Kuznetsov, Pham Trong An', 1992; Kuznetsov, 2000). We found this species in Vu Quang Nature Reserve (Kuznetzov et al., 2001) and in Ke Bang (Kruskop, 2000b). This species is likely to be common in limestone (and, possibly, other montane) areas elsewhere in North and Central Vietnam.

COMMENTS ON NATURAL HISTORY. Our data suggest that foraging behavior is represented by relatively slow aerial hawking over clearings, riverbeds, or along forest edges at the canopy level (Borissenko et al., 2001). Droppings of this bat always contain fragments of thick chitinous covers, and particles of large beetles and cicadids were collected under the roosting site of this species. Roosting bats have been found in caves. This species uses large cavities on the ceiling, where individuals keep a certain distance (ca. 15 cm) from each other (Kruskop, 2000a). The peak of births in Central Vietnam is probably confined to the end of April. Echolocation call in Ke Bang, referred to the given species, was relatively loud CF at 78 kHz.

Hipposideros turpis Bangs, 1901

COMMON NAMES. Dơi mũi nhỏ; Ryukyu leafnosed bat; Японский листонос.

MATERIAL STUDIED. Three specimens, tentatively referred to this species, from Cuc Phuong (collected by Dr. G. V. Kuznetsov); one specimen from unknown locality (collected by Dr. Dao Van Tien).

IDENTIFICATION. A medium to large leafnosed bat (weight ca. 32 g.; forearm ca. 67–80 mm; CCL 21.4–23.7 mm), in general appearance resembling *H. armiger*. Ears relatively large (ca. $^{2}/_{5}$ of head and body length), broadly triangular and pointed. Noseleaf with three or four pairs of supplementary leaflets. Posterior leaf almost equal in width to the anterior leaf. Frontal gland well-developed. Fur of various brown tinges, with light hair roots; belly paler than back. Ears and membranes dark gray-brown, muzzle less pigmented.

Amongst the Vietnamese leafnosed bats, this species could be confused with large specimens of *H. larvatus* or with small *H. lylei*. It differs from the former by the absence of a medial emargination on the anterior leaf, and from the latter by the poor development or absence of fleshy outgrowths behind the posterior leaf.

Another form — *pendleburyi* Chasen, 1936, somewhat larger, than the Ryukyu specimens (from the type locality of the species), was described as a separate species from peninsular Thailand. Our specimens correspond well with the diagnosis provided in Lekagul and McNeely (1977), and thus seem to be similar to the Thai form. On the other hand, there is some difference between them and nominative *H. turpis*, according to the description in Yoshiyuki (1989) and available skull images (Abe, 2000). While *H. turpis* s. str. is assumed to be a member of the *H. armiger* species group and greatly resembles the latter species, our specimens differs from *H. armiger* in several features (i. e. in the shape of the posterior leaf, more similar to that of *H. diadema* and its allies). We may therefore suppose that the Indochinese *Hipposideros* represents a species, distinct from the Ryukyu *H. turpis* which

probably must be named *H. pendleburyi*. The relationship of all these forms needs further investigation of collection material.

DISTRIBUTION AND COLLECTING SITES. The distribution area is disrupted: Ryukyu Islands (Yoshyuki, 1989), Northern Vietnam (Corbet, Hill, 1992) and Thailand, northern part of Malacca (Lekagul, McNeely, 1977). Specimens in ZMMU collection originate from Cuc Phuong National Park (Ninh Binh Province).

COMMENTS ON NATURAL HISTORY. Natural history in Vietnam poorly known. Probably a cave-dweller and a slow-flying aerial insectivore.

Hipposideros pratti (Thomas, 1891)

COMMON NAMES. Dơi mũi Prat; Pratt's leafnosed bat; Листонос Пратта.

MATERIAL STUDIED. No collection material was studied. Description below is mainly based on Allen (1938).

IDENTIFICATION. A large leafnosed bat (forearm ca. 81–89 mm; CCL 27.5–28 mm), in general appearance similar to *H. armiger*. Ear moderate, ca. $^1/_3$ of head and body length. Noseleaf with two pairs of supplementary leaflets. Anterior noseleaf more rounded than that of *H. armiger*, with a distinct median emargination. Posterior leaf narrower than anterior leaf, with only the medium septa well pronounced. Fleshy outgrowths behind the noseleaf form a conspicuous shield-like bilobed structure (Fig. 14), especially large in adult males. Frontal gland well-developed, opening between lobes of the «shield». Pelage cinnamon brown above and paler below, with dark hair roots. Muzzle and ears pale brown, poorly pigmented, membranes brown. Skull with a large sagittal crest and the upper profile of rostrum almost parallel to the palatinum (Fig. 13a).

This species differs well from *H. armiger* and *H. diadema* by pelage coloration and the development of the transverse bilobed «shield»; from closely related *H. lylei* — by distinctly larger size and shape of anterior noseleaf.

DISTRIBUTION AND COLLECTING SITES. A southern Chinese species, distributed in Szechwan, Fukien and Hunan (Allen, 1938) and also northern Vietnam. According to Huynh et al. (1994), this species was reported only from Sa Pa (Lao Cai Province), however, there is evidence for the presence of *H. pratti* considerably further southward, in Phong Na (Quang Binh Province), where it occurs together with related *H. lylei*.

COMMENTS ON NATURAL HISTORY. Natural history poorly known, probably similar to that of *H. armiger*. Cave-dweller, living in colonies; often uses the same shelter with *H. armiger*, but inside the cave it keeps in separate clusters (Allen, 1938).

Hipposideros lylei Thomas, 1913

COMMON NAMES. Dơi mũi khiên; Shield-faced leafnosed bat; Щитомордый листонос.

MATERIAL STUDIED. Ten specimens from Ke Bang (Quang Binh Prov.)

IDENTIFICATION. A large leafnosed bat (weight ca. 32–46.5 g; forearm ca. 76.5–81 mm; CCL 26.7–28.2 mm; Table 14), essentially resembling *H. pratti*, and previously even thought to be a subspecies of the latter (Tate, 1941). Anterior noseleaf with one medial and a pair of lateral emarginations. Transverse fleshy «shield» small in females and immatures, very large in adult males (Fig. 14); its lobes probably even more pointed than that of *H. pratti*. Coloration similar to that of *H. pratti*, relatively pale, with darker hair bases.

This species may be distinguished from *H. pratti* by three emarginations on the anterior leaf and by shorter forearm; from the remainder species of *Hipposideros* — by characteristic bilobed fleshy «shield».

DISTRIBUTION AND COLLECTING SITES. Indochinese and Malayan species, inhabiting Burma, Yunnan, Thailand, Malaya and Vietnam. In Vietnam until recently found only in Phong Nha — Ke Bang (Hendrichsen et al., 1999; Kruskop, 2000b).

COMMENTS ON NATURAL HISTORY. According to wing proportions, the foraging behavior of this bat may be similar to that of *H. armiger* — relatively slow aerial hawking. In Ke Bang this species was observed in various habitats, both primary (evergreen deciduous forest) and secondary. In Phong Na and Ke Bang roosts of *H. lylei* were situated in limestone caves (Timmins et al., 1999; Kruskop, 2000a); animals clustered into small colonies, in the latter case mixed with *H. armiger*. Colonial behavior is similar to that of the latter species. The peak of births in Central Vietnam is probably confined to the end of April.

Hipposideros diadema (E. Geoffroy, 1813)

COMMON NAMES. Dơi mũi lớn; Diadem leafnosed bat; Большой листонос.

MATERIAL STUDIED. No specimens from Vietnam were seen; six specimens from the Philippine Islands were examined.

IDENTIFICATION. A large leafnosed bat (weight ca. 33–45 g; forearm ca. 75–92 mm; CCL ca. 25–30 mm), externally essentially resembling *H. pratti*. Anterior noseleaf with no emarginations. No fleshy outgrowths behind posterior noseleaf. Posterior noseleaf wider than the anterior noseleaf, conspicuously curved downwards. Pelage dark to golden brown with pale bases of hairs and characteristic white or cream-colored spots on shoulders. Muzzle pale, not pigmented, ears and membranes pale brown.

Differs from all similar-sized *Hipposideros* by characteristic coloration pattern and wide and curved posterior noseleaf. The subspecies *H. d. masoni* (Dobson, 1872) was reported from throughout the Indomalayan mainland (type locality in Burma), differing in minor noseleaf characters (Dobson, 1876).

DISTRIBUTION AND COLLECTING SITES. Sunda and Malayan species, inhabiting Indochina and Malacca, Nicobar, Sunda, Philippine and Moluccan Islands. In Vietnam it was reported from Quang Tri and Lam Dong Provinces (Huynh et al., 1994), and from some coastal islands, including Con Dao and Phu Quoc (Kuznetsov, An', 1992).

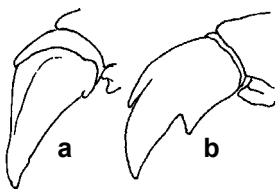

Fig. 15. Upper canines (left lateral view) of *Hipposideros* (a) and *Coelops* (b).


Fig. 16. Interfemoral membrane of *Coelops*.

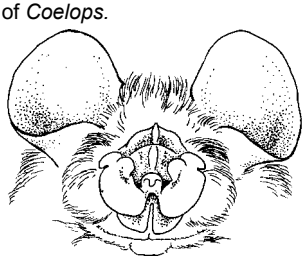
Fig. 17. Face of *Coelops frithii*, anterior view.

COMMENTS ON NATURAL HISTORY. Natural history in Vietnam not known. Probably, a slow-flying aerial insectivore. In Malaysia and the Philippines it is a predominantly gregarious cave-dweller, often associated with *H. armiger*. It also uses hollow trees, inhabiting forested areas, both primary and secondary, from sea level to 900 m a. s. l. (Medway, 1978; Heaney et al., 1998).

Genus *Coelops* Blyth, 1848

GENERAL CHARACTERISTICS. General appearance very peculiar.

DIAGNOSIS. Skull on Fig. 36. Dental formula: $I^1/_2$ $C^1/_1$ $P^2/_2$ $M^3/_3$ $\times 2 = 30$. Dental branch of maxilla and, respectively, upper canines, greatly extending forward. Upper canine with pronounced internal supplementary cusp (Fig. 15b). Basicranial foramina greatly enlarged. Mandibular symphysis U-shaped. Ears rounded, without transverse folds formed by «ribs» of cartilage. Anterior leaf (horseshoe) divided into halves by a median notch extending back to the nasal septum. First metacarpal elongated. Uropatagium conspicuously emarginated, external tail absent (Fig. 16).

DISTRIBUTION. North-east India, southern China, Indochina, Malaya, Java, Bormeo, and the Philippine Islands. Occurrs in Indochina sporadically.

TAXONOMICAL REMARKS. Two species recognized, one of them reported from Vietnam.

Coelops frithii Blyth, 1848

COMMON NAMES. Dơi thùy không đuôi; Tail-less leafnosed bat; Бесхвостый листонос.

MATERIAL STUDIED. One adult male from Vu Quang (Ha Tinh Province) and one adult female from Cat Tien National Park (Dong Nai Province; donated by G. Polet).

IDENTIFICATION. A very small leafnosed bat (weight ca. 3.5 g; forearm ca. 37–42 mm), somewhat resembling a small *Hipposideros*. External tail virtually absent, interfemoral membrane slightly reduced. Wings broad and rounded, terminal phalanges of 4th and 5th wing digits with conspicuous T-shaped cartilaginous apexes. Ears broadly rounded (Fig. 17), with very well developed antitragal lobes, not separated by notches. Noseleaf rather simplex, compared to *Hipposideros*, with reduced intermediate leaf and small posterior leaf not subdivided by median septa.

DISTRIBUTION AND COLLECTING SITES. Distributed sporadically throughout the Malayan subregion, from eastern India and Myanmar to south-eastern China, Taiwan, Java and Sumatra. In Vietnam it was reported by Huynh et al. (1994) from Lai Chau, Lao Cai and Thanh Hoa Provinces. We recorded this species in Vu Quang (Ha Tinh Province; Kuznetsov et al., 2001) and Nam Cat Tien (Dong Nai Province), collected by Mr. Van Derender.

COMMENTS ON NATURAL HISTORY. Natural history is almost unknown. Supposed to be a forest species, roosting in trees or caves (Bates, Harrison, 1997). One observation made in Vu Quang suggests this bat to hunt just a few centimeters above ground level, amongst grassy vegetation (ferns).

Genus *Paracoelops* Dorst, 1947

GENERAL CHARACTERISTICS. Monotypic genus. Appearance generally resembling that of *Coelops*. Ears larger, uropatagium not emarginated, rostrum greatly inflated.

DIAGNOSIS. Dental formula: $I^1/_2\ C^1/_1\ P^2/_2\ M^3/_3 \times 2 = 30$.

DISTRIBUTION. Known from the type locality: Vinh, Nghe An Province.

TAXONOMICAL REMARKS. Taxonomical position uncertain, since little morphological information is retained in the type specimen.

Paracoelops megalotis Dorst, 1947

COMMON NAMES. Dơi thùy tai to; Funnel-eared leafnosed bat; Воронкоухий листонос.

MATERIAL STUDIED. No specimens were studied. The diagnosis below follows Nowak (1994).

IDENTIFICATION. A small leafnosed bat (weight ca. 7 g; forearm ca. 42 mm). Ears very large, approximately $^2/_3$ of head and body length, widely

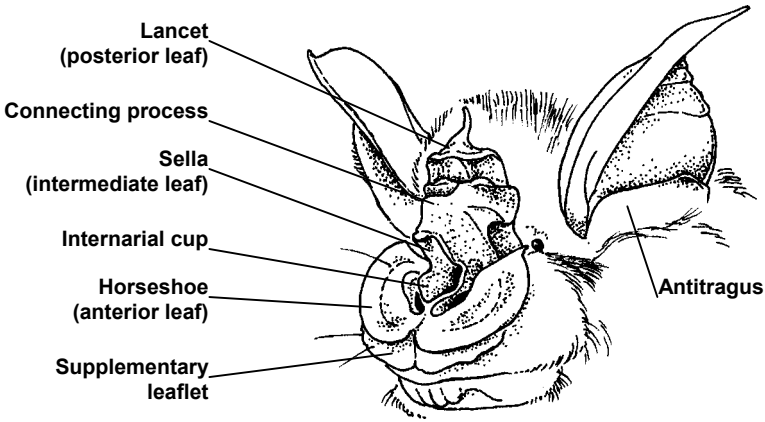

Fig. 18. Head of *Rhinolophus*, demonstrating details of noseleaf structure.

rounded on top. Horseshoe surmounted by rounded supplementary leaf with radial striations. Tail is absent, while the interfemoral membrane is well-developed, supported by long calcars. Pelage in the single known specimen is long and thick, brown on back, light beige with yellow roots on the underparts, and bright yellow on the crown. Membranes dark brown.

This species differs from *Coelops frithii* by the shape of noseleaf, remarkably larger ears and wide interfemoral membrane; from *Aselliscus* and small *Hipposideros* — by absent external tail.

DISTRIBUTION AND COLLECTING SITES. Until now known only from the type locality in Vietnam (Vinh, Nghe An Province).

COMMENTS ON NATURAL HISTORY. Natural history is unknown.

FAMILY RHINOLOPHIDAE GRAY, 1825

COMMON NAMES. Họ dơi lá, Horseshoe bats; Подковоносые.

GENERAL CHARACTERISTICS. A monotypic family. Similarly to Rhinonycteridae, these bats are adapted towards perching on ceilings of roosts and «walking» below them using only hind feet. They also use complex noseleaf structures for the emission of narrow-band constant frequency echolocation signals, enabling to detect fluttering prey against background clutter, using Doppler-shifted echoes.

Genus *Rhinolophus* Lacepede, 1799

GENERAL CHARACTERISTICS. Small to medium-sized bats of characteristic rhinolophoid appearance.

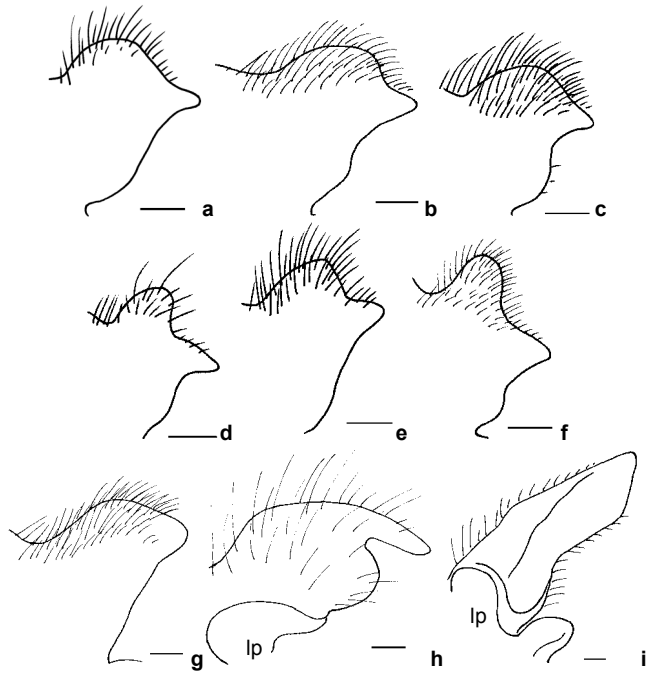

Fig. 19. Schematic profile of the connecting process and sella of selected *Rhinolophus* species, outlined from alcohol-preserved specimens (lateral view, scale to the right of each picture is 1 mm): a) *R. affinis*; b) *R. borneensis*; c) *R. rouxii*; d) *R. pusillus*; e) *R. lepidus*; f) *R. acuminatus*; g) *R. pearsoni*; h) *R. luctus*; i) *R. paradoxolophus*. Lp — basal lappets.

DIAGNOSIS. Skulls on Fig. 37 and Fig. 38. Dental formula: $I^1/_2$ $C^1/_1$ $P^2/_3$ $M^3/_3$ ×2 = 32. P_2 minute and sometimes vestigial, however, usually present. P^2 of various size, positioned within toothrow or extruded. Upper molars with well-developed hypocone basins. Premaxillae slender, only their palatal branch developed and sutured to the palate. Noseleaf structure complex, containing four major elements: anterior leaf (horseshoe), intermediate leaf (sella), connecting process and posterior leaf (lancet); additional structures present in some species (lappets, imternarial cup). Ear without tragus and with a large antitragal lobe. Toes (except for hallux) with three phalanges. Tail vertebrae flex dorsally.

DISTRIBUTION. Widely distributed throughout the Old World: in the southern Palaearctic, Africa (except Madagascar), Indomalayan Region, south to Eastern Australia. Very common and diverse throughout Indochina.

NATURAL HISTORY. Specialized insectivores, predominantly aerial foragers; many use perches to detect and consume prey, others hunt in continuous flight. Particularly abundant in areas with caves, however, quite common in various primary and disturbed landscapes. They require more or less exposed roosting sites, where they could hang freely from the ceiling. Powerful constant frequency (CF) echolocation signals are emitted. The frequency of these calls is usually species-specific and may be used in field identification of similar species occurring in one locality.

TAXONOMICAL REMARKS. A very complex genus with ca. 70–80 recognized species and numerous named forms of contradictory status, ca. 17 of them reported from Vietnam.

Key to the Vietnamese *Rhinolophus*

1 Sella with conspicuous basal lappets (Fig. 19h–i).....**2**

— Sella without basal lappets (Fig. 19a–g).....**4**

2 Size very large: FA over 65 mm, CCL over 27 mm. Lancet well-developed. Internarial cup not expanded, its margins not leaf-like. Sella of moderate size. Connecting process broadly rounded. Ears less than $^1/_2$ of forearm length .....*R. luctus* (p. 106)

— Size smaller: FA under 65 mm, CCL under 25 mm. Lancet greatly reduced. Internarial cup expanded sidewards to form prominent leaflets. Sella very long, leaf-like, approaching ears in length. Connecting process with very wide base. Ears exceed $^2/_3$ of forearm length **3**

3 Size larger: forearm over 54 mm. Lancet broadly rounded. Base of sella conspicuously narrower than internarial cup... *R. paradoxolophus* (p. 107)

— Size smaller. Forearm less than 47 mm. Lancet more or less triangular. Base of sella widened, reaching internarial cup in width. ....*R. marshalli* (p. 108)

4 Upper and lateral parts of lancet curved forward and form a truncate structure enclosing the posterior part of connecting process, which is very low, almost obscure.....*R. shameli* (p. 108)

— Lancet not curved forward, with erect tip, hastate or triangular at frontal view. Connecting process of various shape, but usually well-defined **5**

5 Sella definitely widened, it's width at base more than 3 mm; ear length over 21 mm **6**

— Sella narrow, it's width at base less than 2 mm; ear length less than 22 mm **8**

6 Size smaller: forearm less than 50 mm; CCL less than 17 mm. Ears exceeding $^1/_2$ of forearm length. Notch present between connecting process and apex of sella (at lateral view).....*R. macrotis* (p. 106)

— Size larger: forearm length over 50 mm; CCL over 20 mm. Ears do not exceed $^1/_2$ of forearm length. Anterior part of connecting process reaches the tip of sella, no notch present at lateral view **7**

7 Smaller: forearm less than 55 mm, condylocanine length less than 22 mm. ..... *R. pearsoni* (p. 104)

— Larger: forearm over 54 mm; condylocanine length over 22 mm..... ..... *R. yunnanensis*

8 Connecting process broadly rounded, sometimes very low (Fig. 19a–c); supplementary leaflets of horseshoe usually well-developed..... ..... «*affinis*» group (see **Table 1**)

— Connecting process prominent, triangular, acutely pointed or horn-like (Fig. 19d–f), although its tip may be rounded; supplementary leaflets of horseshoe usually reduced to haired folds beneath horseshoe..... .....«*lepidus*» group (see **Table 2**)

Rhinolophus affinis Horsfield, 1823

COMMON NAMES. Dơi lá đuôi, Intermediate horseshoe bat, Азиатский подковонос.

MATERIAL STUDIED. A total of 16 specimens from Vu Quang (kindly identified by Dr. Gabor Csorba, Hungarian Museum of Natural History) and 10 individuals from Da Lat.

IDENTIFICATION. A small to medium-sized horseshoe bat (weight ca. 9.9–16.9 g; forearm ca. 48–53 mm; CCL ca. 18.7–20.5 mm; after Bates Harrison, 1997; Table 15). External appearance typical for *R.* «*affinis*» group. Horseshoe of moderate size, with well-developed supplementary leaflets and deep medial emargination; connecting process broadly rounded. Sella not enlarged, slightly convex at frontal view, without basal lappets. Internarial cup not expanded. Lancet subtriangular in shape, with unreduced tip. Pelage fine and soft (not wooly), its coloration is uniformly dark grayish brown to reddish brown (in reproducing individuals). Rostrum of skull with well-developed lateral anterior nasal compartments and moderate medial compartments, both anterior and posterior, forming a shape somewhat intermediate between that of *R. borneensis* and *R. malayanus*. Small upper premolar usually less reduced, than in the remainder Indomalayan species of the «*ferrumequinum*» group, not extruded from toothrow.

Table 1. Diagnostic characters of the *Rhinolophus* «*affinis*» species group.

Species	FA, mm	CCL, mm	Sella	Lancet	Comments
R. affinis (p. 95)	48–53	18.7–20.5	pandurate	subtriangular	
R. borneensis (p. 97)	41–47	ca. 16.8	pandurate, elongated	subtriangular	
R. malayanus (p. 98)	40–44	ca. 16.3	parallel-sided	strongly hastate, with elongated tip	
R. stheno (p. 100)	45–48	ca. 16.3	parallel-sided	broadly hastate, hairy	tail reduced
R. rouxii (p. 98)	45–53	17.4–18.5	pandurate	strongly hastate	
R. thomasi (p. 100)	44–46	?	parallel-sided	reduced	

Table 2. Diagnostic characters of the *Rhinolophus* «*lepidus*» species group.

Species	FA, mm	CCL, mm	C–M^3, mm	M^3–M^3, mm	Connecting process
R. pusillus (p. 101)	35–40	13.2–14.6	5.4–6.2	5.4–5.8	acutely pointed (Fig. 19d)
R. lepidus (p. 102)	37–42	14.2–16.4	6.0–7.1	5.7–6.9	broadly pointed (Fig. 19e)
R. subbadius (p. 102)	31.5–36	11.9–12.9	5.1–5.5	4.4–4.9	acutely pointed to horn-like
R. cornutus	37–42	13.2–14.6	5.4–6.3	ca. 5.7	narrow pointed triangular
R. acuminatus (p. 103)	46–53	17.7–19.3	7.4–8.9	7.7–8.5	acutely pointed (Fig. 19f)

This species could be confused with other similar-sized representatives of the *R.* «*ferrumequinum*» group, particularly with *R.* cf. *rouxii*, from which it could be distinguished by larger condylocanine length and lancet shape. The remainder species are reported to have significantly smaller size, however, in Vietnam the range of variation in external and cranial measurements of *R. affinis* is not sufficiently studied.

DISTRIBUTION AND COLLECTING SITES. Widely distributed from Nepal and northern India to south-eastern China, Malacca peninsula and Sunda Islands (Corbet, Hill, 1992). In Vietnam reported from Lao Cai, Lang Son, Ninh Binh and Lam Dong Provinces (Huynh et al., 1994). We found this species in Vu Quang Nature Reserve (Kuznetsov et al., 2001) and on Lang Bian (Da Lat) Plateau (our surveys). Supposedly, this species is distributed in mountainous territories through North and Central Vietnam.

COMMENTS ON NATURAL HISTORY. Aerial insectivore hunting in continuous flight; perching behavior was only rarely observed (Borissenko et al., 2001). In Langbian and Vu Quang these bats were frequently observed flying along streams and roads, about 1.5–2 m above the ground. Also they were quite frequent around campsites, flying into houses or under tents. This species inhabits mainly forested areas, both primary and secondary formations, but not heavily disturbed landscapes. In Vu Quang it was found from 200 to 1300 m a. s. l., on Langbian plateau — up to 1800 m a. s. l.. Roosts are probably located in rock crevices or hollow trees. Echolocation calls are of relatively high intensity; in Vu Quang the CF component was detected around 90 kHz, and on Langbian plateau it was about 78 kHz.

Rhinolophus borneensis Peters, 1861

COMMON NAMES. Dơi lá sa đen; Bornean horseshoe bat; Калимантанский подковонос.

MATERIAL STUDIED. Three tentatively identified specimens from Tay Ninh Province.

IDENTIFICATION. A small to medium-sized horseshoe bat (weight ca. 8–10 g; forearm ca. 46.5 mm; CCL ca. 16.8 mm; Table 16), essentially similar in external appearance to *R. affinis*, but noticeably smaller, otherwise similar to *R. malayanus*. Ears and noseleafs of moderate size, lancet somewhat shortened. Horseshoe with well-developed supplementary leaflets and deep medial emargination. Sella proportionally elongated (compared to *R. affinis*), slightly convex at frontal view (pandurate), without basal lappets. Internarial cup not expanded. Connecting process broadly rounded. P^2 reduced, but not extruded from toothrow. Pelage coloration is uniformly dark brown to dark grayish brown.

Differs from *R. affinis* and *R. rouxii* by smaller size, and, supposedly in grayer pelage coloration; from *R. thomasi* and *R. stheno* in the shape of lancet and sella. Differs from *R. malayanus* mainly in the shape of the anterior nasal swellings (e. g., Hill, Thonglongya, 1972): median rostral swellings smaller and less inflated, not extending laterally down the side of rostrum, while the lateral swellings are conspicuously larger, than in *R. malayanus*.

DISTRIBUTION AND COLLECTING SITES. Hitherto provisionally reported from the southern part of the country (Tay Ninh Province, this study). The named form *chaseni* Sanborn, 1939 referred to this species (Hill, Thonglongya, 1972) is reported from Con Dao Island, off the southern coast of Vietnam.

COMMENTS ON NATURAL HISTORY. Natural history poorly known. The specimens from Tay Ninh mentioned above were captured while flying closely to the ground in secondary forest formations and *Acacia* plantations. Echolocation calls (detected in Tay Ninh) are of high intensity with the CF component around 80 kHz.

Rhinolophus malayanus Bonhote, 1903

COMMON NAMES. Dơi lá Mã Lai, North Malayan horseshoe bat, Малайский подковонос.

MATERIAL STUDIED. One tentatively identified specimen from Phong Nha — Ke Bang National Park.

IDENTIFICATION. A small to medium-sized horseshoe bat (weight ca. 6.7 g; forearm ca. 41.3 mm; CCL ca. 16.6 mm), in size and external appearance essentially similar to *R. borneensis*. Sella without lappets, more or less parallel-sided; lancet hastate with elongated tip. Internarial cup not expanded. Connecting process broadly rounded. P^2 reduced, but not extruded from toothrow. Pelage coloration is uniformly brown to reddish brown.

Distinguished from *R. affinis* and *R. rouxii* by smaller size; from *R. thomasi* and *R. stheno* in the shape of lancet and sella. Differs from *R. borneensis* mainly in the shape of the anterior nasal swellings (e. g., Hill, Thonglongya, 1972): medial rostral swellings large, much inflated, extending laterally down the sides of rostrum to the extent that the lateral swellings are relatively small.

DISTRIBUTION AND COLLECTING SITES. Indochinese species, inhabiting Vietnam, Laos, Thailand, adjacent parts of Myanmar, Cambodia and Malaya (Corbet, Hill, 1992; Bates et al., 2000; Hendrichsen et al., 2001). Huynh et al. (1994) reported it in Vietnam from Lai Chau Province. We found this species in Ke Bang (Quang Binh Province; Kruskop, 2000b).

COMMENTS ON NATURAL HISTORY. Natural history in Vietnam poorly known. Probably, a aerial insectivore and cave dweller. The single specimen mentioned above was captured in a limestone cave, however no perching horseshoe bats were observed in the same shelter (Kruskop, 2000a).

Rhinolophus cf. *rouxii* Temminck, 1835

COMMON NAMES. Dơi lá Rut; Roux's horseshoe bat; Подковонос Ру, Южнокитайский подковонос.

MATERIAL STUDIED. Eleven specimens from Phong Nha — Ke Bang National Park, part of the series kindly identified (provisionally) by Dr. Paul Bates (Harisson Zoological Museum, UK); an additional specimen from Nepal, kindly identified by Dr. G. S. Csorba (Hungarian Natural History Museum).

IDENTIFICATION. A small to medium-sized horseshoe bat (weight ca. 7.7–14.1 g; forearm ca. 41.7–45.4 mm; CCL ca. 7.6–8.2 mm; after Bates, Harrison, 1997; Table 17), essentially similar to *R. affinis*, but slightly smaller. Horseshoe of moderate size, connecting process broadly rounded, sella pandurate, without supplementary lappets, ears also of moderate size. Lancet strongly hastate. Pelage coloration is gray-brown to reddish or orange brown (in reproducing individuals). P^2 reduced, but not extruded from toothrow.

Differs from *R. affinis* in a more strongly hastate sella. Until recently it was accepted (Corbet and Hill, 1992; Koopman, 1994; Bates, Harrison, 1997), that *R. rouxii* contains two mainland subspecies (*R. r. rouxii* and *R. r. sinicus* Andersen, 1905), the latter sometimes treated as a separate species (e. g., Thomas, 2000). It is this named form which hitherto has been recorded from Indochina (Koopman, 1994) and to which the considered specimens were tentatively allocated by Dr. Bates. This predominantly montane form differs from the lowland *R. rouxii* s. str. in somewhat smaller size and longer second phalanx of third digit (usually over 65% of respective metacarpal, compared to usually less than 66% in *R. rouxii*; Bates, Harrison, 1997). The series from Ke Bang, however, does not correspond well to either the provided diagnoses of *sinicus* or to the available Nepalese specimen, and may prove to represent another taxon. Until a more comprehensive study of Vietnamese specimens is carried out, we tentatively refer them to *R. rouxii* implying that it is a polytypic species.

DISTRIBUTION AND COLLECTING SITES. *Rhinolophus rouxii* s. lato is widely distributed through South-East Asia from India and Sri Lanka to Hainan and south-east China (Corbet, Hill, 1992; Bates, Harrison, 1997). In Vietnam it was recorded from Ninh Binh Province (Huynh et al., 1994), from Pu Mat Nature Reserve, Nghe An Province (Hayes, Howard, 1998) and probably from Ke Bang, Quang Binh Province (Kruskop, 2000b).

COMMENTS ON NATURAL HISTORY. Aerial forager, probably sometimes using perches. Roosts found in caves, crevices, hollow trees, temples and old buildings. This bat lives solitarily, in small aggregations or in colonies up to several hundred individuals (Bates, Harrison, 1997; Csorba et al., 1998). It inhabits predominantly forested areas; typical *R. rouxii* was reported as a lowland form, and *R. r. sinicus* — as a montane form (Bates, Harrison, 1997). In Ke Bang it was captured both in secondary formations and in pri-

mary deciduous forest. Part of females, caught there in the end of March and April, were pregnant.

Rhinolophus thomasi Andersen, 1905

COMMON NAMES. Dơi lá Tôma; Thomas's horseshoe bat; Подковонос Томаса.

MATERIAL STUDIED. No material was studied; the description below is based on data from literature.

IDENTIFICATION. A small to medium-sized horseshoe bat (weight ca. 6.5–11.5 g; forearm ca. 40.8–43.9 mm; after Robinson, Smith, 1997) in external appearance essentially typical of the «*ferrumequinum*» group. Horseshoe of moderate size, connecting process broadly rounded, sella parallel-sided, without supplementary lappets. Connecting process distinctly notched. Lancet short and broadly hastate, with reduced tip. P^2 reduced, but not extruded from toothrow.

DISTRIBUTION AND COLLECTING SITES. Sporadically distributed in southern China (Yunnan), eastern Myanmar, Thailand and Vietnam. A distinct form *latifolius* Sanborn, 1939 was described from Muong Muon (Lai Chau Province). Also was reported from Lao Cai, Ninh Binh and Dong Nai provinces and from some coastal islets in the Gulf of Tonkin (Kuznetsov, An', 1992; Huyinh et al., 1994). The previously published record from Ke Bang (Kruskop, 2000b) was probably based on a misidentification.

COMMENTS ON NATURAL HISTORY. Natural history in Vietnam unknown, probably in general similar to that of *R. rouxii*. Cave-dweller (Robinson, Smith, 1997).

Rhinolophus stheno Andersen, 1905

COMMON NAMES. Lesser brown horseshoe bat; Малазийский подковонос.

MATERIAL STUDIED. No material was seen; the diagnosis below follows Csorba and Jenkins (1998).

IDENTIFICATION. A small to medium-sized horseshoe bat (weight ca. 8–9 g; forearm ca. 43.8–47.2 mm). Sella parallel-sided. Connecting process typical of the «*ferrumequinum*» species group, rounded. Lancet broadly hastate, with unreduced tip, densely covered with hairs. Tail characteristically short, shorter than tibia (15–18 mm). Anterior medial nasal compartment of skull rostrum well-developed, while the posterior nasal compartment is weekly developed, forming a prominent concavity behind nasal elevation.

This species may be distinguished from similar-sized *R. borneensis* and *R. rouxii* by parallel-sided (not pandurate) sella and shortened tail, from *R.*

thomasi also by unreduced lancet tip; from *R. malayanus* — by slightly larger overall size and proportions of nasal compartments.

DISTRIBUTION AND COLLECTING SITES. Malayan species, inhabiting southern Thailand, Malacca, Java and Sumatra. In Vietnam it was found in Na Hang Nature Reserve, Tuyen Quang Province (Csorba, Jenkins, 1998), from where a distinct subspecies was described (*R. s. microglobosus* Csorba, Jenkins, 1998).

COMMENTS ON NATURAL HISTORY. Natural history poorly known. Mainly a cave-dweller, however netted in tall forest, far from known caves (Medway, 1978).

Rhinolophus pusillus Temminck, 1834

COMMON NAMES. Dơi lá muỗi; Least horseshoe bat; Карликовый подковонос.

MATERIAL STUDIED. Two specimens from Vu Quang (Ha Tinh Province); one additional specimen from Nepal was examined.

IDENTIFICATION. A small-sized horseshoe bat (weight ca. 4.5–5 g; forearm ca. 35–39 mm; CCL ca. 13.2–14.6 mm; Table 19). Ears and horseshoe not especially enlarged, supplementary leaflets present, but poorly developed; lancet not reduced; connecting process rather long, acutely pointed, but not horn-like. Pelage fine and soft, light buffy brown to darker brown above, paler below. Hairs with noticeably paler bases.

This bat could be confused with *R. lepidus*, differing slightly in averagely smaller size, finer dentition and somewhat more acute and narrow connecting process. From *R. subbadius* it differs in larger size and wider connecting process.

Another similar species reported from Vietnam (reviewed in Huynh et al., 1994) is *R. cornutus*. Otherwise close to *R. pusillus*, it differs slightly in the shape of the connecting process, which is very long and narrowly triangular, nearly horn-like. All the dimensions, reported in literature, are very similar to those of the latter species. Distributed extralimitally in Japan (including Ryukyu) and, possibly, southern China (Allen, 1938; Corbet, Hill, 1992). We do not know of significant evidences for the presence of *R. cornutus* in Vietnam, however it may occur in the northern part of the country.

DISTRIBUTION AND COLLECTING SITES. Widely distributed from northern India and Nepal (southern slopes of Himalayas) to south-eastern China, Hainan, Malaysia and Great Sunda Islands (Corbet, Hill, 1992). Huynh et al. (1994) indicate two records (from Bac Thai and Ninh Binh provinces), however, it is possible that at least part of the records of *R. cornutus* and *R. subbadius* provided therein are also more appropriately referable to *R. pusillus*.

We found this species only in Vu Quang Nature Reserve (Ha Tinh Province, Kuznetsov et al., 2001).

COMMENTS ON NATURAL HISTORY. Aerial forager, probably perch-hunter (Borissenko et al., 2001). Few observations were made in Vu Quang of this bat flying close to vegetation along the road. In Nepal we observed this species in a forested area, hunting over a stream. According to Allen (1938) this horseshoe bat is more characteristic or humid uplands. In India it was found mainly at relatively high altitudes, ca. 1070–1300 m a. s. l. (Bates, Harrison, 1997); however, in Vu Quang *R. pusillus* was caught in lowlands, at about 200 m a. s. l. (Kuznetsov et al., 2001). Echolocation calls are of moderate intensity with the CF component around 110 kHz.

Rhinolophus subbadius Blyth, 1844

COMMON NAMES. Dơi lá nâu; Little Nepalese horseshoe bat; Каштановый подковонос.

MATERIAL STUDIED. No material was seen; the description below follows Corbet, Hill (1992) and Bates, Harrison (1997).

IDENTIFICATION. A small-sized horseshoe bat (forearm ca. 31.5–36 mm; CCL ca. 11.9–12.9 mm), similar to *R. pusillus* but slightly smaller. Connecting process acutely pointed, somewhat horn-like

The taxonomical position of this species initially described from Nepal is questionable, and its specific distinction from *R. pusillus* requires revision. Specimens from Myanmar, North China and North Vietnam have been allocated to this species provisionally (Corbet, Hill, 1992; Bates, Harrison, 1997). According to available literature data (ibid.) *R. subbadius* differs from the otherwise similar *R. pusillus* by significantly smaller size (forearm length, skull dimensions) and more horn-like shape of the connecting process.

DISTRIBUTION AND COLLECTING SITES. Sporadically found from Nepal to NE India, Burma and, supposedly, North Vietnam (Corbet, Hill, 1992). Records from Central and South Vietnam (Huynh et al., 1994) are most likely to be misidentified *R. pusillus*, however, see taxonomical comments above.

COMMENTS ON NATURAL HISTORY. Natural history almost unknown. In Myanmar it was found in a bamboo clump in dense jungle at an altitude of 1230 m a. s. l. (Bates, Harrison, 1997). Probably, a cave-dweller (Timmins et al., 1999).

Rhinolophus lepidus Blyth, 1844

COMMON NAMES. Dơi lá Ôgut; Blyth's horseshoe bat; Индийский подковонос.

MATERIAL STUDIED. One specimen from Con Dao Island (collected by Dr. G. V. Kuznetsov).

IDENTIFICATION. A small-sized horseshoe bat (weight ca. 6.2–6.8 g (Bates et al., 2000); forearm ca. 37–42 mm; CCL ca. 14.2–16.4 (Corbet, Hill, 1992) mm). Ears and horseshoe not especially enlarged, lancet not reduced; connecting process well pronounced, acutely or broadly pointed, with a wide base. Pelage most similar to that of *R. pusillus* in structure and coloration pattern.

Essentially similar to *R. pusillus*, differing in averagely larger size, more massive dentition and generally less acute and more broadly based connecting process. The specimen at our disposal also possesses well-developed supplementary leaflets of horseshoe (a similar trait also mentioned by Allen, 1938), differentiating it from all other representatives of the «*lepidus*» group. However, it requires confirmation whether this trait persists in other Vietnamese *R. lepidus*.

DISTRIBUTION AND COLLECTING SITES. Widely distributed through the Indomalayan region, from India to south-east China, Malaysia and Sumatra (Corbet, Hill, 1992). Questionably reported from Vietnam by Sokolov et al. (1986) and Huynh et al. (1994). The ZMMU specimen was collected on Con Dao Island.

COMMENTS ON NATURAL HISTORY. Cave-dweller; roosts in caves, tunnels, ruined temples and old houses. Lives solitarily or in clusters from tens to several hundred individuals, sometimes in association with other bats, including *Taphozous* sp. and small *Hipposideros* (Bates, Harrison, 1997). Inhabits forested areas from about sea level up to 2340 m a. s. l. (ibid.) Foraging behavior probably similar to that of *R. pusillus*. This species explores the edge of vegetation, space inside foliage, sometimes taking insects from leaf surface.

Rhinolophus acuminatus Peters, 1871

COMMON NAMES. Dơi lá mũi nhọn; Acuminate horseshoe bat; Серый подковонос.

MATERIAL STUDIED. Eight specimens from Lo Go Xa Mat (Tay Ninh Province), Cat Loc (Lam Dong Province) and Ma Da (Dong Nai Prov; collected by A. N. Kuznetsov).

IDENTIFICATION. A small to medium-sized horseshoe bat (weight ca. 8.3–13.5 g; forearm ca. 45–50 mm; CCL 17.7–19.3 ca. mm; Table 18). Ears and horseshoe not especially enlarged, supplementary leaflets well-developed; lancet not reduced; connecting process rather long and narrow, but rather rounded than pointed apically, not horn-like.

Significantly larger than any other member of the «*pusillus*» group, this bat clearly falls within the same size class as *R. borneensis*, from which it is readily distinguished by narrower and more acute connecting process.

DISTRIBUTION AND COLLECTING SITES. Hitherto there have been no reports of this species from Vietnam, however, it has been found in the neighboring Laos and Cambodia (Hill, Thonglongya, 1972), and also in peninsular Thailand, on Great and Lesser Sunda Islands and Palawan Island (Corbet, Hill, 1992). Recent records from Tay Ninh, Cat Loc and Ma Da (these surveys) suggest that it may be distributed far more extensively at least throughout South Vietnam.

COMMENTS ON NATURAL HISTORY. Natural history poorly known. Observations in Tay Ninh and Cat Tien indicate that this species has a typical slow and maneuverable flight pattern and powerful echolocation signal with the CF component around 90 kHz, usually foraging at subcanopy level, several meters above the ground. This bat was found to be rather common in lowland dipterocarp forests; from there it may penetrate into secondary growth formations and even plantations, e. g. *Acacia* and *Anacardium*.

Rhinolophus pearsoni Horsfield, 1851

COMMON NAMES. Dơi lá Pecxôn; Pearson's horseshoe bat; Поковонос Пирсона.

MATERIAL STUDIED. Six specimens from Ke Bang (Quang Binh Province), also two specimens from unknown locality in Vietnam (collected by Dr. Dao Van Tien).

IDENTIFICATION. A medium-sized horseshoe bat (weight ca. 13.7–18.2 g; forearm ca. 50–57 mm; CCL ca. 20.1–21.6 mm; original data and those of Hill, 1986; Table 20). Ears and horseshoe not enlarged. Sella without basal lappets. Connecting process at lateral view similar to that of *R. luctus*, very low and broadly rounded (Fig. 19g). Pelage wooly, uniformly chestnut brown. Upper surface and posterior border of interfemoral membrane covered with hairs.

This species differs form other Vietnamese horseshoe bats by overall size and distinctive structure of the connecting process. The closest relative of very similar appearance is *R. yunnanensis*, which could be distinguished mainly by larger size.

DISTRIBUTION AND COLLECTING SITES. Distributed from Nepal and northern India to southern China and northern Indochina. In Vietnam it was reported from Lai Chau and Lao Cai Provinces (Huynh et al., 1994).

COMMENTS ON NATURAL HISTORY. This species was find mainly in montane areas, up to 3380 m a. s. l. (in Nepal; Bates, Harrison, 1997). In Ke Bang it is closely affiliated with primary deciduous forest and with limestone outcrops (the same was shown for this species in Thailand; Robinson, Smith, 1997). One specimen was observed in a small limestone cavity, three indi-

viduals were netted nearby. Perching behavior was not observed, but may be deduced on the basis of wing morphology.

Rhinolophus yunnanensis Dobson, 1872

COMMON NAMES. Dơi lá Đôpxôn; Yunnan horseshoe bat; Юннаньский подковонос.

MATERIAL STUDIED. No material was seen; the diagnosis below follows mainly Bates and Harrison (1997).

IDENTIFICATION. A medium-sized horseshoe bat (weight ca. 16 g; forearm ca. 54–60 mm; CCL ca. 22–23 mm; after Corbet, Hill, 1992), in general appearance greatly similar to *R. pearsoni*, but larger. Differs from other Vietnamese horseshoe bats with simple noseleafs in larger size and shape of the connecting process.

DISTRIBUTION AND COLLECTING SITES. Sporadically found in northeastern India, northern Burma, Thailand and southern China; until now the only reported locality in Vietnam is Pu Mat Nature Reserve, Nghe An Province (Hayes, Howard, 1998).

COMMENTS ON NATURAL HISTORY. Natural history poorly known. Inhabits high altitudes up to 1200 m a. s. l. (Bates, Harrison, 1997). In Myanmar one individual was captured in a thatched roof of a local house (ibid.) The specimen from Pu Mat was netted at a cave entrance (Hayes, Howard, 1998).

Rhinolophus shameli Tate, 1943

COMMON NAMES. Dơi lá Samen; Shamel's horseshoe bat; Подковонос Шамеля.

MATERIAL STUDIED. No specimens from Vietnam were seen; one specimen from Cambodia was examined.

IDENTIFICATION. A small horseshoe bat (weight ca. 10 g; forearm ca. 47.5 mm; CCL ca. 18.3 mm) of characteristic appearance. Connecting process very characteristic, thickened and folded, its sides and tip curved forward to form a fissure enclosing the rear of the connecting process. Ears moderate, ca. $^{2}/_{5}$ of forearm length. Small upper premolar not minute, within toothrow or slightly displaced outwards.

This bat species differs from other similar-sized horseshoe bats by characteristic shape of the connecting process (see keys). From the most similar extralimital *R. coelophyllus* Peters, 1867 it differs in skull characters (Corbet, Hill, 1992): postnarial rostral depression shallow, little developed, with narrow supraorbital ridges (prominent, moderately deep, enclosed by broad, well-developed supraorbital ridges in the latter species).

DISTRIBUTION AND COLLECTING SITES. According to Corbet and Hill (1992), this species has a disrupted range in Myanmar and northern Thailand

and in south-eastern Thailand and Cambodia. From Vietnam it was reported for the first time by Hayes and Howard (1998).

COMMENTS ON NATURAL HISTORY. Natural history almost unknown. Probably, a cave-dweller. The specimen from Cambodia was netted over a forest trail in highly disturbed forest.

Rhinolophus macrotis Blyth, 1844

COMMON NAMES. Dơi lá tai dài; Big-eared horseshoe bat; Длинноухий подковонос.

MATERIAL STUDIED. No material was seen; the diagnosis below is based chiefly on Bates and Harrison (1997).

IDENTIFICATION. A small to medium-sized horseshoe bat (weight ca. 6–8 g; forearm ca. 39–46 mm; CCL ca. 15.2–16.6 mm) of characteristic appearance. The sella projects forward, its transition into the connecting process with a conspicuous notch, its inferior surface very broad (over 3 mm in width). Connecting process very broad-based, broadly rounded. Ears relatively large, ca. $^1/_2$ of forearm length. Pelage soft and wooly, buffy brown above, slightly paler below.

This bat species differs from other similar-sized horseshoe bats by characteristic shape of sella and connecting process and relatively large ears.

DISTRIBUTION AND COLLECTING SITES. Widely distributed from Pakistan through Nepal to Southern China, Malaysia and the Philippines, this bat is known from Vietnam by few records (Huynh et al., 1994).

COMMENTS ON NATURAL HISTORY. Confined to relatively high altitudes (Bates, Harrison, 1997; Csorba et al., 1998). Roosting sites in caves and mines. Reported to be an aerial forager, feeding on small flying insects (Bates, Harrison, 1997).

Rhinolophus luctus Temminck, 1835

COMMON NAMES. Dơi lá lớn; Wooly, or Greater Eastern horseshoe bat; Гигантский подковонос.

MATERIAL STUDIED. Two males (adult and subadult) from Vu Quang.

IDENTIFICATION. A very large horseshoe bat (weight ca. 27–35 g; forearm ca. 70–80 mm; CCL ca. 14.8–16.2 mm; Table 21) of characteristic appearance. There are pronounced basal lappets on either side of sella between the latter and the internarial leaflets; connecting process very low and broadly rounded, tip of sella extending far beyond it (Fig. 19h). Pelage thick, dense and wooly, uniform black or grayish black with slightly paler hair tips; in reproducing individuals with brownish tints.

Readily distinguished from other horseshoe bats by very large overall size and structure of sella. Another considerably smaller (forearm ca. 50–53 mm)

South-East Asian species of horseshoe bat possessing supplementary lappets of sella is *R. trifoliatus* Temminck, 1834. At present its nearest reported locality is Thailand, however, its rather wide distribution range (NE India to Java and Borneo) leaves certain probability for its occurrence in Vietnam.

DISTRIBUTION AND COLLECTING SITES. Widely distributed through the Indomalayan region, from India and Nepal to Taiwan, peninsular Thailand and Great Sunda Islands (Corbet, Hill, 1992). In Vietnam it was reported from Bac Thai and Vinh Phu Provinces (Huynh et al., 1994), Con Dao Island (Kuznetsov, An', 1992) and Nghe An Province (Hayes, Howard, 1998). We found this species in Vu Quang Nature Reserve (Kuznetsov et al., 2001).

COMMENTS ON NATURAL HISTORY. Inhabits mainly forested areas. Reported to be an aerial forager (Bates, Harrison, 1997), but observed perching on protruding branches ca. 5 m above a road in Vu Quang (Borissenko et al., 2001). In the same area one specimen (subadult male) was taken in a niche in the cliffs over a river (two specimens were observed there). Reported to roost in caves and hollow trees, living solitary or in pairs (Bates, Harrison, 1997), which are most likely to be mother-and-infant groups. Echolocation calls are of high intensity with the CF conponent around 110 kHz.

Rhinolophus paradoxolophus (Bourret, 1951)

COMMON NAMES. Dơi lá quạt; Big-leafed horseshoe bat; Большеухий подковонос.

MATERIAL STUDIED. One specimen from Ke Bang (Quang Binh Province), collected by Dr. M. V. Kalyakin.

DIAGNOSIS. A medium-sized horseshoe bat (weight ca. 12 g; forearm ca. 51.1–51.9; CCL ca. 18 mm) of characteristic appearance. Ears very large, exceeding $^1/_2$ forearm in length, with prominent antitragal lobes nearly $^1/_2$ of ear pinna in height. Noseleaf structure very peculiar. Lancet obscure, rounded; connecting process also reduced (Fig. 19i). Sella very large (reaching antitragal lobes in height), leaf-like, with well-developed basal lappets. Internarial cup expanded, its sides forming prominent rounded leaflets.

Differs readily from all Vietnamese horseshoe bats (except *R. marshalli*) by characteristic noseleaf structure; from the latter species — by larger size and structure of sella. Another similar species hitherto recorded from southern China is *R. rex* (Hill, 1972) which is considerably larger (forearm over 59 mm).

DISTRIBUTION AND COLLECTING SITES. Indo-Chinese species of middle elevations. Except for Vietnam, *R. paradoxolophus* was found only in Thailand (Thonglongya, 1973). In Vietnam it was recorded in Sa Pa (Northern Vietnam; type locality) and in Phong Nha — Ke Bang National Park (Timmins et al., 1999; Kruskop, 2000b).

COMMENTS ON NATURAL HISTORY. Natural history poorly known. The single individual captured in Ke Bang in April was netted in dense undergrowth in a primary deciduous forest. Taking into account this fact together with wing and ear morphology, it is possible to suppose, that this species could be a typical «forester» and perch-hunter. The mentioned specimen was a pregnant female.

Rhinolophus marshalli Thonglongya, 1973

COMMON NAMES. Dơi lá Masan; Marshall's horseshoe bat; Подковонос Маршалла.

MATERIAL STUDIED. No collection material was seen; the diagnosis below is based on Thonglongya (1973).

IDENTIFICATION. A small to medium-sized horseshoe bat (forearm ca. 44–47 mm; CCL ca. 17 mm) essentially similar to *R. paradoxolophus* in external appearance. Lancet reduced, broadly triangular. Sella very large, abruptly broadened at base. Internarial cup expanded, its sides forming prominent leaflets giving it trapezoid appearance.

Differs from *R. paradoxolophus* in size and shape of sella and internarial cup.

DISTRIBUTION AND COLLECTING SITES. This species distributed sporadically in Thailand, Malaya and Northern Vietnam (Corbet, Hill, 1992).

COMMENTS ON NATURAL HISTORY. No data available for Vietnam. Supposedly, a cave-dwelling species (Bates et al., 2001).

FAMILY VESPERTILIONIDAE GRAY, 1821

COMMON NAMES. Họ dơi muỗi, Plain-nosed bats; Гладконосые.

GENERAL CHARACTERISTICS. The most diverse and widespread bat family displaying a tremendous variety of foraging and roosting adaptations.

DIAGNOSIS. Premaxillae with reduced palatal branches and well-developed nasal branches, completely fused with maxillae, widely apart from each other, with at least one pair of well-developed upper incisors. Dental structure essentially similar to that of other microchiropteran bats. Upper molars usually with reduced hypocone basin. The lower molar has two principal types of the position of postcristid relative to the posterior cusps (Fig. 20). Typically it connects the hypoconid with the entoconid, leaving the hypoconulid separate; this condition (characteristic of the vespertilionid genus *Myotis*) is called «**myotodont**». If the postcristid is shifted posteriorly joining the hypoconid with the hypoconulid, this condition (characteristic of the vespertilionid genus *Nyctalus*) is called «**nyctalodont**».

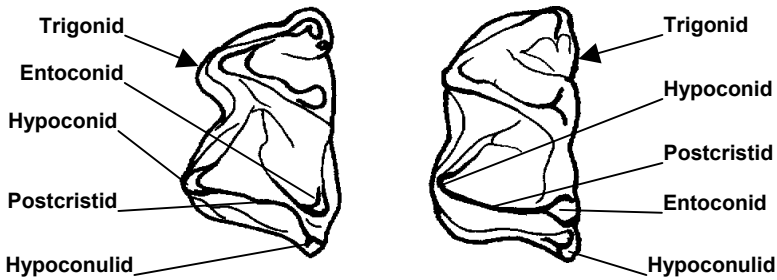

Fig. 20. Two basic types of cusp pattern of a the lower molars in vespertilionid bats (first right molar). Left: nyctalodont (*Pipistrellus javanicus*) and right: myotodont (*Hypsugo pulveratus*).

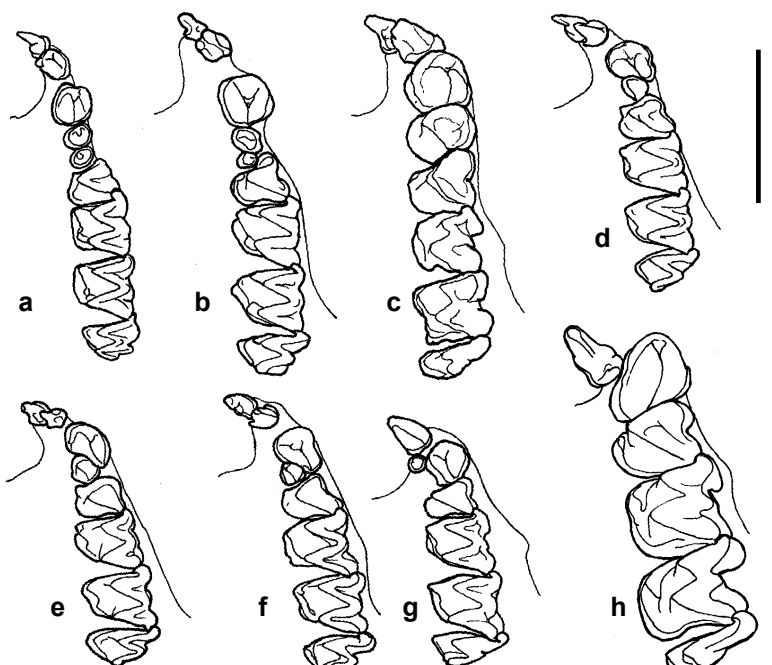

Fig. 21. Left upper toothrows in Vespertilionidae (ventral view), scale 3 mm. a) *Myotis muricola*; b) *Myotis hasselti*; c) *Murina huttoni*; d) *Pipistrellus coromandra*; e) *Glischropus tylopus*; f) *Hypsugo pulveratus*; g) *Hesperoptenus blanfordi*; h) *Scotophilus kuhli*.

Basisphenoid pits shallow or lacking. Dental formula variable. Small upper premolars, when reduced, tend to become intruded from toothrow.

External appearance most variable. No leaflike outgrowths on muzzle. Tail long, reaching the edge of uropatagium, which is also well-developed; tail vertebrae flex ventrally. Calcar long, sometimes with an accessory lobe at base. Ears (Fig. 24) always with a tragus; antitragal lobe variously present.

DISTRIBUTION. Distributed worldwide, except for polar regions and the most remote oceanic islands, range nearly matching that of the order. Many species common throughout Indochina. Inhabiting a wide variety of landscapes and displaying a wide gamut of foraging and roosting preferences.

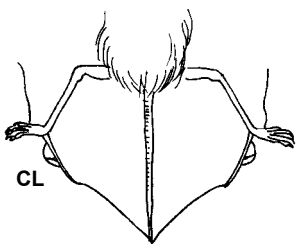

Fig. 22. Interfemoral membrane in *Hesperoptenus blanfordi*. CL — calcar lobe.

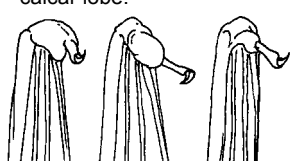

Fig. 23. Shape of the thumb pad in various representatives of Vespertilionidae: a) *Eudiscopus denticulus*; b) *Myotis rosseti*; c) *Myotis muricola*.

NATURAL HISTORY. Most are aerial insectivores, however, a number of facultative and specialized gleaners exist. Typically they roost clinging on to vertical walls of the shelter, often in crevices.

TAXONOMICAL REMARKS. Taxonomically very complex group with ca. five subfamilies, ca. 40 genera and over 300 species, of which 45–47 species of 17 genera have been reported from Vietnam. Many of these taxa are of uncertain status. The monotypis subfamily Miniopterinae was sometimes raised up to family level (e. g., Mein, Tupinier, 1977; Tiunov, 1997). The most problematic is the composition and taxonomic structure of the nominative subfamily. Traditionally, is divided into four tribes, as it was suggested by Tate (1942). However, latest phylogenetic investigations (both morphological and molecular, see: Simmons, Gaisler, 1998) showed the insufficiency of such devision. For example, Myotini was suggested to be a separate subfamily.

Insufficient substantiation of the tribe Nycticeini was shown in a set of works (Menu, 1987; Hill, Harrison, 1987), and various genera from this former taxon were united with different vespertilionine groups. At least, on the basis of mostly karyological data the nominative tribe was suggested to be divided to three different lineages (Heller, Volleth, 1984; Volleth, Heller, 1994), and former Nycticeini were included into one of these, «Eptesicini».

Here we accepted in part the view of the latter authors, but with several corrections. We left the tribe Myotini inside the nominative subfamily, and did not separate the nominative tribe. Genus *Eudiscopus* was provisionally

allocated with Myotini. It seems most reconcilable that the former nominative tribe (including Nycticeini) may be rather naturally divided into two clusters, which were named here Pipistrellina (*Pipisterllus* and related genera with nyctalodont lower molars and relatively large outer upper incisors), and Vespertilionina s. str. (genera with myotodont lower molars and usually somewhat reduced outer incisors). However, this system is clearly not final and needs further investigations.

Key to the genera of Vietnamese Vespertilionidae

External characters

1 Tragus straight, narrow, with maximum width at base, sharply pointed or only slightly blunt at top.....**2**

— Tragus of various shape; if straight, blunt or rounded on top and commonly not narrow; if pointed, distinctly curved frontward.....**6**

2 Interfemoral membrane dorsally covered with long hairs. Nostrils prominent and noticeably tubular in shape **3**

— Interfemoral membrane not covered with fur or only at base. Nostrils not noticeably tubular.....**4**

3 Size larger: forearm commonly longer than 44 mm..... ..... *Harpiocephalus* (p. 161, one species, *H. harpia*[*])

— Size smaller: forearm commonly shorter than 44 mm .....*Murina* (p. 120)

4 Ears funnel-shaped, their width subequal to their height. Height of tragus not less than $^{2}/_{3}$ of ear length. Fur soft and wooly, densely covering head and muzzle .....*Kerivoula* (p. 117)

— Ears not funnel-shaped, relatively long and straight; their width ca. twice larger than length. Height of tragus usually $^{1}/_{2}$ or less of ear length. Fur not very soft and wooly; not concealing most of the muzzle and lips.....**5**

5 Well-developed concave adhesive pads on hind feet and pads on thumb (forearm 34–39 mm) ..... *Eudiscopus* (p. 133, one species, *E. denticulus*)

— No definite adhesive pads on feet and thumb, if present, forearm less then 31 mm .....*Myotis* (p. 120)

6 Calcar with a well-developed lobe or keel (*epiblema*), commonly possessing a transverse cartilaginous septum.....**7**

— Calcar lobe (epiblema) reduced or absent, if present, very narrow and without a transverse septum **9**

[*] See comments under *H. harpia* for its distinction from the similar *H. mordax* and the taxonomic status of the latter.

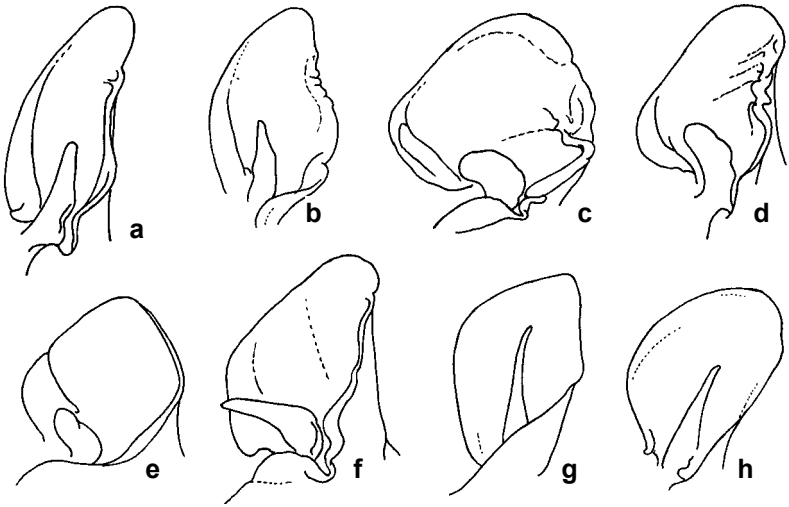

Fig. 24. Variations in ear shape in Vespertilionidae: a) *Eudiscopus denticulus*; b) *Myotis horsfieldi*; c) *Nyctalus noctula*; d) *Pipistrellus tenuis*; e) *Hesperoptenus blanfordi*; f) *Scotophilus heathi*; g) *Kerivoula picta*; h) *Murina huttoni*.

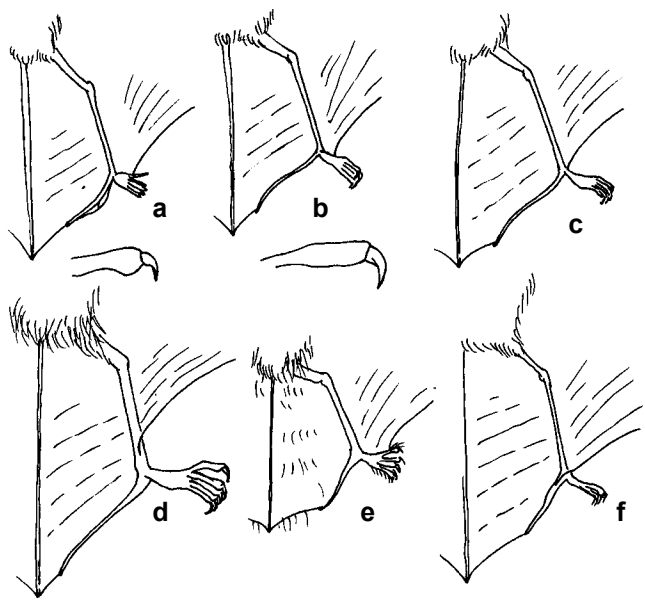

Fig. 25. Variations in hind foot proportions and the pattern of attachment of the wing membrane in Vespertilionidae: a) *Myotis muricola*; b) *Myotis horsfieldi*; c) *Myotis hasselti*; d) *Myotis ricketti*; e) *Murina aurata*; f) *Miniopterus magnater*.

7 Tragus relatively long, its length ca. twice exceeding width. Frontal part of face more or less concave **8**

— Tragus short, its length subequal to width. Frontal part of face flat, without any flexure..... *Hesperoptenus blanfordi* (p. 153)

8 Well-developed not pigmented pads on the base of thumb ....*Glischropus* (p. 141, one species, *G. tylopus*)

— Adhesive pads on bases of thumbs absent; base of thumb usually well pigmented.....*Pipistrellus* (p. 135)

9 Tragus prominently deflected forward, its distal half narrower then basal, sometimes slightly pointed.....**10**

— Tragus not definitely deflected forward, its distal half equal in width or wider then basal, not pointed.....**11**

10 Dorsal pelage without spots. Wings uniform in color. Tragus more or less pointed.....*Scotophilus* (p. 155, two species):

10a Forearm usually less then 55 mm. Ventral pelage buffy-brown..... .....*S. kuhli* (p. 156)

10b Forearm always more then 55 mm. Ventral pelage with distinct yellowish tinge .....*S. heathi* (p. 155)

— Dorsal pelage with white spots on crown, back and shoulders. Forearm and metacarpals flesh-colored, membranes between them dark-brown. Tragus with blunt tip ..... *Scotomanes* (p. 153, one species, *S. ornatus*)

11 Forearm length less then 30 mm. Distinctive adhesive pads present on feet and thumb.....*Tylonycteris* (p. 150, two species):

11a Pelage with distinct golden tinge, brown dorsally and pale golden-brown on throat. .....*T. pachypus* (p. 151)

11b Pelage without golden tinge, dark brown dorsally, and dull gray-brown on throat ..... *T. robustula* (p. 151)

— Forearm more then 30 mm. Usually no any adhesive pads.....**12**

12 Forearm not less then 70 mm .....*Ia* (p. 147, one species, *I. io*)

— Forearm commonly less then 60 mm **13**

13 Distal phalanx of third digit very long, only slightly shorter then correspondent metacarpal (Fig. 30)..... *Miniopterus* (p. 162)

— Distant phalanx of third digit less then $^1/_2$ of correspondent metacarpal...**14**

14 Ears with well-visible white margins. Dorsal pelage dark, tipped with cuprous-red or orange .....*Arielulus* (p. 148, two species):

14a Forearm less then 44 mm. Throat pelage same color as all the ventral part .....*A. circumdatus* (p. 149)

14b Forearm length more then 46 mm. Pale yellowish color on throat, contrast to the rest dark ventral pelage .....*A. aureocollaris* (p. 149)

— Ears with no white margins. Dorsal pelage of various color, but not tipped with cuprous-red or orange.....**15**

15 Tragus club-shaped, more then twice wider in distal part then at base (Fig. 24c). Ventral surface of wing membrane along the forearm distinctly covered with fur .....*Nyctalus* (p. 143, one species, *N. noctula*)

— Tragus not club-shaped, less then twice wider in distal part then at base. Ventral surface of wing membrane, except for the armpit not covered with fur.....**16**

16 Forearm less then 40 mm .....*Hypsugo* (p. 144, two species):

16a Dorsal pelage essentially black, tipped with golden-brown. Tragus in height ca. $^1/_3$ of ear pinna.....*H. pulveratus* (p. 144)

16b Dorsal pelage chestnut brown, somewhat darker at roots. Tragus in height slightly less than $^1/_2$ of very broad ear pinna ...*H. cadornae* (p. 145)

— Forearm usually not less then 50 mm **17**

17 Dorsal pelage commonly with more or less distinct yellowish tinge, ears yellowish-brown. Forearm and metacarpals pale flesh-colored, membranes between them dark .....*Hesperoptenus tickelli* (p. 152)

— Dorsal pelage without yellowish tinge, more or less dark, ears dark. Wings uniformly dark brown..... *Eptesicus* (p. 146, one species, *E. serotinus*)

Cranial characters

1 Two small premolars (six cheek teeth) in each side of upper jaw.....**2**

— No more then one small premolar (four or five cheek teeth) in each side of upper jaw.....**3**

2 Upper small premolars ($P^{2–3}$) subequal in size, not greatly reduced. Upper toothrows somewhat S-shaped (at ventral view), sub-parallel an the levels of C–P^3 and $M^{1–3}$, convergent at the level of P^4 .....*Kerivoula* (p. 117)

— Second upper premolar (P3) more or less reduced, $^1/_2$ or less of the first premolar in height. Upper toothrows not S-shaped, gradually convergent in their anterior half..... *Myotis* (p. 120), part.

3 Three premolars (six cheek teeth) in each side of lower jaw.....**4**

— Five or four cheek teeth in each side of lower jaw.....**6**

4 Second lower premolar displaced inward from the toothrow. Skull much flattened: height of braincase less then 60% of mastoid width..... ..... *Eudiscopus* (p. 133, one species, *E. denticulus*)

— Second lower premolar not displaced from toothrow. Skull not flattened: height of braincase more then 70% of mastoid width **5**

5 Anterior part of braincase much inflated, with deep fronto-nasal flexure. Sagittal crest with more developed anterior (interorbital) part..... ..... *Miniopterus* (p. 162)

— Braincase commonly not much inflated (at least in local species), fronto-nasal flexure moderate or absent. Anterior part of sagittal crest (when present) less developed then posterior part.....*Myotis* (p. 120), part.

6 Skull very much flattened (Fig. 45): height of braincase ca. $^1/_2$ of mastoid width.....*Tylonycteris* (p. 150, two species):

6a Nasal notch not expanded backwards to the level of infraorbital foramina. Rostrum relatively narrow and light.....*T. pachypus* (p. 151)

6b Nasal notch expanded backwards over the level of infraorbital foramina. Rostrum relatively wide and robust..... *T. robustula* (p. 151)

— Skull not distinctly flattened: height of braincase ca. 70% of mastoid width or more **7**

7 Two upper premolars in each side.....**8**

— One upper premolar in each side.....**17**

8 Anterior upper premolar relatively large, always distinctly higher than cingulum of upper canine or posterior premolar **9**

— Anterior upper premolar much reduced, less in height than canine cingulum; occasionally concealed in gum and in this case seen only on a cleared skull **14**

9 Anterior upper premolar not or insignificantly displaced from toothrow, entirely seen at lateral view.....**10**

— Anterior upper premolar significantly displaced from toothrow, partly or entirely invisible behind other teeth at lateral view.....**12**

10 Anterior upper premolar distinctly smaller then posterior premolar, differs well from it in crown shape.....*Myotis* (p. 120), part.

— Anterior upper premolar (P^3) quite similar to posterior premolar (P^4) in crown shape, its height and crown area not less than $^1/_2$ of that of posterior premolar **11**

11 Upper molars with reduced crown elements, obscured W-shaped ectoloph pattern (Fig. 28a). M^3 much reduced, not exceeding $^1/_3$ of M^2 in crown width..... *Harpiocephalus* (p. 161, one species, *H. harpia*)

— Upper molars with typical W-shaped crown structure (Fig. 28b). Posterior upper molar (M^3) not reduced, ca. $^1/_2$ of second molar (M^2) in width..... .....*Murina* (p. 157)

12 Outer upper incisor situated directly laterally from the inner one (Fig. 21e), all four incisors form an almost straight transverse row..... .....*Glischropus* (p. 141, one species, *G. tylopus*)

— Outer upper incisor situated latero-posteriorly from the inner one **13**

13 Lower molars of nyctalodont-type (postcristid connected with hypoconulid) .....*Pipistrellus* (p. 135)

— Lower molars of myotodont-type (postcristid connected with entoconid).... .....*Hypsugo pulveratus* (p. 144)

14 Condylocanine length more than 25 mm.....*Ia* (p. 147, one species, *I. io*)

— Condylocanine length less than 20 mm **15**

15 Condylocanine length more than 16 mm. Lower molars of nyctalodont-type.....*Nyctalus* (p. 142, one species, *N. noctula*)

— Condylocanine length less than 16 mm. Lower molars of the myotodont-type.....**16**

16 Well-developed supraorbital crests protrude over the orbit profile in the shape of angular projections. Condylocanine length more than 14 mm..... .....*Arielulus circumdatus* (p. 149)

— Supraorbital crests poorly developed, no supra-orbital projections. Condylocanine length not more than 13 mm .....*Hypsugo cadornae* (p. 145)

17 Only one upper incisor in each side **18**

— Two upper incisors in each side (outer incisor may be highly reduced and almost completely covered in gum) **19**

18 Anterior palatal emargination quite large and broad, extends backward to the level of upper premolars.....*Scotophilus* (p. 155, two species):

18a Larger: condylocanine length not less than 19 mm, upper toothrow ($C–M^3$) more than 7 mm .....*S. heathi* (p. 155)

18b Smaller: condylocanine length not more than 18 mm, $C–M^3$ less than 7 mm .....*S. kuhli* (p. 156)

— Anterior palatal emargination small and narrow, extending backwards to the level of the mid-line of upper canine .... *Scotomanes* (p. 153, one species, *S. ornatus*)

19 Outer incisor situated laterally from the inner one **20**

— Outer incisor situated almost directly behind the inner one .... *Hesperoptenus* (p. 152, two species):

19a Size considerably larger: upper toothrow (C–M^3) not less than 7 mm ..... *H. tickelli* (p. 152)

19b Size very small: upper toothrow less than 4.5 mm..... ..... *H. blanfordi* (p. 153)

20 Skull with moderately-developed supra-orbital crests and without supra-orbital projections. Last upper molar (M^3) reduced, its crown area less than $^1/_2$ of that of M^2..... *Eptesicus* (p. 146, one species, *E. serotinus*)

— Skull with very prominent supra-orbital crests, divided by deep middle rostral depression, and with well-developed supra-orbital projections. Last upper molar (M^3) not reduced, ca $^1/_2$ or little more of M^2 in crown area..... .....*Arielulus aureocollaris* (p. 149)

Genus *Kerivoula* Gray, 1842

GENERAL CHARACTERISTICS. Small to medium-sized vespertilionid bats with some archaic morphological features.

DIAGNOSIS. Skull on Fig. 39. Dental formula: $I^2/_3$ $C^1/_1$ $P^3/_3$ $M^3/_3$ ×2 = 38. Small upper and lower premolars always lie within the axis of toothrows, variably reduced, but usually correspondent first and second premolars similar in shape and size. Upper toothrows somewhat convergent at the level of P^4 and sub-parallel at the levels of C–P^3 and $M^{1–3}$, which makes them somewhat S-shaped. Skull with very prominently concave posterior rostrum and high, often bulbous braincase. Muzzle relatively long and narrow. Ears funnel-shaped, without any prominent folds or emarginations on posterior border; tragus long, straight and narrow. Pelage dense and ruffled, covering most of the muzzle, except for the tip. Sternum short and broad; only four or five ribs connected to it (character of the subfamily Kerivoulinae).

DISTRIBUTION. Widely distributed in sub-Saharan Africa, Indomalayan region, from India to southern China, Great Sunda and Philippine Islands, also on New Guinea and Bismark Islands.

NATURAL HISTORY. A poorly known group of forest-dwelling bats.

TAXONOMICAL REMARKS. Includes ca. 17 species, with no division into subgenera and/or species groups. Some authors also include here the genus *Phoniscus* with 4 species. In Vietnam three species were recorded, and the presence of an additional one needs further substantiation.

Key to the species of Vietnamese *Kerivoula*

External characters:

1. Larger: forearm ca. 40–45 mm ..... *K. papillosa* (p. 120)
— Smaller: forearm ca. 27–39 mm **2**
2. Fur on back bright red, membranes dark brown with red markings. Uropatagium with a conspicuous fringe of hairs ..... *K. picta* (p. 118)
— Fur on back brown (hairs sometimes with russet tips), membranes more or less uniform brown. Fringe of hairs on uropatagium poorly developed **3**
3. Smaller: forearm 27–31 mm. Wing membranes with whitish tips .... *K. whiteheadi* (p. 120)
— Larger: forearm 30–38.5 mm. Wing membranes uniform brown, without whitish tips ..... *K. hardwickii* (p. 119)

Cranial characters

1. Larger: CBL over 15 mm, C–M^3 6.6–7.4 mm..... *K. papillosa* (p. 120)
— Smaller: CBL less than 14 mm, C–M^3 less than 6 mm. **2**
2. Smaller: CBL less than 12 mm. Upper premolars elongated, oval in cross-section ..... *K. whiteheadi* (p. 120)
— Larger: CBL over 12 mm. Upper premolars subcircular in cross-section .. **3**
3 Inner upper incisor noticeably bicuspid ..... *K. picta* (p. 118)
— Inner upper incisor unicuspid ..... *K. hardwickii* (p. 119)

Kerivoula picta (Pallas, 1767)

COMMON NAMES. Dơi mũi nhẵn đốm vàng; Painted bat; Пестрокрылый воронкоухий гладконос.

MATERIAL STUDIED. One specimen, supposedly from Vietnam; two additional specimens from extalimital SE Asia (deposited in ZISP collection).

IDENTIFICATION. A small vespertilionid (weight ca. 4.5 g; forearm ca. 32–39 mm; CBL ca. 12–14 mm) of characteristic appearance. Interfemoral membrane covered with hairs along its proximal half, hairs also extend along hind limbs and form a characteristic fringe along the edge of uropatagium. Pelage coloration is bright red to orange above, somewhat paler underneath. Wing membranes dark brown with bright red markings along the body and limbs (in live specimens); interfemoral membrane red throughout. Muzzle completely covered with hairs, only the nostrils protruding out.

Clearly differs from its congenerics by characteristic coloration pattern; from similar-sized *K. hardwickii* — also in the form of inner upper incisor I^1.

DISTRIBUTION AND COLLECTING SITES. Widely but sporadically distributed from south-west India and Sri Lanka to Hainan, Malacca, Great Sunda Islands and Moluccas (Corbet, Hill, 1992). In Vietnam it was reported from Lao Cai, Bac Thai, Na Noi, Quang Nam — Da Nang and Khanh Hoa Provinces (Huynh et al., 1994).

COMMENTS ON NATURAL HISTORY. Natural habits in Vietnam little known. This species was reported to roost in dead down-hanging banana leafs, solitarily or in pairs, using their bright orange-black coloration as camouflage. It also roosts amongst dry leafs of other plants, sugar cane and other tall grass, and in empty nests of some birds, e. g. *Ploceus* (Lekagul, McNeely, 1977; Bates, Harrison, 1997). Flight slow and maneuverable, with fluttering motion, making this bat looking like a large moth. According to external morphology, this species seems to be capable of ground or foliage gleaning (Kruskop, 1999).

Kerivoula hardwickii (Horsfield, 1824)

COMMON NAMES. Dơi mũi nhẵn; Hardwicke's forest bat; Воронкоухий гладконос Хардвика.

MATERIAL STUDIED. No material from Vietnam was seen; the diagnosis below generally follows Bates and Harrison (1997).

IDENTIFICATION. A small vespertilionid (weight ca. 4–5 g; forearm ca. 30–39 mm; CBL ca. 12–14 mm). In general appearance similar to *K. picta*, except for coloration pattern. Interfemoral membrane not conspicuously haired; there is no distinct fringe of hairs on its edge. Pelage brown to dark brown above, hairs on the belly with dark bases and paler tips. Membranes uniform brown.

Differs from *K. picta* in coloration pattern, from *K. papillosa* in smaller size, from *K. whiteheadi* in larger size and absence of white tips on wigs. May be confused with small *Myotis* species, from which it could be distinguished by intensively haired muzzle, funnel-shaped ears, abruptly steep skull profile and the nearly equal size of the first and second small upper premolars.

DISTRIBUTION AND COLLECTING SITES. Widely distributed from southern India and Sri Lanka to south and eastern China, Vietnam, Malaysia, Sunda and Philippine Islands (Corbet, Hill, 1992). In Vietnam known from Dac Lac (Huynh et al., 1994) and Nghe An (Hayes, Howard, 1998) Provinces.

COMMENTS ON NATURAL HISTORY. Natural habits in Vietnam not known. In the Indian subcontinent probably confined to disturbed forests and orchards at various elevations, up to 2060 m a. s. l. (Bates, Harrison, 1997). Roosts in houses (Csorba et al., 1998) and, probably in foliage. Judging by wing morphology, it may be a ground or foliage gleaner (Kruskop, 1999).

Kerivoula papillosa Temminck, 1840

COMMON NAMES. Dơi mũi nhẵn Java; Papillose bat; Яванский воронкоухий гладконос.

MATERIAL STUDIED. No material from Vietnam was seen; the diagnosis below generally follows Bates and Harrison (1997).

IDENTIFICATION. A small to medium-sized vespertilionid (weight ca. 9–10 g; forearm ca. 40–45 mm; CBL ca. 15.6–16.1 mm; Medway, 1978). Interfemoral membrane not conspicuously haired; there is no fringe of hairs on its edge. Fur above brown with russet tips, pale midparts and dark roots; belly more grayish, also with darker hair bases. Membranes uiform brown.

Differs from the remainder Vietnamese *Kerivoula* by larger size. Could be confused with medium-sized *Myotis* (*M. montivagus*, *M. adversus*, *M. hasselti*), however differs from them clearly in skull shape, relative size of small upper premolars, shape of ears and muzzle.

DISTRIBUTION AND COLLECTING SITES. Disrupted distribution area, including north-eastern India, Vietnam, Cambodia, Malaysia, Great Sunda Islands and Sulawesi (Corbet, Hill, 1992; Bates, Harrison, 1997; Kock, 2000). In Vietnam it was reported from Dac Lac Province (Huynh et al., 1994).

COMMENTS ON NATURAL HISTORY. A forest-dwelling species; natural history in Vietnam unknown.

?*Kerivoula whiteheadi* Thomas, 1894

COMMON NAMES. Dơi rừng; Whitehead's wooly bat; Воронкоухий гладконос Уайтхеда.

MATERIAL STUDIED. No material was seen.

IDENTIFICATION. A very small vespertilionid (weight ca. 3.3 g; forearm ca. 27–31 mm; CBL ca. 11.8–11.9 mm). Proximal part of interfemoral membrane conspicuously haired, however, hairs do not extend far along the limbs and along the edge of the membrane. Wing membranes with conspicuous whitish tips.

Differs from the remainder species of *Kerivoula* by small size, white tips of wings and more prominent fronto-nasal concavity, forming almost right angle between rostrum and forehead.

DISTRIBUTION AND COLLECTING SITES. Distributed sporadically on Philippine Islands, Borneo and Malacca Peninsula. Hitherto no published records from Indochina; was only provisionally reported by B. Hayes (pers. comm.).

COMMENTS ON NATURAL HISTORY. Unknown.

Genus *Myotis* Kaup, 1829

GENERAL CHARACTERISTICS. Small to large «typical» vespertilionid bats, usually with two small premolars in each jaw.

DIAGNOSIS. Skulls on Fig. 40 and Fig. 41. Dental formula: $I^2/_3$ $C^1/_1$ $P^{2-3}/_{2-3}$ $M^3/_3$ ×2 = 34–38. Anterior upper and lower premolars (P^2 and P_2) simple, but not greatly reduced, always within toothrows. Middle premolars (P^3 and P_3) similar to them in shape, variable in size, however in the upper jaw distinctly smaller than anterior premolars, in some species intruded from the axis of the toothrows, or absent. Upper molars with well-developed mesostyle and reduced, but always present hypocone; sometimes they also possess paraconules. Lower molars of myotodont type. Upper outer incisor with supplementary cusps, larger, than inner one. Canine without any supplementary cusps.

Ear relatively narrow, its length always exceeds its width. Tragus straight, narrow and usually pointed. Ear pinna not funnel-shaped, slightly folded on posterior margin. Muzzle variably covered with fur (occasionally almost naked). Wings wide or moderately narrowed, with almost equal metacarpals (5th slightly shorter than 4th and 3rd). Hind foot size and pattern pf attachment of the wing membrane to the leg are most variable (Fig. 25).

DISTRIBUTION. Worldwide, equal to that of family Vespertilionidae except for New Zealand. In Vietnam — everywhere, on all elevations and in both primary and variously disturbed habitats.

NATURAL HISTORY. Most species are specialized aerial insectivores; several forms are ground of foliage gleaners, or water gleaners (trawlers), capable of feeding on aquatic invertebrates and even small fish. Most common day roosts are hollow trees, caves, crevices in tree trunks, rocks and buildings. Usually small aggregations of ten to thirty individuals are formed, some species are highly colonial; males and subadults may live solitarily.

TAXONOMICAL REMARKS. One of the most complex genera within the family and the order, including nearly 100 species. This amount of taxa is divided into many species groups and variable number of subgenera (from three (Findley, 1972) to nine (Pavlinov et al., 1995)). Some of these subgenera virtually razed to generic rank. The most popular system divides the genus into four major groups (Koopman, 1994): *Myotis* s. str., *Selysius*, *Leuconoe* and *Cistugo*. However, molecular (Reudi, Mayer, 2001), as well as some morphological evidences do not support this point of view, which is based mainly on adaptive features. Until comprehensive taxonomical studies of *Myotis* are carried out, we suggest using for Indochina the system offered in Pavlinov et al. (1995), except for the position of *M. ricketti*. According to it there are 11 *Myotis* species in the Vietnamese fauna, representing three subgenera. Two additional species which may be found in Vietnam are *M.* (*Isotus*) *altarium* and *M.* (*Chrysopteron*) *formosus*.

Key to Vietnamese *Myotis* (external and cranial characters combined)

1. Hind foot (with claws) considerably exceeding $^1/_2$ of tibia, wing membrane attaches to metatarsus or to tibia (Fig. 25bcd). No calcar lobe. Upper molars with distinct paraconules **2**

— Hind foot (with claws) shorter or nearly equal to $^1/_2$ tibia, wing membrane attaches to the base of the outer digit (Fig. 25a). Calcar lobe variously present, often well developed. Upper molars without paraconules **6**

2 Larger: forearm over 50 mm, CCL over 17.5 mm. Hind foot very large, ca. $^3/_4$ of tibia length ..... *M. ricketti* (p. 133)

— Smaller: forearm less than 45 mm, CCL less than 16 mm. Hind foot does not exceed $^2/_3$ of tibia..... **3**

3. Size very small: forearm 35 mm or less, CCL less than 12 mm, C–M^3 less than 5.5..... *M. annamiticus* (p. 129)

— Larger: forearm over 35 mm, CCL over 12.5 mm, C–M^3 usually over 5.5 mm **4**

4. Wing membrane attaches to metatarsus (below ankle). P^3 usually not less than $^1/_2$ P^2 in crown area, positioned more or less within toothrow, P^2 separated from P^4 by a distinct gap, P^3 visible at lateral view..... **5**

— Wing membrane attaches to ankle or lower part of tibia. P^3 usually reduced, less than $^1/_2$ P^2 in crown area, variously intruded from toothrow. P2 compressed against P4 (Fig. 21b), P3 not visible at lateral view .... *M. hasselti* (p. 132)

5. Canines relatively large, nearly twice the height of P^4. Wingtip index (ratio of third digit to forearm length) more than 1.8..... *M. horsfieldi* (p. 131)

— Canines relatively reduced, about the same height as P^4. Wingtip index less than 1.8..... *M.* cf. *daubentoni* (p. 130)

6. Larger: forearm over 39 mm, CCL over 13 mm **7**

— Smaller: forearm less than 37 mm, CCL less than 13 mm **10**

7. Very large: forearm over 60 mm, CCL over 20 mm ..*M. chinensis* (p. 123)

— Smaller: forearm less than 55 mm, CCL less than 17 mm **8**

8. Larger: forearm 45–53 mm, CCL over 16 mm. Pelage bright red, membranes dark brown with bright red markings along skeletal elements..... .....*M. formosus*

— Smaller: less than 47 mm, CCL less than 16 mm. Pelage uniform brown, slightly paler underneath, membranes uniformly dark **9**

9. Ears over 20 mm, when laid forward extend far beyond muzzle. Calcar lobe not developed. P^3 not intruded from toothrow.....*M. altarium*

— Ears shorter than 16 mm, when laid forward not extending beyond muzzle. Calcar lobe well developed. P^3 strongly intruded from toothrow, P^2 compressed against P^4.....*M. montivagus*[*] (p. 124)

10. Forearm 27–31 mm. Conspicuous inflated pads at the bases of thumbs. P^3 and P_3 absent.....*M. rosseti* (p. 128)

— Forearm over 30 mm. Bases of thumbs without pads. P^3 and P_3 variously reduced but always (typically) present.....(«*muricola*» group[†]) **11**

11. Smaller: forearm ca. 31–36 mm, CCL usually less than 12 mm, C–M^3 usually less than 5 mm. Skull profile raised abruptly in frontal region (Fig. 26). Lower canine not exceeding P_4 in height *M. siligorensis* (p. 125)

— Larger: forearm ca. 32–37 mm, CCL usually over 11.5 mm, C–M^3 usually over 5 mm. Skull profile rising less abruptly in frontal region. Lower canine exceeding P_4 in height.....**12**

12. Smaller: forearm ca. 32–35 mm, CCL usually less than 12.5 mm, C–M^3 usually less than 5.5 mm. Calcar lobe well pronounced. Dentition less robust.....*M. muricola* (p. 126)

— Larger: forearm ca. 34–37 mm, CCL usually over 12.5 mm, C–M^3 usually over 5.4 mm. Calcar lobe poorly developed (as a narrow keel along calcar) or absent. Dentition more robust.....*M. ater* (p. 127)

Myotis chinensis (Tomes, 1857)

COMMON NAMES. Dơi tai lớn; Chinese mouse-eared bat; Южнокитайская ночница.

MATERIAL STUDIED. Collection material from Vietnam was not seen. Only one specimen from SE China was studied (deposed in State Darwin Museum, Moscow).

IDENTIFICATION. A large vespertilionid bat (weight ca. 25–30 g; forearm ca. 65–69 mm; CCL ca. 20.5–22 mm). Wing attaches to the outer metatarsus just above the basal phalanx of the first finger. Ear slightly elongated, when laid forward extending beyond the tip of the muzzle. calcar without basal lobe. P^3 ca. $^1/_2$ of P^2, slightly intruded from the toothrow. Pelage color uni-

[*] See comments under *M. montivagus* for distinction from extralimital *M. annectans*.

[†] Precise identification of members of the «*muricola*» group is possible only provided that sufficient comparative collection material is available. Any identification of a single specimen using these keys should be regarded as provisional. See also comments under *M. muricola*.

form olive brown or dark gray above and slightly paler below. Membranes, ears and muzzle dark gray.

Readily distinguishable from the remainder *Myotis* species by its size, largest within the genus. From similar-sized *M. ricketti* it could still be distinguished by larger size, smaller foot (ca. $^1/_2$ of tibia length) and the pattern of attachment of the wing membrane to the foot.

DISTRIBUTION AND COLLECTING SITES. Chinese species, inhabiting eastern and southern China, northern Thailand, Myanmar and Vietnam (Allen, 1938; Bates et al., 2001). In Vietnam it was found in Phong Nha, Pu Mat and Huu Lien Nature Reserves and in Cuc Phuong National Park (Bates et al., 1999). Probably inhabit all limestone areas in northern half of the country.

COMMENTS ON NATURAL HISTORY. Most of the recent records of this species in SE Asia (Bates et al., 1999; Bates et al., 2001) report it being netted near cave entrances in or adjacent to limestone areas with rivers and streams.

Myotis montivagus Dobson, 1874

COMMON NAMES. Dơi tai Miến Điện; Burmese whiskered bat; Бирманская ночница.

MATERIAL STUDIED. One adult nulliparous female from Vu Quang.

DIAGNOSIS. Medium-sized vespertilionid bats (weight ca. 12 g; forearm ca. 39–47 mm; CCL ca. mm).

Medium-sized *Myotis*, largest of Vietnamese whiskered bats (forearm 39–47 mm). Pelage soft and thick, with almost black roots and with tips dark brown dorsally and buffy brown ventrally. Naked parts almost black. Wings are relatively long and wide. Wing membrane attached to the base of outer metatarsus. Calcar sometimes with small keel. Ears relatively small, blunt and concave posteriorly. Foot of moderate size, ca. $^1/_2$ of tibia length. Skull with robust rostrum and smooth upper profile, poorly concave in fronto-nasal part. Second upper premolar (P3) highly displaced from toothrow, thirst and third premolars almost in contact.

The presence of a lobe on the calcar and somewhat shortened toothrow makes this species possible to confuse with serotine-like bats (*Eptesicus* and *Hesperoptenus*), from which it clearly differs by the presence of two upper and two lower small premolars and by tragus shape, typical of *Myotis*. From similar-sized *Myotis* species from «*adversus*» group, *M. montivagus* may be distinguished by slightly smaller foot and more massive and shortened rostrum of skull (and also by more massive and broad muzzle).

A very similar species found in Indochina (recently reported from Cambodia; Hendrichsen et al., 2001), but not yet reported from Vietnam is *M. annectans* (Dobson, 1871). It is claimed to be distinguished by minute and sometimes absent small premolars (P^3 and P_3) which constitute less than 20%

of crown area of the respective second premolars (P^2 and P_2), anteorbital foramen positioned closer to the anterior rim of orbit. However, considering the wide intraspecific variation of *M. montivagus* (including its three additional proposed subspecific forms) and that both species are known from very few specimens collected over a vast territory of Southeast Asia, the specific rank of *M. annectans* requires further substantiation involving much more collection material.

DISTRIBUTION AND COLLECTING SITES. Trans Indo-Malayan species. Distributed from India and Myanmar to South-East China and Borneo (Corbet, Hill, 1992). In Vietnam was recorded twice: from Pu Mat (Bates et al., 1999) and Vu Quang (Kuznetsov et al., 2001) Nature Reserves.

COMMENTS ON NATURAL HISTORY. Observed in Vu Quang flying ca. 5 m above the ground over a road in heavily disturbed agricultural landscape ca. 200 m a. s. l. Echolocation calls relatively tonal and high-intensity, somewhat resembling those of small eptesicoid bats, with maximum energy around 50 kHz. In Pu Mat (Bates et al., 1999) a specimen was netted over a small stream in a cliffy forested (although moderately disturbed) area 150 m a. s. l.

Myotis siligorensis (Horsfield, 1855)

COMMON NAMES. Dơi tai sọ cao; Himalayan whiskered bat; Гималайская усатая ночница.

MATERIAL STUDIED. Eighteen specimens from Vu Quang (Ha Tinh Province), three specimens from Quang Binh Province, one specimen from Cat Loc (Lam Dong Province).

IDENTIFICATION. Small vespertilionid bat (weight ca. 2.9–4.3 g.; forearm ca. 31.8–35.3 mm; CCL ca. 11.4–12.2 mm; Table 22). Pelage soft and thick, buff to dark brown, with darker roots. Naked parts dark brown to black. Ears relatively long and narrow, extending to the tip of muzzle when laid forward, with narrowly pointed tragus. Wing membrane attached to the base of outer toe. Foot small, less than $^1/_2$ of tibia length, with small claws. Calcar lobe variously (often well) developed. Skull with light and low rostrum, distinctly elevated posteriorly (fronto-nasal flexure well prominent; Fig. 26b). Teeth small. Both upper small premolars loosely in toothrow. Canines narrow and small: upper equal, and lower less in height than correspondent large premolars (P4 and p4). No protoconules on upper molars.

This bat is most similar externally to *M. muricola*, from which may be reliably distinguished only by cranial and dental shape. From *M. annamiticus* and *M. laniger* this species differ by smaller hind foot and claws, and by some dental characters. Amongst other genera, *M. siligorensis* is quite similar to *Kerivoula whiteheadi*, from which it could be distinguished by proportionally shorter tail and tibiae, and not funnel-shape ears.

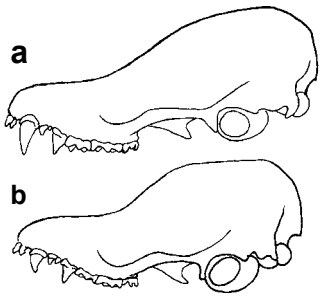

Fig. 26. Skull profiles of *Myotis*: a) *M. muricola*; b) *M. siligorensis*.

DISTRIBUTION AND COLLECTING SITES. Trans-Himalayan species of middle elevations, distributed from North-West India trough Nepal, northern Thailand and Lao to South-East China, and also on Malacca and Borneo. In Vietnam, according to Corbet and Hill (1992), *M. siligorensis* occurs in whole Tonkin and then somewhat south along the Vietnam-Lao border. Huynh et al. (1994) indicate this bat for four localities in Northern Vietnam and also for Kon Tum province. This species was also found in Cuc Phuong, Pu Mat and Phong Nha (Bates et al., 1999), in Ke Bang and town of Minh Hoa (Kruskop, 2000b), Vu Quang (Kuznetsov et al., 2001) and in Cat Tien.

COMMENTS ON NATURAL HISTORY. Bats of this species have been netted in secondary or disturbed primary forest formations, usually near streams or at cave entrances (Bates et al., 1999; our data) at low or moderate elevations. Typical aerial foragers, they have been observed flying near vegetation or over riverbeds, at an altitude of ca. 0.5–3 m (Borissenko et al., 2001). The echolocation calls are FM signals of very low intensity with maximum energy at 45–50 kHz, frequency range not evaluated (our data).

Myotis muricola (Gray, 1846)

COMMON NAMES. Dơi tai chân nhỏ; Nepalese whiskered bat; Малая ночница, Непальская усатая ночница.

MATERIAL STUDIED. Two specimens from Vu Quang (Ha Tinh Province), ten specimens from Cat Loc (Lam Dong Province), ten specimens from Than Binh (Tay Ninh Province), six specimens from Langbian Plateau (Lam Dong Province), additionally, two specimens from Annapurna (Nepal) and six specimens from Cambodia.

IDENTIFICATION. Small vespertilionid bat (weight ca. 3.2–6.5; forearm ca. 32.4–38.3 mm; CCL ca. 12.0–12.4 mm; Table 23). Externally very similar to previous species, from which it is distinguished by slightly larger size (on the average) and (during the direct comparison) somewhat shorter ears and more robust muzzle. Different populations (also inside Vietnam) demonstrate some variability in average size and coloration. Cranial profile more smooth with less pronounced flexure between rostrum and brain case. Teeth more massive, than in previous species, lower canine not less in height than p4. No protoconules on upper molars.

This bat species may be reliably differentiated from *M. siligorensis* and *M. ater* almost only by direct comparison of collection material. In general it

differs from the former by larger, and from the second — by smaller average size, both external and cranial, and from the latter also by lighter coloration. From other similar-sized *Myotis*, *M. muricola* may be distinguished by smaller hind foot, place of attachment of wing membrane to foot, and by absence of paraconules on upper molars.

Another similar species, reportedly occurring in Vietnam, without reference to collection material (e. g., Huynh et al., 1994) is *Myotis mystacinus* (Kuhl, 1819). The occurrence of this otherwise Palaearctic species in Indochina requires further substantiation; for now it seems reasonable to assume that these records may represent misidentified *M. muricola* and/or its allies, from which it differs in the absence of calcar lobe, and tentatively by pelage coloration, more narrow cingulum of the upper canine and ratio of mandible to condylocanine length, which is usually less than 0.81, whereas in *M. muricola* and *M. ater* it is usually more than 0.81.

DISTRIBUTION AND COLLECTING SITES. Trans Indo-Malayan species of low to high elevations. Distributed from Afghanistan and northern Pakistan to Eastern China, Great Sunda and Philippine islands. In Vietnam probably distributed through all the country (Corbet, Hill, 1992), but number of confirmed localities is limited. It was indicated for Dac Lac province by Huynh et al. (1994; as *M. mystacinus*) and for Pu Mat NR by Bates et al. (1999). We found this species in Vu Quang NR (Kuznetsov et al., 2001), in Lo Go Xa Mat (Tay Ninh Province), Cat Tien National Park and on Da Lat plateau.

COMMENTS ON NATURAL HISTORY. A fairly common inhabitant of disturbed and agricultural landscape at various elevations up to 1400 m a. s. l. (on Langbian plateau). Commonly observed foraging over roads, streams and other linear landscape elements in open and semi-open places, flying several meters above the ground. In Pu Mat specimens were netted above a stream in a forested area (Bates et al., 1999); on Langbian plateau we observed these bats foraging only over Da Nhim river. However, our observations in other localities show no strong confinement of this bat either to water or to woodland. Females observed in Lam Dong Province in the first half of April were either pregnant or lactating.

Myotis ater (Peters, 1866)

COMMON NAMES. Moluccan whiskered bat; Темная ночница, Молукская усатая ночница.

MATERIAL STUDIED. One specimen from Cat Loc (Lam Dong Province), nine specimens from Lo Go Xa Mat (Tay Ninh Province).

IDENTIFICATION. Small *Myotis* (weight ca. 4.3–6 g, forearm ca. 32–40 mm, CCL ca. 12.5–13.3 mm; Table 24). Pelage soft and thick, with black roots and tips brown ventrally and blackish brown dorsally. Naked parts are

also almost black. In all other External characters *M. ater* resembles previous species. Skull with very shallow concavity posterior to rostrum, latter is relatively light and slander, not looking more robust than in *M. muricola*. Dentition relatively massive, canines large, visibly exceeds correspondent large premolars in height. Second upper small premolar usually displaced from toothrow, but the gap between first and third premolars remains.

This species is quite similar in most external and Cranial characters to *M. muricola*, from which it could be distinguished presumably by the direct comparison by darker coloration and more robust dentition.

DISTRIBUTION AND COLLECTING SITES. Sunda-Malayan species of low and probably middle elevations. Including in *M. muricola* by Koopman (1994). Not ever indicated for Asian mainland by Corbet and Hill (1992). Probably distributed in Indochina, Malayan peninsula, Sunda and Philippine islands, but not on New Guinea (Flannery, 1995). For Vietnam was firstly indicated by Bates et al. (1999), based on records from Cuc Phuong NP, Pu Mat and Phong Nha NR. We found this species in Tay Ninh province and in Cat Tien National Park; in the latter it was previously also recorded by B. Hayes (in: Pham Nhat et al., 2001).

COMMENTS ON NATURAL HISTORY. Natural history seems to be similar to that of *M. muricola*. This bat was reported from woodlands and semi-forested areas, close to small rivers (Bates et al., 1999). In Lo Go Xa Mat (Tay Ninh Province), where both *M. muricola* and *M. ater* were observed, it appeared to be more confined to primary forest, although used similar habitats (roads and trails) for foraging.

Myotis rosseti (Oey, 1951)

COMMON NAMES. Dơi tai ngón lớn; Thick-thumbed mouse-eared bat; Толстопалая ночница.

MATERIAL STUDIED. Eight specimens from Cat Loc (Lam Dong Prov.)

IDENTIFICATION. A small *Myotis* species (weight ca. 4.5–5.5 g, forearm ca. 29–31 mm, CCL ca. 10.9–11.1 mm; Table 25) with characteristic thickened pink pads on feet and especially at the bases of thumbs (Fig. 23b). Lobe on the calcar is more or less well-developed; P^3 and P_3 are absent. Ear with distinctive emargination on outer margin; shape of ear and tragus typical for *Myotis*. Pelage light gray, only slightly lighter on the belly than on the back. Ear and membranes dark gray, muzzle and limbs not especially pigmented, pinkish.

This species differs from the remainder *Myotis* of Vietnam by small size, thickened pads on thumbs, and absence of third premolars. From *Glischropus* it could be distinguished by shorter forearm, dark gray pelage, and shape of ear and tragus.

DISTRIBUTION AND COLLECTING SITES. Indochinese species. Abroad Vietnam it inhabits Cambodia and southern part of Thailand, north of Kra (Corbet, Hill, 1992). In Vietnam was initially reported by Sokolov et al. (1986), but without references to any localities. Recently it was found in Cat Tien National Park (Hayes, in: Pham Nhat et al., 2001; and this survey).

COMMENTS ON NATURAL HISTORY. No data published for Vietnam. Distinctive morphological features and recent captures suggest this species to be confined to bamboo associations, particularly adapted to using bamboo stems as shelter (which, however, was not found). Strong infestation with ectoparasites (nycteribiid flies) suggests gregarious habits. In Cat Loc It was observed foraging ca. 1–2 m above the ground among thickets and over corn fields in semi-disturbed and agricultural landscape. Females captured in November had conspicuous traces of postlactation, suggesting a late summer or early autumn birth peak and thus possibly polyestrous reproductive cycles.

Myotis annamiticus Kruskop, Tsytsulina, 2001

COMMON NAMES. Dơi tai Trường Sơn; Annamite water bat; Аннамская ночница.

MATERIAL STUDIED. Thirteen specimens (including the holotype) from Ke Bang (Quang Binh Province).

IDENTIFICATION. A *Myotis* species of very small size (weight ca. 3–5.7 g, forearm 30.6–34.3 mm, CCL ca. 11.3–11.6 mm; Table 26). Ear narrow and relatively long, extending to the tip of muzzle when laid forward. Tragus about one half of ear length. Pelage relatively short and medium dense, dark grayish-brown on the dorsum and frosted with white tips on the venter. Wing membrane attaches to the middle of outer metatarsus. Frontal part of skull distinctly elevated from low rostrum (as in *M. siligorensis*). Both small upper premolars in toothrow and similar in shape unlike most of other small Vietnamese species of *Myotis*, P^3 sometimes not in contact with P^4.

By the general skull shape this species is most similar to *M. siligorensis*, from which it well differ by the large hind foot, place of wing membrane attachment and some dental features. In general shape and position of upper premolars *M. annamiticus* amongst local species resembles *M.* cf. *daubentonii* (see comments on the latter), from which it differs by some cranial measurements and more concave upper profile of rostrum.

DISTRIBUTION AND COLLECTING SITES. *M. longipes* was reported to Lai Chau and Hoa Binh provinces (Huynh et al., 1994), however these records were subsequently attributed to misidentified *M. laniger* (Topal, 1997). From the standpoint of the description of *M. annamiticus*, these two sites, or any one of them may be referred to this latter species. We found this species only in Ke Bang (Kruskop, 2000b; Kruskop, Tsytsulina, 2001), but probably this

bat inhabiting valleys of small streams in middle elevations through the whole Central Vietnam.

COMMENTS ON NATURAL HISTORY. Inhabiting valleys of small rivers, with variably disturbed vegetation. Foraging bats were seen only over the water surface. The most typical flight pattern — in elongated circles ca. 10–15 cm above the water surface with occasional upward spurts on 30–60 cm. Foraging behavior very similar to that of the European *M. daubentonii* (Jones, Rayner, 1988; Kalko, Schnitzler, 1989). Trawling behavior was observed in very few instances. Pregnant females were observed in the mid to late April. Echolocation calls are high intensity steep FM signals sweep from ca. 60 to 35 kHz, with maximum energy around 45 kHz.

Myotis cf. *daubentonii* (Kuhl, 1817)

COMMON NAMES. Dơi tai Đaobentôn; Indochinese water bat; Индокитайская водяная ночница.

MATERIAL STUDIED. No material from Vietnam was seen. Many specimens from various parts of the Palaearctic region were examined.

IDENTIFICATION. A small vespertilionid bat (forearm ca. 35.3–36.1 mm [34–35 mm; Allen, 1938]; CCL ca. 12.8–13.1 mm [10.6–11.9; Allen, 1938]), in general appearance similar to *M. horsfieldii*, and even more to the extralimital Palaearctic species *M. daubentonii* (present description generally follows Bates et al., 1999). Hind foot slightly exceeding $^1/_2$ of tibia length. Wing membrane attaches to the outer metatarsal. Small upper premolars within toothrow, rather loosely positioned; P^3 not intruded, small or absent. Upper canine very small, slightly exceeding P^4 in height. Lower canine similarly small, shorter than P_4.

Differs from *M. hasseltii* by the place of attachment of the wing membrane, from *M. annamiticus* by larger size, from essentially similar *M. horsfieldii* by reduced canines and small premolars not extruded from toothrow.

A series of bats of the «*daubentonii*» morphotype collected in Vietnam was used by G. Topal (1997) to substantiate the specific distinctness of *M. laniger*, to which they were referred by the above author. However, the measurements given therein (particularly those of the cranium) distinctly exceed those provided by G. Allen (1938) for a series of *M. laniger* from South China (which more appropriately match those of *M. annamiticus* and its allies extralimital to Vietnam). Bates et al. (1999) indicate both *M. daubentonii* and *M. laniger* for Vietnam, stating that they may represent forms of subspecific rank, however the characters provided therein cannot ensure clear identification of the two taxa. Consequently here we refrain from separating them and assigning definite specific names until further specimens from Vietnam and type material of *M. laniger* is analyzed.

DISTRIBUTION AND COLLECTING SITES. The species *M. daubentonii* is widely distributed through the Palaearctic, from West Europe to Japan. The considering form ranging from Northern Vietnam probably to Tibet and north-east India (Harrison, Bates 1997). In Vietnam reported by Bates et al. (1999) from Cuc Phuong National Park as *M. daubentonii* and from Ta-Phinh as *M. laniger*.

COMMENTS ON NATURAL HISTORY. No data available for Vietnam. The specimen from Cuc Phuong was caught at a cave entrance in an agricultural landscape. Foraging behavior may be similar to that of the European representatives of *M. daubentonii* (Jones, Rayner, 1988; Kalko, Schnitzler, 1989).

Myotis horsfieldii (Temminck, 1840)

COMMON NAMES. Dơi tai Đâynan; Horsfield's bat; Ночница Хорсфилда.

MATERIAL STUDIED. Three specimens from Vu Quang and one female from Langbian plateau (Lam Dong Province).

IDENTIFICATION. A medium-sized *Myotis* species (weight ca. 5.6–7.6 g, forearm ca. 34–37 mm, CCL ca. 12.8–13.7 mm; Table 27). Ear not extending beyond the end of muzzle when laid forward, bluntly pointed. Hind foot enlarged, slightly over $^1/_2$ of tibia length, with strongly curved large claws. Wing membrane attaches to the metatarsus (below the ankle). Pelage dark grayish-brown, with almost black hair bases, underparts somewhat paler. Muzzle, ears and membranes dark brown. Second small upper premolar (P^3) strongly compressed by anterior and posterior premolars, however not entirely removed from the toothrow and usually seen in lateral view.

This bat is greatly similar to *M. hasseltii*, from which it differs in the place of wing membrane attachment and in position of second upper premolar. From *M.* cf. *daubentonii* it could be distinguished by larger canines and longer wing tip (ratio of the third digit to forearm ca. 1.9 on the average, as opposed to 1.7 in *M. daubentonii* sensu lato).

DISTRIBUTION AND COLLECTING SITES. Indomalayan species, sporadically distributed from western India and Sri Lanka to Hainan, Mindanao, Sulawesi and Java islands (CORBET, HILL, 1992). Initially reported from Vietnam by Sokolov et al. (1986); not included in Vietnamese faunal list by Huynh et al. (1994) however, very likely, that records of *M. adversus*, reported in the given publication (Lao Cai Province and Hanoi City) must be referred to this species. Bates et al. (1999) reported *M. horsfieldii* to Phong Na — Ke Bang National Park and Pu Mat Nature Reserve. We found this bat in Vu Quang (Ha Tinh Province) and on Langbian plateau (Lam Dong Province).

COMMENTS ON NATURAL HISTORY. Confined to rivers and streams. In Vietnam hitherto captured and observed only above the water (Bates et al., 1999; our data). Typically it flies in circles ca. 10 cm above the water surface,

quite similar to the European *M. daubentonii*. Trawling behavior was observed in very few instances. Echolocation calls are of fairly high intensity, a steep FM sweep from ca. 100 to 45 kHz, with maximum energy around 50 kHz. Roosts were found in caves (Bates, Harrison, 1997).

Myotis hasselti (Temminck, 1840)

COMMON NAMES. Dơi tai Hátxen; Van Hasselt's bat; Ночница Хасселта.

MATERIAL STUDIED. Four specimens from Cambodia (Pnom-Penh); material from Vietnam was not seen.

IDENTIFICATION. Medium-sized vespertilionid bat (weight ca. 13.6–15.4; forearm ca. 37.5 mm; CCL ca. 14.0 mm; based on Cambodian specimens), similar in general appearance to *M. horsfieldii*. Hind foot conspicuously enlarged, somewhat over $^1/_2$ of tibia length, with large and strongly curved claws. Wing membrane attaches to the ankle or distal part of tibia. Pelage on upperparts grayish-brown, with somewhat darker hair basis, pale-gray on the underparts. Ears and membranes brown, muzzle except to the most tip poorly pigmented. Second upper premolar (P^3) entirely displaced from the toothrow, P^2 and P^4 usually in contact.

This bat may be confused with *M. horsfieldii*, from which it differs by slightly larger skull (on the average), position of P^3 and place of wing membrane attachment.

Differentiation of *Myotis hasseltii* from extralimital *M. adversus* (reported from Vietnam by Huynh et al. (1994), probably, erroneously) is based on a set of minor features, some of which seem to be doubtful (Bates et al., 1999). According to Hill (1983) and Corbet and Hill (1992), in *M. adversus* the dentition is similar to that of *M. horsfieldii* (but see Dobson, 1876) and the place of membrane attachment is similar to that of *M. hasseltii*. Tate (1941) thought *M. adversus* to be a synonym of *M. horsfieldii*. The resolving of this question requires investigation of comparative material, including type specimens.

DISTRIBUTION AND COLLECTING SITES. This species is sporadically distributed most of Indomalayan region, from north-east India and Sri Lanka to Vietnam, Borneo and Java (Corbet, Hill, 1992). From Vietnam was initially reported by Sokolov et al. (1986) without any data on localities. However, Huynh et al. (1994) reported this bat from Ha Noi Province, with reference to the latter paper. Bates et al. (1999), on the basis of the collection of Hungarian Natural History Museum, reported *M. hasseltii* to Co-Loa.

COMMENTS ON NATURAL HISTORY. Probably, confined to large water surfaces. In Cambodia (our observations) these bats were observed hunting over Bassak River ca. 20–50 cm above the water. The flight is quite fast and straight. Echolocation calls are of fairly high intensity, with maximum energy

around 45–50 kHz. Roosts are found in crevices of buildings and trees (Bates, Harrison, 1997; our data).

Myotis ricketti (Thomas, 1894)

COMMON NAMES. Rickett's big-footed bat; Азиатская рыбоядная ночница, Рикеттия.

MATERIAL STUDIED. One specimen from China (in the collection of the State Darwin Museum); no specimens from Vietnam have been seen.

IDENTIFICATION. Medium to large-sized vespertilionid bat (forearm ca. 53–57.5 mm; CCL ca. 17.8–18.8 mm; based on Bates et al., 1999 and single Chinese specimen) of characteristic appearance. Hind foot greatly enlarged, over 80% of tibia length, with enlarged and strongly curved claws. Ears brown, bluntly pointed, not extending beyond the end of muzzle when laid forward. Hind limbs up to the ankles and proximal part of interfemoral membrane conspicuously covered with hairs. Calcars very long, ca. $^4/_5$ of posterior border of interfemoral membrane and longer than tibia. Dorsal pelage gray-brown, with darker roots, ventral pelage with dark-gray hair bases and almost white tips. Membranes dark brown. Wing membrane attaches to the ventral side of distal part of tibia.

This species is differs well from all other Vietnamese Vespertilionidae, particularly, *Myotis* species, due to its characteristic hind limb proportions.

DISTRIBUTION AND COLLECTING SITES. *M. ricketti* is distributed in eastern China, Lao and Vietnam. Initially reported from Vietnam by Sokolov et al. (1986) without any exact localities. Bates et al. (1999) reported this species for Phong Nha (Quang Binh Province), Pu Mat (Nghe Anh Province) and Huu Lien (Lang Son Province).

COMMENTS ON NATURAL HISTORY. This bat with strongly pronounced trawling behavior and combined insectivorous and piscivorous habits is confined to rivers and streams, and was captured at cave entrances (Bates et al., 1999).

Genus *Eudiscopus* Consbee, 1953

GENERAL CHARACTERISTICS. A small *Myotis*-like bat with adhesive disks.

DIAGNOSIS. Skull on Fig. 42. Dental formula: $I^2/_3\ C^1/_1\ P^2/_3\ M^3/_3 \times 2 = 36$. P^2 not intruded and not especially compressed within toothrow. P_3 minute, completely intruded from the lower toothrow, compressed between P_2 and P_4. Skull with noticeably flattened braincase (however to a lesser degree, than in *Tylonycteris*) and elongated rostrum. One upper and two lower small premolars in each side — a combination, not present in any other Vietnamese Vespertilionid genera (except *Miniopterus* and rarely *Myotis*). Canine of *Myotis* type, with blunt posterior blade and without any supplementary cusps on cin-

gulum. Outer upper incisor larger than the inner one in crown area, also as in *Myotis*. Lower molars of myotodont type.

TAXONOMICAL REMARKS. A monotypic genus of questionable taxonomic affinities. Following the work of Tate (1942) who tentatively included it within the tribe Pipistrellini, essentially based on the thickened foot pads similar to those of *Tylonycteris*, this enigmatic genus has hitherto been affiliated with the pipistrelles (i. e., Koopman, 1972; Nowak, 1994; Pavlinov et al., 1995), particularly with *Glischropus* and *Tylonycteris*. The only feature these taxa actually have in common is the presence of «adhesive» pads on feet and thumbs, however, most different in size proportions and shape and apparently evolved independently due to similar roosting habits. In general appearance, wing proportions, shape of ear and tragus, and dental parameters, *Eudiscopus* appears more similar to a medium-sized *Myotis*. Despite that this morphological resemblance may prove to be symplesiomorphic, we find it more appropriate at this time to allocate this genus to Myotini, until more refined taxonomic studies are carried out.

Eudiscopus denticulus (Osgood, 1932)

COMMON NAMES. Dơi chai chân; Disc-footed bat; Дисконог, Розетконогий гладконос.

MATERIAL STUDIED. One adult female from Cat Tien National Park.

IDENTIFICATION. A small-sized vespertilionid bat (weight ca. 5 g, forearm ca. 34–38 mm, CCL ca. 13.4 mm) externally resembling a small *Myotis*. Wings relatively long and broad. Ear reaches the tip of muzzle, when laid forward. Well noticeable disk-like pads are present on feet; pads at the bases of thumbs are poorly developed. Tragus straight and narrow, slightly blunt at tip. Calcar lobe is not developed. Fur dense and soft, cinnamon-brown at dorsum, paler below. The membranes are dark; ears and muzzle and paler, not as well-pigmented.

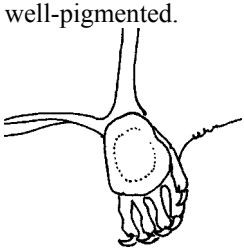

Fig. 27. Left hind foot of *Eudiscopus denticulus*, demonstrating adhesive disc (ventral view).

Easily distinguishable by its very well developed disk-like pads on feet, by flattened braincase and also by number of small premolars. From all Vietnamese bats with pads on feet (*Tylonycteris*) *Eudiscopus* is well distinguished by the ear and tragus shape and by overall size.

DISTRIBUTION AND COLLECTING SITES. A rare species known previously from three collecting sites (Northern Laos, Southern Burma and, more recently, Thailand; Koopman, 1972; Schliemann, Kock, 2000). The first claimed record of this species from Vietnam (Cao Van Sung, 1976, subsequently listed in Huynh et al., 1994) is

apparently erroneous*. The first documented record therefore is an adult female of *E. denticulus* captured in Cat Tien National Park in 2001, representing the fourth known locality of this species (the remainder three in Northern Lao, Southern Burma and Thailand (Koopman, 1972; Kock, Kovac, 2000).

COMMENTS ON NATURAL HISTORY. There is little data available on the biology of this bat, except for its roosting habits; these bats have been found in internodal spaces of bamboo stems (Kock, Kovac, 2000; Schliemann, Kock, 2000); our observations corroborate the affiliation of this species with bamboo formations. One specimen was captured with mobile traps while foraging over a pasture at the foothills of a slope covered with bamboo thicket. The observed bat had a very distinctive flight pattern: the flight was slow and highly maneuverable; hovering flight alternated with short gliding phases during which the wings remained still in slightly lifted position — a similar flight pattern could be observed in nightjars. Three additional sightings of bats with similar flight pattern elsewhere in Cat Loc suggest that the foraging sites of *E. denticulus* are probably confined to forest (thicket) edges.

Genus *Pipistrellus* Kaup, 1829

GENERAL CHARACTERISTICS. Small vespertilionid bats of typical to the family appearance.

DIAGNOSIS. Dental formula: $I^2/_3\ C^1/_1\ P^2/_2\ M^3/_3 \times 2 = 34$. Small upper premolar usually not reduced, but variably displaced internally from toothrow. Gap between canine and posterior premolar variable, sometimes almost closed. Outer upper incisor not greatly reduced, variably smaller than inner one, situated latero-posteriorly from the latter. Upper canine without secondary cusps. Lower molars of nyctalodont type, talonid exceeds trigonid in size. Braincase not flattened, lacking sagittal crest. Tragus moderate in length, almost straight-sided, with blunt tip. No thickened pads on thumbs and hind feet. Calcar lobe (epiblema) well-developed and very conspicuous. Baculum long and thin, commonly curved in lateral view, slightly widened at base, which usually possess medial notch, and gradually narrowing to the weakly bifurcated tip (Hill, Harrison, 1987; Volleth, 1989).

DISTRIBUTION. Widely distributed through the Old World, from Western Europe and Sakhalin to South Africa and some Indo-Pacific islands, and also in northern Australia and North America.

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* According to the description provided by Cao Van Sung (1976, p. 1882), two captured males had dark brown back and yellowish brown underneath. Moreover, their length of forearm and tibia was 26,5 and 11,5 mm, respectively. The only character used to identify these specimens was the presence of disk-like adhesive pads on feet. Thus it seems more likely that the captured specimens are either *Tylontcteris sp.* or, as the author tentatively suggests, a new species (or genus).

NATURAL HISTORY. Typically low to medium-altitude aerial insectivores with moderately fast maneuverable flight. Roosts are usually located in various crevices.

TAXONOMICAL REMARKS. Very complex group with discussed affinities to several other taxa, regarded as subgenera of *Pipistrellus* or as separate genera (part of which not even closely related to the *Pipistrellus* s. str.). As accepted here, the given genus contains ca. 20 species, divided into two subgenera. Six species of nominative subgenus occur in Vietnam.

Key to Vietnamese *Pipistrellus*

1. Larger: forearm usually over 35 mm, CCL over 13 mm. Pelage coloration relatively contrast: belly conspicuously paler, than back and throat (nearly whitish).....*P. ceylonicus* (p. 136)

— Smaller: forearm usually less than 35 mm, CCL less than 13 mm. Pelage coloration more uniform: belly only slightly paler than back **2**

2. Canine usually without secondary posterior cusp. (Overall coloration dark brown, penis very long, over 10 mm in length).....*P. paterculus* (p. 137)

— Canine with posterior secondary cusp (eventually rudimentary) **3**

3. Superorbital region relatively broad, forming (especially in males) abruptly incurving upper margins of orbits. Pelage coloration usually relatively pale. Penis long, over 8 mm in length. Tragus gradually narrowing along its terminal half, its apex somewhat pointed **4**

— Superorbital region relatively narrow. Pelage coloration usually relatively dark. Penis short, less than 8 mm in length. Tragus more or less even throughout, its apex broadly rounded.....**5**

4. Larger: forearm 30–36 mm, CCL ca. 11.9–13.1 mm. Penis relatively short, ca. 8–10 mm in length (shorter than tibia). Cingulum of P^4 widened to form antero-buccal shelf (variously developed) external to P^3 ....*P. javanicus* (p. 138)

— Smaller: forearm 29–33 mm, CCL ca. 10.9–11.1 mm Penis relatively long, ca. 10–13 mm in length (longer than tibia). Cingulum of P^4 usually not conspicuously widened anteriorly..... *P. abramus* (p. 139)

5. Larger: forearm 26–35 mm, CCL ca. 10.6–11.9 mm ....*P. coromandra* (p. 140)

— Smaller: forearm 25–31 mm, CCL ca. 9.3–10.7 mm .....*P. tenuis* (p. 140)

Pipistrellus ceylonicus (Kelaart, 1852)

COMMON NAMES. Dơi muỗi Xây Lan; Kelaart's pipistrelle; Цейлонский нетопырь.

MATERIAL STUDIED. No collection specimens were seen; the diagnosis below follows Bates, Harrison, (1997).

IDENTIFICATION. A small to medium-sized vespertilionid bat (weight ca. 7–8 g, forearm ca. 33–42 mm, CCL ca. 13.1–14.3 mm; Bates, Harrison, 1997), largest within the Vietnamese representatives of the genus. External appearance typical for the genus. Upper canine distinctively bicuspid. Small upper premolar not reduced, but completely intruded from the toothrow (compressed against canine), and invisible at lateral view. Penis not especially long. Pelage coloration gray brown to chestnut or golden brown above, conspicuously paler (nearly whitish) below. Ears, muzzle and membranes uniform dark brown.

Differs from other Vietnamese *Pipistrellus* species by size and pelage coloration pattern; from similar-sized *Hypsugo pulveratus* — in the presence of a well-developed calcar lobe and nyctalodont lower molars.

DISTRIBUTION AND COLLECTING SITES. Distributed through the Indian subcontinent, from Pakistan to Sri Lanka (Bates, Harrison, 1997), and than eastward to northern Vietnam and Hainan I. (Corbet, Hill, 1992). Listed for North Vietnam, including coastal islands, by Sokolov et al. (1986), Kuznetsov and An' (1992), Corbet and Hill (1992) and Huynh et al. (1994). Was also reported in Phong Nha — Ke Bang National Park, Quang Binh Province (Timmins et al., 1999), and Nam Cat Tien National Park (Hayes, in: Pham Nhat et al., 2001).

COMMENTS ON NATURAL HISTORY. Data for Vietnam is not available; foraging and roosting ecology essentially similar to that of other pipistrelles (e. g., Bates, Harrison, 1997).

Pipistrellus paterculus Thomas, 1915

COMMON NAMES. Dơi muỗi Mianma; Burmese pipistrelle; Бирманский нетопырь.

MATERIAL STUDIED. No collection material was seen; the diagnosis below follows Bates et al. (1997).

IDENTIFICATION. A small vespertilionid bat (forearm ca. 29–34 mm, CCL ca. 10.6–11.6 mm; Bates, Harrison, 1997). Upper canine usually unicuspid. Small upper premolar not reduced, variably intruded from the toothrow, and clearly visible at lateral view. Penis very long, over 10 mm in length. Pelage, ears, face and membranes uniformly dark brown, ventral hairs with reddish tips.

This species is essentially similar in appearance to *P. javanicus* and *P. abramus*, differing in a number of minor characteristics (generally coloration pattern and penial structure); precise identification of individual females is virtually impossible. From similarly colored *Hypsugo cadornae* it differs

(aside from penial morphology) in smaller size, less reduced P^3 and nyctalodont lower molars.

DISTRIBUTION AND COLLECTING SITES. Sporadically distributed from northern Pakistan to Thailand, Vietnam and southern China. From Vietnam it was reported only by Bates et al. (1999) from Cuc Phuong National Park.

COMMENTS ON NATURAL HISTORY. Found in Vietnam in semi-open mosaic habitats, including settlements (Bates et al., 1997), data on foraging and roosting preferences unavailable.

Pipistrellus javanicus (Gray, 1838)

COMMON NAMES. Dơi muỗi Java; Javan pipistrelle; Яванский нетопырь.

MATERIAL STUDIED. Eight specimens from Vu Quang (Ha Tinh Province), ten specimens from Ho Chi Minh City, and two specimen from unknown locality in Vietnam («Luong»).

IDENTIFICATION. A small vespertilionid bat (weight ca. 4.5–7 g, forearm ca. 30–36 mm, CCL ca. 11.9–13.1 mm; Bates, Harrison, 1997; Table 28). Tragus gradually narrowing along its terminal half, its apex narrowly pointed. Upper canine usually bicuspid. Small upper premolar not reduced, intruded from the toothrow, its tip visible at lateral view. Large upper premolar (P^4) with distinct antero-lingual projection. Anterior part of P^4 cingulum wide, often forming distinct projection or shelf. Penis long, ca. 8 mm in length, however, shorter than tibia. Pelage uniform brown of various shades, belly only slightly paler than back. Ears, muzzle and membranes brown, well pigmented, in general appearance looks not as dark than in previous species.

This species is most similar in appearance to *P. paterculus* and *P. abramus*, differing in minor dental characteristics and distinctly shorter penis; precise identification of individual females, without reference to capture locality, is virtually impossible.

DISTRIBUTION AND COLLECTING SITES. Widely distributed through the Indomalayan region from eastern Afghanistan and Pakistan to southern Tibet, Indochina, Malacca peninsula, Andaman, Nicobar, Sunda and Philippine Islands and Sulawesi (Corbet, Hill, 1992). Was reported in Vietnam from Quang Tri, Thua Thien — Hue (Huynh et al., 1994; other records in this work could be assigned to *P. abramus*); Cham Island in Central Vietnam (Kuznetsov, 2000), and from Nam Cat Tien National Park (Hayes, in: Pham Nhat et al., 2001). We found this species in Vu Quang Nature Reserve (Kuznetsov et al., 2001; probably the most northern record within Vietnam) and in Ho Chi Minh City, where this species is very abundant.

COMMENTS ON NATURAL HISTORY. This is an aerial insectivore with fast maneuverable flight typical of the genus. In Ho Chi Minh City this bat was quite common, observed foraging in open and moderately cluttered areas ca.

6–15 m above the ground or water. Colonies of several tens of individuals were found in crevices in buildings. In Vu Quang it was found in primary and secondary forest formations (up to 700 m); the typical observed foraging flight was around the canopy of trees or just above canopy level (Borissenko et al., 2001), more rarely in open air, once caught at subcanopy level (in primary forest). Two day roosts were found in hollow trees at heights of over 15 m. Echolocation calls are steep then shallow FM from ca. 70 to 45 kHz, with maximum energy around 50–55 kHz.

Pipistrellus abramus Temminck, 1840

COMMON NAMES. Dơi muỗi Nhật Bản; Japanese pipistrelle; Восточный нетопырь.

MATERIAL STUDIED. A total of 54 specimens from Hanoi (most of them collected by G. V. Kuznetsov, skulls not extracted), two specimens from Vu Quang (Ha Tinh Province).

IDENTIFICATION. A small vespertilionid bat (weight ca. 3.8–5.8 g, forearm ca. 29–33 mm, CCL ca. 10.9–11.1 mm; Bates, Harrison, 1997; Table 29), greatly similar in appearance to *P. javanicus*. Upper canine usually bicuspid. Small upper premolar intruded from the toothrow, only its tip visible at lateral view. Anterior shelf of P^4 cingulum less pronounced and virtually displaced to the toothrow midline. Penis very long, ca. 10–12 mm in length, longer than tibia. Pelage uniform light brown of various shades, belly only slightly paler than back; in general this bat appears paler, than the remainder Vietnamese species of *Pipistrellus*. Ears, muzzle and membranes brown, well pigmented.

This species differs from closely related *P. paterculus* and *P. javanicus* only in some minor dental characteristics (from the former — also in pelage coloration); precise identification of individual females, without reference to capture locality, is virtually impossible.

DISTRIBUTION AND COLLECTING SITES. Distributed from Russian Far East, Korea and Japan to southern China and Vietnam (Corbet, Hill, 1992; Tiunov, 1997). In Vietnam reported from Son La and Bac Thai Provinces and from Hanoi city (Huynh et al., 1994); from Cat Ba and Kaitien Islands (Kuznetsov, 2000); from Cuc Phuong National Park, Ninh Binh Province (Bates et al., 1997) and from Vu Quang, Ha Tinh Province (Kuznetsov et al., 2001). The latter locality by far represents the southernmost extremity of its known distribution range within the country.

COMMENTS ON NATURAL HISTORY. This is one of the most abundant bat species in Hanoi and, supposedly, also in other human settlements and heavily disturbed areas of North Vietnam. Foraging behavior and echolocation calls essentially similar to those of *P. javanicus*.

Pipistrellus tenuis (Temminck, 1840)

COMMON NAMES. Dơi muỗi mắt; Least pipistrelle; Изящный нетопырь.

MATERIAL STUDIED. Four specimens from Vu Quang Nature Reserve, two specimens from Hanoi City.

IDENTIFICATION. A very small vespertilionid bat (weight ca. 2.9–3.5 g, forearm ca. 25–31 mm, CCL ca. 9.3–10.7 mm; Bates, Harrison, 1997; Table 31). Tragus more or less even throughout, its apex broadly rounded. Upper canine usually bicuspid. Small upper premolar intruded from the toothrow, its tip visible at lateral view. P^4 lacking anterolabial projection and cingulum shelf. Penis short, less than 8 mm in length. Pelage relatively dark brown, belly only slightly paler than back. Ears, muzzle and membranes dark brown, well pigmented.

This species is most similar in appearance to *P. javanicus* and *P. paterculus*, differing in size, minor dental characteristics and distinctly shorter penis; precise identification of individual females is virtually impossible.

Koopman (1994) accepted the deviation of this species to *P. tenuis* and *P. mimus* Wroughton, 1899, and reported the latter species from Vietnam . Here we assigned all Vietnamese records to *P. tenuis*, because of uncertain distinctive characters of these species. However, taking into account some difference between Hanoi and Vu Quang individuals, we may suppose, that the both species are occur in Vietnam.

DISTRIBUTION AND COLLECTING SITES. This complex taxon recently is often divided into several distinct species (e. g., Flannery, 1995), therefore distribution of *P. tenuis* s. str. is restricted to Indochina, Malacca, Great and Lesser Sunda Islands, the Philippines and Sulawesi. In Vietnam it was reported from Son La, Vinh Phu and Quang Tri Provinces (Huynh et al., 1994; as *P. mimus*), Ninh Binh Province (Bates et al., 1997) and Ha Tinh Province (Kuznetsov et al., 2001). We made one else record in Hanoi city.

COMMENTS ON NATURAL HISTORY. Probably characteristic of agricultural and heavily disturbed landscape (including cities, e. g., Hanoi), where it may prove to be abundant. By far not captured in primary or secondary forest formations. The flight pattern is similar to that of *P. javanicus*, but at lower altitudes. Echolocation calls are steep to shallow FM, with maximum energy around 55–60 kHz, frequency range not determined.

Pipistrellus coromandra (Gray, 1838)

COMMON NAMES. Dơi muỗi nâu; Indian pipistrelle; Индийский нетопырь.

MATERIAL STUDIED. One specimen from Nha Trang (Khanh Hoa Province) and fifteen individuals from Langbian plateau (Lam Dong Province).

IDENTIFICATION. A small vespertilionid bat (weight ca. 4.3–5.1 g, forearm ca. 33–35 mm, CCL ca. 10.6–11.9 mm; Bates, Harrison, 1997; Table 30). Tragus more or less even throughout, its apex broadly rounded. Upper canine usually bicuspid. Small upper premolar intruded from the toothrow, its tip visible at lateral view. P^4 with distinct anterolabial projection but lacking antero-labial cingulum shelf. Penis short, less than 8 mm in length. Pelage dark brown, belly only slightly paler than back. Ears, muzzle and membranes dark brown, well pigmented.

Essentially similar to *P. tenuis*, differing in size and minor dental characters.

DISTRIBUTION AND COLLECTING SITES. Widely distributed on Indian subcontinent, from Afghanistan to Sri Lanka, also in Tibet, Thailand, Vietnam and Hainan I. (Koopman, 1994; Bates, Harrison, 1997). Corbet and Hill (1992) did not reported this species to Indochina, allocating form, described from Tonkin (*P. c. tramatus* Thomas, 1928), to *P. tenuis*. Nevertheless, this species was reported from Lao Cai, Bac Thai, Vinh Phu, Nghe An, Quang Tri, Thua Thien — Hue and Quang Nam — Da Nang Provinces (Huynh et al., 1994) and for Nam Cat Tien National Park (Hayes, in: Pham Nhat et al., 2001). Specimen from Khanh Hoa, preserving in ZMMU, provisionally allocate to this species. We found this pipistrelle on Lang Bian (Da Lat) plateau (this survey).

COMMENTS ON NATURAL HISTORY. Hitherto found in primary and secondary forest formations at high altitudes (up to 1700 m). The flight pattern is typical of pipistrelles, fast and maneuverable. On Langbian Plateau foraging was observed ca. 8–12 above land or water surface. The echolocation signal is high-intensity FM with maximum energy around 40–45 kHz.

Genus *Glischropus* Dobson, 1875

GENERAL CHARACTERISTICS. Small pipistrelle-like vespertilionid bats with pads on thumbs and hind feet.

DIAGNOSIS. Skull on Fig. 46. Dental formula: $I^2/_3\ C^1/_1\ P^2/_2\ M^3/_3 \times 2 = 34$. Small upper premolar displaced medially from toothrow, but not reduced. Outer upper incisor not reduced, slightly smaller than inner one, situated directly laterally from the latter (Fig. 21e), therefore all four incisors form almost straight transverse row. Upper canine with small secondary internal cusp on cingulum. Lower molars of nyctalodont type, with talonid and trigonid almost equal in size. Braincase not flattened. Thickened pads present on the base of thumbs and on the sole of hind foot (however, distinctly less developed than in *Eudiscopus*).

DISTRIBUTION. Distributed from Vietnam, Thailand and Myanmar to Sunda Islands, the Philippines and the Moluccas.

NATURAL HISTORY. Probably, affiliate to bamboo. Foraging habits seems to be similar to that of *Pipistrellus*.

TAXONOMICAL REMARKS. Two species are currently recognized, one of them occurs in Vietnam.

Glischropus tylopus (Dobson, 1875)

COMMON NAMES. Dơi muỗi ngón lớn; Thick-thumbed pipistrelle; Толстопалый нетопырь.

MATERIAL STUDIED. Five specimens from Cat Loc (Lam Dong Province).

IDENTIFICATION. A small *Pipistrellus*-like bat (weight ca. 4–5 g, forearm ca. 33–36 mm, CCL ca. 11.7–12.2 mm; Table 32) with moderately-sized pads on thumbs. Lobe on the calcar is well-developed. Ear and tragus «*Pipistrellus*-like». Pelage light-brown above and yellowish-brown below. Ear tip and membranes dark gray; ear base, tragus, muzzle and thumb pads not especially pigmented, pinkish.

Differs from similar-sized pipistrelles by thumb pads, position of outer upper incisor, and the presence of a secondary internal cusp on upper canine. From other bats with thumb pads it could be distinguished by longer forearm (except *Eudiscopus*) and absence of pads on feet.

DISTRIBUTION AND COLLECTING SITES. Inhabited Thailand, Myanmar, Southern Vietnam, Sumatra, Borneo, Palawan I. in the Philippines and Bacan I. in North Moluccas (Corbet, Hill, 1992). In Vietnam was already found only in Cat Loc (Lam Dong Province; this survey).

COMMENTS ON NATURAL HISTORY. This species shows certain affiliation with bamboo areas. The flight pattern and echolocation signals of *G. tylopus* resemble those of pipistrelles. In Cat Loc foraging bats were observed at dusk and before dawn above plantations of cashew nut and in agricultural landscape — particularly over rice fields, commonly hunting together with *Tylonycteris sp*.

Genus *Nyctalus* Bowdich, 1825

GENERAL CHARACTERISTICS. Medium-sized to large vespertilionid bats with robust dentition and characteristic narrowed and pointed wing tips.

DIAGNOSIS. Dental formula: $I^2/_3\ C^1/_1\ P^2/_2\ M^3/_3 \times 2 = 34$. Upper small premolar always intruded from toothrow, reduced and usually obscured by canine cingulum in lateral view. Outer upper incisor with small supplementary cusps, subequal to inner incisor in crown area and about $^1/_3$ of it in height. Inner upper incisor unicuspid. Upper canine without supplementary cusps. Molars unreduced. Lower molars of nyctalodont type; in M_1 and M_2 talonid exceeds trigonid in size, in M_3 they are subequal. Skull with prominent basisphenoid pits, weak sagittal crest and well-developed lambdoid and occipi-

tal crests. Anterior palatal emargination wide and relatively deep. Ear wide and thickened, with short tragus, distinctly widened at distal half. Wing characteristically narrow and pointed, with shortened fifth metacarpal and elongated third metacarpal, which is equal to forearm in length.

DISTRIBUTION. Widely distributed through Palaearctic region, including Japan and the Azores (Corbet, 1978), sporadically in Himalayas, southern China, Thailand and Vietnam.

NATURAL HISTORY. High altitude fast flying aerial insectivores, usually confined to forest formations.

TAXONOMICAL REMARKS. This genus, unambiguously recognized by all authors since at least Miller (1907), is among of the most taxonomically stable ones within vespertilionine. Some authors also include the «*stenopterus*» species group (Miller, 1907; Ellerman, Morrison-Scott, 1966; Koopman, 1994), otherwise placed in *Pipistrellus* (Hill, Harrison, 1987; Volleth, 1989). As accepted here, five to eight species are recognized, combined into three species groups (Pavlinov et al., 1995); one species probably lives in Vietnam.

Nyctalus cf. *noctula* (Schreber, 1774)

COMMON NAMES. Dơi ngón ngắn; Noctule; Рыжая вечерница.

MATERIAL STUDIED. Many specimens of non-tropical races from Russia and Central Asia, one adult female from Nepalese Himalayas; material from Vietnam was not available, hence the given description is based on the specimens from China.

IDENTIFICATION. Medium-size to large vespertilionid bat (weight ca. 23 g., forearm ca. 49–50.5 mm, CCL ca. 14.8–18.3 mm; after Allen, 1938). Fur uniform brown, without light reddish tinge. Calcar lobe well developed, with transverse septum. Ear sub-triangular, with broadly rounded angles. Skull with massive rostrum and sagittal crest, not projected beyond the occiput. Small upper premolar always present, highly reduced, entirely intruded from toothrow.

Amongst Vietnamese bats, *N. noctula* is most similar to *Scotophilus kuhli*, from which it is easily distinguished by tragus, wide and broadly rounded on top, presence of upper small premolar and second upper incisor, well developed calcar lobe, and shape of occipital region of skull. From similar-sized *Eptesicus serotinus* and *Hesperoptenus tickelli* the Noctule could be distinguished by smooth fur and narrowed and pointed wing, and also by coloration and cranial (particularly, dental) features.

DISTRIBUTION AND COLLECTING SITES. *Nyctalus noctula* complex is distributed through temperate and semiarid zone of Palaearctic and north of Indo-Malayan region. *N. plancei* inhabits east and south China and, probably,

north of Indochina. In Vietnam this species possibly inhabit middle elevations close to Chinese and Lao borders (Corbet, Hill, 1992).

COMMENTS ON NATURAL HISTORY. No data available for Vietnam. Extralimitally to South-East Asia this is a well-studied species; high-altitude and high-speed aerial insectivore, with a wide spectrum of consumed prey items. Tree-dweller, making its nursing and mating colonies in old hollow trees (see e. g., Gromov et al., 1963; Kruskop, 1999; also many special publications).

Genus *Hypsugo* Kolenati, 1856

GENERAL CHARACTERISTICS. Small pipistrelle or serotine–like vespertilionid bats.

DIAGNOSIS. Dental formula: $I^2/_3\ C^1/_1\ P^{1-2}/_2\ M^3/_3 \times 2 = 32–34$. Small upper premolar always intruded from toothrow and variably reduced, from relatively large to absent (in some individuals it may be absent in one side of jaw). Outer upper incisor not greatly reduced, only slightly smaller than inner one, may possess minute supplementary cusps. Inner upper incisor more or less bicuspid. Upper canine without supplementary cusps. Lower molars of myotodont-type, talonid exceeds trigonid in size. Ear shape as in *Pipistrellus*, tragus usually slightly curved forward. Calcar with weak and narrow keel. Baculum not very long, with wide and parallel-sided body, slightly bifurcated at base with thick basal projections and variably widened (sometimes bulbous) at tip (Hill, Harrison, 1987; Volleth, 1989).

DISTRIBUTION. Southern Palaearctic and North America, most of Africa and Indomalayan region south to Lesser Sunda Islands.

NATURAL HISTORY. Fast and maneuverable aerial foragers, essentially similar to pipistrelles in foraging and roosting habits.

TAXONOMICAL REMARKS. Species from this taxonomically complex genus have been variously referred to *Eptesicus* (e. g., Ognev, 1928) and more recently to *Pipistrellus* (Hill, Harrison, 1987; Corbet, Hill, 1992; Koopman, 1994), however, they possess distinctive peculiarities differentiating them from both of the above genera (Heller, Volleth, 1984; Horacek, Hanak, 1985–86). As accepted here, *Hypsugo* includes ca. 15 species, divided into several species groups. Two species occurs Vietnam.

Hypsugo pulveratus (Peters, 1871)

COMMON NAMES. Dơi muỗi Trung Quốc; Chinese pipistrelle; Китайский кожановидный нетопырь.

MATERIAL STUDIED. One adult female from Ke Bang (Quang Binh Prov.)

IDENTIFICATION. A small vespertilionid bat (weight ca. 7.5 g, forearm ca. 34–36 mm, CCL ca. 12.6–13 mm; Bates, Harrison, 1997) of pipistrelle-like appearance, but with reduced calcar lobe. Ears rather narrowed, with very

thin whitish margins, somewhat resembling those of *Arielulus* spp., but far less pronounced. Tragus ca. $^1/_3$ of ear pinna in height. Small upper premolar not reduced, however, intruded, tightly compressed between canine and P^4, invisible at lateral view. Canine unicuspid. Pelage uniform dark grayish black, somewhat paler and more grayish ventrally. Hairs on back slightly tipped with golden brown.

Could be confused with similar-sized *Pipistrellus* species, differing in poorly developed calcar lobe and myotodont lower molars. From *H. cadornae* it differs in overall larger size, ear and tragus shape, larger P^2.

DISTRIBUTION AND COLLECTING SITES. Sporadically in southern and south-eastern China, Thailand and Vietnam (Corbet, Hill, 1992; Bates et al., 1997). In Vietnam reported from Ba Be National Park, Cao Bang Province, Cuc Phuong, Ninh Binh Province (Bates et al., 1997) and Phong Nha — Ke Bang National Park, Quang Binh Province (Kruskop, 2000b).

COMMENTS ON NATURAL HISTORY. Specimens in Cuc Phuong were netted in the cave entrance (Bates et al., 1997), indicating the preferable type of day roosts. Specimen in Ke Bang was netted over the small river; some bats, tentatively assign to the same species were observed hunting over the valley, ca. 10–12 m above the ground. In both cases animals were found in relatively disturbed environment.

Hypsugo cadornae Thomas, 1916

COMMON NAMES. Dơi muỗi Cađôna; Cadorna's pipistrelle; Южноазиатский кожановидный нетопырь.

MATERIAL STUDIED. No material from Vietnam was available. The given description is based chiefly on: Bates et al. (1997).

IDENTIFICATION. A very small vespertilionid (forearm ca. 32.6–36.5 mm; CCL ca. 12.6–12.8 mm, following Bates, Harrison, 1997), of pipistrelle-like appearance, but with reduced calcar lobe. Ears broad with rounded tips. Tragus in height slightly less than $^1/_2$ of very broad ear pinna, noticeably bent forward. Dorsal pelage chestnut brown, somewhat darker at roots, ventral side somewhat paler.

In external appearance this species closely resembles small pipistrelles, differing in poorly developed calcar lobe and myotodont lower molars. From *H. pulveratus* it differs in smaller size, ear and tragus shape, smaller P^2.

DISTRIBUTION AND COLLECTING SITES. Sporadically in north-east India (west Bengal), northern Myanmar, Thailand and Vietnam (Robinson, Smith, 1997; Bates et al., 1997, 2000). In Vietnam reported from Cuc Phuong, Ninh Binh Province, and Na Hang, Tuyen Quang Province (Bates et al., 1997).

COMMENTS ON NATURAL HISTORY. The specimen in Cuc Phuong was captured in disturebed environment, near the national park headquarters (Bates et

al., 1997). In north-east Thailand remains of one specimen were found inside a cave (Robinson, Smith, 1997).

Genus *Eptesicus* Rafinesque, 1820

GENERAL CHARACTERISTICS. Small to large vespertilionid bat of typical appearance, with entirely absent upper small premolars.

DIAGNOSIS. Dental formula: $I^2/_3\ C^1/_1\ P^1/_2\ M^3/_3 \times 2 = 32$. Upper small premolar absent. Outer upper incisor variably reduced, unicuspid, distinctly smaller than inner one. Inner incisor unicuspid. Posterior upper molar sometimes reduced. Lower molars of myotodont type, in M_1 and M_2 talonid and trigonid almost equal in size. Upper canine without supplementary cusps. Anterior palatal emargination small, projected backward to the level of canine mid-line. Skull with widened rostrum. In some species supraoccipital region distinctly projecting backward. Tragi relatively broad, parallel-sided and blunt on top. Calcar with weak and narrow keel. Baculum characteristically simple, small and short, widened and notched at base (Hill, Harrison, 1987; Volleth, 1989)

DISTRIBUTION. Widely distributed in Holarctic, reaching the Polar Circle, Central and most of South America, sub-Saharan Africa and northern parts of Indomalayan region.

NATURAL HISTORY. Maneuverable aerial foragers, usually feeding on flying insects; some species possess abilities for ground or foliage gleaning. Predominantly cave dwellers.

TAXONOMICAL REMARKS. This genus includes ca. 20 species, divided into two or three subgenera (Hill, Harrison, 1987; Pavlinov et al., 1995). Despite the *Eptesicus* forming rather well bordered group, its interrelations with some other taxa still uncertain; some of them were included in this genus under various ranks, namely *Arielulus* (Heller, Volleth, 1984) and *Neoromicia* (McBee et al., 1987). One species supposedly occurs in Vietnam.

Eptesicus serotinus Schreber, 1774

COMMON NAMES. Dơi nâu; Serotine; Поздний кожан.

MATERIAL STUDIED. No material from Vietnam was seen; numerous extralimital material (mostly East Europe and Central Asia) examined, including one specimen from China.

IDENTIFICATION. A large — medium-sized vespertilionid bat (forearm ca. 54.2–55.1 mm; CCL ca. 18.3–19.5 mm, following Bates, Harrison, 1997). The ears are short, subtriangular in shape, with a moderate bluntly pointed tragus. Lobe on the calcar poorly developed. Pelage is dark brown above, paler and more grayish below. Hairs on the back with glossy tips. The membranes, ears and muzzle are dark, well-pigmented.

Externally similar to *Ia*, *E. serotinus* is distinctly smaller. From *Scotophilus* and *Scotomanes* it differs in the number of upper incisors; from the latter also in pelage coloration pattern. One else South Asian species of the genus *Eptesicus*, *E. pachyotis* (Dobson, 1871), hitherto known from north-east India, Myanmar and Thailand (Corbet, Hill, 1992), differs from *E. serotinus* by smaller size (forearm less than 40 mm; Lekagul, McNeeley, 1977).

DISTRIBUTION AND COLLECTING SITES. Widely distributed in North and West Africa, in Eurasia from Britain to Korea, south to Pakistan, northern India, Thailand and Taiwan (Gromov et al., 1963; Corbet, Hill, 1992; Bates, Harrison, 1997). Tentatively reported from North Vietnam (Nguyen Xuan Dung, Pham Nhat, 2000; G. Csorba, pers. comm.).

COMMENTS ON NATURAL HISTORY. No data available for Vietnam.

Genus *Ia* Thomas, 1902

GENERAL CHARACTERISTICS. Very large serotine-like bats.

DIAGNOSIS. Dental formula: $I^2/_3\ C^1/_1\ P^2/_2\ M^3/_3 \times 2 = 34$. Upper small premolar minute, entirely intruded from the toothrow; canine and posterior premolar in close contact. Outer upper incisor minute, unicuspid, not exceeds in height cingulum of inner incisor. Inner incisor unicuspid. Lower molars of myotodont type, in M_1 and M_2 talonid exceed trigonid in size. Upper canine without supplementary cusps. Anterior palatal emargination small, not projected backward beyond the posterior border of canine. Skull with widened rostrum. Sagittal crest well developed, somewhat more prominent in anterior half. Calcar with weak and narrow keel.

DISTRIBUTION. From Nepal to south-east China and Vietnam.

TAXONOMICAL REMARKS. One species is currently recognized. The genus and its taxonomic status was reviewed by G. Topal (1970).

Ia io Thomas, 1902

COMMON NAMES. Dơi iô; Great evening bat; Большой кожан, Бархатный кожан.

MATERIAL STUDIED. Four individuals from China (deposed in the State Darwin Museum, Moscow); collection material from Vietnam was not seen.

IDENTIFICATION. A very large vespertilionid bat (forearm ca. 70–77.5 mm; CCL ca. 25.2–26.2 mm, following Bates, Harrison, 1997), externally somewhat resembling *Eptesicus*. The ears are short, subtriangular in shape, with a moderate bluntly pointed tragus. Lobe on the calcar poorly developed. Pelage is gray-brown above and below, hairs on the back with slightly glossy tips. The membranes, ears and muzzle are dark, well-pigmented (the interfemoral membrane is paler below).

DISTRIBUTION AND COLLECTING SITES. Sporadically in Nepal (Csorba, 1996), Assam, southern China, Thailand, Lao and Vietnam (Corbet, Hill, 1992). In North Vietnam reported from Son La and Ninh Binh Provinces (Topal, 1970; Huynh et al., 1994) and from somewhere near the Chinese border (Csorba, 1996). Also found in Phong Na — Ke Bang National Park (Timmins et al., 1999; Kruskop, 2000b).

COMMENTS ON NATURAL HISTORY. Slow flying medium to high-altitude aerial insectivore with characteristic heavy flight. Roosting is conferred to caves, where it forms small colonies of several individuals (Topal, 1970; Csorba et al., 1998).

Genus *Arielulus* Hill, Harrison, 1987

GENERAL CHARACTERISTICS. Small to medium-sized vespertilionid bats, similar to *Eptesicus* and *Hypsugo*, with very distinctive coloration.

DIAGNOSIS. Skull on Fig. 44. Dental formula: $I^2/_3\ C^1/_1\ P^{1-2}/_2\ M^3/_3 \times 2 = 32–34$. P^2 intruded from toothrow, variably reduced, or absent. Upper outer incisor small, ca. twice exceeds cingulum of inner incisor in height. Upper canine without supplementary cusps. Posterior upper molar not reduced. Lower molars are of myotodont-type, in M_1 and M_2 talonid exceed trigonid in size. Skull with broad and massive rostrum. Sagittal crest not very prominent, but supra-orbital crests well-developed, continuous out of skull profile into supra-orbital projections. Wing relatively narrow and pointed, with long distal phalanx on third digit. Coloration of dorsal pelage very distinctive, dark with bright (orange to silver) hair tips. Baculum small, ventrally concave, with short body and wide, deeply notched base (Hill, Harrison, 1987).

DISTRIBUTION. From central Nepal to southern China, Indochina and Malacca; also on Java and Borneo.

NATURAL HISTORY. Poorly known. Fast-flying high to medium-altitude aerial insectivores, confined to primary and secondary forest formations.

TAXONOMICAL REMARKS. *Arielulus circumdatus* and allies for long time were treated as a species group of *Pipistrellus* (Ellerman, Morrison-Scott, 1966). Heller and Volleth (1984) allocate them to the genus *Eptesicus*, on the ground of karyology and bacular morphology. Taxon *Arielulus* was described by Hill and Harrison (1987) as subgenus of *Pipistrellus*. Later, on the basis of unique combination of craniodental, external and karyological features it was raised to the generic rank (Csorba et al., 1998; Csorba, Lee, 1999). In the latter work the genus *Thainycteris*, recently described from Thailand (Kock, Storch, 1996) was recognized a junior synonym of *Arielulus*, and one additional species was described.

Arielulus cf. *circumdatus* (Temminck, 1840)

COMMON NAMES. Dơi muỗi đen; Black gilded serotine; Бронзовый кожанок.

MATERIAL STUDIED. One adult female from Vu Quang (Ha Tinh Province) and one adult male from Langbian plateau (Lam Dong Province).

IDENTIFICATION. A medium-size vespertilionid bat (weight ca. 8.2–8.5 g, forearm ca. 39.4–43.5 mm, CCL ca. 14.8–15.2 mm) with distinct coloration pattern. In general appearance somewhat resembling serotines, but with more broad and short muzzle and very distinct pelage. Ear moderate, rounded on top, with prominent whitish margin. Tragus in shape looks like that of *Hypsugo*, less than half of ear length, blunt or bluntly pointed on tip, slightly convex posteriorly and concave anteriorly. Fur moderate in length and very dense, dark-brown (in Langbian specimen) or black, conspicuously tipped with orange or light golden on back and dirty-white on belly. Small upper premolar varies in size, but always displaced inward the toothrow, occasionally absent or present only in one side.

This species could be easily distinguished from all other Vietnamese bats by the unique combination of Cranial characters and characteristic coloration pattern. From in general similar *Hypsugo pulveratus* it differs by more prominent orange tips on dorsal pelage, whitish ear margins and larger size, from *A. aureocollaris* — by smaller size, dorsal coloration and lacking of yellowish «collar».

DISTRIBUTION AND COLLECTING SITES. Sporadically through Indo-Malayan region, from central Nepal to Sumatra (Bates, Harrison, 1997; Csorba et al., 1998; Csorba, Lee, 1999; Bates et al., 2000; Hendrichsen et al., 2001). In Vietnam more or less typical *A. circumdatus* were found by us on Langbian plateau. Specimen collected in Vu Quang (see: Kuznetsov et al., 2001) differs from more or less typical specimens from Nepal in most somewhat smaller size and lighter coloration.

COMMENTS ON NATURAL HISTORY. In Vu Quang it was observed in primary *Fokienia* forest (1300 m a. s. l.) flying at canopy or subcanopy level above the stream, in relatively uncluttered space. On Langbian Plateau if was observed in primary mixed (broad-leafed and coniferous) forest at ca. 1700 m a. s. l.

Arielulus aureocollaris (Kock, Storch, 1996)

COMMON NAMES. Collared serotine; Ошейниковый кожанок.

MATERIAL STUDIED. One adult individual from Vu Quang Nature Reserve (Ha Tinh Province).

DIAGNOSIS. Relatively large bat (weight ca. 15.4 g, forearm ca. 47.5–52 mm, CCL ca. 16.8 mm), resembling previous species in most qualitative fea-

tures. Pelage relatively long, almost black, conspicuously tipped on back with silver. Throat and sides of neck — with pale yellowish «collar», contrasting with dark underparts. Skull with very prominent supra-orbital crests, continuous on large angular supra-orbital projections. Deep medial depression situated between these crests, in the part of their bifurcation. Dentition in general similar to that of *A. circumdatus*, but more massive proportionally to lager size. Upper small premolar commonly absent.

Except for the distinctly smaller *A. circumdatus*, no other Vietnamese bat may be confused with this peculiar species.

DISTRIBUTION AND COLLECTING SITES. Indo-Chinese species, found in Thailand, Cambodia and Vietnam (Kock, Storch, 1996; Eger, Theberge, 1999). In Vietnam it was found twice — in Na Hang Nature Reserve, Tuyen Quang Province (Eger, Theberge, 1999) and in Vu Quang, Ha Tinh Province (Kuznetsov et al., 2001).

COMMENTS ON NATURAL HISTORY. Probably confined to primary or moderately disturbed forest habitats in montane areas (Eger, Theberge, 1999), both Vietnamese specimens (males) captured over streams. Supposedly a fast-flying aerial insectivore (Borissenko et al., 2001). Roosting habits unknown.

Genus *Tylonycteris* Peters, 1872

GENERAL CHARACTERISTICS. Very small vespertilionid bats with thumb and feet pads and characteristically flattened skull.

DIAGNOSIS. Skull on Fig. 45. Dental formula: $I^2/_3\ C^1/_1\ P^1/_2\ M^3/_3 \times 2 = 32$. Outer upper incisor ($I^2$) with minute supplementary cusps on cingulum, ca. twice smaller than inner incisor (I^1) in height and crown area. I^1 with small supplementary cusp. Upper canine with supplementary cusp on posterior blade. Lower molars of myotodont type; in M_1 and M_2 talonid slightly exceeds trigonid. Skull with greatly flattened braincase, which height ca. twice less than mastoid width. Supraorbital tubercles prominent. Ear with short, but not widened tragus. Bases of thumbs and soles of hind feet with fleshy pads.

DISTRIBUTION. Widely distributed throughout the Indomalayan Region from India to southern China, Philippine and Sunda Islands and Sulawesi.

NATURAL HISTORY. Low to middle altitude aerial insectivores, with strong confinement to bamboo formations (Medway, 1971), exhibiting moderately maneuverable flight.

TAXONOMICAL REMARKS. Readily distinguishable from small *Pipistrellus* and *Glischropus* by the presence of well-developed rounded disk-like pads on soles and at bases of thumbs, short tragus and noticeably flattened head, poor development of the lobe on the calcar. Most likely to be confused with *Hes-*

peroptenus blanfordi, however, differing in the position of upper incisors, uneven pelage coloration, presence of pads on feet.

Tylonycteris pachypus (Temminck, 1840)

COMMON NAMES. Dơi chân đệm thịt; Lesser flat-headed bat, Club-footed bat; плоскоголовый кожанок.

MATERIAL STUDIED. Nine specimens from Cat Loc (Lam Dong Province).

IDENTIFICATION. A very small bat (weight ca. 2.5–4.6 g, forearm ca. 25.4–27.4 mm, CCL ca. 10.4–10.8 mm; Table 33), of characteristic general appearance. Thumbs and feet with very well developed flattened disk-like pads. Pelage coloration golden or yellowish-brown on the head and underparts, dark grayish-brown on back. Ear short, with short and blunt rounded tragus. Membranes, tips of ears and muzzle well-pigmented, dark-brown.

Essentially similar to *T. robustula*, differing in the presence of yellowish or golden-brown pelage colors, shorter nasal emargination of skull and smaller, more slender skull.

DISTRIBUTION AND COLLECTING SITES. Distribution nearly coinciding with that of genus. Isolated locality in southwestern India, from northeastern India to southern China, all of Indochina, Malacca, Andaman, Great Sunda and Philippine Islands (Corbet, Hill, 1992; Bates, Harrison, 1997). In Vietnam it has been found sporadically throughout the country. Reported by Huynh et al. (1994) from Lai Chau, Lao Cai and Kon Tum Provinces. Recently captured in Pu Mat, Nghe An Province (Hayes, Howard, 1998) and Cat Tien NP , Dong Nai Province (Hayes in Pham Nhat et al., 2001) and Cat Loc, Lam Dong Province (our surveys). Apparently it should be expected to be common in areas with suitable habitats.

COMMENTS ON NATURAL HISTORY. Within Cat Loc this was the most numerous and abundant bat species, apparently connected with bamboo thickets on hill slopes and with agricultural landscapes of valleys. Foraging bats were observed at dusk and before dawn in very large numbers, often occupying much of the air space, filling it more or less evenly, often together with other less numerous bat species, within the altitude range of ca. 10 to over 50 meters. Sometimes they formed rather dense aggregations. *T. pachypus* emit characteristic rather powerful tonal echolocation calls with maximal energy around 60 kHz.

Tylonycteris robustula Thomas, 1915

COMMON NAMES. Dơi rô bút; Greater flat-headed bat; Косолапый кожанок.

MATERIAL STUDIED. No material was seen. The diagnosis below is based chiefly on Bates and Harrison (1997).

IDENTIFICATION. A very small bat (weight ca. 2.5–4.6 g, forearm ca. 26–28 mm, CCL ca. 11.1–12.8 mm), in external appearance essentially similar to *T. pachypus*.

The main differences from *T. pachypus* are: lack of yellow color on head and underparts, deeper nasal emargination of skull, larger and more massive skull.

DISTRIBUTION AND COLLECTING SITES. From easternmost India to Vietnam, peninsular Thailand, Sunda, Philippine Islands, Sulawesi and Timor. In Vietnam it is reported from Quang Tri Province (Huynh et al., 1994) and Pu Mat, Nghe An Province (Hayes in Pham Nhat et al., 2001)

COMMENTS ON NATURAL HISTORY. No specific data for Vietnam, supposedly, habits are essentially similar to those of *T. pachypus* (Medway, 1972; Bates, Harrison, 1997).

Genus *Hesperoptenus* Peters, 1868

GENERAL CHARACTERISTICS. Small to large serotine-like vespertilionid bats with characteristic position of upper incisors.

DIAGNOSIS. Skull on Fig. 43. Dental formula: $I^2/_3$ $C^1/_1$ $P^1/_2$ $M^3/_3$ ×2 = 32. Upper small premolar absent. Outer upper incisor greatly reduced, equal in height to cingulum of inner incisor, and situated almost directly behind it (Fig. 21g). Inner upper incisor large, unicuspid. Upper canine without supplementary cusps. Anterior and middle lower molars of myotodont type, with talonid exceeds trigonid in size. Rostrum short, robust and widened. Ears with short tragi, distinctly widened in distal half (Fig. 24e). Calcar lobe variably developed. Baculum similar to that of *Eptesicus*, but with distinctly narrowed and elongated body (Hill, Harrison, 1987).

DISTRIBUTION. Distributed through the Indomalayan region, from western India and Sri Lanka to Indochina, Malacca, Borneo and Sulawesi.

NATURAL HISTORY. Poorly known; supposedly low to medium-speed aerial insectivores.

TAXONOMICAL REMARKS. Five species are currently recognized, divided into two subgenera. Two species of subgenus *Milithronycteris* occurs in Vietnam.

?*Hesperoptenus tikkeli* (Blyth, 1851)

COMMON NAMES. Dơi răng cửa to; Tikkel's bat; Кожан Тиккеля.

MATERIAL STUDIED. One specimen from India; no material from Vietnam was studied.

DIAGNOSIS. A medium to large-sized vespertilionid bat (forearm ca. 50–61 mm, CCL ca. 17.2–19.6), most similar in appearance to *Eptesicus*. No pads on thumbs or feet; calcar with poorly developed lobe. Ears short, subtri-

angular in shape, with a bluntly pointed tragus. Pelage grayish-yellow to bright golden brown, ventral surface paler and more grayish. Membranes dark-gray, limbs pale, uropatagium light reddish-brown.

From similar-sized *Eptesicus* and *Nyctalus* it differs in the pattern of wing and uropatagium coloration and position of incisors, from *Scotomanes* — by pelage coloration and the presence of second upper incisor.

DISTRIBUTION AND COLLECTING SITES. Indian species of middle elevations. Sri Lanka and Andaman islands, Indian peninsula to Myanmar, Thailand, southern China and, probably, northern Vietnam.

COMMENTS ON NATURAL HISTORY. Slow-flying aerial insectivore roosting in tree canopy (Bates, Harrison, 1997). No data available for Vietnam.

Hesperoptenus blanfordi (Dobson, 1877)

COMMON NAMES. Dơi răng cửa nhỏ; Blanford's bat; Кожан Бланфорда.

MATERIAL STUDIED. One adult female from Ma Da (Dong Nai Province); four additional specimens from Cambodia.

IDENTIFICATION. A very small bat (weight ca. 5.9 g, forearm ca. 25–27 mm, CCL ca. 11.8 mm), in general appearance similar to *Tylonycteris*. Thumbs with well developed pads, no pads on feet. Pelage dark brown above, paler on underparts. Ear short, with short and blunt tragus. Membranes, ears and muzzle well-pigmented, grayish-brown.

This bat could be distinguished from small *Pipistrellus* by the position of incisors, short tragus and presence of thumb pads; from *Tylonycteris* by incisors, poor development of feet pads, and by well developed calcar lobe with transverse septum.

DISTRIBUTION AND COLLECTING SITES. Southern Burma and Thailand, whole Malacca peninsula, also on northern Borneo (Corbet, Hill, 1992). In Indochina first found in Cambodia by V. Matveev (in press, voucher specimens revised). In Vietnam was only found by us on Ma Da River on the western border of Dong Nai Province.

COMMENTS ON NATURAL HISTORY. In Ma Da it was captured in a heavily disturbed agricultural landscape. The flight is fast and maneuverable, ca. 7–10 m above the ground, usually in open places. Roosting habits unknown, the presence of thumb pads suggests adaptations towards clinging to smooth surfaces.

Genus *Scotomanes* Dobson, 1875

GENERAL CHARACTERISTICS. Large vespertilionid bat with characteristic coloration pattern.

DIAGNOSIS. Dental formula: $I^1/_3\ C^1/_1\ P^1/_2\ M^3/_3 \times 2 = 30$. First and second upper molars with unreduced mesostyles (central outer cusps), posterior mo-

lar reduced. Anterior and middle lower molars of myotodont-type, with talonid larger than trigonid. Anterior palatal emargination small, projected backward to the level of canine mid-line. Skull with widened rostrum and pronounced sagittal crest, projecting backward beyond the occiput. In external appearance similar to serotines, but with characteristic bright reddish pelage coloration with conspicuous white spots.

DISTRIBUTION. From Nepalese Himalayas to southern China and Central Vietnam.

NATURAL HISTORY. Maneuverable aerial foragers, probably tree-dwellers.

TAXONOMICAL REMARKS. Usually only one species (with two or three subspecies) is recognized; *S. emarginatus* (Dobson, 1871) is often treated as an extra species (Shina, Chakraborty, 1971), however the rank of this form, known only from holotype, still uncertain.

Scotomanes ornatus (Blyth, 1851)

COMMON NAMES. Dơi đốm hoa; Harlequin bat; Гладконос-арлекин, украшенный гладконос.

MATERIAL STUDIED. One specimen from the vicinity of Hanoi (collected by G. V. Kuznetsov), one specimen from Vu Quang, five individuals from Ke Bang (Quang Binh Province); one additional specimen from Nepal.

DIAGNOSIS. A large vespertilionid bat (weight ca. 23–39 g; forearm 50–64 mm; CCL ca. 19.4–19.9 mm; Table 34), in general appearance similar to serotine. Muzzle broad and almost naked, brown. Ears moderate and also brown;. tragi similar to that of serotines, but concave anteriorly and convex posteriorly. Fur dense and somewhat tousled, dorsally rufous-brown to orange with remarkable white spots; ventral part is parti-colored brown and white, with pale "collar". Wing membranes dark-brown, contrasting with orange or incarnate radius and metacarpals.

Scotomanes differ from similar-sized *Scotophilus heathi* by characteristic coloration pattern, broader wings, and small palatal emargination; from *Eptesicus serotinus* and *Hesperoptenus tickelli* — by presence of only one pair of upper incisors.

DISTRIBUTION AND COLLECTING SITES. Himalayan species of middle altitudes, distributed from Central Nepal (Csorba et al., 1998) to South China and Vietnam. In Vietnam it was found in middle elevations in Cuc Phuong, Kon Ha Nung (Huynh et al., 1994), Vu Quang (Kuznetzov et al., 2001) and Ke Bang (Kruskop, 2000b).

COMMENTS ON NATURAL HISTORY. Tree-dweller, reported to be found roosting on tree branches and banana leafs (Allen, 1938; Lekagul, McNeely, 1977). The typical flight pattern is slow heavy flight in open areas or near trees or rocky walls, usually not lower than 10 m above the ground. The spe-

cies seems very abundant at certain localities (e. g., Vu Quang, Ke Bang) at least in areas with secondary growth. Echolocation calls are very high intensity steep to shallow FM from ca. 80 to 25 kHz with maximum energy around 30 kHz.

Genus *Scotophilus* Leach, 1821

GENERAL CHARACTERISTICS. Large vespertilionid bats, externally similar to *Eptesicus* and *Nyctalus*, with characteristic dentition.

DIAGNOSIS. Dental formula: $I^1/_3\ C^1/_1\ P^1/_2\ M^3/_3 \times 2 = 30$. Anterior and middle upper molars and with greatly reduced mesostyle and thus distorted W-shaped pattern of ectoloph. Anterior and middle lower molars of myotodont type, with trigonid equal or exceeds talonid in size; in posterior lower molar talonid almost reduced. M^3 greatly reduced. Skull massive with somewhat shortened rostrum and broad palatal emargination, which expands backward to the level of upper premolars. Sagittal crest projected backward beyond the occiput. Tragi narrowed near the tip and more or less curved forward (Fig. 24f). Wings with narrowed and pointed tips, third and fourth metacarpals elongated, equal or even exceed forearm in length.

DISTRIBUTION. Widely distributed from Africa throughout the Indomalayan Region, most common in Indochina.

NATURAL HISTORY. High altitude aerial foragers inhabiting mostly secondary and disturbed habitats (including large cities).

TAXONOMICAL REMARKS. Ten species currently recognized (Robbins et al., 1985; Bates, Harisson, 1997), two of which occur in Vietnam.

Scotophilus heathi Horsfield, 1831

COMMON NAMES. Dơi nghệ; Greater Asiatic yellow bat; Большой домовый гладконос.

MATERIAL STUDIED. Five specimens from Hanoi City and surroundings.

IDENTIFICATION. A large vespertilionid bat (weight ca. 46 g; forearm 54–69 mm; CCL ca. 20.7 mm), externally similar to *Serotinus* or *Nyctalus*, which it resembles by somewhat elongate body with relatively small head, and by long pointed wings. Pelage relatively short and smooth, slightly longer on nape and throat. Dorsal pelage buff brown, ventral — yellowish buff. Wings uniform brown, unlike that of *Scotomanes*. Tragus curved frontward, with narrow, occasionally pointed distal part.

This species differ from *Scotomanes* and *Eptesicus* by general body and wing proportions, coloration and short smooth fur. From quite similar *Nyctalus* it distinguished by lacking of calcar lobe, shape of tragus (long and pointed), relatively short metacarpal bones (third metacarpal always shorter than radius) and by presence of only one pair of upper premolars.

DISTRIBUTION AND COLLECTING SITES. Trans Indo-Malayan species, probably concerned with human buildings. Distributed from Afghanistan and western India to South-East China and Indochina (Corbet, Hill, 1992). In Vietnam it was found in Cao Bang, Quang Tri, Dac Lac and Khanh Hoa provinces and also in Hanoi and surroundings and in Ho Chi Minh City (Huynh et al., 1994). We observed visually this species in Ke-Bang (Kruskop, 2000b), and, probably, in Hanoi.

COMMENTS ON NATURAL HISTORY. This is a high to medium altitude fast flying aerial forager (insectivore) confined to various open and semi-open habitats from forest edges to cultivated areas, settlements and large cities (including Hanoi and Ho Chi Minh). Roosts are found in crevices of rocks and buildings, trees and leaf stems in the crowns of coconut palms (Bates, Harrison, 1997). Colonies vary in size from 1 to 50 individuals (ibid.) In flight they emit high intensity FM echolocation signals with maximum energy around 30 kHz; audible vocalizations are often heard. In flight this species could be distinguished by characteristically narrow wings and large size.

Scotophilus kuhli Leach, 1821

COMMON NAMES. Dơi nâu; Lesser Asiatic yellow bat; Азиатский домовый гладконос.

MATERIAL STUDIED. Four specimens (one from Cat Loc, Lam Dong Province; three from Ho Chi Minh City). Eleven additional specimens from Sumatra and the Philippine Islands.

IDENTIFICATION. Distinctly smaller than previous species (weight ca. 16–25 g; forearm 45–55 mm, CCL ca. 18.5 mm; Table 35). Similar to it in most external and cranial characteristics, differ from it, except to size, by buffy-brown ventral pelage without yellowish tints. From *Nyctalus* this species differs, like *S. heathi*, by one pair of upper incisors, lacking the calcar lobe and shape of ear and tragus.

DISTRIBUTION AND COLLECTING SITES. Trans Indo-Malayan species, concerned with human buildings. Distributed from Pakistan and western India to South-East China, Indochina, Philippine and Sunda islands (Corbet, Hill, 1992). In Vietnam it was found in Quang Tri, Quang Ngai provinces and in Hanoi (Huynh et al., 1994). According to Corbet and Hill (1993), inhabiting all the territory of Vietnam. We found this species in Ho Chi Minh City and observed visually in Vu Quang, Ke Bang and Hanoi.

COMMENTS ON NATURAL HISTORY. High altitude fast flying aerial insectivore confined to various open and semi-open habitats. Quite common throughout Vietnam, predominantly in disturbed and agricultural landscape. In Ho Chi Minh City it uses crevices in buildings as daytime shelters, forming colonies of several to hundreds of individuals. In flight they emit high

intensity FM echolocation signals; audible vocalizations are often heard. The flight pattern is similar to that of *S. heathi*, however the latter is conspicuously larger, especially noticeable by comparison.

Genus *Murina* Gray, 1842

GENERAL CHARACTERISTICS. Small to medium-sized vespertilionid bats with tubular nostrils and dense wooly pelage.

DIAGNOSIS. Skull on Fig. 47. Dental formula: $I^2/_3$ $C^1/_1$ $P^2/_2$ $M^3/_3$ ×2 = 34. Dentition massive, Small upper premolar (P^3) similar in shape to posterior premolar (P^4), eventually nearly approaching it in size. Outer upper incisor with pronounced supplementary cusps, slightly exceeding the inner incisor in size. Internal upper incisor bicuspidate. Upper molars with variably reduced mesostyles, but always with distinctive W-shaped pattern of ectoloph (Fig. 28b). Talonids of lower molars variable in size, but never exceed trigonids. Wings very broad, with elongated thumb possessing a large curved claw. Wing membrane attaches to the basal phalanx of outer toe (Fig. 25e). Ears broadly rounded with elongated sharply pointed tragi. Nostrils characteristically tubular, their tips pointing anterolaterally. Pelage characteristically dense and wooly, variably extending onto the proximal area of the wing membranes and always completely covering the upper surface of the interfemoral membrane and hind limbs up to the toes.

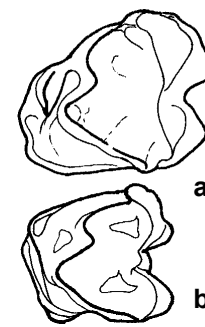

Fig. 28. First upper molars in Murininae: a) *Harpiocephalus harpia*; b) *Murina huttoni*.

DISTRIBUTION. From Southwest and South Siberia, Transbaikalia, Russian Far East and Japan southwest to Pakistan and northern India, south to the Philippines, New Guinea and north-eastern Australia.

NATURAL HISTORY. Strongly associated with humid forest formations. Aerial or ground-gleaning insectivores with powerful highly maneuverable flight, capable of efficient quadrupedal ground locomotion. Roosting usually confined to tree hollows, canopy and caves.

TAXONOMICAL REMARKS. Fifteen species are currently recognized (Pavlinov et al., 1995). Most of them belongs to the nominative subgenus; one additional subgenus *Harpiola* Thomas, 1915 consists of single species, known only from holotype. The nominative subgenus is divided into two to five species groups, however two main divisions seems to be most realistic («*cyclotis*» and «*suilla*» group sensu Koopman, 1994).

Identification keys to Vietnamese *Murina*

1. Size larger: forearm not less than 36 mm, CCL more than 15.5 mm. Fur on the underparts with pale roots..... *M. leucogaster* (p. 160)

— Smaller: forearm less than 36 mm, CCL 15,5 mm or less. Hair roots on the belly distinctly darker than tips **2**

2. Trigonid on m1–2 twice large than talonid ..... *M. cyclotis* (p. 158)

— Trigonid on m1–2 no larger than $^3/_2$ of talonid.....**3**

3 Size smaller: forearm usually less than 30 mm, CCL less than 13 mm. Dorsal pelage dark brown with a touch of bright golden hairs. Canine small, subequal to P4 in height. Talonids on lower molars about equal to trigonids .....*M. aurata* (p. 161)

— Size larger: forearm usually over 30 mm, CCL over 13 mm. Dorsal pelage red, brown or grayish-brown, without golden hairs. Canine of moderate size, higher than large premolar (P4). Talonids on lower molars less than trigonids **4**

4 Ear with smoothly convex posterior border, without emargination. Upper toothrows almost parallel. Size larger: CCL more than 14.5 mm .... *M. huttoni* (p. 159)

— Ear with emargination on the posterior border. Upper toothrows distinctly convergent anteriorly. Size smaller: CCL less than 14.5 mm .... *M. tubinaris* (p. 160)

Murina cyclotis Dobson, 1872

COMMON NAMES. Dơi ống tai tròn; Round-eared tube-nosed bat; Круглоухий трубконос.

MATERIAL STUDIED. No material was studied; the diagnosis below follows Bates and Harrison (1997).

IDENTIFICATION. A small to medium-sized vespertilionid bat (weight ca. 6–11 g, forearm ca. 29.5–34.5 mm, CCL ca. 13.9–15 mm), of typical appearance. Fur dense and wooly, reddish-brown to orange on upperparts and pale gray with distinctly darker roots on the belly. Wing membranes grayish-brown. Ears and muzzle pale. Ears relatively short and widely rounded. Dentition with characteristically reduced mesostyles on the upper molars and hypoconids and entoconids — on lower. Anterior and posterior premolars in each jaw almost equal in size.

This species is similar in general appearance to *M. huttoni*, from which it could be distinguished by shorter ears and peculiar dentition. From similar-sized *M. leucogaster* it could be distinguished by dental characters and ven-

tral pelage coloration. From *Harpiocephalus* species it differs in smaller overall size and less reduced crown structures on molars.

DISTRIBUTION AND COLLECTING SITES. Widely distributed from Sri Lanka, eastern and northern India and Nepal to Vietnam, Hainan I., peninsular Thailand and Malaysia, Borneo and the Philippines (Ingle, Heaney, 1992; Corbet, Hill, 1992; Bates, Harrison, 1997). In Vietnam it was found in Lai Chau (Osgood, 1931), Nghe An (Hayes, Howard, 1998) and Quang Binh (Timmins et al., 1999) Provinces. Report from Ke Bang (Kruskop, 2000b) was based on misidentification of *M. huttoni*.

COMMENTS ON NATURAL HISTORY. No data available for Vietnam. Extralimitally it is confined to forests, observed foraging in the air near forest edges and in thickets (Phillips, 1980; Bates, Harrison, 1997). Roosts were found in dry cardamom leafs or in caves, where groups of several individuals may reside (ibid.).

Murina huttoni (Peters, 1872)

COMMON NAMES. Dơi mũi ống; Hutton's tube-nosed bat; Трубконос Хаттона.

MATERIAL STUDIED. One adult specimens from Ke Bang (Quang Binh Province).

IDENTIFICATION. A small to medium-sized vespertilionid bat (weight ca. 6.5 g, forearm ca. 32.8–35.5 mm, CCL ca. 14.9–15.5 mm), in general appearance similar to *M. cyclotis*. Ears more slender and long, ca. 15 mm, without posterior emargination. Pelage coloration brown above and pale below, with dark hair roots. Dentition with somewhat less reduced mesostyles on the upper molars and relatively large talonids on lower, comparable in size to corresponding trigonids.

This species may be confused with *M. cyclotis*, differing in longer ears, skull measurements and structure of lower molars (trigonid/talonid ratio). From *M. leucogaster* it differs in pelage coloration pattern and smaller overall size. From similar-sized *M. tubinaris* it differs in ear shape, proportions of skull and dentition.

DISTRIBUTION AND COLLECTING SITES. Sporadically distributed from northern Pakistan, northern India and Nepal to southern and south-eastern China, northern Thailand and Vietnam (Corbet, Hill, 1992; Bates, Harrison, 1997). Was reported by Huynh et al. (1994) from Bac Bo and Dac Lac Provinces. We found this species in Phong Nha — Ke Bang National Park, Quang Binh Province.

COMMENTS ON NATURAL HISTORY. One specimen was netted above a small stream near the border of a disturbed primary broad-leafed forest and banana plantations at ca. 400 m a. s. l.

Murina tubinaris (Scully, 1881)

COMMON NAMES. Dơi mũi ống lông chân; Scully's tube-nosed bat; Кашмирский трубконос.

MATERIAL STUDIED. No material was studied; the diagnosis below follows Corbet and Hill (1992) and Bates and Harrison (1997).

IDENTIFICATION. A small vespertilionid bat (forearm ca. 31–34.1 mm, CCL ca. 13.4–14.2 mm). Ears short and broad, with small emargination on posterior border. Pelage thick and soft, gray or gray-brown above (ferruginous red in a minority of individuals; Bates, Harrison, 1997), pale gray with dark gray roots on the underparts. Thirst upper and lower premolars smaller than correspondent second premolars.

This species differs from similar-sized *M. cyclotis* and *M. huttoni* in smaller skull dimensions, dental structure and presence of an emargination on the posterior ear margin. From the generally similar *M. aurata* it differs in larger size and pelage coloration pattern.

DISTRIBUTION AND COLLECTING SITES. Sporadically from northern Pakistan and India to Thailand and Vietnam (Corbet, Hill, 1992). Was reported by Huynh et al. (1994) for Dac Lac Province.

COMMENTS ON NATURAL HISTORY. No data available.

? *Murina leucogaster* Milne-Edwards, 1872

COMMON NAMES. Dơi mũi ống lớn; Greater tube-nosed bat; Большой трубконос.

MATERIAL STUDIED. Material from Vietnam was not seen; many specimens of the north-temperate race *hilgendorffi* from Siberia and Russian Far East were studied.

IDENTIFICATION. A small to medium-sized vespertilionid bat (weight ca. 7–13 g, forearm ca. 36–44 mm, CCL ca. 16.5 mm), of typical appearance. Fur dense and tuffled, reddish-brown to orange on upperparts (however some color variations may be found) and very pale on the belly, with almost equal coloration between hair roots and tips. Wing membranes grayish-brown. Muzzle dark. Ears relatively short and wide, broadly rounded on tips, with conspicuous emargination on posterior border. Dentition robust and massive, but molars with distinctly less reduced structures, than in *M. cyclotis*.

From all other *Murina* species, inhabiting the region, *M. leucogaster could* be distinguished by larger size and also by pale hair bases on the underparts. From similar-sized *Harpiocephalus harpia* it differs well by distinctly less reduced W-shaped pattern of molar crists.

DISTRIBUTION AND COLLECTING SITES. Disrupted distribution in South Siberia, Transbaikalia, Russian Far East, Japan, Korea, northern, eastern and southern China, central Himalayas and Indochina (Wallin, 1969; Corbet,

1978; Corbet, Hill, 1992). From Vietnam provisionally reported by Hendrichsen (in: Timmins et al, 1999) from Phong Nha — Ke Bang National Park (Quang Binh Province).

COMMENTS ON NATURAL HISTORY. No data available for Vietnam. Extralimitally to Indochina it inhabits hilly areas with mixed forest and underground cavities; roosts on trees and in caves; capable to glean prey items from the ground (Tiunov, 1997; Bates, Harrison, 1997).

Murina aurata Minle-Edwards, 1872

COMMON NAMES. Dơi mũi ống nhỏ; Little tube-nosed bat; Малый трубконос.

MATERIAL STUDIED. One specimen (adult female) from Langbian Plateau (Lam Dong Province).

IDENTIFICATION. A small vespertilionid bat (weight ca. 4.2 g, forearm ca. 27.7–30 mm, CCL ca. 12.3 mm), smallest within the genus. Ear broad, without emargination or with small one. Pelage on the upperparts represent rich mixture of dark-brown and gold hairs, underparts are pale gray with dark hair bases. End of the muzzle, ears and wing membranes dark, rich pigmented.

This species differs from looking similar *M. tubinaris* by pelage coloration and smaller overall size. It is also distinctly smaller (especially in cranial dimensions) than all other Vietnamese *Murina* species.

DISTRIBUTION AND COLLECTING SITES. This species distribution corresponds to mountain areas of South-East Asia, from Nepal to southern China and northern Thailand. In Vietnam it was found in Pu Mat Nature Reserve, Nghe An Province (Hayes, Howard, 1998) and on Langbian (Da Lat) plateau, Lam Dong Province (our survey).

COMMENTS ON NATURAL HISTORY. One individual was captured in mixed (broad-leafed and coniferous) montane primary forest at 1800 m a. s. l. No other data available.

Genus *Harpiocephalus* Gray, 1842

GENERAL CHARACTERISTICS. Includes large tube-nosed bats with highly modified dental structure.

DIAGNOSIS. Dental formula: $I^2/_3\ C^1/_1\ P^2/_2\ M^3/_3 \times 2 = 34$. M^1 and M^2 with almost absent mesostyle and highly obliterated W-shape pattern of the metaloph (Fig. 28a). Canine and cheek teeth very massive but M^3 is vestigial. Incisors greatly compressed between each other and canines.

NATURAL HISTORY. Virtually unknown, but supposedly similar to that of *Murina*.

TAXONOMICAL REMARKS. Two species have been proposed (e. g., Koopman, 1994; Corbet, Hill, 1992), however, the form *H. mordax*, whose specific

status was proposed by Hill and Francis (1984), is hitherto known only by females. Until the pattern of sexual dimorphism of *H. harpia* in Indochina is adequately studied, we consider it premature to treat these two forms as separate species and hence herein the genus is treated as monotypic.

Harpiocephalus harpia (Temminck, 1840)

COMMON NAMES. Dơi mũi ống cánh lông; Hairy-winged tube-nosed bat; Шерстокрылый трубконос.

MATERIAL STUDIED. No material from Vietnam was available; two specimens from Cambodia were examined (representing both «*harpia*» and «*mordax*» morphotypes).

IDENTIFICATION. A medium to large vespertilionid bat (weight ca. 12.5 g, forearm ca. 44.4–50.2 mm, CCL ca. 18.4–20.2 mm), of typical tube-nosed bat external appearance; ears and muzzle similar to those of *Murina cyclotis*. Wing membrane attaches to the base of the outer toe. Muzzle hairy, except for the tips of nostrils. Interfemoral membranes and parts of wings proximal to the body are covered with long hairs which also extend over hind limbs and toes. Pelage coloration brightly red-brown, hairs on the back with gray bases, hairs on the venter pale gray with dark bases.

The form «*mordax*» Thomas, 1923, proposed as a separate species by Hill and Francis (1984) is claimed to be distinguished by the following characters. Rostrum broader: external canine width not less than 6,9 mm (less than 6,8 mm in *H. harpia*). Zygomatic arch more expanded, zygomatic width more than 14 mm (less than 14 mm in *H. harpia*). Forearm 48 mm or longer (less than 50 mm in *H. harpia*).

DISTRIBUTION AND COLLECTING SITES. Sporadically found throughout the Indomalayan region, from southern India to Taiwan and Great Sunda Islands. In Vietnam reported by D. Hendrichsen (in Timmins et al., 1999) from Phong Nha, as both *H. harpia* (male) and *H. mordax* (female).

COMMENTS ON NATURAL HISTORY. No data available for Vietnam.

Genus *Miniopterus* Bonaparte, 1837

GENERAL CHARACTERISTICS. Small to medium-sized vespertilionid bats with characteristically fused braincase and elongated distal phalanx of the third digit. Contains species very similar in external appearance, differing predominantly in size.

DIAGNOSIS. Skull on Fig. 48. Dental formula: $I^2/_3\ C^1/_1\ P^2/_3\ M^3/_3 \times 2 = 36$. Upper molars with distinctly enlarged hypocone basins (Fig. 29). Upper small premolar not greatly reduced, but distinctly smaller and more simple than posterior premolar. Inner and outer upper incisors subequal in size. Skull with relatively low rostrum and characteristically fused braincase (in general

appearance similar to the skull of *Kerivoula*). Ears small and wide, with short parallel-sided and blunt tragi. Terminal phalanx of third wing digit conspicuously elongated (ca. $^2/_3$ of correspondent metacarpal), when at resting posture folded ventrally beneath the wing (Fig. 30). Proximal part of interfemoral membrane covered dorsally with thick hairs up to the end of the first or second tail vertebra and to the midst of femurs.

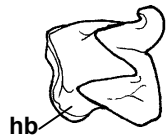

Fig. 29. First left upper molar of *Miniopterus*; hb — hypocone basin.

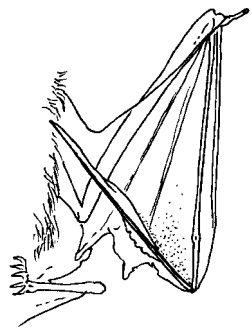

Fig. 30. Folded left wing of *Miniopterus* in ventral view.

DISTRIBUTION. Widely distributed throughout the Old World tropics southeast to Australia and the New Hebrides.

NATURAL HISTORY. Specialized high altitude aerial insectivores with fast maneuverable flight. Highly gregarious, roosting strongly confined to caves of artificial analogs thereof.

TAXONOMICAL REMARKS. A small but very complex genus, its species predominantly distinguished by overall size. Nine to twelve species are currently recognized, not divided neither into subgenera nor even into species groups; tree, probably, four species occur in Vietnam.

Identification keys to Vietnamese *Miniopterus*

1. Smaller: forearm less than 45 mm, CBL less than 13.4 mm, C–M3 less than 5.5 mm, M3–M3 less than 5,7 mm ..... M. pusillus* (p. 164)

— Larger: forearm over 45 mm, CBL over 14,5 mm, C–M^3 over 5,8 mm, M3–M3 over 6,3 mm **2**

2. Smaller: forearm less than 50 mm, CBL less than 16 mm, C–M^3 less than 6.7 mm, M3–M3 less than 7.3 mm..... *M schreibersi* (p. 163)

— Larger: forearm over 47 mm, CBL over 15.7 mm, C–M^3 over 6.4 mm, M3–M3 over 7.4 mm ..... *M. magnater* (p. 165)

Miniopterus schreibersi (Kuhl, 1817)

COMMON NAMES. Dơi cánh dài; Common bent-winged bat; Обыкновенный длиннокрыл.

MATERIAL STUDIED. No specimens were seen from Vietnam; two specimens from Cambodia, three specimens from Himalayas and also considerable

* See comments under *M. pusillus* for its distinction from extralimital *M. australis*.

material from the Palaearctic was examined.

IDENTIFICATION. A medium-sized vespertilionid bat (weight ca. 8.1 g (in Cambodian specimens); forearm ca. 45–50 mm; tibia ca. 16–22 mm; CBL ca. 14.6–15.9 mm; C–M^3 ca. 5.8–6.7 mm; M^3–M^3 ca. 6.3–7.3 mm), of typical appearance. Pelage soft and silky, uniform dark grayish-brown to reddish-brown, with darker roots. Tip of muzzle, ear tips and membranes are dark brown, ear bases and almost naked cheeks poorly pigmented.

From other representatives of the genus this species differs in minor external and dental features, mainly by skull dimensions. It is necessary to note that *M. schreibersi* itself is a polytypic species, containing several more or less distinct forms of uncertain status, which needs further revision.

DISTRIBUTION AND COLLECTING SITES. Cosmopolitan Old-World species, widely distributed from Western Europe and Africa to Japan and north-eastern Australia. According to Corbet and Hill (1992), its distribution area covers the whole territory of Indochina. Huynh et al. (1994) reported *M. schreibersi* for Lao Cai, Ha Giang, Ninh Binh and Lam Dong Provinces.

COMMENTS ON NATURAL HISTORY. No reliable published data available for Vietnam; supposedly similar inhabits to other species of *Miniopterus*.

Miniopterus pusillus Dobson, 1876

COMMON NAMES. Dơi cánh dài nhỏ; Nikobar bent-winged bat; Никобарский длиннокрыл.

MATERIAL STUDIED. Five specimens from Cat Loc (Lam Dong Province), three additional specimens from Cambodia.

IDENTIFICATION. A small bent-winged bat (weight ca. 7–8.8 g; forearm ca. 39–45 mm; tibia ca. 16–18 mm; CBL ca. 12.7–13.4 mm; C–M^3 ca. 5.0–5.4 mm; M3–M3 ca. 5.4–5.7 mm; Table 36), in general appearance similar to *M. schreibersi*. Pelage uniform grayish-brown, with almost black roots. Tip of muzzle, ear tips and membranes dark-brown; muzzle and ear bases poorly pigmented.

From *M. schreibersi* this species could be distinguished by several skull dimensions and slightly more haired interfemoral membrane.

A similar-sized species provisionally reported from Vietnam (Pu Mat and Cuc Phuong; B. Hayes, pers. comm.) is *M. australis*, which is distinguished by shorter tibia (ca. 11–13 mm) and also by slightly larger size (forearm ca. 34–40 mm; CBL ca. 12.7–14.0 mm; C–M^3 ca. 4.7–5.7 mm; M3–M3 ca. 5.1–6.0 mm), however, its previously known distribution range (Philippines and the eastern Sunda Islands) indicates the possibility for erroneous identification of Vietnamese specimens.

DISTRIBUTION AND COLLECTING SITES. Sporadically distributed from India, Nepal and south China to Thailand and Vietnam, Nicobar, Great Sunda

and Togian Islands, Sulawesi, Timor, the Moluccas, New Caledonia and Loyalty Islands (Corbet, Hill, 1992). In Vietnam found in Nam Cat Tien National Park, Dong Nai Province (Hayes, in Pham Nhat et al., 2001) and in Cat Loc, Lam Dong Province (our survey).

COMMENTS ON NATURAL HISTORY. In Cat Loc this species (probably few hundred individuals) was found in a mixed cave colony of bats (together with *M. magnater* and *Hipposideros larvatus*). The bats were perching on exposed parts of the walls and ceiling, together with another species of bent-winged bat (*M. magnater*). No observations of foraging behavior available for Vietnam.

Miniopterus magnater Sanborn, 1931

COMMON NAMES. Dơi cánh dài lớn; Western bent-winged bat; Большой длиннокрыл.

MATERIAL STUDIED. Thirteen specimens from Cat Loc National Park.

IDENTIFICATION. A large to medium-sized bent-winged bat (weight ca. 11.9–15.4 g; forearm ca. 47.5–52.5 mm; tibia ca. 21 mm; CBL ca. 15.7–17.3 mm; C–M^3 ca. 6.4–7.3 mm; M3–M3 ca. 7.4–8.0 mm; Table 37). Pelage thick and soft, brownish-gray, with blackish hair bases, almost unicolored on the upper and under sides of body. Muzzle, ear tips and margins and tragi dark grayish-brown, membranes almost black.

Amongst Vietnamese bats this species may be confused with *M. schreibersi*, from which it differs mainly by some skull dimensions.

DISTRIBUTION AND COLLECTING SITES. Sporadically from northern Myanmar and Hainan to Malacca, Great Sunda Islands, Timor, the Moluccas, New Guinea and Bismark Islands (Corbet, Hill, 1992). In Vietnam it was found in Nam Cat Tien National Park, Dong Nai Province (Hayes, in Pham Nhat et al., 2001) and in Cat Loc, Lam Dong Province (our survey).

COMMENTS ON NATURAL HISTORY. In Cat Loc representatives of this species composed the bulk of the mixed colony (together with *M. pusillus* and *Hipposideros larvatus*) of bats living in a cave, reaching the size of many hundreds and, possibly, several thousand individuals. The bats were perching on exposed parts of the walls and ceiling, together with another species of bent-winged bat (*M. pusillus*). High concentration of animals in the cave resulted in high contamination with ectoparasites (mainly Streblidae and Nycteribiidae), probably common with the remainder species. No observations of foraging behavior available for Vietnam.

FAMILY MOLOSSIDAE GERVAIS, 1856

COMMON NAMES. Họ dơi thò đuôi, Free-tailed bats; Свободнохвостые, Бульдоговые.

GENERAL CHARACTERISTICS. Medium to large-sized (forearm up to 85 mm) specialized aerial foragers with pronounced adaptations towards fast non-maneuverable flight.

DIAGNOSIS. Ears usually fleshy and wide, conjoined by their anterior margins or by a wide or narrow skin fold, occasionally also connected to upper surface of muzzle. Tragus and antitragus variably developed, commonly both are present. Tragus in some species is hidden by the larger antitragus. Lips commonly wide and fleshy, sometimes more or less plicate. Wing characteristically long, pointed and narrowed in its distal half. Hind limb thick and fleshy, with thick digits, possessing long seta-like hairs, highly expanded over the end of claw. Tail also thick, projected halfway beyond the posterior margin of interfemoral membrane. Skull with more or less massive rostrum and smooth upper profile. Sagittal crest variable in size and proportions but in Indochinese species usually not especially developed. Always one pair of sharply pointed upper incisors (relatively large and simple), but lower incisors vary from one to three pairs occasionally between individuals of same species. In all Indochinese species two upper and two lower premolars are present; small upper premolar not displaced from toothrow. Coronoid process of the lower jaw weak, only slightly higher than the articulating process.

DISTRIBUTION. Widely distributed throughout the Old World and New World tropics, also on many islands of the Pacific and the Caribbean and in Australia, penetrating into the subtropics and arid parts of temperate zones.

NATURAL HISTORY. Specialized high-altitude aerial foragers with characteristically strong quasi-CF echolocation signals, sometimes audible to a human ear. They may be found in various habitats, sporadically found in large numbers throughout Indochina. At rest they usually cling on to vertical surfaces, often in open situations.

TAXONOMICAL REMARKS. In the world fauna this family is represented by 14–15 genera and ca. 90 species, inhabiting tropics and subtropics of both Old and New World and Australia. For Vietnam one species was confirmed, however, at least two other species could be found in this country in future.

Key to the species of Vietnamese Molossidae

External characters

1 Larger: forearm more than 55 mm **2**

— Smaller: forearm not more than 51 mm ..... *Chaerephon plicata* (p. 168)

2 Anterior margins of ears connected by the skin fold only at base. Dorsal pelage uniform dark, brown or gray. Forearm length commonly less than 63 mm ..... *Tadarida teniotis*[*]

— Anterior margins of ears connected on almost full their length to each other and to upper surface of muzzle. Fur on shoulders and nape pale grayish-white, contrasting to other dark dorsal pelage. Forearm usually more than 63 mm..... *Otomops wroughtoni*[†]

Cranial characters

1 Each zygoma with big post-orbital lobe. Additional pair of basisphenoid pits deep and very well-defined..... *Otomops wroughtoni**

— Zygomta straight in lateral profile, without post-orbital lobe. Basisphenoid pits week and shallow **2**

2 Condylocanine length less than 18 mm; upper toothrow less than 7,5 mm. Premaxillae not fused but almost in contact..... ..... *Chaerephon plicata* (p. 168)

— Condylocanine length more than 21 mm; upper toothrow more than 8 mm. Premaxillae (and thus upper incisors) divided by small but well prominent palatal emargination ..... *Tadarida teniotis**

Genus *Chaerephon* Dobson, 1874

GENERAL CHARACTERISTICS. Medium-sized to large bats with general appearance typical to Molossidae.

DIAGNOSIS. Skull on Fig. 49. Dental formula: $I^1/_2\ C^1/_1\ P^2/_2\ M^3/_3 \times 2 = 30$. Ears large, wide and fleshy, with their anterior borders connected with skin fold. Tragus very small, commonly hidden by larger antitragus. Muzzle almost naked, lips wide and fleshy, with distinct transverse folds. Wings long, narrow and pointed, with characteristic short fifth metacarpal. Hind foot fleshy, with long seta like hairs on digits. Calcar almost reduced. Skull with short and massive rostrum. Sagittal crest week in its posterior part and more prominent anteriorly. Small upper premolar almost in toothrow. One pair of upper incisors and one or two pair of lower. No anterior palatal emargination. Basisphenoid pits always present, but variably developed. Coronoid process is low, approximately at the level of lower canine and articulary process.

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[*] The European free-tailed bat, *Tadarida teniotis*, inhabiting all the southern China close to the Vietnamese border (Corbet, Hill, 1992) and probably also inhabits the highlands of north Tonkin (Sokolov et al., 1986; Huynh et al., 1994).

[†] Wroughton's free-tailed bat, *Otomops wroughtoni*, was recently found in Cambodia (Walston, Bates, 2001).

DISTRIBUTION. Widely distributed from sub-Saharan Africa through India, Ceylon and Indochina to Fiji Islands and northern Australia.

NATURAL HISTORY. Fast flying high to medium altitude aerial insectivores, confined to open, disturbed habitat, including large cities. Colonies of many thousands of individuals may be formed in buildings and caves.

TAXONOMICAL REMARKS. Previously included within the genus *Tadarida*. Thirteen species are currently recognized (Koopman, 1994).

Chaerephon plicata (Buchanan, 1800)

COMMON NAMES. Dơi thò đuôi; Wrinkle-lipped free-tailed bat; Южноазиатский складчатогуб.

MATERIAL STUDIED. One specimen, captured in the Gulf of Tonkin.

IDENTIFICATION. Medium-sized free-tailed bat (weight ca. 12.5–21 g, forearm ca. 43–50 mm, CCL ca. 17.5–17.9 mm), distinctly differ from all other bats found for sure in Vietnam. Ears with their anterior borders connected with skin fold. Tragus very small, concealed entirely by the antitragus. Muzzle almost naked. Pelage short, very dense and soft, somewhat velvet, dark brown on upper side, slightly paler on ventral surface. Small upper premolar in toothrow, slightly compressed between canine and large premolar. Lower incisors individually varies in number (one or two pairs).

Amongst Vietnamese bats this species to some extent similar to *Taphozous* spp., but easily differ by longer wings, wide and fleshy ears and plicate upper lips. From all other free-tailed bats, existed in the region, *C. plicata* distinguished by distinctly smaller size.

DISTRIBUTION AND COLLECTING SITES. Trans Indo-Malayan species, often correspondent to cities and towns. Distributed from western India to southern China, Vietnam, Philippines and Indonesia. In Vietnam it was found only in Hanoi City (Huynh et al., 1994; also our preliminary observation data).

COMMENTS ON NATURAL HISTORY. No precise data available for Vietnam. Extralimitally it is reported to forage at high altitudes and roost in buildings, eventually forming very large aggregations (Bates, Harrison, 1997; V. A. Matveev, pers. comm.; our observations). The echolocation signal is quite powerful with a shallow FM component around 30 kHz.

APPENDIX

SKULLS OF SELECTED VIETNAMESE CHIROPTERA

[lateral (left) and ventral view]

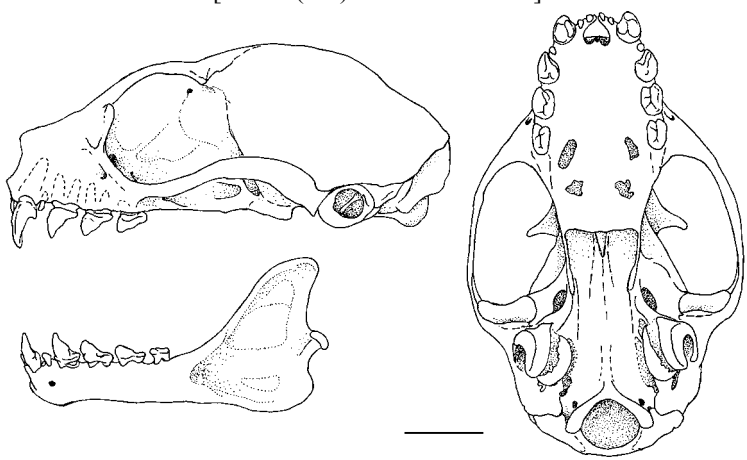

Fig. 31. Skull of *Megaerops niphanae* ZMMU S-168329 (scale bar 5 mm).

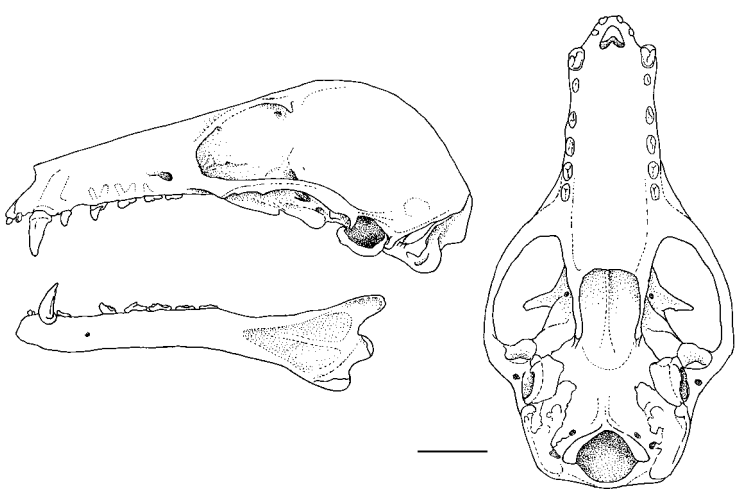

Fig. 32. Skull of *Macroglossus sobrinus* ZMMU S-167143 (scale bar 5 mm).

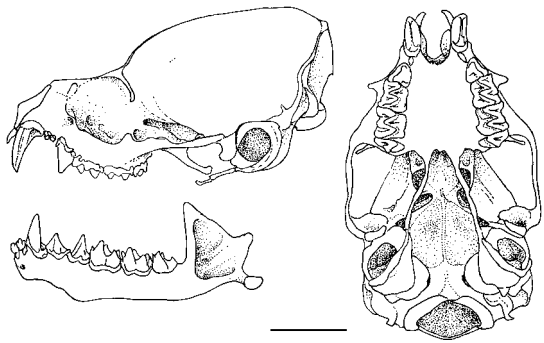

Fig. 33. Skull of *Taphozous melanopogon* ZMMU S-172666 (scale bar 5 mm).

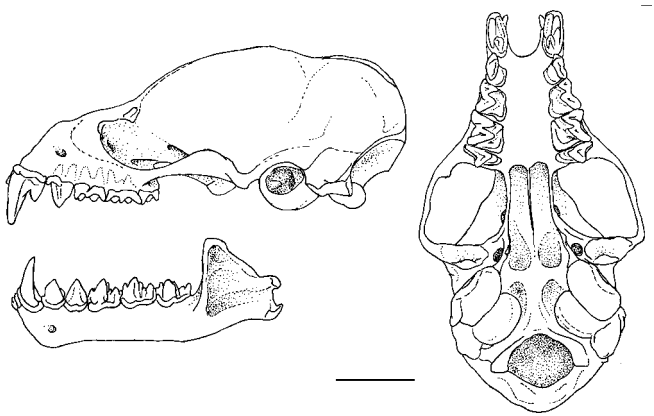

Fig. 34. Skull of *Megaderma spasma* ZMMU S-101654 (scale bar 5 mm).

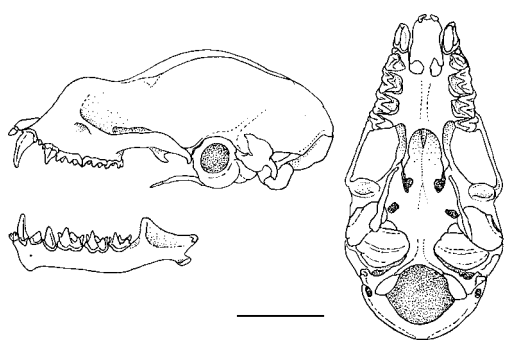

Fig. 35. Skull of *Hipposideros pomona* S-167174 (scale bar 5 mm).

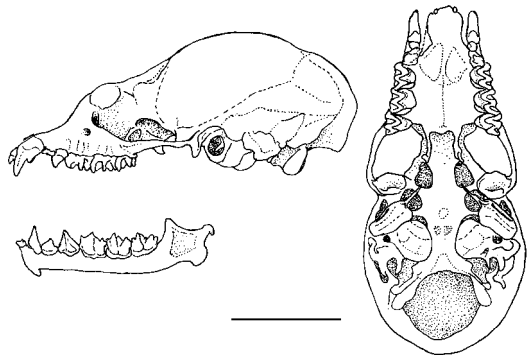

Fig. 36. Skull of *Coelops frithii* S-164993 (scale bar 5 mm).

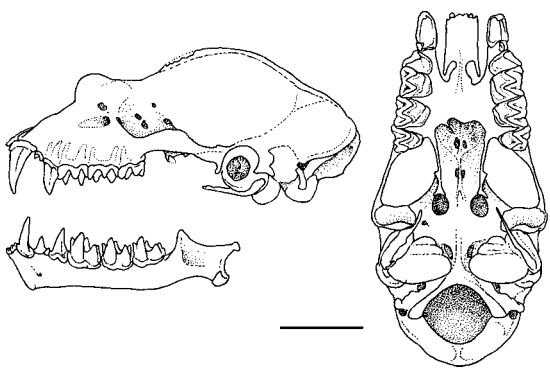

Fig. 37. Skull of *Rhinolophus affinis* S-165098 (scale bar 5 mm).

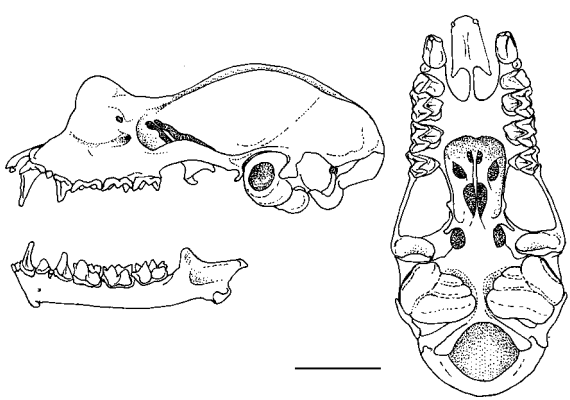

Fig. 38. Skull of *Rhinolophus shameli* S-168305 (scale bar 5 mm).

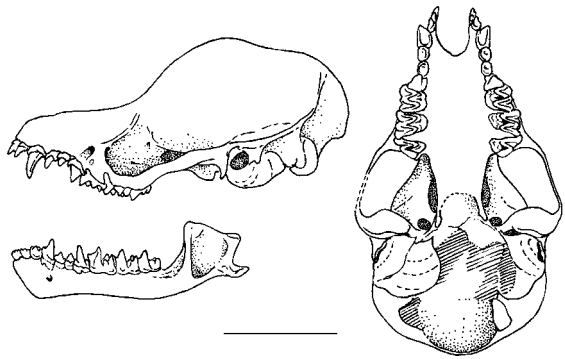

Fig. 39. Skull of *Kerivoula picta* ZISP-859 (scale bar 5 mm).

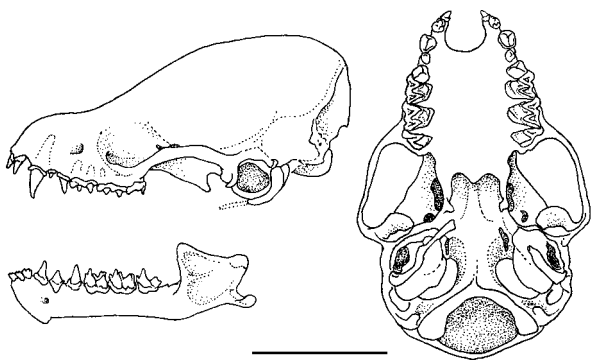

Fig. 40. Skull of *Myotis rosseti* S-172636 (scale bar 5 mm).

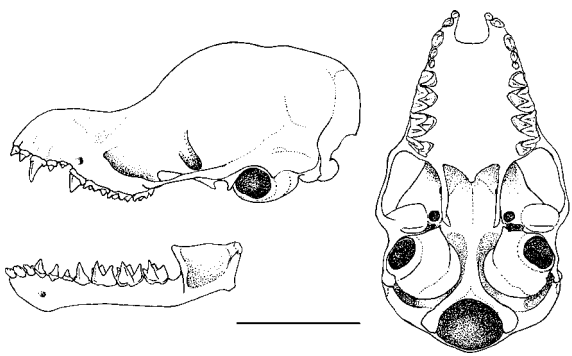

Fig. 41. Skull of *Myotis annamiticus* S-167123 (scale bar 5 mm).

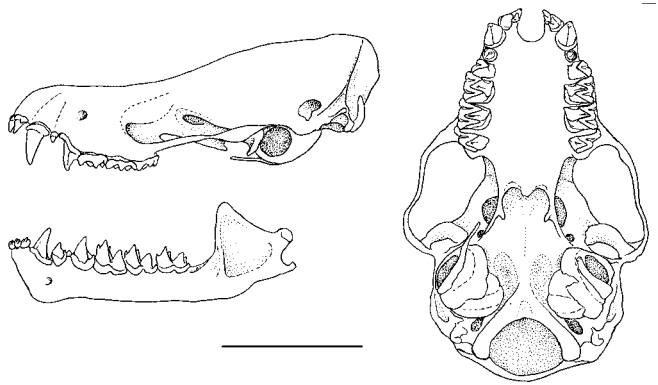

Fig. 42. Skull of *Eudiscopus denticulus* S-172558 (scale bar 5 mm).

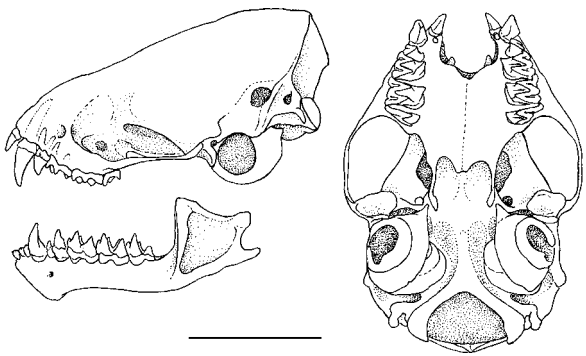

Fig. 43. Skull of *Hesperoptenus blanfordi* S-168300 (scale bar 5 mm).

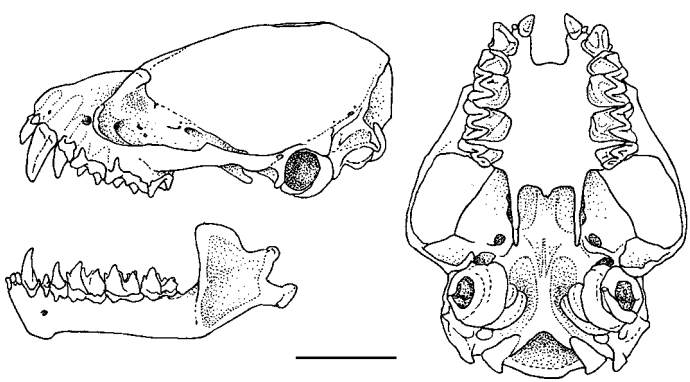

Fig. 44. Skull of *Arielulus aureocollaris* S-164990 (scale bar 5 mm).

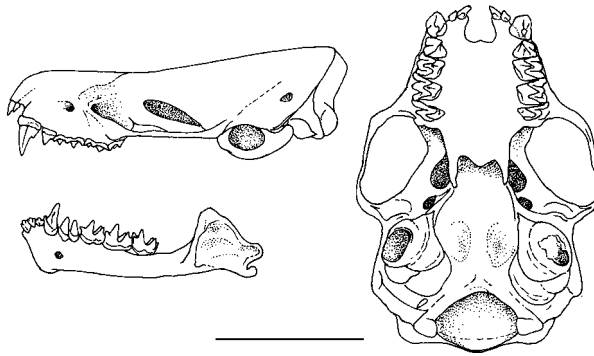

Fig. 45. Skull of *Tylonycteris pachypus* S-172658 (scale bar 5 mm).

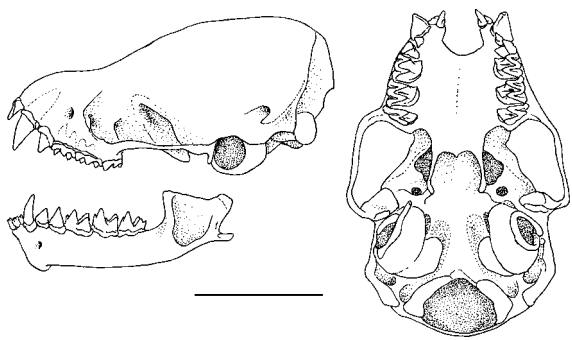

Fig. 46. Skull of *Glischropus tylopus* S-172561 (scale bar 5 mm).

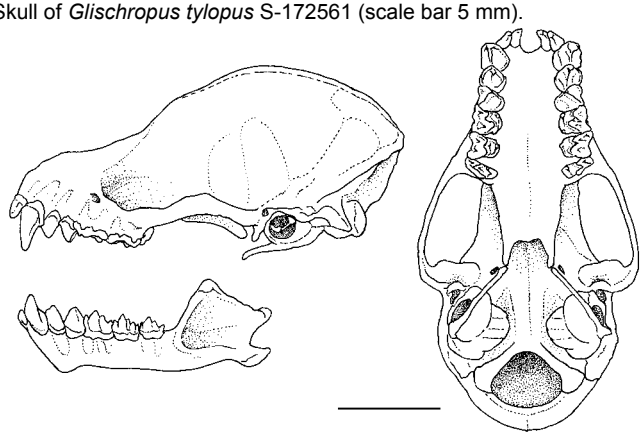

Fig. 47. Skull of *Murina huttoni* S-167185 (scale bar 5 mm).

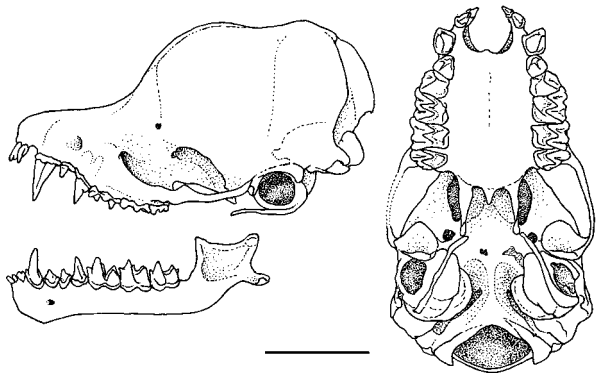

Fig. 48. Skull of *Miniopterus magnater* S-172586 (scale bar 5 mm).

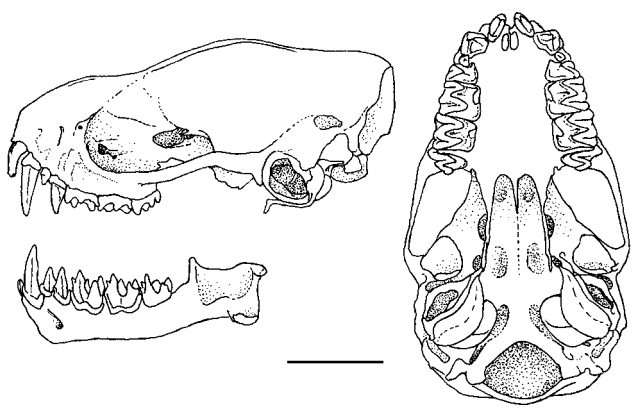

Fig. 49. Skull of *Chaerephon plicata* S-166121 (scale bar 5 mm).

WEIGHT AND EXTERNAL MEASUREMENTS OF SELECTED VIETNAMESE BATS

Table 3. *Cynopterus brachyotis*					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	31.5±7.60	63.3±2.87	84±5.7	12.9±3.90	16.3±4.59
range	21.5-44.6	58,9-66,7	76-93	8.0-18.5	7.1-19.5
n	6	5	6	6	6
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	32.3±2.64	64.3±2.49	85±5.5	12.8±2.90	17.7±0.94
range	26.5-35.5	60.6-67.9	76-95	7.0-16.0	16.6-19.2
n	9	9	9	9	9

Table 4. *Cynopterus sphinx*					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	49.5±6.68	70.8±2.10	101±6.8	14.4±1.24	22.2±2.92
range	39.5-57.2	66.4-73.2	85-106	13.0-16.5	18.1-27.9
n	8	8	8	8	8
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	41.4±3.59	69.4±2.30	95±5.8	12.6±2.65	21.2±1.46
range	33.4-48.6	65.3-74.6	85-107	7.0-18.0	17.9-23.1
n	20	19	19	20	20

Table 5. *Megaerops niphanae*, both sexes					
	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	25.1±2.88	57.3±3.40	82±5.1	0.0±0.00	18.9±1.12
range	21.9-27.5	53.5-60.2	78-88	0.0-0.0	17.6-19.7
n	3	3	3	3	3

Table 6. ***Eonycteris spelaea***					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	52.4±2.15	68.9±1.32	101±4.6	18.2±3.76	20.4±1.31
range	49.5-54.6	66.9-70.5	97-108	14.2-24.0	18.5-21.9
n	5	5	5	5	5

Table 7. ***Macroglossus sobrinus***					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	24.4±1.61	47.9±0.88	80±3.0	1.3±1.57	17.6±0.78
range	23.0-27.7	46.7-49.2	76-84	0.0-3.0	16.3-18.7
n	7	7	7	7	7
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	23.0±2.44	47.7±1.04	78±4.4	0.5±1.22	16.8±1.33
range	18.0-26.6	45.7-48.9	74-86	0.0-4.1	13.3-18.3
n	13	13	13	13	13

Table 8. ***Saccolaimus saccolaimus***					
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	33.9±2.44	67.8±1.29	88±4.0	24.3±1.53	19.4±1.97
range	31.2-37.1	66.7-69.2	84-92	23.0-26.0	17.8-21.6
n	4	3	3	3	3

Table 9. ***Taphozous melanopogon***					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	27.2±5.02	65.1±1.13	79±2.8	27.5±0.71	19.9±0.14
range	23.6-30.7	64.3-65.9	77-81	27.0-28.0	19.8-20.0
n	2	2	2	2	2

Table 10. *Hipposideros pomona*					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	6.8±0.97	42.0±0.99	46±2.5	33.4±2.14	23.4±0.83
range	5.9-7.8	40.6-42.8	43-49	31.0-36.0	22.4-24.3
n	4	4	4	4	4
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	6.3±0.65	41.6±1.14	47±4.1	33.5±1.69	23.4±0.39
range	5.7-7.2	40.2-42.7	42-52	31.0-34.6	23.1-24.0
n	4	4	4	4	4

Table 11. *Hipposideros cineraceus*, **males**					
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	4.3±0.46	34.4±0.72	44±2.2	25.7±1.73	16.4±0.70
range	3.7-4.9	33.1-35.5	41-47	23.0-28.2	15.4-17.4
n	8	8	8	8	8

Table 12. *Hipposideros larvatus*					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	14.1±0.97	58.8±3.82	65±4.3	33.5±2.17	22.0±1.89
range	12.4-15.1	51.6-62.0	59-70	30.0-36.0	19.7-24.1
n	6	6	6	6	6
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	16.4±0.81	62.1±1.00	70±3.5	32.3±1.15	23.0±0.40
range	15.9-17.3	61.3-63.2	67-74	31.0-33.0	22.6-23.4
n	3	3	3	3	3

Table 13. ***Hipposideros armiger***					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	42.0±2.76	88.6±0.92	92±1.4	55.5±2.12	31.7±0.85
range	40.0-43.9	87.9-89.2	91-93	54.0-57.0	31.1-32.3
n	2	2	2	2	2
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	45.0±5.23	90.3±1.78	94±5.0	57.4±3.27	33.0±2.08
range	37.2-51.1	88.0-92.5	88-104	51.5-61.0	29.8-36.6
n	8	9	9	9	9

Table 14. ***Hipposideros lylei***					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	39.3±5.27	78.2±0.86	87±2.8	54.4±2.97	31.2±1.46
range	31.9-46.3	76.8-79.2	84-90	51.0-59.0	29.2-32.5
n	5	5	5	5	5
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	41.2±2.71	79.7±0.78	93±4.2	54.9±2.30	31.8±2.04
range	37.3-44.5	78.6-80.7	88-98	52.0-57.0	28.5-33.8
n	5	5	5	5	5

Table 15. ***Rhinolophus affinis***					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	11.7±1.33	49.7±1.28	59±2.8	25.9±1.70	18.5±3.10
range	9.9-14.3	48.1-52.1	53-64	23.6-29.5	8.3-21.5
n	16	16	16	16	16
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	13.6±2.30	51.4±1.05	61±4.0	25.5±1.65	19.9±1.44
range	9.9-16.9	49.6-53.2	55-66	22.9-27.0	17.3-21.7
n	10	10	10	10	10

Table 16. *Rhinolophus* cf. *borneensis*, both sexes					
	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	9.2±0.85	46.4±0.06	55±0.6	26.3±1.15	19.0±0.82
range	8.2-9.8	46.4-46.5	55-56	25.0-27.0	18.3-19.9
n	3	3	3	3	3

Table 17. *Rhinolophus* cf. *rouxii*					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	9.9±2.39	43.9±1.18	52±2.8	23.4±1.52	18.3±1.36
range	7.7-14.1	41.7-45.4	48-56	21.5-25.0	15.8-19.6
n	7	7	7	7	7
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	8.5±0.84	44.4±0.06	53±5.0	22.3±1.53	17.5±1.89
range	7.7-9.4	44.3-44.4	48-58	21.0-24.0	15.9-19.6
n	3	3	3	3	3

Table 18. *Rhinolophus acuminatus*					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	9.9±1.10	46.8±1.50	57±2.2	25.0±3.16	18.2±0.61
range	8.3-10.7	45.8-48.5	54-59	22.0-29.0	17.7-19.1
n	4	3	4	4	4
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	12.5±1.48	48.8±0.62	62±2.9	25.7±1.53	19.1±0.74
range	10.8-13.5	48.1-49.3	60-65	24.0-27.0	18.3-19.7
n	3	3	3	3	3

Table 19. *Rhinolophus pusillus*, both sexes					
	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	4.9±0.21	38.3±1.19	44±1.1	23.6±0.71	16.3±0.32
range	4.7-5.0	37.4-39.1	43-45	23.1-24.1	16.1-16.6
n	2	2	2	2	2

Table 20. *Rhinolophus pearsoni*					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	15.3±1.56	50.2±1.34	58±2.2	20.6±1.83	25.2±0.63
range	13.7-18.2	48.5-52.2	54-60	17.5-23.0	24.5-26.2
n	6	6	6	6	6

Table 21. *Rhinolophus luctus*, males					
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	34.2±0.35	69.3±1.36	80±4.2	50.7±4.67	39.0±1.05
range	33.9-34.4	68.3-70.2	77-83	47.4-54.0	38.2-39.7
n	2	2	2	2	2

Table 22. *Myotis siligorensis*					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	3.6±0.25	33.5±0.86	41±2.0	37.3±1.78	12.3±0.56
range	3.3-4.2	32.2-35.3	38-44	33.8-40.2	11.6-13.4
n	12	12	12	12	12
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	3.6±0.40	33.3±0.97	41±3.6	36.9±2.27	12.9±0.60
range	2.9-4.3	31.8-35.1	37-49	33.5-41.0	11.8-13.9
n	10	10	10	10	10

Table 23. *Myotis muricola*					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	4.6±0.78	35.8±1.11	44±2.4	41.4±2.04	13.0±0.56
range	3.5-6.5	34.3-38.3	41-49	37.0-44.5	12.3-14.1
n	17	15	15	15	14
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	4.1±0.45	34.8±1.16	45±2.6	39.1±1.56	12.5±1.02
range	3.2-4.6	32.4-36.1	42-50	36.5-41.2	10.6-13.7
n	10	10	10	10	10

Table 24. *Myotis ater*					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	5.4±0.54	35.9±0.34	44±1.4	39.3±3.10	12.4±0.53
range	4.7-6.0	35.6-36.4	43-46	35.0-42.0	11.8-13.1
n	4	4	4	4	4
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	5.2±0.56	35.7±1.23	46±2.5	39.1±2.34	12.4±0.64
range	4.3-5.8	34.5-37.4	42-48	37.0-42.6	11.4-13.1
n	5	5	5	5	5

Table 25. *Myotis rosseti*					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	5.1±0.34	30.0±0.75	43±3.2	38.6±2.19	12.6
range	4.9-5.6	28.9-30.8	39-46	35.0-41.0	—
n	5	5	5	5	1
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	4.7±0.32	29.6±0.32	45±1.2	37.0±1.73	12.7±0.14
range	4.5-5.1	29.2-29.8	44-46	36.0-39.0	12.6-12.8
n	3	3	3	3	2

Table 26. ***Myotis annamiticus***					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	4.3±0.69	32.7±0.96	40±2.8	35.0±1.08	13.9±0.54
range	3.6-5.7	31.5-34.3	37-46	33.5-37.0	13.1-14.6
n	10	10	10	10	10
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	3.2±0.15	31.3±0.95	38±2.0	33.5±0.50	14.0±0.42
range	3.0-3.3	30.6-32.4	36-40	33.0-34.0	13.7-14.5
n	3	3	3	3	3

Table 27. ***Myotis horsfieldi*****, both sexes**					
	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	6.2±0.95	35.3±0.90	49±1.1	39.2±2.95	14.4±0.63
range	5.6-7.6	34.4-36.5	49-51	35.6-42.8	13.8-15.1
n	4	4	4	4	4

Table 28. ***Pipistrellus javanicus***					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	6.5±0.74	32.8±1.52	49±1.4	36.4±1.59	11.3±0.62
range	5.8-7.6	30.9-34.5	48-51	35.0-39.0	10.8-12.3
n	5	5	5	5	5
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	5.5±0.79	31.5±0.91	48±3.2	34.6±3.11	11.1±0.80
range	4.5-7.0	30.3-32.8	40-53	31.8-42.5	10.0-12.2
n	11	10	10	10	10

Table 29. *Pipistrellus abramus*					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	4.8±0.78	31.3±1.10	44±2.5	34.5±2.64	10.9±1.07
range	3.8-5.8	29.4-32.5	41-49	31.5-38.5	9.3-12.3
n	8	8	8	8	8
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	4.3±0.32	31.3±0.87	41±2.8	34.4±2.30	10.9±0.92
range	3.9-4.8	30.3-32.8	37-46	31.7-38.4	9.9-12.5
n	8	8	8	8	8

Table 30. *Pipistrellus coromandra*, males					
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	4.7±0.22	33.8±0.58	48±1.4	36.0±1.58	12.3±1.02
range	4.3-5.1	33.0-34.9	44-50	33.0-39.0	9.6-13.3
n	15	15	15	15	15

Table 31. *Pipistrellus tenuis*, both sexes					
	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	3.2±0.31	28.9±1.72	41±1.7	33.2±2.96	10.5±0.56
range	2.9-3.5	27.2-30.7	39-42	30.9-36.5	9.9-11.0
n	3	3	3	3	3

Table 32. *Glischropus tylopus*, both sexes					
	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	4.3±0.35	34.1±1.13	44±3.3	39.8±1.92	10.7±1.12
range	4.0-4.9	32.8-35.7	40-48	38.0-43.0	9.6-12.2
n	5	5	5	5	5

Table 33. ***Tylonycteris pachypus***					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	3.5±0.85	26.8±0.35	41±3.8	31.8±2.22	9.7±1.37
range	2.6-4.6	26.4-27.2	37-46	29.0-34.0	8.8-11.7
n	4	4	4	4	4
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	3.3±0.41	26.3±0.74	40±2.6	28.7±3.39	8.3±1.32
range	2.7-3.7	25.4-27.4	38-44	23.0-32.0	6.2-9.8
n	6	5	5	5	5

Table 34. ***Scotomanes ornatus***					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	36.2±2.54	58.3±2.22	78±4.0	60.0±4.36	21.5±0.80
range	34.6-39.1	55.8-60.1	74-82	55.0-63.0	20.7-22.3
n	3	3	3	3	3
Males:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	23.7±1.02	57.5±1.51	69±4.5	59.6±0.69	21.9±0.29
range	23.0-24.9	56.1-59.1	65-74	58.8-60.0	21.7-22.2
n	3	3	3	3	3

Table 35. ***Scotophilus kuhli***					
Females:	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	20.7±4.06	50.1±0.21	70±3.1	52.2±1.26	14.1±0.55
range	16.8-24.9	49.9-50.3	67-73	51.0-53.5	13.5-14.6
n	3	3	3	3	3

Table 36. *Miniopterus pusillus*, both sexes					
	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	7.6±0.71	41.7±0.36	52±2.8	49.8±1.10	9.9±0.41
range	7.0-8.8	41.4-42.2	50-57	48.0-51.0	9.3-10.2
n	5	4	5	5	4

Table 37. *Miniopterus magnater*, both sexes					
	weight, g	forearm, mm	head&body, mm	tail, mm	ear, mm
average	14.0±0.93	49.5±1.06	62±3.0	59.8±2.52	13.6±0.72
range	11.9-15.4	48.4-50.5	58-69	56.0-64.0	13.0-14.4
n	11	3	11	11	3

Note: The original measurements provided below were taken by the authors post-mortem or from live individuals. Therefore they slightly exceed those which may be retrieved from collection specimens. These measurements also may not correspond to those provided in the Identification sections of the respective species accounts, which were compiled from both original (when available) and literature data.

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INDEX OF NAMES

SCIENTIFIC NAMES

Number in **bold** typeface indicates the page containing the description of a taxon, number in *italic* indicates the page on which the taxon is being keyed out, number in ***bold italic*** corresponds to the page containing keys to taxa of lower rank.

COMMON NAMES

VIETNAMESE

ENGLISH

RUSSIAN

Lyle's flying fox, *Pteropus lylei*.

Tail-less fruit bat, *Megaerops niphanae*.

Common short-nosed fruit bat, *Cynopterus sphinx*.

Above: Pouch-bearing tomb bat, *Saccolaimus saccolaimus*.

Above and right:
Black-bearded tomb bat, *Taphozous melanopogon*.

Right: Lesser false vampire, *Megaderma spasma*.

Left: Acuminate horsheshoe bat, *Rhinolophus acuminatus*

Below: Intermediate horseshoe bat, *Rhinolophus affinis*.

Horsfield"s leafnosed bat, *Hipposideros larvatus*

Faun leafnosed bat, *Hipposideros galeritus*.

Lest leafnosed bat, *Hipposideros cineraceus*.

Above: Nepalese whiskered bat, *Myotis muricola*.

Left: Thick-thumbed mose-eared bat, *Myotis rosseti*.

Below: Moluccan whiskered bat, *Myotis ater*.

Disk-footed bat, *Eudiscopus denticulus*.

Lesser flat-headed bat, *Tylonycteris pachypus*.

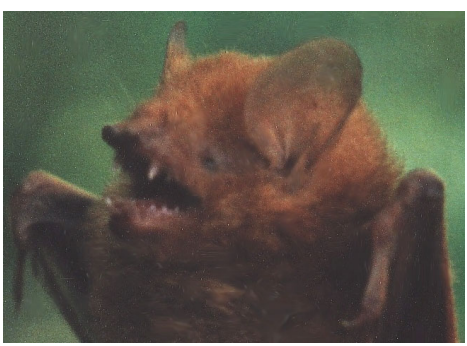
Left: Indian pipistrelle, *Pipistrellus coromandra*

Collared serotine,
Arielulus aureocollaris.

Black gilded serotine,
Arielulus circumdatus.

Above: Lesser Asiatic yellow bat,
Scotophilus kuhli.

Right: Hutton's tube-nosed bat,
Murina huttoni.



Thick-thumbed pipistrelle, *Glischropus tylopus*.

Nikobar bent-winged bat, *Miniopterus pusillus*.

Western bent-winged bat, *Miniopterus magnater*.

Photographers:
Photograph of *Pteropus lylei* was made by Vitaly A. Matveev from captive specimen, originated from Cambodia. All other pictures were made from Vietamese specimens the authors — Sergei Kruskop (*Rhinolophus affinis*, *Pipistrellus coromandra*, *Arielulus circumdatus* and *Murina huttoni*) and Alex Borissenko (the rest photographs).

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