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Series

Bats of Vietnam

Checklist and an identification manual

by Sergei V. Kruskop

2nd edition, revised and supplemented

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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С. В. Крускоп

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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.

Подготовлено в соответствии с планом научно-исследовательских работ Совместного Российско-Вьетнамского Тропического научно-исследовательского и технологического центра по программе «Тропическая экология». Руководитель программы академик Д.С. Павлов.

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Contents

Предисловие

Получить исчерпывающие сведения о составе фауны определённой территории мечтает любой зоолог, приступающий к изучению той или иной группы в том или ином регионе. Получить такие сведения для фауны рукокрылых – одного из самых загадочных, а потому привлекающих повышенное внимание зоологов отряда млекопитающих – особенно заманчиво. А получить их для тропической страны, которая протянулась с севера на юг почти на две тысячи километров и в которой представлены самые разнообразные ландшафты, не только заманчиво, но и очень сложно. Приятно отметить, что предлагаемая вниманию читателей книга в значительной степени выполняет эту задачу. Во втором издании монографии о рукокрылых Вьетнама ведущего российского специалиста по этой группе суммируется весь объём сведений об их составе и распространении, накопленный к настоящему моменту и самими исследователями, и специалистыми из других стран . Нет сомнений в том, что в это издание вошли все известные на сегодня литературные данные на эту тему. Нет также сомнений и в том, что автору хорошо известны и обсуждаемые виды, и населяемые ими районы страны: за 13 лет, в течение которых специалисты Совместного Российско-Вьетнамского Тропического центра заняты изучением данной группы, им удалось посетить и обследовать десятки районов, в буквальном смысле слова подержать в руках представителей подавляющего большинства обитающих здесь видов рукокрылых , внести существенные дополнения в видовой список рукокрылых Вьетнама.

С момента выхода в свет первой сводки по фауне летучих мышей этой страны прошло 10 лет. За эти годы опубликовано большое число работ, выполненных как западными, так и вьетнамскими исследователями, посвященных новым фаунистическим находкам или результатам фаунистических обследований (например, Nguyen Truong Son et al., 2009, 2010; Vu Dinh Thong et al., 2006, 2011; Lunde et al., 2007), а также вопросам таксономии рукокрылых (например, Furey et al., 2009; Csorba et al., 2011; Vu Ding Thong et al., 2012). Результаты ряда таксономических исследований, осуществленных за пределами Вьетнама, также внесли вклад в изменение знаний о вьетнамской фауне. Напомним, что за это время вышли и две обобщающих сводки по фауне млекопитающих Вьетнама (Кузнецов, 2006; Dang Ngoc Can et al., 2008), а также справочник по млекопитающим Юго-Восточной Азии (Francis, 2008), вносящий ясность в некоторые вопросы идентификации вьетнамских материалов и распростране-

ние вьетнамских видов. Автором книги и его коллегами по изучению рукокрылых А.В. Борисенко и П.Н. Морозовым проведено обследование 12 новых точек на севере и на юге страны, а также существенно дополнены данные по трём районам, посещавшимся ранее. Результатами этих экспедиций стали многочисленные фаунистические находки. Три вида обнаружены впервые для Вьетнама, для десяти видов выявлены новые районы распространения, существенно расширившие их ареалы. Часть этих данных опубликована в российских изданиях и международных журналах либо обнародована в качестве докладов на конференциях. Обнаружено несколько неизвестных науке таксонов, два из которых описаны в качестве новых видов (Borisenko et al., 2008; Kruskop, Eger, 2008). Всего число известных видов фауны рукокрылых Вьетнама увеличилось с 95 до 120, то есть почти на четверть, а статус многих форм был пересмотрен. В результате назрела необходимость переработать справочник и создать новую, гораздо более полную версию.

Нет нужды напоминать о том, насколько сложна работа с данной группой и насколько специфичны методы изучения рукокрылых. Тем не менее, автор не только выполнил классические работы по поиску и фиксации новых для науки и для фауны страны форм, не только собрал соответствующий материал, проанализированный затем классическими морфологическими методами, но привлек и современные подходы, заключающиеся в применении генетических методов. В частности, большой объём данных, собранных во Вьетнаме, был проанализирован в рамках международной программы «Штрих-код живого» (Barcoding of life). И, конечно, необходимо напомнить об использовании ими важнейшего в таких работах методологического приёма – опоре на сбор, изучение и переизучение коллекционных материалов. Автор смог обработать не только уже упомянутые собственные научные материалы, но и коллекции ряда мировых собраний рукокрылых, перечень которых вы найдёте в тексте справочника.

Завершая предисловие к книге, хочется подчеркнуть ещё несколько важных, на наш взгляд, моментов. Достигнутый успех – а публикация второго издания книги о рукокрылых фауны Вьетнама безусловно является важной вехой на пути изучения биоразнообразия страны и её лесных экосистем, – стал возможен благодаря высокоэффективному сотрудничеству двух стран в деле изучения животного мира Вьетнама, целенаправленным усилиям, которые руководство Российско-Вьетнамского Тропического центра приложило к организации полевых работ в самых интересных, хорошо сохранившихся и порой крайне труднодоступных

районах этой замечательной страны. Полученные представления о том, где и как живут во Вьетнаме более сотни видов рукокрылых, делают их одной из наиболее хорошо изученных групп животных. Эти сведения, безусловно, ещё будут дополняться и уточняться, что важно и интересно само по себе. Однако продолжения и развития заслуживают, на наш взгляд, не только эти исследования, составляющие базу для любых последующих изысканий, связанных с рукокрылыми. Важно то, что они заложили фундамент для детального знакомства с экологией данной группы и фактически уже стали началом экологических работ, поскольку автором получены и частично включены в текст монографии новые и очень важные данные по биологии и экологии группы. Такие исследования невозможно осуществлять силами одного или двух исследователей, можно констатировать, что публикация данной книги обеспечивает возможность продолжать и расширять изучение пространственных, временных и функциональных связей рукокрылых с другими элементами сложнейших и богатейших по составу лесных экосистем Вьетнама, привлекая к этим работам новых специалистов. Очевидно, что будущие исследования позволят обнаружить и на этом направлении массу нового, интересного и неожиданного, однако уже сейчас можно констатировать, что многолетние целенаправленные исследования биоты Вьетнама, осуществляемые Тропическим центром, дали прекрасные результаты, одним из свидетельств чего и служит эта монография.

М. В. Калякин
д.б.н., директор Научно-исследовательского Зоологического музея МГУ

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Полевые исследования, давшие основной материал, легший в основу данной книги, стали возможны блаодаря поддержке со стороны Объединеннойго Российско-Вьетнамского Тропического Центра и личного вклада А. Н. Кузнецова и генерала Чинь Куок Кханя, генеральных директоров Тропического Центра, В. С. Румака и Чан Суан Тху, бывших директоров Головного отделения ТЦ, В. Л. Трунова и Нгуен Тхи Нга, содиректоров Южного Отделения ТЦ, В. В. Сунцова, Хоанг Ань Туета и Ву Ван Тиеу, бывших директоров Южного отделения, Нгуена Ван Кхуэ, замести-

теля директора по науке Южного отделения, Л. П. Корзуна и В. В. Рожнова, кураторов направления изучения экологии наземных экосистем, и председателя Координационного Комитета Тропического Центра академика Д. С. Павлова. Нет необходимости напоминать, что успех сегодняшних зоологичесикх исследований под эгидой Тропического Центра во многом определен деятельностью академика В. Е. Соколова.

До 2007 года неоценимый вклад в осуществление биологических исследований и организацию научных экспедиций Тропического Центра был внесен Фан Лыонгом, бывшим заведующим Лабораторией экологии.

Органицация экспедиций и полевых выездов в последнее десятилетие осуществлялась А. Н. Кузнецовым, С. П. Кузнецовой, Фан Лыонгом, В. Л. Труновым, А. Л. Монастырским, Нгуеном Ван Кхуэ, Ву Суан Кхоем, бывшим заведующим Лабораторией экологии Южного отделения, Нгуеном Данг Хоем, А. Е. Аничкиным и Нгуеном Ван Тхинем. Полевые исследования были поддержаны рядом организаций, в первую очередь – Отделом долгосрочных международных проектов Института экологии и эволюции им. А.Н. Северцова РАН. Значительную помощь автору в ходе полевых работ оказали сотрудники Тропического Центра, в особенности Нгуен Ван Тхинь, Ву Мань, Нгуен Данг Хой, Фам Хонг Фыонг, Нгуен Хыу Тхык, В. Л. Трунов, А. Б. Васильева, А. В. Щинов, А. Е. Аничкин и И. В. Палько; а также М. В. Калякин, Н. А. Поярков, Э. А. Галоян (Московский государственный университет); А. В. Абрамов (Зоологический институт РАН). Особую благодарность хочется выразить администрации всех существующих и планируемых природоохранных территорий, охваченных нашими исследованиями. Личную благодарность я приношу Чан Ван Диену и Чан Ван Тханю, действующему и бывшему директорам Национального парка Каттьен, играющего ключевую роль в изучении сообществ рукокрылых Вьетнама.

Г. В. Кузнецов любезно предоставил для изучения свои материалы по рукокрылым Вьетнама. Кроме этого, экземпляры вьетнамских летучих мышей были предоставлены М. В. Калякиным, А. Н. Кузнецовым, П. Н. Морозовым, А. В. Зиновьевым, А. В. Щиновым, А. В. Абрамовым, Д. А. Васеньковым, И. В. Палько и Э. А. Галояном.

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В ходе обработки собранных в полях материалов помощь в определении отдельных коллекционных экземпляров, неопубликованные оригинальные данные о фауне Вьетнама и/или важные заечания по подготовке книги были даны Е. А. Цыцулиной (ранее: Зоологический инситут РАН, ныне – независимый исследователь), Г. Топалом и Г. Чорбой (Венгерский музей Естественной истории), Нгуеном Чыонг Шоном и Ву Динь Тхонгом (Институт Экологии и Биологичесикх ресурсов, Ханой), Дж. Л. Игер (Королевский музей Онтарио), Ч. Фрэнсисом (Канадская Служба изучения дикой природы), Е. И. Кожуриной (Институт экологии и эволюции РАН), Г. В. Фарафоновой и А. А. Панютиной (Биологичесикй факультет МГУ). Подготовка рукописи была осуществлена в Зоологическом музее Московского университета при поддержке его директора М. В. Калякина.

К сожалению, мой обычный соавтор А. В. Борисенко не имел возможности принять деятельное участие в подготовке рукописи. Однако необходимо отметить его неоценимый вклад в сбор и обработку материалов по вьетнамским рукокрылым и в подготовку первого издания «Рукокрылых Вьетнама».

Preface

Every zoologist beginning work in a certain geographic area aspires to obtain exhaustive information on its faunal content. To obtain such information on bats – one of the most enigmatic mammalian orders garnering extra attention from zoologists – is particularly appealing. Furthermore, obtaining it for a tropical country stretching latitudinally for nearly 2,000 km and housing a diverse gamut of landscapes is not only appealing but extremely difficult. It is a pleasure to say that the book by Sergei Kruskop largely fulfils this goal. The second edition of the monograph on bats of Vietnam written by Russia's leading expert in this group summarises the entire volume of knowledge about their species composition and distribution accumulated to date, thanks to his own efforts and those of other researchers. Undoubtedly, this book covers all currently available literature data on the subject. It is also clear that the author is deeply familiar with these species and the areas they inhabit. Over the last 13 years of bat research by experts from the Russia-Vietnam Tropical Centre, he visited dozens of habitats across the country, literally held most Vietnamese bat species in the hand and made several important additions to the nation's faunal checklist.

Ten years have passed since the publication of the first faunal reference on Vietnamese bats. Since then, researchers from Vietnam and other countries have published many studies in bat faunistics (e.g., Nguyen Truong Son et al., 2009, 2010; Vu Dinh Thong et al., 2006, 2011; Lunde et al., 2007) and taxonomy (e.g., Furey et al., 2009; Csorba et al., 2011; Vu Ding Thong et al., 2012). A number of taxonomic revisions done outside Vietnam also contributed to the accumulation of knowledge about the Vietnamese fauna. Several large compilations have been on the mammals VIietman (Кузнецов, 2006; Dang Ngoc Can et al., 2008), and Southeast Asia at large (Francis, 2008), which clarified some questions related to the identification of Vietnamese bat species. The author and his fellow chiropterologists A.V. Borisenko and P.V. Morozov studied 12 new localities in the north and south of the country and added to the data on three previously studied sites. These expeditions resulted in many faunistic findings; three species were recorded in Vietnam for the first time and the known distribution ranges of many others were expanded significantly. Some of these results were published in Russian and international journals or reported in international conferences. Several taxa new to science were found, two of which were described as new species (Borisenko et al., 2008; Kruskop, Eger, 2008). Overall, the bat faunal list of Vietnam was expanded by nearly one-quarter – from 95 to 120; the taxonomic status of many named forms has been revised. As a result, it became imperative to prepare a completely revised taxonomic reference that would incorporate these new findings.

Needless to say, the study of bats is complicated and has many specifics imposed by the peculiar features of this taxon. Nevertheless, the author not only accomplished a thorough task of reporting taxonomic and faunistic findings using classical survey approaches and morphological data but also applied innovative molecular methodologies. A significant part of the materials collected in Vietnam has been scrutinized using short standardized DNA sequences within the framework of the International Barcode of Life project (iBOL). Importantly, the author relied on another key methodological approach for this type of research – the examination and reexamination of available collection material. Besides studying collections resulting from his own surveys, he also had the privilege of working is some of the world's largest repositories listed in the corresponding sections of this reference.

I would like to conclude by making a few important remarks. The publication of the second edition of comprehensive reverence of Vietnamese bats is a major milestone in the study of the biological diversity of Vietnamese forest ecosystems. This breakthrough was made possible, thanks to the effective collaboration of two countries in the area of wildlife research in Vietnam; in particular, the dedicated efforts that the leaders of the Vietnam-Russia Tropical Centre have put towards coordinating field work in the most interesting and well preserved habitats, often in remote and inaccessible locations of this amazing country. The data thus obtained on the distribution and natural history of over one-hundred Vietnamese bat species make them one of the better studied animal groups in the country. Undoubtedly, new information will be added to this knowledge base that will, hopefully, go beyond the scope of this study centered around taxonomy and faunistics. It is important that this reference provides baseline data on ecology and natural history of many bats that can be a starting point for further in-depth enquiry. A thorough ecological survey cannot be completed by one or two researchers alone; however, the publication of this book can serve as the crystallization point for future extensive analyses of spatial, temporal and functional relationships of bats with other elements of the hyperdiverse and infinitely complex forest ecosystems of Vietnam. Hopefully, it will spur interest among experts working in adjacent disciplines and will attract new researchers. While future investigations in this field promise to reveal new, interesting and unexpected findings, we are pleased to see that dedicated long-term survey efforts of the Vietnamese biota spearheaded by the Vietnam-Russia Tropical Centre have paid off in spades, as illustrated by the publication of this monograph.

M.V. Kalyakin
Dr.Sci., Director, Zoological Museum of Moscow University

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Unfortunately, my usual co-author A.V. Borisenko was not able to take significant part in processing of this manuscript. However it is necessary to mention his invaluable contribution to collecting and procession of scientific material of Vietnamese bats and in preparing of the first edition of "Bats of Vietnam".

Introduction

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 Vietnamese 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.

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). 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).

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 possessing only alive individuals. The same section "Identification" contains commnets about possible taxonomical ambiguity or complexity (especially relevant to problems in identification). For higher taxa comments on their taxonomy and recent changes in nomenclature are specified under "Taxonomical remarks".

Distribution is provided for all the species combined from available literature and author's original data. For most species schematic distribution maps are also provide. Since detailed biogeographic account is not the aim of this book, we may miss some particular faunistic publications and thus may also miss some already published records. So, for most records we provide only the relevant province (both in text and on appropriate map), focused in more details only on specifically interesting cases (e.g. species known from only very few localities). Such data though not detailed, can give an idea of general pattern of the species distribution and help one in the identification of material.

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, but, however, original materials were available.

Bat research efforts in Indochina

The bat fauna of Vietnam, as well as much of the Indomalayan Region, remained poorly studied until the late 1990-s. Relatively few regional faunal checklists and taxonomic reviews were published by the time when the first edition of "Bats of Vietnam" came out. The situation changed drastically over the last 1.5 decades, thanks to extensive recent surveys in several key protected areas undertaken by researchers from Vietnam and other countries (Abramov et al., 2009; Furey et al., 2010; Hendrichsen et al., 2001; Vu Dinh Thong et al., 2010; Vu Dinh Thong, Furey, 2008; etc.). These surveys have steadily provided important zoogeographic and taxonomic findings (e.g. Furey

et al., 2009; Borisenko et al., 2008; Csorba et al., 2007, 2011; Kruskop et al., 2006; Kruskop, Eger, 2008; Vu Dinh Thong et al., 2006; 2008; 2012a, b). Systematic revisions within all major bat groupings resulted in the revalidation and description of many new species and subspecies, the rearrangement of known genera and even subfamilies. Increasing use of molecular genetic approaches add further veracity to these findings, highlight previously overlooked taxonomic problems and help to reveal cryptic taxonomic diversity (see e.g. Francis et al., 2010). Coupled with a much denser geographic coverage, these findings boost our knowledge of the biodiversity and guild structure of Indochinese bats. Nonetheless, the continually increasing number of new faunal records and taxonomic revisions clearly indicate that this work is still far from completion. Every year and each field trip brings new interesting information and sometimes overturns previously established concepts. This second edition summarizes the findings made in the past decade; however, it is not intended to be the 'ultimate' reference for bat research in the region.

Several prominent researchers, from Osgood to Van Peenen, studied Vietnamese bats and other mammals during the XX century and their work has set the stage for follow up surveys that continue today. A detailed historical account of zoological research in Indochina is provided by V.V. Rozhnov (2001). Here we shall restrict ourselves to outlining the role of the Vietnamese-Russian Tropical Centre (VRTC) in the study of Vietnamese Chiroptera.

Russian zoological studies in Vietnam started in 1978 by the initiative of the academician V.E. Sokolov. The VRTC was established in 1988 and since that time hosted field ecological survey expeditions of the Russian specialists. However, until 1997 no specific bat surveys were undertaken. Material on bats was collected as a by-product of mammalogical and ornithological surveys and part of it was subsequently deposited in the Zoological Museum of Moscow University, Moscow, Russia (ZMMU). Most ZMMU bats from this period were donated by German V. Kuznetsov and Mikhail V. Kalyakin and either captured in bird mist nets or taken inside day roosts. A number of interesting specimens collected earlier was kindly donated to the Zoological Museum by Dr. Dao Van Tien. Most of the specimens collected before 1997 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 lack of dedicated chiropterological surveys resulted in relatively poor or fragmentary representation of the diversity of bats in each of the field sites. Nonetheless, these data were used to assemble in a number of mammalian faunal lists (Sokolov et al., 1986) and a general mammalogical compendium

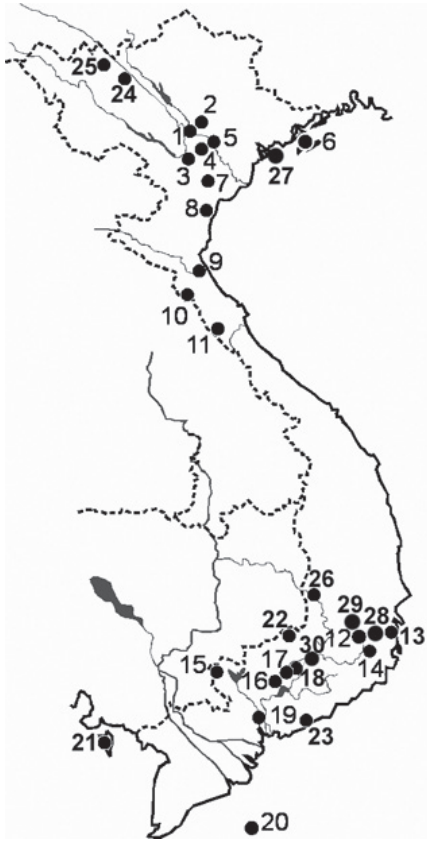
(Dang Huy Huynh et al., 1994). Unfortunately, some of the information contained in these lists is based on unverified citations of earlier works, rarely refers to voucher specimens, and hence requires reevaluation. Interestingly, Sokolov et al. (1986) listed several bat species (e.g., *Saccolaimus saccolaimus, Rhinolophus acuminatus, Myotis chinensis*) whose presence in Vietnam remained unconfirmed by vouchers until later surveys.

In 1997 the first dedicated bat survey was carried out during an expedition to Vu Quang Nature Reserve facilitated by VRTC (Borissenko et al., 2001; Kuznetsov et al., 2001). The outcome of this expedition was positively evaluated by the VRTC Board and since 1997 particular attention was paid to surveying bats. As a result, Chiroptera were surveyed much more thoroughly, which led to the compilation of relatively more comprehensive faunal lists of the studied areas. In addition to the standard method of capturing bats in mist nets, ultrasound detectors were employed, and a new method of capturing foraging bats with mobile traps (Borissenko, 1999) was introduced, which enabled to collect data on behavioral patterns of certain bat species.

Particular focus on bats during the expeditions of the VRTC further added data on ecology and natural history of bats that were collected as a by-product of 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).

The success of bat surveys during six expeditions of the Tropical Centre carried out in 1997–2002 also pointed out to the unsatisfactory state of identification keys (outdated and either too generic or extralimital) which hampered the identification of specimens collected. This prompted the compilation of available information about Vietnamese bat records in form of an identification manual (Borissenko, Kruskop, 2003). Although it was probably the most complete an up to date regional bat checklist in its time, it was promptly outdated by a large volume of new data that became available shortly after.

To date, the VRTC has facilitated bat surveys in 30 localities, mostly confined to the north, north-central and southern parts of Vietnam (see map on Fig. 1). The bat species collected during the expeditions amount to 92, of the ca. 120 species hitherto reported from this country. Among them are species which have not been previously listed in available publications and unpublished reports and therefore were reported for Vietnam for the first time (e.g., *Saccolaimus saccolaimus*, *Rhinolophus acuminatus*, *Arielulus circumdatus*, *Barbastella darjelingensis*, *Hypsugo joffrei*, *Harpiola isodon*, *Murina chrysochaetes*). This



Explanations of localities:

1. Ba Vi;
2. Tam Dao;
3. Kim Boi;
4. Quoc Oai;
5. Hanoi City and surroundings;
6. Phuong Vong Is.;
7. Cuc Phuong;
8. Thanh Hoa;
9. Vinh;
10. Vu Quang;
11. Ke Bang;
12. Bi Doup – Nui Ba;
13. Nha Trang;
14. Cong Troi;
15. Lo Go Xa Mat;
16. Vinh Cuu;
17. Nam Cat Tien;
18. Cat Loc;
19. Ho Chi Minh City and surroundings;
20. Con Dao Is.;
21. Phu Quoc Is.;
22. Bu Gia Map;
23. Binh Chau;
24. Van Ban;
25. Sa Pa;
26. Yok Don;
27. Cat Ba Is.;
28. Hon Ba;
29. Chu Yang Sin;
30. Loc Bao.

Localities 1, 2, 3, 4, 6, 7, 8, 9, 13, 14 were surveyed by G.V. Kuznetsov. Localities 15, 18, 28 were surveyed by A.V. Borisenko. Localities 21, 24 were surveyed by P.N. Morozov.

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

includes three species which were described as new to science – *Myotis annamiticus* (Kruskop, Tsytsulina, 2001) *Murina harpioloides* (Kruskop, Eger, 2008) and *Myotis phanluongi* (Borisenko et al., 2008), and at least three other species which a still awaiting formal description. Several regional checklists were expanded and/or verified (e.g., Kuznetsov et al., 2001; Kruskop, 2001b, 2010a, 2011; Abramov et al., 2009; Kruskop, Shchinov, 2010).

The natural resources of Vietnam are being exploited at an ever increasing pace, with habitat loss being possibly the biggest factor threatening the

existence of most native flora and wildlife (e.g. Furey et al., 2009). In view of this, biodiversity assessments of the local bat communities are particularly important, because they are indicative of the state of the ecosystems in general. Although baseline ecological assessments are part of the recent bat surveys, they are often insufficient to provide even basic ecological knowledge about certain species of potential conservation importance. This calls for the need to conduct extensive ecological monitoring in key sites. Naturally, such efforts should not undermine the value of background biodiversity surveys resulting in species checklists, which should form an essential component of any field study and the basis for elaborating site-specific conservation activities.

General overview of the Vietnamese bat fauna

The order of bats (Chiroptera) is the second largest order of mammals containing about 1250 known species and having nearly worldwide distribution (Simmons, 2005 and pers. comm; http://www.planet-mammiferes.org/). The bulk of this diversity is confined to the tropics, where bats play a tremendous role in ecological communities as consumers of insect and plant biomass, as pollinators and an important food resource for a variety of predators (Wilson, 1989). This role, however, is apparently underestimated, due to insufficient of knowledge of most tropical bat assemblages. The Indochinese biogeographical division (sensu Koopman, 1989; Corbet, Hill, 1992) is home to more than 150 bat species, nearly $^{2}/_{3}$ of which occur in Vietnam.

A detailed zoogeographical account was not the intention of this book. A comprehensive overview of mammalian distributional patterns in Vietnam was provided by G.V. Kuznetsov (2000; 2001; 2006) and herein we shall outline a some key points of relevance to Chiroptera. 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*.). To this point, about 120 bat species from eight families were reported from Vietnam. In particular, at least 40 species were documented in Cat Tien National Park (Dong Nai province; Polet, Ling, 2004; our data), demonstrating the diversity of some Vietnamese bat communities. This makes the Vietnamese bat fauna one of the richest in the Palaeotropics, and opens future avenues to use it as a model for intense study of bat guilds in a phylogeographic context with wide ranging implications from basic ecology and phylogenetics to conservation biology and biomedicine.

The dynamics of data accumulation on the diversity of Vietnamese bats is illustrated in Table 1. This list will likely expand further in the coming years,

due to possible vagrants from adjacent territories of Cambodia, Laos and China. It is also likely that more new species will be described from Vietnam. It should be noted that most species recently found in Vietnam were described from extralimital type localities; the new species listed in Table 1 are restricted only to those described from the territory of Vietnam. . There are, however, several cases when a species of bat was found in Vietnam shortly after its description. For example, *Harpiola isodon* was described from Taiwan (Kuo et al., 2006) simultaneously as it was found for the first time in Vietnam (Kruskop et al., 2006). *Thainycteris aureocollaris* was described from Thailand (Kock, Storch, 1996) just one year before it was recorded in Vietnam (Eger, Theberge, 1999; Kuznetsov et al., 2001). *Murina chrysochaetes* was found in Northern Vietnam even before it was formally described from China (Eger, Lim, 2011).

According to Kuznetsov, there are two main factors contributing to the high mammalian biodiversity in Vietnam. 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, either parsing or blending climatic influences of the Pacific and continental Indochina. This forms a complex pattern of highly mosaic landscapes and sustains the patchiness of habitats. The result of this unique geographical position of Vietnam is that mammal assemblages in different regions of the country are influenced by different faunal complexes. The Vietnamese bat fauna conforms to this pattern; in particular, the bat assemblages of North Vietnam contain a mixture of taxa of different zoogeographic origin. At this point, there are no comprehensive phylogeographic analyses of the Vietnamese bat fauna. One can speculate about the influence of Indo-Malayan, Himalayan (or montane Indo-Burmese) and Palaearctic faunal elements, although it is possible that these ideas may be revised as new data accumulate on molecular biodiversity and a larger proportion of autochthonous species will be confirmed. The outline below should be considered as provisional and pending further validation using molecular phylogeographic data.

Most bats inhabiting the montane forests of Vietnam appear to be of Himalayan origin, and their southward distribution is facilitated by the existence of continuous mountain systems stretching across Southeast Asia. Such are *Ia io*, *Myotis siligorensis*, *Pipistrellus coromandra*, *Hypsugo joffrei*, and several species of *Rhinolophus*. Being essentially southeastern spurs of the Himalayan mountain country, the mountains of Vietnam may have also acted

as a Pleistocene refuge, from which the above species then spread to more northern regions. Several bat species occurring in northern Vietnam (including *Myotis chinensis, M. laniger, Murina chrysochaetes, Hipposideros pratti* etc.) are confined to northern Indochina and southern China. *Harpiola isodon* has disruptive distribution with patches on Taiwan and in two places in Vietnam. Such distribution may represent traces of a much wider former range. Since another *Harpiola* species occurs in mountains of northern India (Bhattacharyya, 2002) the whole genus may be regarded as Himalayan.

Most species which inhabit the lowlands represent Malayan faunal elements though their origin and exact relations are uncertain. During the last ocean regression, the Gulf of Siam was virtually non-existent (Hanebuth et al., 2000) and therefore there should have been a land connection between Indochina and the Malayan peninsula. It would thus be logical to suppose that bats of the lowland forests of South Vietnam are of Malayan or even Sunda origin. This may be the case for several species, such as *Pteropus hypomelanus*, *Cynopterus brachyotis*, *C. horsfieldii*, *Macroglossus minimus*, *Hipposideros diadema*, *Rhinolophus stheno*, *Kerivoula papillosa*, *Phoniscus jagorii*, and *Myotis hasseltii*. Other lowland species, such as *Cynopterus sphinx*, *Megaderma lyra*, *M. spasma*, *Hipposideros armiger*, *Rhinolophus luctus*, *Pipistrellus tenuis* etc. have a wide distribution across South and Southeast Asia, making it problematic to refer them to a certain zoogeographical grouping. Other widely distributed bats such as *Myotis muricola*, *Kerivoula hardwickii*, *Hipposideros pomona* and *H. larvatus* are represented in the region by several genetic lineages each (Francis et al., 2010) and the origin of these lineages can be different.

Several bat species, such as *Hipposideros khaokhouaensis*, *Rhinolophus marshalli*, *R. microglobosus*, *Murina harrisoni*, *M. harpioloides*, *M. beelsebub*, *M walstoni*, *Kerivoula kachinensis*, *K titania*, *Myotis phanluongi* and *Thainycteris aureocollaris* are Indochinese endemics; however, most of them have close relatives from Himalayan or Malayan lineages. For example, *R. microglobosus* is closely related to the Malayan *R. stheno* and *M. phanluongi* is a close relative to the Indo-Himalayan *M. siligorensis*.

Palaearctic faunal elements are rare and represented in Vietnam by *Nyctalus noctula*, *Eptesicus* cf. *serotinus* and *Barbastella* cf. *darjelingensis*. The occurrence of *Myotis nipalensis* and *Myotis daubentonii* in Indochina is highly unlikely and currently not supported by vouchered collection specimens. Earlier records (Dang Ngoc Can et al., 2008) can be a result of misidentification.

Despite the high diversity of Vietnamese mammal fauna, its level of endemism is rather low. G.V. Kuznetsov (2006) indicates seven endemic mammal species, which include but two bats: *Paracoelops megalotis* (currently dis-

missed as a misidentified *Hipposideros pomona* (Vu Dinh Thong et al., 2012c)) and *Myotis annamiticus* (which is likely to occur in Laos). Most bat species described in recent years from Vietnam also occur in adjacent countries; the only known exceptions are *Murina harpioloides* from Dalat Plateau (Kruskop, Eger, 2008), *Myotis phanluongi* (Borisenko et al., 2008), *Hipposideros griffini* (Vu Dinh Thong et al., 2012a) and *H. alongensis* (Vu Dinh Thong et al., 2012b). It is still possible, however, that the mosaic habitats of Vietnam house a number of endemic bat species which remain to be described.

Table 1. Recent changes of knowledge about Vietnamese bats.

Families	Genera	Species				New records for Vietnam (last 12 years)	New species (last 12 years)	Supposed new species (undescribed)
		Corbett, Hill, 1992	Borissenko, Kruskop, 2003	Dang Ngoc Can et al., 2008	Current data (2012)			
Pteropodidae	7	9	12	12	13	1		
Hipposideridae	3	11	13	16	16+	3	1	2+
Rhinolophidae	1	12	17	18	19	3		
Megadermatidae	1	2	2	2	2			
Emballonuridae	2	2	3	4	4	2		
Vespertilionidae	20	22	43	53	59+	13	5	4+
Miniopteridae	1	1	3	4	3	1		
Molossidae	1	1	1	1	1+			

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 pro-

vided below. For detailed information we should refer the reader to special works (Tuttle, 1974; Tideman, Woodside, 1978; Kunz, Kurta, 1988; 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 is 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, 1988; 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. 2) 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 (Fig. 2 a, b). The echolocation system of most insect-eating 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. Pteropodid 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.

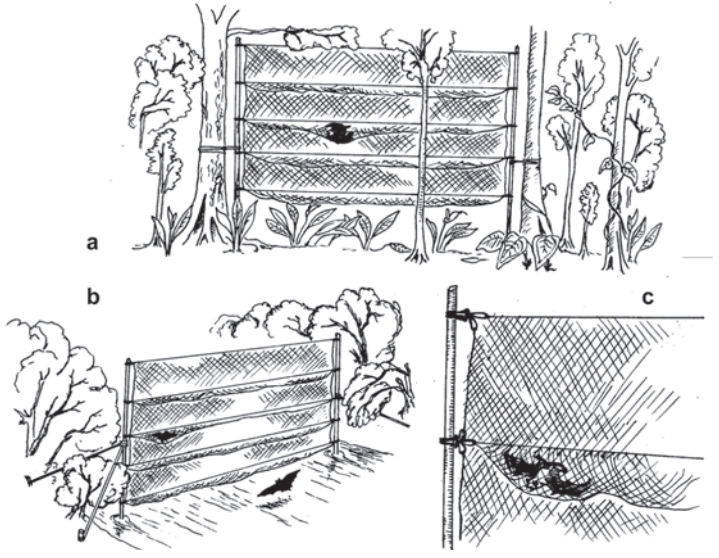


Fig. 2. The use of mist nets for catching bats: «typical» ways of setting up mist nets to catch bats a) in a forest opening and b) across a narrow stream; c) details of attachment of a mist net to a pole.

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 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). It is also necessary to mention that, after few individuals were captured, most bats learn the position of the mist net and exert themselves to avoid it. 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,

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

1978; Kunz, Kurta, 1988; 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.[1] 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.

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, Fig. 3.). 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 popu-

[1] 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.)

lation 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.

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).

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.

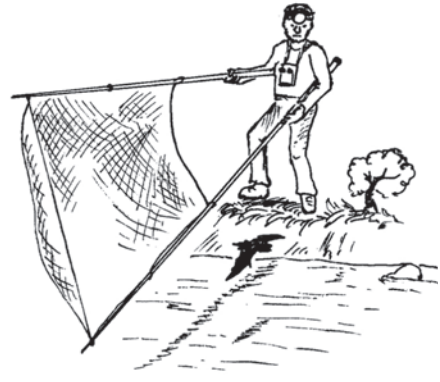


Fig. 4. Using a mobile trap to catch bats in flight.

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 well). 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 simplest 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, 1988), 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 are the optimum for a 17×25 cm bag. Solitary or carnivorous species should be kept individually or in mother-and-infant groups[2].

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 holding 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

[2] 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).

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 stressing 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[3]. 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

[3] 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.

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 characters 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 post-lactational 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 qualitative 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. In the case of Hipposideridae and Rhinolophidae, **Antitragus length** is measuring instead of tragus and in the same manner. 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.

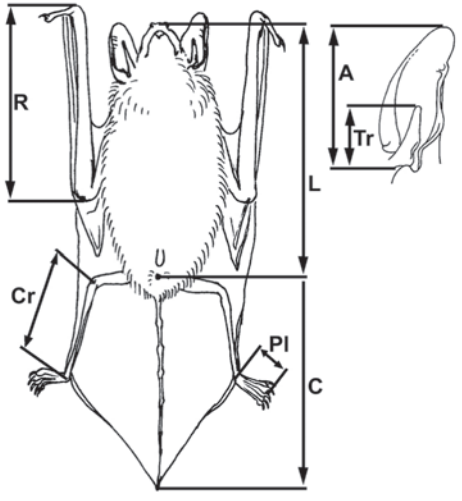


Fig. 5. Schematic representation of the standard measurements of a bat. See text for explanations.

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 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;

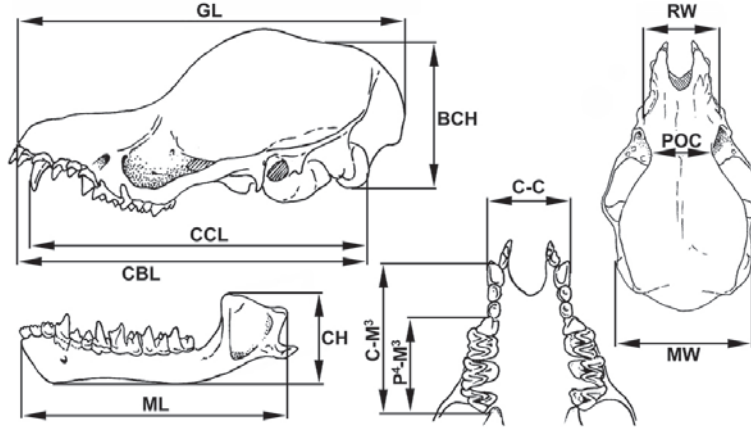


Fig. 6. Schematic representation of the basic cranial measurements of a bat (*Kerivoula*). See text for explanations.

Width of postorbital constriction (POC) – narrowest width across skull, measured behind the orbits; **Rostral width** (RW) – distance between contralateral anterorbital foramina; **Mandible length** (ML) – length of the lower jaw branch from the outermost part of the symphysis to the articulary process; **Coronoid height** or **Lower jaw height** (CH) – height of the coronoid process of the lower jaw measured from its tip to the inferior plane of the main ramus of the jaw; **Upper tooth row length** (C–M^3) – distance from the anterior edge of the upper canine to the posterior edge of the last molar; **Upper molariform tooth row 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 provide 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 for 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 accompanies respective collection materials.

Substantial part of keys and diagnosis in this book is based on the original material collected by the author and his colleagues during the field trips or processed in different natural history collections. Acronyms of these institutions are as follows: GNHM – Geneva Natural History Museum, Geneva, Switzerland; HNHM – Hungarian Natural History Museum, Budapest, Hungary; IEBR – Institute of Ecology and Biological Resources, Hanoi, Vietnam; NIBR – National Institute of Biological Resources, South Korea; ROM – Royal Ontario Museum, Toronto, Canada; SDM – State Darwin Museum, Moscow, Russia; ZISP – Zoological institute of the Russian Academy of Sciences, St.-Petersburg, Russia; ZMB – Zoological Museum of Berlin, Germany; ZMMU – Zoological Museum of Moscow State University, Moscow, Russia.

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 mountain 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.

One more hazard is coming from electricity. Carboplastic fishing rods, using for "flap-traps" and as poles for setting up mist-nets, are highly electroconductive. Thus they should be used carefully under the transmission facilities, especially in moist weather. In the risk of thunderstorm these poles should be folded up and lying down on the ground in some distance from people and tents to prevent lightning affection.

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 behavior.

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 (2006) and Simmons (2005), with some corrections followed after latest molecular studies (see commnets under particular taxonomic groups); the arrangement of tribes in Vespertilionidae follows Kruskop (2012).

Order Chiroptera Dobson, 1872

Suborder Yinochiroptera Koopman, 1985 (=Pteropodifomes Hutcheon, Kirsch, 2006)

Superfamily Pteropodoidea

Family Pteropodidae Gray, 1821

Subfamily Pteropodinae s. str.

Genus *Pteropus* Erxleben, 1777

"*vampyrus*" group
Pteropus lylei K. Andersen, 1908
Pteropus vampyrus (Linnaeus, 1758)

"*subniger*" group
Pteropus hypomelanus Temminck, 1853

Subfamily Rousettinae Koopman, Jones, 1970

Genus *Rousettus* Gray, 1821
Rousettus amplexicaudatus (E. Geoffroy, 1810)
Rousettus leschenaulti (Desmarest, 1820)

Genus *Eonycteris* Dobson, 1873
Eonycteris spelaea (Dobson, 1871)

Subfamily Cynopterinae Gray, 1866

Genus *Cynopterus* F. Cuvier, 1824
Cynopterus sphinx (Vahl, 1797)
Cynopterus brachyotis (Mueller, 1838)
Cynopterus horsfieldi Gray, 1843

Genus *Sphaerias* Miller, 1906
Sphaerias blanfordi (Thomas, 1891)

Genus *Megaerops* Peters, 1865
Megaerops niphanae Yenburta, Felten, 1983

Subfamily Macroglossinae Gray, 1866

Genus *Macroglossus* F. Cuvier, 1824
Macroglossus sobrinus K. Andersen, 1911
Macroglossus minimus (E. Geoffroy, 1810)

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 Hipposideridae Lydekker, 1891

Tribe Hipposiderini s. str.

Genus *Aselliscus* Tate 1941
Aselliscus stoliczkanus (Dobson, 1871)

Genus *Hipposideros* Gray, 1831

Subgenus *Hipposideros* s. str.

"*larvatus*" group
Hipposideros larvatus (Horsfield, 1823)
Hipposideros grandis Allen, 1936
Hipposideros armiger (Hodgson, 1835)
Hipposideros alongensis Bourett, 1942
Hipposideros griffini Thong, Puechmaille, Denzinger, Dietz, Csorba, Bates, Teeling and Schnitzler, 2012

"*pratti*" group
Hipposideros pratti (Thomas, 1891)
Hipposideros lylei Thomas, 1913
Hipposideros scutinares Robinson, Jenkins, Francis and Fulford, 2003

"*diadema*" group
Hipposideros diadema (E. Geoffroy, 1813)

Subgenus *Chrysonycteris* Gray, 1866

"*bicolor*" group
Hipposideros pomona K. Andersen, 1918
Hipposideros cineraceus Blyth, 1853
?*Hipposideros ater* Templeton, 1848
Hipposideros khaokhouayensis Guillen-Servent, Francis, 2006

"*galeritus*" group
Hipposideros galeritus Cantor, 1846

Tribe Coelopsini Tate, 1941

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

Family Rhinolophidae Gray, 1825

Genus *Rhinolophus* Lacepede, 1799

"*megaphyllus*" group
Rhinolophus affinis Horsfield, 1823
Rhinolophus chaseni Sanborn, 1939
Rhinolophus malayanus Bonhote, 1903
Rhinolophus stheno Andersen, 1905
Rhinolophus microglobosus Csorba, Jenkins, 1998

"*rouxii*" group
Rhinolophus sinicus Andersen, 1905
Rhinolophus thomasi Andersen, 1905

"*pusillus*" 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 siamensis* Gyldenstolpe, 1917
Rhinolophus luctus Temminck, 1835
Rhinolophus paradoxolophus (Bourret, 1951)
Rhinolophus marshalli Thonglongya, 1973

Suborder Yangochiroptera Koopman, 1985 (=Vespertilionifomes Hutcheon, Kirsch, 2006)

Superfamily Emballonuroidea

Family Emballonuridae Gervais, 1856

Subfamily Thaphozoinae Jerdon, 1877

Genus *Taphozous* E. Geoffroy, 1818
Taphozous melanopogon Temminck, 1841
Taphozous theobaldi Dobson, 1872
Taphozous longimanus Hardwicke, 1825

Genus *Saccolaimus* Temminck, 1838
Saccolaimus saccolaimus (Temminck, 1838)

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 kachinensis Bates, Struebig, Rossiter, Kingston, Sai Sein Lin Oo, Khin Mya Mya, 2004
Kerivoula titania Bates, Struebig, Hayes, Furey, Khin Mya Mya, Vu Dinh Thong, Pham Duc Tien, Nguyen Truong Son, Harrison, Francis, Csorba, 2007

Genus *Phoniscus* Miller, 1905

Phoniscus jagorii Peters, 1866

Subfamily Murininae Miller, 1907

Genus *Murina* Gray, 1842

Murina cyclotis Dobson, 1872
Murina fionae Francis, Eger, 2012
Murina huttoni (Peters, 1872)
Murina harrisoni Csorba, Bates, 2005
Murina feae (Thoimas, 1891)
Murina beelsebub Son, Furey, Csorba, 2011
Murina leucogaster Milne-Edwards, 1872
Murina eleryi Furey, Thong, Bates, Csorba, 2009
Murina walstoni Furey, Csorba, Son 2011
Murina harpioloides Kruskop, Eger, 2008
Murina chryzochetes Eger, Lim, 2011
Murina annamitica Francis, Eger, 2012

Genus *Harpiola*

Harpiola isodon Kuo, Fang, Csorba, Lee, 2006

Genus *Harpiocephalus* Gray, 1842

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

Subfamily Myotinae Tate, 1942

Genus *Myotis* Kaup, 1829

Subgenus *Myotis* s.str

Myotis chinensis (Tomes, 1857)

Subgenus *Leuconoe* Boie, 1830

"*montivagus*" group
Myotis montivagus (Dobson, 1874)
Myotis annectans (Dobson, 1871)

"*muricola*" group
Myotis muricola (Gray, 1846)
Myotis ater (Peters, 1866)

"*mystacinus*" group
Myotis cf. nipalensis (Dobson, 1871)

"*rosseti*" group
Myotis rosseti (Oey, 1951)

"*siligorensis*" group
Myotis annamiticus Kruskop, Tsytsulina, 2001
Myotis laniger (Peters, 1871)
Myotis siligorensis (Horsfield, 1855)
Myotis phanluongi Borisenko, Kruskop, Ivanova, 2008

"*adversus*" group
Myotis horsfieldii (Temminck, 1840)
Myotis hasseltii (Temminck, 1840)

"*ricketti*" group
Myotis ricketti (Thomas, 1894)

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

Subfamily Vespertilioninae

Tribe Plecotini Gray, 1866

Genus *Barbastella* Gray, 1821
Barbastella cf. darjelingensis Hodgson, 1855

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 bucephalus Csorba, 2011

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

Unnamed subtribe
(=Hypsugine group sensu Roehrs, Lack, Van den Bussche, 2010)

Genus *Hypsugo* Kolenati, 1856

Hypsugo pulveratus (Peters, 1871)
Hypsugo cadornae (Thomas, 1916)
Hypsugo sp.
Hypsugo cf. joffrei (Thomas, 1915)

Genus *Tylonycteris* Peters, 1872

Tylonycteris pachypus (Temminck, 1840)
Tylonycteris robustula Thomas, 1915

Tribe Nycticeiini Gervais, 1855

Genus *Eptesicus* Rafinesque, 1820

Eptesicus serotinus Schreber, 1774

Genus *Ia* Thomas, 1902

Ia io Thomas, 1902

Genus *Arielulus* Hill, Harrison, 1987

Arielulus circumdatus (Temminck, 1840)

Genus *Thainycteris* Kock, Storch, 1996

Thainycteris aureocollaris Kock, Storch, 1996

Genus *Hesperoptenus* Peters, 1868

Subgenus *Milithronycteris* Hill, 1976
Hesperoptenus tickelli (Blyth, 1851)
Hesperoptenus blanfordi (Dobson, 1877)

Genus *Scotomanes* Dobson, 1875

Scotomanes ornatus (Blyth, 1851)

Tribe Scotophilini Hill, Harrison, 1987

Genus *Scotophilus* Leach, 1821

Scotophilus heathii Horsfield, 1831
Scotophilus kuhlii Leach, 1821

Family Miniopterinae Dobson, 1875

Genus *Miniopterus* Bonaparte, 1837

Miniopterus fuliginosus (Hodgson, 1835)
Miniopterus pusillus Dobson, 1876
Miniopterus magnater Sanborn, 1931

Family Molossidae Gervais, 1856

Subfamily Tadaridinae Legendre, 1984

Genus *Tadarida* Rafinesque, 1814

Tadarida sp. (*T. ?insignis* Blyth, 1862)

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.

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

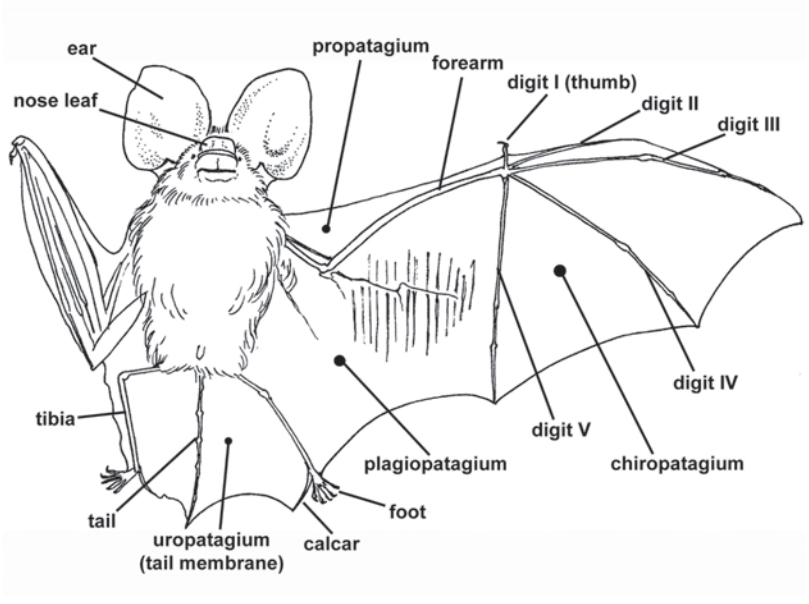


Fig. 7. Schematic representation of the external appearance of a «typical» bat (exemplified by *Hipposideros*).

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 most families and, with few exceptions, has a well-developed claw in Pteropodidae.

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. 8), often with complex outgrowths, sometimes leaf-like. Ears also of various shape and size (Fig. 8), from simple to complex, with supplementary structures (tragus, antitragus). Eyes from large (in Pteropodidae) to medium or small (in various insect bats), corresponding to the role of vision in flight.

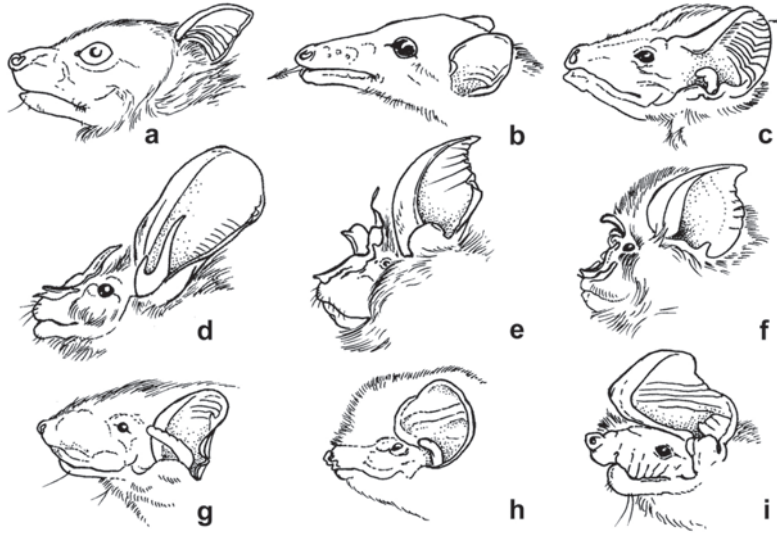


Fig. 8. Variation in the shape of muzzle and ears in Indochinese Chiroptera: a) Pteropodidae (*Cynopterus*); b) Pteropodidae (*Macroglossus*); c) Emballonuridae (*Taphozous*); d) Megadermatidae (*Megaderma*); e) Rhinolophidae (*Rhinolophus*); f) Hipposideridae (*Hipposideros*); g) Vespertilionidae (*Scotophilus*); h) Miniopteridae (*Miniopterus*); i) Molossidae (*Chaerephon*).

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. Tail usually well-developed though can be short or absent in some cases (some Pteropodidae, Megadermatidae and Hipposideridae, Fig. 9a, c). If long, tail is usually totally included into uropatagium, but in Emballonuridae and Molossidae its distal half is free from membrane (Fig. 9b, f)

Skull (see Figures in the Appendix I) 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[4] $I^{1-2}/_{1-3}$, $C^{1}/_{1}$, $P^{1-3}/_{2-3}$, $M^{1-3}/_{1-3} \times 2 = 20–38$. 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

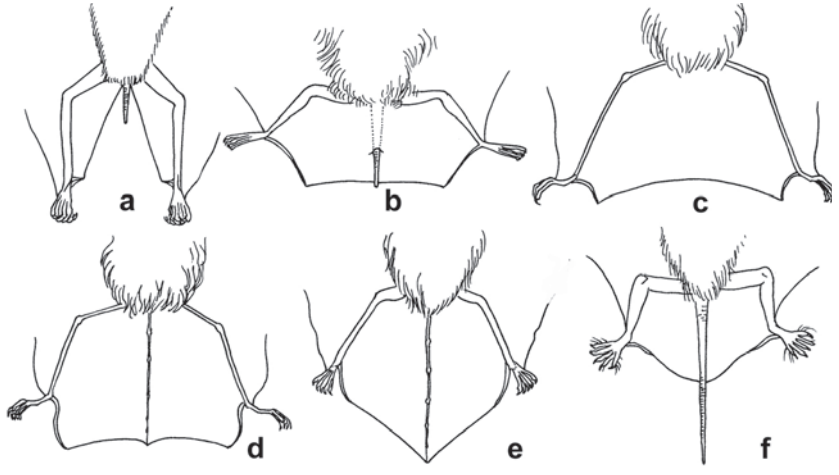


Fig. 9. Structure of the interfemoral membrane (uropatagium) in Vietnamese bats (dorsal view). a) Pteropodidae (*Eonycteris*); b) Emballonuridae (*Taphozous*); c) Megader-matidae (*Megaderma*); d) Rhinolophidae (*Rhinolophus*); e) Vespertilionidae (*Scotomanes*); f) Molossidae (*Chaerephon*).

[4] 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.

variable within this suborder, making dental structure an especially valuable character complex for diagnostics of taxa at various levels.

Upper molars (Fig. 10) 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 **hypocone 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.

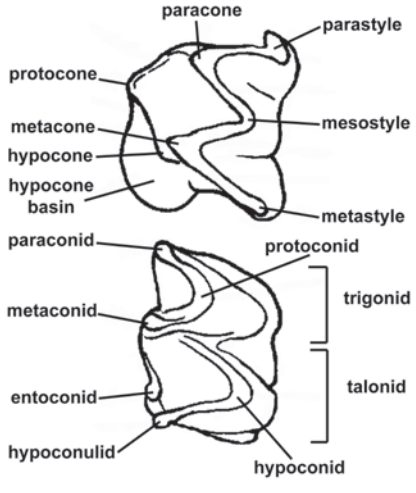


Fig. 10. Structure of a typical tribosphenic teeth (left upper and right lower second molars (M2 and M2) of *Rhinolophus*). Note the W-shaped ectoloph of upper molar.

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 lat-

ter – **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 Pteropodidae, while all other 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).

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 is very complex and contradictory. Two major suborders were formerly recognized: Megachiroptera (only one family Pteropodidae) and Microchiroptera (the remainder families). Later studies (Eick et al., 2005; Hutcheon, Kirsh, 2006; Teeling et al., 2002, 2005; Teeling, 2009) demonstrate that the latter taxon is paraphyletic and arrangement of suborders should be different: Yinochiroptera (=Pteropodiformes) contains Pteropodidae plus Rhinolophoidea, and Yangochiroptera (=Vespertilioniformes) includes the rest of families. Includes 20 families, over 180 genera and over 1200 species.

Key to the families of Chiroptera, found in Indochina[5]

External characters

1 Eyes large (over 4 mm in diameter); muzzle elongated or somewhat dog-like; ear pinna simple, without tragus and antitragus (small notches may be present in their places; Fig. 8a–b). Second digit of wing with well developed phalanges; usually (with one exception for Vietnam) bearing a claw.

[5] 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.

Tail, if present, shorter than $^1/_2$ of tibia; interfemoral membrane reduced or virtually absent (Fig. 9a) ..... **Pteropodidae** (p. 61)

– 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. 8cghi) **6**

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

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. 8ef)..... **5**

– Noseleaf structure different. Tragus always present and conspicuous, antitragal lobe not developed (Fig. 8d) **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. 81)

– 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 17) ..... **Rhinolophidae** (p. 110)

– Intermediate noseleaf low and wide, in shape of a transverse dermal ridge; posterior leaf low and flattened (Fig. 11) ..... **Hipposideridae** (p. 85)

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. 9f) ..... **Molossidae** (p. 240)

– 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 shorter than $^1/_2$ of body length, protrudes dorsally from the interfemoral membrane near its mid-point (Fig. 9b) and continues along its upper surface, tail vertebrae flex dorsally ..... **Emballonuridae** (p. 137)

– 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..... **9**

9 Third wing digit with two phalanges of which distal one is very long (only slightly shorter than corresponding metacarpal), folded ventrally when animal resting..... **Miniopteridae** (p. 235)

– Third wing digit with three phalanges comparable in length to each other and distinctly shorter than corresponding metacarpal .... **Vespertilionidae** (p. 143)

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. 61)

– 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. 44). 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. 81)

– 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. 45) ..... **Hipposideridae** (p. 85)

– 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. 48) .... **Rhinolophidae** (p. 110)

6 Postorbital processes well-developed, long and thin. Premaxillae sutured to maxillae (Fig. 33) ..... **Emballonuridae** (p. 137)

– 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. 70). Posterior margin of palate lies at the level of posterior borders of last upper molars, or slightly behind ..... **Molossidae** (p. 240)

– Premaxillae not in contact, palate widely emarginated anteriorly (Fig. 50, 69). Posterior margin of palate extends distinctly behind the level of last upper molars **9**

9 Skull with low rostrum and conspicuously inflated braincase, usually with small but seen anterior (frontal) half of sagittal crest. (One upper small pre-

molar.) Upper molars with characteristically large hypocone basins (Fig. 37).....**Miniopteridae** (p. 235)

– Skull commonly has another shape, with less concaved upper profile, otherwise (in some *Kerivoula* and *Myotis*), there are two upper small premolars. Sagittal crest, if present, better developed in its posterior (temporal) half. Upper molars with reduced hypocon basins .....**Vespertilionidae** (p. 143)

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 Yinochiroptera Koopman, 1985

General characteristics. This group contains two major clades, morphologically very different from each other. First one includes fruit eating or nectar eating bats without ability to "true" echolocation, which formerly were treated as a suborder Megachiroptera. Another includes animalivorous echolocating bats combined into superfamily Rhinolophoidea s. lato, with specifically reduced premaxillae and upper incisors, with variably inflated swellings around the nasal opening and usually possessing noseleafs.

Taxonomical remarks. For decades two mentioned clades were thought to be members of different suborders (Dobson, 1876; Koopman, 1993, 1994; MacKenna, Bell, 1997) and even for Megachiroptera it was supposed the order level (Pettigrew, 1986). However it was shown by the latest genetic studies (Eick et al., 2005; Hutcheon, Kirsh, 2006; Teeling et al., 2002, 2005; Teeling, 2009) that Microchiroptera are paraphyletic against Pteropodidae and that Rhinolophoidea more closely related to the latter than to other insect bats. Thus, Koopman's Yinochiroptera were raised to suborder level and the Old World fruit bats are now treated as a monotypic superfamily in this suborder. Also names Yinpterochiroptera and Pteropodiformes are using for this taxon (Hutcheon, Kirsh, 2006; Teeling et al., 2005).

As accepted here, suborder contains two supefamilies.

1. **Pteropodoidea** (nasal branch of premaxilla well developed, last cervical vertebra not fused with first thoracic, no accessory structures present on muzzle, no false pubic nipples, ear pinna simple, ayes large, well-developed; cheek teeth with reduced ectoloph), represented by the single family Pteropodidae.

2. **Rhinolophoidea** (nasal branch of premaxilla reduced or absent, palatal branch well-developed or absent, last cervical vertebra at least partly fused with the first thoracic, more or less complex leaf-like structures commonly present on muzzle, false pubic nipples usually present in females, cheek teeth with W-shaped ectoloph, typical to insect-eating bats), represented in Vietnam by three families of five: Megadermatidae, Hipposideridae and Rhinolophidae.

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 vertebrae 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 is short, its base attached to the distal part of tibia (not to ankle as in most other 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; see Fig. 39), 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 fruit bats 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, formerly referred to a separate suborder (or even an order), but later was shown to be related (though distantly) to Rhinolophoidea.

The family was traditionally divided into two subfamilies – Pteropodinae and Macroglossinae – with many tribes (Koopman, 1994). This was revised by Giannini and Simmons (2007) who proposed to divide Pteropodidae into seven subfamilies, restricting nominotypical subfamily to the former tribe Pteropodini s. str. and regarding *Eonycteris* closely related to *Rousettus*, not to *Macroglossus*. In Vietnam four of these subfamilies are present, representing by seven genera.

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. 72)

– 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. 68)

– 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. 66)

– Forearm 170–210 mm ..... *Pteropus vampyrus* (p. 67)

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. 79)

– Forearm less than 44 mm. Distinct internarial groove noticeably extending across the upper lip..... *Macroglossus minimus* (p. 80)

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. 78)

– 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. 77)

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. 69)

10 Body weight (in adults) more than 35 g. Forearm commonly more than 67 mm.....**11**

– Body weight less than 35 g. Forearm commonly less than 66 mm..... .....*Cynopterus brachyotis* (p. 75)

11 Body weight usually less than 50 g.....*Cynopterus sphinx* (p. 73)

– Body weight usually more than 50 g.....*Cynopterus horsfieldi* (p. 75)

Cranial characters

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

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

2 Greatest length of skull more than 70 mm.....*Pteropus vampyrus* (p. 67)

– Greatest length of skull less than 70 mm **3**

3 Dentition massive, longitudal length of cusps of first and secong upper molars no less than 4.5 mm.....*Pteropus hypomelanus* (p. 68)

– Dentition definitely weaker, length of cusps of the first and second upper molars no more than 4.5 mm.....*Pteropus lylei* (p. 66)

4 Only one pair of lower incisors.....*Megaerops niphanae* (p. 78)

– 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. 79)

– 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. 80)

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. 72)

– 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. 69)

– Last lower molars subcircular, their length and width are subequal..... .....*Rousettus amplexicaudatus* (p. 70)

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. 77)

– 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..... **12**

– Condylobasal length usually less than 28 mm (maximum ca. 29). C–M^1 usually less than 10 mm (maximum 10.7) ... *Cynopterus brachyotis* (p. 75)

12 Cheek teeth rownded in occlusial view, proportionally smaller; posterior lower premolar and first lower molar without prominent cusps or ridges, 1.6 mm or less in crown width ..... *Cynopterus sphinx* (p. 73)

– Cheek teeth rectangular in occlusial view, proportionally large and massive; posterior lower premolar and first lower molar possess visibal additional cusps or ridges, more than 1.8 mm in crown width ....*Cynopterus horsfieldi* (p. 75)

Genus *Pteropus* Erxleben, 1777

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

Diagnosis. Skull on Fig. 39. Dental formula: $I^2/_2\ C^1/_1\ P^3/_3\ M^2/_3 \times 2 = 34$. 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 are 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. Three specimens from Soc Trang Province (ROM); also three individuals from Cambodia.

Identification. A large pteropodid (weight ca. 390–480 g.; forearm ca. 145–160 mm; CBL ca. 57–62 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 forehead 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 external size, pointed ear pinna, bicuspid upper molars and proportionally smaller and weaker dentition.

Distribution and collecting sites. See Map 1. Distribution restricted to lowlands of south Thailand, Cambodia and likely South Vietnam (Corbet, Hill, 1992). Reported from Vietnam (Ho Chi Minh City) by Dang Huy Huynh et al. (1994), thought this record was not mentioned in later literature. Dang Ngoc Can et al. (2008) reported this species from five localities in southernmost Vietnam, Thua Thien-Hue Province and also from Phu Quoc Island.

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 but apparently similar to that of *P. vampyrus*.

Map 1. *Pteropus vampyrus* – gray shading; *P. lylei* – black dots; *P. hypomelanus* – black squares.

Pteropus vampyrus (Linnaeus, 1758)

Common names. Dơi ngựa lớn; Giant flying fox; Гигантская летучая лисица, Калонг.

Material studied. One specimen from Soc Trang Province; also two specimens from the Philippines and one from unknown locality.

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. 74–84 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 55–65% of 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. See Map 1. 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 Bach Ma, not far from Hue, Soc Trang, Kien Giang and Ca Mau provinces and on islands off the southern coast of the country, including Phu Quoc (Kuznetsov, An', 1992; Dang Huy Huynh et al., 1994; Dang Ngoc Can et al., 2008). Record from Con Dao seems to be erroneous (Kruskop, 2011a).

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. Two individuals from Con Son I. (including type in ZMB) and one another specimen from unknown locality, supposedly originating from Vietnam; also two specimens from Malaysia and the Philippines.

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 describing as 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. 60% 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 external size and short and blunt ears; skull dimensions similar to that of *P. lylei* but teeth are definitely more robust.

Distribution and collecting sites. See Map 1. Malayan and Sunda species, commonly inhabiting small islands. Distributed from the Maldives through coastal territories of Burma, Thailand, and 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 Dang Huy Huynh et al. (1994) though this record

was not later mentioned by Dang Ngoc Can et al. (2008). Latter authors also reported this fruit bat from Soc Trang and Kien Giang provinces (Hon Khoai Island) in Southern Vietnam.

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). On Con Son Island animals were observed feeding on *Terminalia* fruits. This species is mainly confined to islands and coastal areas (Medway, 1978). On Con Dao apparently lives solitary or in small groups, making nightly movements through the island. Roosts on various trees including coconut palms.

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. About seven species are currently recognized (Koopman, 1994; Simmons, 2005), though as understand traditionally this genus is paraphyletic (Alvarez et al., 1999). Apparently closely related to *Eonycteris* with which forms subfamily *Rousettinae* (Giannini, Simmons, 2007). Two species have been reported in Vietnam.

Rousettus leschenaulti (Desmarest, 1820)

Common names. Dơi ngựa nâu; Fulvous fruit bat; Летучая собака Лешенолта.

Material studied. Eleven specimens (eight adult of both sexes and three immature) from Dong Nai and Da Nang, T.P. Ho Chi Minh, Tai Nguyen plateau and from unknown locality in Vietnam; also 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, posterior upper molar in adult specimens oval or subtriangular, widened anteriorly.

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. See Map 2. Indo-Malayan species, whose distribution extends from Pakistan and Sri Lanka to south China, Vietnam and Sunda Islands. In Vietnam this species is widely distributed but apparently very sporadic and not common. It was reported from Ha Giang, Lao Cai, Tuyen Quang, Bac Kan, Lang Son, Son La, Phu Tho, Ha Tay, Vinh Phuc, Bac Thai, Hoa Binh, Ha Tay, Thanh Hoa, Ninh Binh, Qung Binh, Thua Thien-Hue, Quang Nam, Da Nang, Kon Tum, Binh Dinh, Gia Lai, Dak Lak, Dong Nai, Lam Dong and Khanh Hoa provinces and from Hanoi and Ho Chi Minh Cities (Dang Huy Huynh et al., 1994; Dang Ngoc Can et al., 2008). However, the slight difference between this species and *R. amplexicaudetus* precludes from unambiguously allocating most of the Indochinese records of *Rousettus* to *R. leschenaulti*.

Map 2. *Rousettus 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). In Cat Tien this bat was reported foraging in local orchards (Abramov, pers. comm.). This species seems to be the most “mountainous” of all Vietnamese fruit bats: it was reported from Nepal at the elevation over 2000 m (Csorba et al., 1999) and presumably this species was observed in Hoang Lien Son mountains at the elevation of ca. 1950 m a.s.l. (Kruskop, Schinov, 2010).

Rousettus amplexicaudatus (E. Geoffroy, 1810)

Common names. Dơi ngựa đuôi lớn; Geoffroy’s fruit bat; Летучая собака Жоффруа.

Material studied. Five specimens from Ha Tay

Province (collected by Dr. G.V. Kuznetsov); also two specimens from Malaysia (ROM collection).

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, however, having similar forearm length. Ears seem to be somewhat narrower. Posterior lower and upper molars 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.

Map 3. *Rousettus amplexicaudatus*.

Distribution and collecting sites. See Map 3. 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 Tay Province (originally Ha Shon Binh), Northern Vietnam. Also reported for Tuyen Quang Bac Kan, Thai Nguyen, Ninh Binh, Binh Dinh and Thua Thien-Hue provinces by Dang Ngoc Can et al. (2008); for Cat Ba Island – by Vu Dinh Thong and Furrey (2008).

Comments on natural history. Cave-dweller (Cao Van Shung, 1976), essentially similar in biology to *R. leschenaulti* (Medway, 1978).

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. This genus was traditionally treated as closely related to long-tongued bats, *Macroglossus* (Koopman, 1994), but removed later to subfamily *Rousettinae* (Giannini, Simmons, 2007). 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. Ten specimens from Tuyen Quang, Ha Tinh and Quang Binh provinces.

Identification. A medium-sized fruit bat (weight ca. 49–55 g; forearm ca. 66–78 mm; CBL ca. 31.7–36.3 mm; App. II., Table 2), 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.

Map 4. *Eonycteris spelaea.*

Distribution and collecting sites. See Map 4. This species is distributed throughout the Indomalayan region from south-western India to Vietnam, Sunda and Philippine Islands (Corbet, Hill, 1992). In Vietnam this bat has wide but sporadic distribution. It was reported from Lai Chau, Tuyen Quang, Bac Kan, Son La, Phu Tho, Vinh Phuc, Ninh Binh, Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Thua Thien-Hue, Quang Tri, Kon Tum, Binh Dinh, Lam Dong, Soc Trang, Dong Nai provinces and from Ho Chi Minh City (Dang Huy Huynh et al., 1994; Dang Ngoc Can et al., 2008). We found this bat 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 *Cynopterus* F. Cuvier, 1824

General characteristics. Small to medium-sized bats (forearm ca. 60–75 mm) with short muzzle (Fig. 8a), characteristic white margins of ears and pale colored wing digits.

Diagnosis. Skull on Fig. 40. 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; Francis, 2008), though their actual number and interspecies borders are not absolutely clear (Francis et al., 2010); three species occur in Vietnam.

Cynopterus sphinx (Vahl, 1797)

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

Material studied. Ninety two specimens from Dong Nai, Tay Ninh, Lam Dong, Ba Ria – Vung Tau, Binh Phuoc, Dac Lac, Ha Tinh, Quang Binh and Lao Cai provinces and from Phu Quoc I.; 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; App. II., Table 2) 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, and 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. From very similar *C. horsfieldi* this bat differs by lighter weight and by less robust cheek teeth, which look rounded in occlusial view.

Distribution and collecting sites. See Map 5. 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. We found this bat in Dong Nai (Vinh Cuu and Nam Cat Tien), Tay Ninh (Lo Go Xa Mat), Lam Dong (Cat Loc and Loc Bao), Ba Ria-Vung Tau (Binh Chau), Binh Phuoc (Bu Gia Map), Dak Lak (Yok Don and Chu Yang Sin), Ha Tinh (Vu Quang), Quang Binh (Ke Bang) and Lao Cai (Van Ban) provinces, on Phu Quoc I., in Hanoi City and Nha Trang. Dang Ngoc Can et al. (2008) also reported this species from Ha Giang, Lai Chau, Tuyen Quang, Bac Kan, Lang Son, Son La, Phu Tho, Tai Nguyen, Vinh Phuc, Hai Phong, Ninh Binh, Thanh Hoa, Nghe An, Quang Tri, Thua Thien-Hue, Da Nang, Quang Nam, Kon Tum, Binh Dinh, Gia Lai, Dak Nong, Ninh Thuan, Soc Trang, Kien Giang and Ca Mau provinces.

Map 5. *Cynopterus sphinx.*

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). Can “build” shelters, half-cutting central vein of the banana leaf or radial veins on palm leafs. 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, litchis, 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. Ha Noi, Ho Chi Minh and Nha Trang. 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 horsfieldi Gray, 1843

Common names. Dơi chó mũi ống; Horsfield's short-nosed fruit bat; Короткомордый крылан Хорсфилда.

Material studied. Four specimens from Dong Nai province; also two specimens from Malaysia. The description below also based on Corbet and Hill (1992) and Francis (2008).

Identification. A small to medium-sized fruit bat (weight ca. 50–70 g; forearm ca. 68–76 mm; CBL ca. 31 mm) of characteristic appearance. Rudimentary external tail is always present The pelage is short, grayish-brown on upperparts and yellowish-brown on belly; mantle reddish-brown, especially well-seen in adult males. The ear margins and wing bones are distinctly whitish. Teeth look very robust in comparison to that of other *Cynopterus* species; they are rectangular in occlusial view and possess well-seen ridges or small cusps on occlusial surfaces.

This species is greatly resembles *C. sphinx* in external appearance, but is more heavy and with more massive and shortened muzzle. More confidently these two species can be distinguished by shape of molars. From all similar-sized fruit bats this species can be differ in the same way as *C . sphinx.*

Distribution and collecting sites. Malayan species, distributed throughout Great Sunda Islands, on Malayan Peninsula and sporadically through the mainland South-East Asia (Corbet, Hill, 1992; Francis, 2008). In Vietnam to date this bat is known only from Cat Tien.

Comments on natural history. Natural habits essentially similar to that of other *Cynopterus*. Roosts in canopies, under banana leafs and also in limestone crevices and caves. Tending to consume larger fruits than other *Cynopterus* species. In Southern Vietnam pregnant takes place in May-June.

Cynopterus brachyotis (Mueller, 1838)

Common names. Dơi chó tai ngắn; Lesser short-nosed fruit bat; Короткомордый крылан малайский.

Material studied. Forty five specimens from Dong Nai, Tay Ninh, Ba Ria-Vung Tau and Lam Dong provinces and from Phu Quoc I.; eight additional specimens from Cambodia.

Map 6. *Cynopterus brachyotis.*

Identification. A small-sized fruit bat (weight ca. 21–35 g; forearm ca. 59–68 mm; CBL ca. 26–28,8 mm; App. II., Table 2), 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. See Map 6. Indomalayan species, widely distributed from southern India and Sri Lanka to southern China, Vietnam, Sunda and Philippine Islands. Reported from Lao Cai, Bac Kan, Hoa Binh, Ninh Binh, Nghe An, Ha Tinh, Quang Tri, Thua Thien-Hue, Da Nang, Kon Tum, Gia Lai, Dak Lak, Lam Dong, Khanh Hoa, Ninh Thuan and Tay Ninh provinces (Dang Huy Huynh et al., 1994; Dang Ngoc Can et al, 2008), 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 Dong Nai (Ma Da and Cat Tien), Tay Ninh (Lo Go Xa Mat), Ba Ria-Vung Tau (Binh Chau) provinces and on Phu Quoc I. Supposedly have wide distribution throughout the Southern Vietnam in the same habitats, as *C. sphinx*, 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. Five specimens: from Tam Dao (collected by Dr. G.V. Kuznetsov) and from Vu Quang, Lao Cai and Quang Nam.

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. See Map 7. Extralimitally it is known from mountain massifs of northern India, Bhutan, south-west Tibet, Myanmar, northern Thailand and south-western China (Bates, Harrison, 1997). Up to recent time the only two known localities of *S. blanfordi* in Vietnam were Tam Dao and Vu Quang (Borissenko, Kruskop, 2003); however more recently it was revealed widely in Northern Vietnam. Dang Ngoc Can et al. (2008) report this fruit bat from Ha Giang, Tuyen Quang, Bac Kan, Son La, Phu Tho, Ninh Binh, Nghe An, Thua Thien-Hue and Quang Nam provinces; it was also found in lower parts of Hoang Lien Son mountains, Lao Cai (Rozhnov et al., 2008).

Map 7. *Sphaerias blanfordi.*

COMMENTS ON NATURAL HISTORY. Little is known on the biology of this bat in Vietnam. Supposedly it is confined to mountain 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 mountain *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. 41. Dental formula: $I^2/_1$ $C^1/_1$ $P^3/_3$ $M^1/_2$ ×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. Fourteen specimens form Dong Nai, Ha Tinh, Ba Ria-Vung Tau and Gia Lai provinces; also three additional specimens from Cambodia.

Identification. A small fruit bat (weight ca. 22–28 g; forearm ca. 52–63 mm; CBL ca. 25.6–26.7 mm; App. II., Table 2). 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.

Map 8. *Megaerops niphanae.*

Distribution and collecting sites. See Map 8. Indochinese species of middle elevations. Distributed from east India to Vietnam. In Vietnam it was reported (as *M. ecaudatus*) from Vinh Phuc, Kon Tum, Lam Dong and Ninh Thuan provinces (Dang Huy Huynh et al., 1994). Dang Ngoc Can et al. (2008) reported this fruit bat also from Lao Cai, Phu Tho, Ninh Binh, Nghe An, Ha Tinh, Quang Binh, Thuan Thien-Hue, Gia Lai, Dak Lak, Khanh Hoa and Dong Nai provinces. We found it in Dong Nai (Ma Da), Ha Tinh (Vu Quang), Lam Dong (Loc Bao), Dak Lak (Chu Yang Sin) and Ba Ria – Vung Tau (Binh Chau) provinces.

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), in Chu Yang Sin – at ca. 1030 m a.s.l. In Binh Chau animals were captured on the edge of dry dipterocarp forest at low elevation, almost at the sea level. Animals maintained in captivity in Vu Quang did not show any strong preference to any of the fruit offered.

Genus *Macroglossus* F. Cuvier, 1824

General characteristics. Small nectarivorous bats (forearm ca. 36–51 mm) with characteristically elongated muzzle (Fig 8b).

Diagnosis. Skull on Fig. 42. Dental formula: $I^2/_2$ $C^1/_1$ $P^3/_3$ $M^2/_3$ ×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. However, despite these species are thought to be clearly separated by morphology, no genetic difference was revealed between them at least in Indochina (Francis et al., 2010).

Macroglossus sobrinus K. Andersen, 1911

Common names. Dơi ăn mật hoa; Hill long-tongued bat; Большой длинноязыкий крылан.

Material studied. Eighteen specimens Ha Tinh, Quang Binh, Binh Phuoc and Dong Nai provinces.

Identification. A small fruit bat (weight ca. 18–28 g; forearm ca. 45–50 mm; CBL ca. 26.6–27.0 mm; App. II., Table 2) 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.

Map 9. *Macroglossus sobrinus.*

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. See Map 9. Indo-Malayan species, distributed from the north-easternmost India and Myanmar to Vietnam and western Great Sunda islands. Reported from Vietnam by Dang Huy Huynh et al. (1994) as *M. minimus sobrinus* for Lam Dong, Vung Tau and Ho Chi Minh City. Reported by Dang Ngoc Can et al. (2008) also from Bac Kan, Son La, Phu Tho, Ninh Binh, Nghe An, Ha Tinh, Quang Binh, Thua Thien-Hue, Quang Nam, Gia Lai, Ninh Thuan and Dong Nai provinces. We found this bat in Vu Quang, Ke Bang, Bu Gia Map and Cat Loc (Ha Tinh, Quang Binh, Binh Phuoc and Lam Dong provinces, respectively). Supposedly, it inhabits forested landscapes (both primary and secondary) throughout 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 Bu Gia Map this bat observed feeding on banana flowers. 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. Dơi ăn mật hoa bé; Lesser long-tongued bat; Малый длинноязыкий крылан.

Material studied. One adult female from Con Son I.; two specimens from the Philippine Islands were also 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. sobrinus*, 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.

Map 10. *Macroglossus minimus.*

Distribution and collecting sites. See Map 10. 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). However this locality does not included into species distribution by Dang Ngoc Can et al. (2008) who reported this bat from Ninh Binh, Ninh Thuan, Lam Dong and Kien Giang provinces, from T.P. Ho Chi Minh and from Con Son Island. We found this bat only on Con Dao islands.

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. Single female on Con Son Island was netted in the thick bushes on the slope of main ridge.

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 insectivory 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 and body, their inner margins fused at bases; tragus long, slender, and unevenly bifid (Fig. 8d). 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. 83)

– 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. 84)

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. 43. 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. Doi ma nam; Lesser false vampire; Малайский лжевампир.

Material studied. Twenty two specimens from Dong Nai, Tay Ninh, Dak Lak, Lam Dong and Ba Ria – Vung Tau provinces; 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; App. II, Table 3) of characteristic appearance. Ears very large (ca. $^1/_2$ of head and body length or longer) with a long bifid tragus.

The presence of a well-developed tragus readily distinguishes this bat from all other leaf nosed 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. See Map 11. Widely distributed throughout the Indomalayan region, from western India to Vietnam, Philippine and Sunda Islands (Corbet, Hill, 1992). In Vietnam This species seems to be common and widespread in lowland woodlands. It was reported mainly from the southern and central parts of the country: Dak Lak, Tay Ninh and Dong Nai provinces, Con Son Island (Dang Huy Huynh et al., 1994), Thom and Phu Quoc Islands (Kuznetsov, Pham Trong An', 1992), Ninh Binh, Nghe An, Quang Binh, Quang Tri, Thua Thien – Hue, Binh Dinh, Dak Nong and Kien Giang provinces (Dang Ngoc Can et al., 2008). We found this species in Tay Ninh (Lo Go Xa Mat), in Dong Nai (Vinh Cuu and Cat Tien), Binh Phuoc (Bu Gia Map), Dak Lak (Yok Don) and Lam Dong (Loc Bao) provinces and on Con Dao islands.

Map 11. *Megaderma spasma.*

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). Feces collected in Ma Da

forest contained remains of mantids and large cockroaches. 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. Births probably correlated with the end of dry season: females with newborns were observed in Yok Don in second half of April, on Con Son Is. – in the beginning of June.

Megaderma lyra E. Geoffroy, 1810

Common names. Dơi ma bắc; Great false vampire; Индийский лжевампир.

Material studied. Nine specimens from Dong Nai, Binh Phuoc and Dak Lak provinces; one specimen from India was also examined.

Identification. A medium to large megadermatid (weight ca. 35–60 g; forearm ca. 56–72 mm; CCL ca. 24.5–28 mm; App. II, Table 3), 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.

Map 12. *Megaderma lyra*.

The presence of a well-developed tragus readily distinguishes this bat from all other leaf nosed 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. See Map 12. Trans-Indomalayan species. Widely distributed from Pakistan to Thailand and eastern China. In Vietnam until recently it was known from only Hoa Binh Province (Huynh et al, 1994) and from Phong Nha – Ke Bang National Park (Timmins et al., 1999; Kruskop, 2000b). Later was also reported from Tuyen Quang, Bac Kan, Lang Son, Son La, Thai Nguyen, Ninh Binh, Hoa Binh, Nghe An, Ha Tinh,

Thua Thien-Hue, Gia Lai, Dak Lak, Lam Dong and Dong Nai provinces (Dang Ngoc Can et al., 2008). We captured this bat in Cat Tien, Bu Gia Map and Chu Yang Sin (Dong Nai, Binh Phuoc and Dak Lak Provinces, respectively).

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). Food remains of this species in Bu Gia Map contained parts of large grasshopper, bones of Rhacophorid frogs and feathers and bones of small birds (*Arachnothera*, *Malacopteron* and *Ceyx*). Food remains gathered in Cat Tien, contained mainly bird feathers and also bone remains of arboreal rodent *Chiropodomys gliroides*. Cave-dweller; in Ke Bang a group of 3 individuals was observed inside a cave, inhabited also by three *Hipposideros* species (Kruskop, 2000a). In Bu Gia Map food remains were found and bat was observed in the abandoned house (Kruskop, 2010a) though it was not probably a main roost of the animal.

Family Hipposideridae Lydekker, 1891

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 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.11), 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.

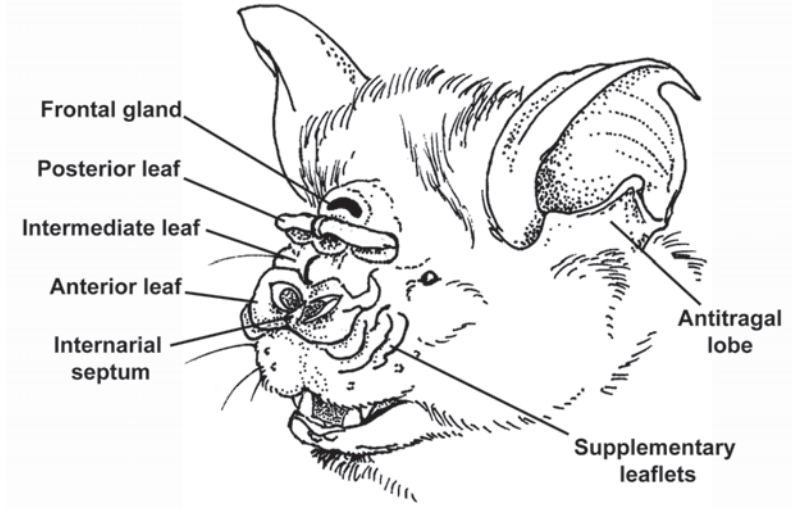


Fig. 11. Head of *Hipposideros grandis*, demonstrating Hipposiderid noseleaf structure.

Natural history. Specialized insectivores, mostly aerial foragers, however, a number of gleaners are known; perches are often used 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. Sometimes regarded as a subfamily within Rhinolophidae (Koopman, 1994; Simmons, Gaisler, 1998), but should be considered as a separate family according to Corbet and Hill (1992), Bogdanowicz and Owen (1998). McKenna and Bell (1997) suggest to use Rhinonycterinae Gray, 1866 for this group instead of Hipposiderinae, because Gray's name has priority over Lydekker's one. For reasons to use Hipposideridae Lydekker, 1891 as valid name for this family see Simmons (2005).

There are four genera traditionally reported for Vietnamese fauna. However, enigmatic genus *Paracoelops* known only by the holotype of single species, *P. megalotis* Dorst, 1947 is now found to be a result of misidentification (Vu Dinh Thong et al., 2012c).

Key to the genera of Vietnamese Hipposideridae

External characters

1 Tail rudimentary, not longer than 2 mm. Anterior noseleaf deeply emarginated anteriorly, supplemented by two forwardly projecting lappets. Interfemoral membrane much reduced ..... *Coelops* (p. 109)

– External tail well-developed. Anterior noseleaf more or less horseshoe-shaped, without forwardly projecting lappets. Interfemoral membrane wide **2**

2 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. 87)

– Posterior leaf has shape of a transverse skin ridge, without distinct lobes. Tail not projected beyond posterior margin of membrane.... *Hipposideros* (p. 89)

Cranial characters

1 Upper canine with two supplementary cusps (Fig. 14b)..... **2**

– Upper canine without distinct supplementary cusps ... *Hipposideros* (p. 89)

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. 87)

– 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. 109)

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 are diverging anteriorly. Rostrum greatly inflated. Sagittal crest poorly developed. Edge of the posterior noseleaf possesses three pointed processes. Tail well-developed, extends beyond the posterior margin of interfemoral membrane.

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 stoliczkanus (Dobson, 1871)

Common names. Dơi mũi ba lá; Stoliczka's trident bat; Южноазиатский трезубценос.

Material studied. Nine specimens from Thanh Hoa, Lao Cai, Hai Phong and Ha Noi provinces, including one specimen from Hanoi donated by Dr. Dao Van Tien. Description below also follows Medway (1978), Lekagul and McNeely (1977), Nowak (1991).

Identification. A small leaf nosed bat (weight ca. 6–8 g; forearm ca. 39–44 mm [5.2–5.7 g and 43.5–45.6 mm in Cat Ba specimens], CCL 26–26.5 mm; App. II, Table 4), somewhat resembling a small short-eared *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 proportionally short, broad with acutely pointed tips.

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

Distribution and collecting sites. See Map 13. Distributed sporadically from Myanmar and southern China south to Malaya. An uncommon bat, with highly sporadic distribution in North and Central Vietnam. Reported by Dang Huy Huynh et al. (1994) from Lao Cai, Lai Chau, Lang Son, Hoa Binh, Ninh Binh and Quang Binh provinces, found in Phong Nha by D. Hendrichsen (Timmins et al., 1999; Hendrichsen et al., 2001). Also reported from Tuyen Quang, Bac Kan, Son La, Phu Tho, Hai Phong, Thanh Hoa, Nghe An, Quang Tri and Thua Thien-Hue by Dang Ngoc Can et al. (2008). Specimen in ZMMU collected by Dao Van Tien probably originated from T.P. Hanoi. We found this bat in Hoang Lien Son (Lao Cai province) and on Cat Ba Island.

Map 13. *Aselliscus stoliczkanus.*

Comments on natural history. Natural history poorly known. Probably, a cave-dweller (Bates et al., 2000). On Cat Ba Island almost all individuals (with single exception) were captured over the road on the edge between agricultural landscape and secondary growth (Abramov, Kruskop, 2012). This bat is fast-flying aerial hawker that most probably prefers open landscapes.

Genus *Hipposideros* Gray, 1831

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

Diagnosis. Skulls on Fig. 44–45. Dental formula: $I^{1}/_{2}$ $C^{1}/_{1}$ $P^{2}/_{2}$ $M^{3}/_{3}$ ×2 = 30. Upper canine simple, without supplementary cusps (Fig. 14a). Sagittal crest variably developed but not 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; usually it is low, with rounded or straight upper margin, somewhat bended forward. 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 (Panyutina, 2008), few perch-hunters and, probably, gleaners are also known.

Taxonomical remarks. An extremely diverse and taxonomically complex genus containing no less then 70 living species (Simmons, 2005), and the descriptions of new species are regularly publishing in last years. Its structure represents a real nightmare for taxonomists. This genus was thought to be paraphyletic against closely related *Aselliscus* and Afro-Arabian *Asellia*, *Anthops* and extinct *Pseudorhinolophus*, however there was no common point of view on this topic (Bogdanowicz, Owen, 1998; Hand, 1998; Wang et al., 2003; Francis et al., 2010). Latest molecular genetic results support the *Hipposideros* monophyly (Murrey et al., 2012). Previously we supposed that some morphologically distinct and commonly accepted species groups may correspond to previously proposed genus-group names (e.g., those of Peters, 1871 and Tate, 1941) thus reflecting hierarchical structure of morphoecological diversity within *Hipposideros*. Hence we found it appropriate to tentatively re-establish some of these names in subgeneric rank, namely *Gloionycteris* Gray, 1866, *Chrysonycteris* Gray, 1866 and *Ptychorhina* Peters, 1871 (Borissenko, Kruskop, 2003). However, such deviation has no support from either morphological (Hand, Kirsh, 1998) or genetic data (Francis et al., 2010; Murrey et al., 2012), except for *Chrysonycteris* since there some genetic evidences for monophyly of the "*bicolor*" species group. The name *Gloionycteris* should not be used because its type species – *H. armiger* – shown to be closely related to *H. larvatus*, member of nominotypical subgenus, and not to other large

Hipposideros (Gu et al., 2008; Francis et al., 2010). Relationships between African and Asian lineages even more uncertain than that between Asian ones, so, the name *Ptychorhina* very doubtfully can be adopted for any Asian species. Until a more reliable phylogenetically substantiated structure will be proposed, it will be more adequate to use hierarchy of species groups sensu Koopman (1994) and Simmons (2005), with certain changes: *H. armiger* and *H. turpis* should be included in "*larvatus*" species group, and *H. galeritus* should be removed to the group of its own, as it was suggested by Tate (1941) and now supported be Murrey et al. (2012).

Key to Vietnamese *Hipposideros*

1 Larger species: FA longer than 51 mm, condylocanine length more than 20 mm.....**2**

– Smaller species: FA not longer than 51 mm, condylocanine length less than 16 mm.....**10**

2 Fleshy outgrowths always present behind the posterior leaf in the shape of bilobed erected structure, which somewhat exceed posterior leaf in height in young animals and females and very large in males (Fig. 12). Two pairs of supplementary leaflets aside anterior leaf. Upper profile of the skull conspicuously concaved in anterior half (Fig. 13a).....**3**

– Fleshy outgrowths behind posterior leaf, if present, not have bilobed shape. Three to four pairs of supplementary leaflets aside anterior leaf. Upper profile of the skull not concaved (Fig. 13b).....**5**

3 Zygomatic width 17 mm or more. Anterior noseleaf rounded, with only medial emargination..... *H. pratti* (p. 99)

– Zygomatic width not more than 17 mm. Anterior noseleaf looks somewhat angular because of small lateral emarginations **4**

4 Larger: condylocanine length more than 26.5 mm. Median emargnation on the anterior leaf less than 1.5 mm in depth .....*H. scutinares* (p. 101)

– Smaller: condylocanine length no more than 26.5 mm. Median emargnation on the anterior leaf 1.5–2 mm in depth .....*H. lylei* (p. 100)

5 Contrast white or (in adult females) yellow spot present on each shoulder. Nasal swellings of skull enlarged, thus upper profile of the rostrum is on the level of braincase (Fig. 13c) .....*H. diadema* (p. 102)

– No contrast spots on shoulders. Nasal swellings not conspicuously enlarged; rostral upper profile more or less gradually slopes to braincase (Fig. 13b).....**6**

6 Forearm more than 65 mm. Outgrowths behind the posterior leaf conspicuous, especially in males (though never have bilobed shape). Posterior leaf proportionally narrow, usually narrower than intermediate one. Fur coloration usually dark brown or blackish **7**

– Forearm less than 65 mm. Outgrowths behind the posterior leaf less conspicuous, represented only by protuberances between noseleaf and eyes. Posterior noseleaf slightly wider than intermediate one. Fur coloration commonly dull-brown to orange **9**

Fig. 12. Head of a male *Hipposideros scutinares*, demonstrating facial «shield».

7 Forearm less than 80 mm, condylocanine length less than 25 mm, upper toothrow 10.2 mm or less .....*H.alongensis* (p. 98)

– Forearm more than 80 mm, condylocanine length more than 25 mm, upper toothrow more than 10 mm. **8**

8 Skull more robust: condilocanine length usually more ttan 27 mm, upper tooth row more than 11.7 mm, width across upper canines 8 mm or more ....*H. armiger* (p. 95)

– Skull less robust: condilocanine length less than 27 mm, upper tooth row no more than 11.5 mm, width across upper canines less than 8 mm.....*H. griffini* (p. 97)

9 Coloration usually dull-brown or greyish. Size smaller: forearm usually less than 58 mm, condylo-canine length usually less than 19.5 mm.....*H. larvatus* (p. 92)[6]

– Coloration usually bright reddish-brown or rich broun. Size larger: forearm more than 57.5 mm, condylo-canine length

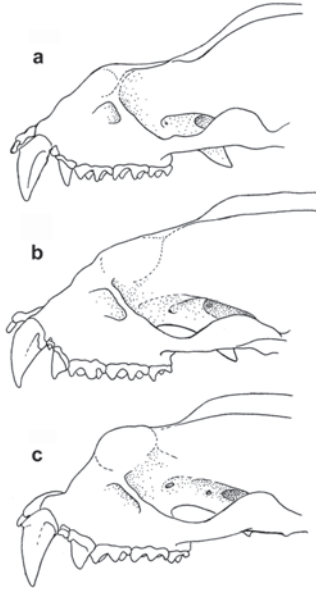


Fig. 13. Rostral profiles of large *Hipposideros*: a) *H. scutinares*; b) *H. armiger*; c) *H. diadema*.

[6] – but see comments under *H. grandis* about specimens from Con Son Islands.

more than 19.5 mm..... *H. grandis* (p. 94)

10 Anterior noseleaf with two pairs of supplementary leaflets. Ears relatively short, not reaching the end of muzzle when laid forward .... *H. galeritus* (p. 108)

– Anterior noseleaf with one pair or no supplementary leaflets. Ears large, extending to or beyond the end of muzzle when laid forward **11**

11 Larger: FA over 45 mm, CCL over 16.5 mm. Internarial septum expanded into a disk-like structure. Anterior noseleaf with a medial emargination **12**

– 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 **13**

12 Internarial disc wider, about 2.5 mm. Anterior noseleaf with well-developed lateral leaflets..... *H. rotalis*[7]

– Internarial disc narrow, about 1.8 mm in width. Anterior noseleaf without any supplementary leaflets ..... *H. khaokhouayensis* (p. 107)

13 Smaller: forearm less than 37 mm (usually less than 35 mm); upper toothrow shorter than 5.3 mm ..... *H. cineraceus* (p. 105)

– Larger: forearm more than 35 mm (usually more than 38 mm); upper toothrow more than 5.5 mm **14**

14 Ears shorter than 20 mm, when laid forward reaching, but not extending beyond the end of muzzle ..... *H. ater* (p. 106)

– Ears longer (over 20 mm) when laid forward extending beyond muzzle .... *H. pomona* (p. 103)

***Hipposideros larvatus* (Horsfield, 1823)**

Common names. Dơi nếp mũi xám; Horsfield's leafnosed bat; Листонос Хорсфилда.

Material studied. Twenty one specimens from Quang Ninh, Ninh Binh, Quang Binh, Quang Tri, Son La and Tuyen Quang provinces and from Cat Ba Island; also two specimens from China.

Identification. A medium-sized leaf nosed bat (weight ca. 11–15 g; forearm ca. 51.5–58.6 mm; CCL ca. 18.2–19.7 mm; App. II, Table 4). Noseleaf structure is relatively complex. Anterior leaf with three supplementary leaflets, with a pronounced medial emargination. Intermediate leaf with one medial

[7] – see comments under *H. khaokhouayensis.*

and a pair of lateral inflations. Posterior noseleaf is subdivided into four cells by three well-developed septa. Adult males possess a well-developed frontal gland just behind posterior noseleaf. Pelage is short and soft, buff brown or grayish-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. Muzzle pale, anterior and posterior leafs and supplementary leaflets brownish-gray.

This bat is very similar in external appearance to *H. grandis* and *H. turpis*, from which can be distinguished mainly by smaller size. It differs from *H. galeritus* by larger size and larger number of supplementary leaflets; from small specimens of *H. lylei* it differs in the absence of fleshy outgrowths behind posterior leaf.

Hipposideros larvatus actually represents a complicated taxonomic group very probably containing of more than one species (Francis et al., 2010). Two subspecies were reported from Indochina, including Vietnam, previously: *H. l. grandis* Allen, 1936 and *H. l. alongensis* Bourret, 1942 (Corbet, Hill, 1992; Koopman, 1994; Borissenko, Kruskop, 2003; Kruskop, 2003); now they are treated as separate species (Simmons, 2005; Vu Dinh Thong et al., 2012b). Probably, *H. larvatus* s. str. occurs in Vietnam only in northern part of the country, on lowland territories of Central Vietnam and on some coastal islands. Specimens from the north may be provisionally assigned with the Chinese *H. l. poutensis* Allen, 1906. Taxonomic status of forms from Halong and Central Vietnam needs clarification; at least latter one could be a separate species. Specimens from Con Dao Islands, though close in measurements to *H. larvatus*, actually more probably belong to *H. grandis* according to genetic data (Kruskop, 2011a).

Map 14. *Hipposideros larvatus* complex: combined range – gray shading; known localities for *H. larvatus* – black squares; verified localities for *H. grandis* – black dots; undescribed form (*H.* cf. *larvatus*) – open square.

Distribution and collecting sites. See Map 14. Thought to be one of the most widespread and abundant *Hipposideros* 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; Dang Huy Huynh et al., 1994; Kuznetsov, 2000). We found this species in Ke

Bang (Qung Binh Province; Kruskop, 2000b, but see comments above) and on Cat Ba Island (Abramov, Kruskop, 2012). Specimens from Son La (in collection of IEBR) and Tuyen Quang (collection of ROM) are also tentatively belonging to this species.

Comments on natural history. Aerial insectivore with powerful and relatively maneuverable flight. In Ke Bang these bats seem to live solitary or in small groups; on Cat Ba Island we also did not observed more then one or two animals simultaneously. Probably a cave-dweller, also inhabiting temples and old mines. All animals observed on Cat Ba demonstrate powerful, swift and relatively maneuverable flight; probably they mainly forage in disturbed and secondary formations with medium-cluttered space. Echolocation signal in general is described with CF component at ca. 110 kHz or higher (Thabah et al., 2006); however on Cat Ba we observed echolocation signals detectible at 93–103 kHz with main frequency at ca. 98–99 kHz (Abramov, Kruskop, 2012).

Hipposideros grandis Allen, 1936

Common names. Dơi nếp mũi xám lớn; Grand leafnosed bat; Листонос средний.

Material studied. A total of 29 specimens from Lam Dong and Dong Nai provinces; 20 specimens from Con Dao archipelago; also 21 specimens from Cambodia were examined.

Identification. A medium-sized leaf nosed bat (weight in mainland individuals ca. 15.5–22.6 g; forearm ca. 57.6–64.2 mm; CCL ca. 19.6–21.7 mm; App. II, Table 4); animals from Con Dao population are significantly smaller. In general appearance and noseleaf structure greatly resembles *H. larvatus* (see comments under that species). Anterior leaf wider than in *H. larvatus*, with three supplementary leaflets. Adult males possess a well-developed pale-whitish frontal gland just behind posterior noseleaf (Fig. 11). Pelage is short and soft, relatively dark russet brown or orange above (in two different color phases), ochraceous brown below; dorsal hairs with conspicuously lighter bases, darker midparts and paler tips, giving dorsal fur a glossy appearance. Ears and membranes are well-pigmented, dark. Muzzle pale, anterior and posterior leafs and supplementary leaflets gray.

Differs from very similar *H. larvatus* by larger size (first of all, by cranial measurements) and, usually, by brighter coloration, from *H. alongensis* and *H. armiger* – by smaller size, fur coloration and absence of fleshy outgrowths behind posterior leaf.

This species for long time was treated as a race of *H. larvatus* (Koopman, 1994), though its distinctiveness was shown on morphological (Kitchener,

Maryanto, 1993), acoustic and genetic (Thabah et al., 2006) data. However proper name for this form is provisional and needs further investigation of the type material (Francis, pers. comm.). Animals from Con Dao archipelago were traditionally allocated to *H. larvatus* and even to Bornean subspecies *H. l. neglectus* Sody, 1936 (Van Peenen et al., 1970; Koopman, 1994). However available genetic data indicate them as an insular smaller race of *H. grandis* (Kruskop, 2011a).

Distribution and collecting sites. See Map 14. Distributed in Myanmar, Thailand, Cambodia and Vietnam. In Vietnam it is known living sporadically throughout the southern part of the country. It is known from Vinh Cuu Reserve (Son et al., 2009), Cat Tien and Cat Loc National Parks and Con Dao Islands; there are almost no doubts that animals from Phu Quoc (reported as *H. larvatus* by Dang Ngoc Can et al., 2008) also belong to this species.

Comments on natural history. Presumably inhabits lowland forested areas. Aerial insectivore. Usually a highly gregarious cave-dweller. A large colony of this species, associated with *Miniopterus* spp., was observed in a cave in Cat Loc. In Cat Tien observed aggregations include from dozens to hundreds of individuals. On Con Son Island about two thousands of Hipposideros were observed simultaneously when they moved from the day roost to their foraging areas. Flight is relatively fast and powerful but not very maneuverable. Foraging areas include forest edges, forest roads and clearings. Echolocation signal is of fairly low intensity, CF component at ca. 98 kHz (Thabah et al., 2006).

Hipposideros armiger (Hodgson, 1835)

Common names. Dơi nếp mũi quạ; Himalayan leafnosed bat; Гималайский листонос.

Material studied. Thirty specimens from Ha Tinh, Quang Binh, Khanh Hoa, Dak Lak, Lam Dong, Dong Nai and Lao Cai provinces.

Identification. A very large leaf nosed bat (weight ca. 37–51 g; forearm ca. 86–92.5 mm; CCL ca. 27.4–29.8 mm; App. II, Table 4). 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 and even intermediate leafs, with three septa and four cells. Frontal gland well-developed in males. As opposed to *H. pratti*, this species has no bilobed “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. 12b).

H. armiger differs from all other *Hipposideros* of similar size by uniform dark coloration and noseleaf proportions; from closely related *H. griffini* – by larger skull size. Vu Ding Thong et al. (2012a) wrote that there is clear difference between the two species in echolocation call frequency. However we found frequency characteristic to *H. griffini* in *H. armiger* from several place in Central and South Vietnam.

Distribution and collecting sites. See Map 15. Indomalayan species, widely distributed from Nepal to Taiwan and Malacca. In Vietnam it was reported from several from Ha Giang, Lao Cai, Tuyen Quang, Bac Kan, Lang Son, Son La, Vinh Phuc, Hai Phong, Hoa Binh, Ninh Binh, Phu Tho, Nghe An, Ha Tinh, Quang Binh, Quang Tri, Thua Thien-Hue, Quang Nam, Da Nang, Kon Tum, Binh Dinh, Dak Lak, Dong Nai and Lam Dong provinces and on Phi Quoc Island (Dang Huy Huynh et al., 1994; Dang Ngoc Can et al., 2008). It is also reported for most of the coastal islets, in both northern (Tonkin Gulf) and southern parts of Vietnam (Kuznetsov, Pham Trong An', 1992; Kuznetsov, 2000); however its occurrence on Con Dao archipelago looks quite doubtful (Kruskop, 2011a). We found this species in Vu Quang Nature Reserve (Kuznetsov et al., 2001), in Ke Bang (Kruskop, 2000b), on Hon Ba mountain (Borissenko et al., 2006), on Dalat Plateau (Abramov et al., 2009), in Chu Yang Sin mountains, in Bao Lam and on Hoang Lien Son. This species is likely to be common in limestone (and, possibly, other montane) areas elsewhere in North and Central Vietnam though sporadic in southern part of the country.

Map 15. *Hiposideros armiger* – gray shading, black dots; *H. griffini* – black squares.

Comments on natural history. This bat occurs in various landscapes from agricultural lands to primary forests though probably prefers outer or disturbed parts of forest massifs. It was found from low elevations up to ca. 1500 m a.s.l. in Hoang Lien Son and Central Highlands. 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). In Cat Ba National Park roosting in buildings was reported (Abramov, Kruskop, 2012). 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 chitin covers, and particles of large beetles and cicadids were collected under the roosting site of this species. The peak of births in Central Vietnam is probably confined to the end of April. According to Vu Dinh Thong et al (2012), call frequencies of *H. armiger* in Vietnam varies from 64.7 to 68.8 kHz. However, echolocation calls in Ke Bang, Bao Lam and Hon Ba, referred to the given species, were moderately loud CF at 78 kHz; on Cat Ba Island echolocation calls at ca. 62 kHz were fixed.

Hipposideros griffini Thong, Puechmaille, Denzinger, Dietz, Csorba, Bates, Teeling and Schnitzler, 2012

Common names. Dơi nếp mũi Grip-phin; Griffin's leafnosed bat; Листонос Гриффина.

Material studied. No material was seen; description below is based on Vu Dinh Thong et al. (2012a).

Identification. A very large leaf nosed bat (weight ca. 44 g; forearm ca. 83.3–90.0 mm; CCL ca. 25.5–26.5 mm), very similar to *H. armiger* in general appearance and proportions. Fur coloration from brown to gray, somewhat paler on the underparts. Ears moderate, broadly triangular. Noseleaf with four pairs of supplementary leaflets (outer pair is the smallest). Anterior leaf with a minute median emargination. Intermediate leaf is equal in width to anterior one, with a swollen median septum. Posterior leaf narrower than anterior and intermediate. Adult males have definite fleshy outgrowths and well-developed glandular sack behind the posterior leaf. Skull with well-developed sagittal crest, robust, similar to that of *H. armiger* but smaller and with more narrow zygomatic arches.

From *H. armiger* with which it is occurs sympatrically on Halong Bay Islands, *H. griffini* differs mainly by smaller skull.

Distribution and collecting sites. See Map 15. This bat was found to date only on Cat Ba Island, Hai Phong province (terra typica) and in Chu Mom Ray National Park, Kon Tum Province (Vu Dinh Thong et al., 2012a).

Comments on natural history. Species is restricted to karstic and mountainous territories covered with variably disturbed forest. It is probably a cave-dweller and an aerial insectivore, similar in that to *H. armiger* and *H. larvatus*. Echolocation frequencies vary from 76.6 to 79.2 kHz. Males, captured in Chu Mom Ray in august were reproductively active.

Hipposideros alongensis (Bourett, 1942)

Common names. Dơi nếp mũi nhỏ; Halong bay leafnosed bat; Халонгский листонос.

Material studied. Seven specimens from Vung Tau and Ninh Binh Provinces; two specimens of *Hipposideros turpis* from Japan were taken for comparison. Description below is also based on Vu Dinh Thong et al. (2012b).

Identification. A medium to large leaf nosed bat (weight ca. 27–35 g.; forearm ca. 66–71 mm in Cat Ba population, ca. 68–76 in mainland population; CCL 22.5–24.4 mm; App. II, Table 4), in general appearance resembling *H. armiger* and extralimital H. *pendleburyi*. 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 leaf nosed bats, this species could be confused with large specimens of *H. grandis* or with small *H. lylei*. It differs from the former by nevertheless larger size and narrower posterior leaf and from the latter by the poor development of fleshy outgrowths behind the posterior leaf. From the closely related *H. armiger* and *H. griffini* this species differs by smaller external and cranial measurements.

This bat was initially described from islands of Halong bay as a subspecies of *H. larvatus* (Corbet, Hill., 1992) and later was allocated to the Japanese *H. turpis* also as a local subspecies (Topal, 1993). The typical race of this species is confined to Ryukyu Islands (Ohdachi et al., 2009). Another form also thought to be a race of *H. turpis – pendleburyi* Chasen, 1936, somewhat larger than the Ryukyu specimens, was described as a separate species from peninsular Thailand. As we stated previously, our specimens from Cuc Phuong (collected by G.V. Kuznetsov) correspond well with the diagnosis provided in Lekagul and McNeely (1977), and thus seem to be similar to the Thai form. However, these specimens demonstrate some difference from typical *H. turpis* (according to the description in Yoshiyuki (1989) and available skull images (Abe, 2000)), on the one hand, and with typical *alongensis*, on another. There was supposed that the Indochinese *Hipposideros* represents a form, distinct from the Ryukyu *H. turpis*, and probably must be allocated to *H. pendleburyi* or to the species of its own (Vu Dinh Thong et al., 2012a; Abramov, Kruskop, 2012). Finally, this complex was revised by Vu Dinh Thong et al. (2012b) who raised *H. alongensis* to the full species

distinct from both *H. pendleburyi* and *H. turpis*, and described mainland form as a separate subspecies *H. a. sungi* Thong et al., 2012.

Distribution and collecting sites. See Map 16. As a separate species, H. alongensis is currently known only from Vietnam; however there are strong probabilities that it will be find in Laos and Southern China. It was reported from Tuyen Quang, Bac Kan, Yen Bai, Ninh Binh, Thanh Hoa Provinces and from islands of Ha Long bay, including Cat Ba (Dang Ngoc Can et al., 2008; Vu Dinh Thong, Furey, 2008; Abramov, Kruskop, 2012; Vu Dinh Thong et al., 2012b).

Map 16. *Hipposideros alongensis.*

Comments on natural history. Natural history in Vietnam poorly known. This bat is a cave-dweller and an aerial insectivore, similar in life stile to *H. armiger* and *H. larvatus*. Colony seen on Cat Ba Island counts about 130–150 individuals; it was situated in a doom-shaped cavern on the grotto ceiling, at about 10–12 m from the flour. Vu Dinh Thong et al. (2012b) reported about typical colony size between 300 and 500 individuals. Echolocation calls detected on Cat Ba were loud CF, at about 78 kHz (Abramov, Kruskop, 2012). According to Vu Dinh Thong et al. (2012b), frequency of CF calls is around 79 kHz in *H. a. alongensis* and 73 kHz in *H. a. sungi*. Newborns were reported from May to June.

Hipposideros pratti (Thomas, 1891)

Common names. Dơi nếp mũi Prat; Pratt's leafnosed bat; Листонос Пратта.

Material studied. No collection material from Vietnam was studied; one specimen from China seen in Geneva Museum of Natural History. Description below is mainly based on Allen (1938) and Robinson et al. (2003).

Identification. A large leaf nosed bat (forearm ca. 79–89.5 mm; CCL ca. 27.8–30 mm), in general appearance similar to *H. armiger*. Ear moderate, ca. $^1/_3$ of head and body length. Noseleaf with two distinct pairs of supplementary leaflets. Anterior noseleaf more rounded than that of *H. armiger*, with a distinct median emargination about 1 mm in depth. Posterior leaf narrower than anterior leaf, with only the medium septa well pronounced. Fleshy out-

Fig. 14. Upper canines (left lateral view) of *Hipposideros* (a) and *Coelops* (b).

Map 17. *Hipposideros pratti* – gray shading; *H. scutinares* – black dots.

growths behind the noseleaf form a conspicuous shield-like bilobed structure (Fig. 12), smaller in females and subadults, larger 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; its upper profile between posterior edge of nasal opening and sagittal crest conspicuously concaved (Fig. 13a).

This species differs from closely related *H. lylei* and *H. scutinares* by narrower "shield" and single and shallow emargination on the anterior leaf; from the former also by larger size. All three species differ well from *H. armiger* and *H. turpis* by the transverse bilobed "shield" and two pairs of supplementary leaflets near the anterior leaf; from *H. diadema* also by definitely different coloration; from all other Vietnamese *Hipposideros* – by larger size.

Distribution and collecting sites. See Map 17. A Chinese species; distributed in Southern and Eastern China and also in northern Vietnam (Allen, 1938; Robinson et al., 2003). In Vietnam is confirmed only from vicinity of Sa Pa, Lao Cai Province (Robinson et al., 2003). However Dang Ngoc Can et al. (2008) also reported this bat for Lai Chau and Lang Son provinces; record in Quang Binh province apparently represents a misidentification of *H. scutinares*.

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; Lesser shield-faced leafnosed bat; Малый щитомордый листонос.

Material studied. No collection material was studied. Description below is mainly based on Robinson et al. (2003) and Francis (2008).

Identification. A large leaf nosed bat (forearm ca. 73–84 mm; CCL 24.1–26.5 mm), essentially resembling *H. pratti*, and formerly even thought to be a subspecies of the latter (Tate, 1941). Anterior noseleaf with one medial and a pair of lateral emarginations; medial one is ca 1.5–2 mm in depth. Transverse fleshy "shield" is very large and wide, especially in adult males. Coloration similar to that of *H. pratti*, relatively pale, with darker hair bases. Ears and margins of noseleafs are blackish or pink.

This species may be distinguished from *H. pratti* by three emarginations on the anterior leaf, about twice larger "shield" and by smaller size.

Distribution and collecting sites. See Map 18. Indochinese and Malayan species, inhabiting Myanmar, Yunnan, Thailand, Malaya and Vietnam. In Vietnam is known from Lao Cai Province (where presumably coexists with *H. pratti*) and from Cuc Phuong National Park; Ninh Binh Province (Robinson et al., 2003).

Map 18. *Hipposideros lylei.*

Comments on natural history. Probably similar to that of *H. armiger* and *H. pratti.*

***Hipposideros scutinares* Robinson, Jenkins, Francis and Fulford, 2003**

Common names. Dơi nếp mũi đông dương; Greater shield-faced leafnosed bat; Большой щитомордый листонос.

Material studied. Ten specimens from Quang Binh province.

Identification. A large leaf nosed bat (weight ca. 32–46.5 g; forearm ca. 76.8–81 mm [77.9–82.7; Robinson et al., 2003]; CCL 26.7–28.2 mm; App. II, Table 4), essentially resembling *H. pratti* and *H. lylei* (with the latter was previously confused: Kruskop, 2000; Hendrichsen et al., 2001; Borissenko, Kruskop, 2003). Anterior noseleaf with one medial and a pair of lateral emarginations. Transverse fleshy "shield" smaller in females and immatures, very large in adult males though proportionally smaller than in *H. lylei*. Coloration similar to that of *H. pratti*, relatively pale, with brown or ginger hair bases, pale midparts and brownish tips. Noseleafs and "shield" are pinkish.

This species may be distinguished from *H. pratti* by three emarginations on the anterior leaf, wider noseleaf (9.5 mm and wider) and by smaller skull; from *H. lylei* – by larger skull and smaller medial emargination on the anterior leaf. Available genetic data did not show difference between this species

and *H. pratti* (Francis et al., 2010), though it could be result of misidentification or DNA introgression.

Distribution and collecting sites. See Map 17. Known only from central parts of Laos and Vietnam. In Vietnam reported from Phong Nha and Ke Bang; Quang Binh Province (Kruskop, 2000; Hendrichsen et al., 2001; Robinson et al., 2003).

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 Nha 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. Two adult specimens from Binh Phuoc province; also six specimens from the Philippine Islands were examined.

Map 19. *Hipposideros diadema.*

Identification. A large leaf nosed bat (weight ca. 33–45 g; forearm ca. 75–92 mm; CCL ca. 25–30 mm; App. II, Table 4), externally essentially resembling *H. pratti*. Anterior noseleaf with no emarginations, usually with three supplementary leaflets. No fleshy outgrowths behind posterior noseleaf besides small protuberances above each eye. Posterior noseleaf wider than the anterior noseleaf, conspicuously curved downwards. Pelage dark to golden brown with pale hair bases and characteristic contrast spots on shoulders: white, cream-colored or (in adult females) yellow. Underparts creamy-white or yellowish. Naked facial parts, noseleafs and ears in studied Vietnamese specimens were conspicuously yellow. Wing membranes brown, darker than the skin along fingers and forearms.

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. See Map 19. 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 (Dang Huy Huynh et al., 1994), from Tuyen Quang and Bac Kan provinces (Dang Ngoc Can et al., 2008), from Bu Gia Map in Binh Phuoc Province (Kruskop, 2010a) and from some coastal islands, including Con Dao and Phu Quoc (Kuznetsov, An', 1992), though its presence on Con Dao looks extremely doubtful (Kruskop, 2011a).

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). Specimens in Bu Gia Map were netted in the tall evergreen forest at the elevation of ca. 400 m a.s.l. over the forest trail; absence of known karst in that site let us to suppose that in Bu Gia Map this bat probably dwells in hollow trees.

Hipposideros pomona K. Andersen,

Common names. Dơi mũi xinh; Andersen's leafnosed bat; Большеухий листонос.

Material studied. Twenty-four specimens were examined from Quang Ninh, Ha Tinh, Quang Binh, Dong Nai, Dak Lak, Ba Ria – Vung Tau provinces; from Cat Ba and Phu Quoc Islands (this includes 3 specimens from unknown locality (collected by Dr. Dao Van Tien)).

Identification. A small leaf nosed bat (weight ca. 5.5–8 g; forearm ca. 39–43 mm; CCL ca. 14.2–14.6 mm; Bates, Harrison, 1997; App. II, Table 4). 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 and usually by more brownish coloration. Form extralimital *H. bicolor* and *H. atrox* it differs in minor details of noseleaf structure and in minute stick-like baculum (Douangboubpha et al., 2010).

Specimens from Vietnam were usually referred to the larger subspecies *H. p. gentilis* Andersen, 1918 (type locality in Myanmar; see e.g. Koopman, 1994). Recent genetic studies (Francis et al., 2010) suggest that *H. pomona* actually represent a complex of species-level forms, of which three presumably occur in Vietnam, replacing each other from north to south. In this case *gentilis* should be restricted to Central and Western Indochina; the valid name for the northern from could be *sinensis* Andersen, 1918; and one from Southern Vietnam is probably still unnamed. Taxonomy of *H. pomona* s. lato thus represents subject for special study.

Distribution and collecting sites. See Map 20. Distributed from eastern-most India to south-eastern China and peninsular Thailand (Corbet, Hill, 1992). Distribution in Vietnam seems to be very sporadic. We found this bat in Ha Tinh (Vu Quang), Quang Binh (Ke Bang), Dong Nai (Cat Tien), Dak Lak (Chu Yang Sin) and Ba Ria – Vung Tau (Binh Chau) provinces and on Cat Ba Island. The older records of *H. bicolor* and, in part, *H. fulvus* from Vietnam (e.g., Dang Huy Huynh et al., 1994) should be treated as mistakes, based on misidentified *H. pomona* (see Hill et al., 1986). 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 Phu Quoc (Kuznetsov, Pham Trong An, 1992; Abramov et al., 2007; in latter case erroneously reported as *H. ater*). Dang Ngoc Can et al. (2008) report this species also from Lai Chau, Lao Cai, Tuyen Quang, Bac Kan (Ba Be and Kim Hy NP), Lang Son, Phu Tho, Thai Nguyen, Vinh Phuc, Ninh Binh, Thanh Hoa, Nghe An (Pu Mat), Quang Tri, Trua Thien-Hue, Kon Tum, Gia Rai, Dak Lak provinces and from the Cat Ba island; report for Con Son Island should be erroneous.

Map 20. *Hipposideros pomona.*

Comments on natural history. Natural history is poorly known; probably a perch-hunter (gleaning or aerial). Occurs mainly in forested areas: lowland or submontane. In northern India it was found from 462 m to 1631 m a.s.l. (Bates, Harrison, 1997). Roosts

mainly in caves or karstic hollows; in Ke Bang a colony of ca. 50 individuals inhabited a small limestone cave together with *H. armiger*, partly in mixed aggregations (Kruskop, 2000a). On Cat Ba Island small group was found living in karstic cave. In Cat Tien this species was observed using hollow tree as a day roost.

***Hipposideros cineraceus* Blyth, 1853**

Common names. Dơi mũi bé; Least leafnosed bat; Карликовый листонос.

Material studied. Twenty specimens from Ha Tinh, Quang Binh and Dong Nai provinces and from Con Dao Islands.

Identification. A very small-sized leaf nosed bat (weight ca. 3.7–4.9 g; forearm ca. 33–35.5 mm; CCL ca. 12.6–13.9 mm; Corbet, Hill 1992; App. II, Table 4). 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 usually pale gray or brownish-gray above, with white hair roots, and dirty-white below, though yellowish and even pale-orange specimens are known.

Differs from all other Vietnamese *Hipposideros* by smaller size, from *H. pomona* also by shorter ears and inflated internarial septum. Latest genetic data (Francis et al., 2010) suggest that this is actually a complex of forms, relationships and level of diversification between which needs further special study.

Distribution and collecting sites. See Map 21. As accepted traditionally, 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). In Vietnam this bat was reported from Bac Kan, Quang Ninh, Thanh Hoa, Ha Tinh, Quang Binh, Quang Tri, Thua Thien-Hue, Lam Dong (Dang Ngoc Can et al., 2008) and Ha Noi (Dang Huy Huynh et al., 1994) provinces. We found this bat in Vu Quang Nature Reserve (Kuznetsov et al., 2001), in Phong Nha – Ke Bang (Kruskop, 2000b), in Cat Tien National Park (Nam Cat Tien and Cat Loc) and on Con Dao archipelago (Kruskop, 2011a).

Map 21. *Hipposideros cineraceus.*

Comments on natural history. 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. In Cat Tien captures were made mainly on the edges of primary forest: over forest roads and semi-dry brook beds. On Con Son Island this species was also seen mainly in forest habitats. 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). Births take place from second part of April to May.

[*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 leaf nosed 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 (less than 20 mm) and inflated internarial septum, and from the latter by larger overall size. Also *H. ater* has relatively large and long baculum (more than 1 mm) while that of *H. pomona* is minute (Douangboubpha et al., 2010; 2011)

Distribution and collecting sites. Widely distributed from western India to Indochina, Malacca Peninsula, Great Sunda Islands, the Philippines and the Moluccas (Corbet, Hill, 1992). Distribution in Vietnam is uncertain since there is high possibility of misidentification (as it was with Phu Quoc record). Previously reported from Thanh Hoa Province (Dang Huy Huynh et al., 1994). According to Douangboubpha et al. (2011), *H. ater* does not occur extralimitally to Indian subcontinent. These authors allocate specimens from Thailand to the new species, *H. einnaythu*, but they did not examine any material from Indochina.

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 khaokhouayensis Guillen-Servent, Francis, 2006

Common names. Dơi mũi Khao Khouay; Khaokhouay leafnosed bat; Лаосский листонос.

Material studied. One specimen from Hai Phong province; description below is also based on Guillen-Servent, Francis (2006).

Identification. A medium-sized leaf nosed bat (weight ca. 7.7–9.6 g; forearm ca. 45.5–48.5 mm; CCL ca. 16.0–17.6 mm) from the *H. bicolor* species group. Noseleaf well-developed and wide, covering muzzle. Anterior leaf with a narrow medial emargination, without supplementary leaflets. The intermediate leaf definitely narrower than posterior leaf; the latter is subdivided by tree septa, similar to *H. pomona*. Internarial septum is expanded into disc-like structure about 1.8 mm in width. Both sexes possess a frontal glandular sac behind posterior leaf. Ears large and rounded. Dorsal pelage is long and soft, mid-brown, with pale tips and white bases of individual hairs; underparts are paler. Skull with moderately developed nasal swellings.

This species differs from *H. pomona* and *H. cineraceus* by definitely larger size, disc-like internarial septum and better developed rostral swellings on skull. From similar size *H. galeritus* it can be distinguished also by larger and more rounded ears and by absence of supplementary leaflets.

Another leaf nosed bat of the same size and appearance, the extralimital *H. rotalis* Francis, Kock, Habersetzer, 1999, described from Laos, may be distinguished by wider internarial disc (about 2.5 mm in width) and presence of a pair of supplementary leaflets. There is possibility that this species will be find in Vietnamese part of Truong Son mountain range.

Distribution and collecting sites. Until recently this *Hipposideros* was known from only small area in Central Laos (Francis, 2008). However it was then found on the island Cat Ba in Hai Phong Province (Vu Dinh Thong et al., 2008; Abramov, Kruskop, 2012).

Comments on natural history. Natural history poorly known. Inhabits evergreen forests at the elevation of ca. 100–400 m a.s.l.; however on Cat Ba adult female was captured near street lamp in front of National Park office (Abramov, Kruskop, 2012). Roosts unknown but probably associated with karst outcrops. Pregnant females ere reported in Laos in February and May. Echolocation call in Laos are at 87–91 kHz (Guillen-Servent, Francis, 2006), 94.3 kHz on Cat Ba Island (Vu Dinh Thong et al., 2008).

Hipposideros galeritus Cantor, 1846

Common names. Dơi mũi Galê; Fawn leafnosed bat; Хохлатый листонос.

Material studied. Seventeen specimens were examined from Tay Ninh, Dong Nai, Lam Dong, Khan Hoa and Dak Lak provinces and from Con Son Island.

Identification. A small to medium-sized leaf nosed bat (weight ca. 5.5–6.8 g; forearm ca. 45–51 mm; CCL ca. 14.6–15.8 mm; App. II, Table 4). 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 is 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 leaf nosed 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 antitragi and noseleafs.

Distribution and collecting sites. See Map 22. *Hipposideros galeritus* has a disrupted range consisting of three areas: India and Sri Lanka; Thailand and Malaya; Java and Borneo (Corbet, Hill, 1992). In Vietnam it was first recorded from Cat Tien National Park, Dong Nai province (B. Hayes, in: Pham Nhat et al., 2001). We also found fawn leaf nosed bat on Con Son Island (Kruskop, 2011a), in Lam Dong province (Cat Loc and Bao Lam), in Lo Go Xa Mat, on Hon Ba and Chu Yang Sin mountains.

Map 22. *Hipposideros galeritus.*

Comments on natural history. Aerial insectivore, foraging along forest roads and trails and forest edges, predominantly in fairly open habitats. In Tay Ninh and Cat Loc and on Con Son island these bats were observed flying along roads and above grassland, ca. 1.5 to 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).

Genus *Coelops* Blyth, 1848

General characteristics. Very small Hipposiderid bats with peculiar general appearance.

Diagnosis. Skull on Fig. 46. 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. 14b). 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. 15).

Fig. 15. Interfemoral membrane of *Coelops*.

Distribution. North-east India, southern China, Indochina, Malaya, Java, Borneo, and the Philippine Islands. Occurs in Indochina sporadically.

Taxonomical remarks. Two species are 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. Four specimens from Ha Tinh, Dong Nai and Lam Dong provinces.

Identification. A very small leaf nosed bat (weight ca. 3.5 g; forearm ca. 37–42 mm; App. II, Table 4), 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. 16), 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.

Fig. 16. Face of *Coelops frithii*, anterior view.

Distribution and collecting sites. See Map 23. Distributed sporadically throughout the Malayan subregion, from eastern India and Myanmar to south-eastern China, Taiwan, Java

Map 23. *Coelops frithii.*

and Sumatra. In Vietnam it was reported mainly from the north of the country: from Lai Chau, Lao Cai, Tuyen Quang, Lang Son, Hai Phong, Ninh Binh, Thanh Hoa and Thua Thien-Hue provinces (Dang Huy Huynh et al., 1994; Dang Ngoc Can et al., 2008). We recorded this species in Vu Quang (Ha Tinh province; Kuznetsov et al., 2001), Nam Cat Tien (Dong Nai province; Polet, Ling, 2004) and from vicinity of Con Giao mountain on Dalat Plateau (Lam Dong Province; Abramov et al., 2009).

Comments on natural history. Natural history is very poorly known. Supposed to be a forest species, roosting in trees or caves (Bates, Harrison, 1997; Francis, 2008). Both Cat Tien specimens were found dead inside houses. One observation made in Vu Quang suggests this bat to hunt just a few centimeters above ground level, amongst grassy vegetation (ferns). On Dalat Plateau these bats were observed foraging above the stream very close to water surface (Abramov et al., 2009).

Family Rhinolophidae Gray, 1825

Common names. Họ dơi lá, Horseshoe bats; Подковоносые.

General characteristics. A monotypic family. Similarly to Hipposideridae, 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.

Diagnosis. Skulls on Figs. 47–48. Dental formula: $I^1/_2$ $C^1/_1$ $P^2/_3$ $M^3/_3 \times 2 = 32$. P_2 minute and sometimes vestigial, however, usually present. P^2 of various sizes, 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 (Fig. 17): anterior leaf (horseshoe), intermediate leaf (sella),

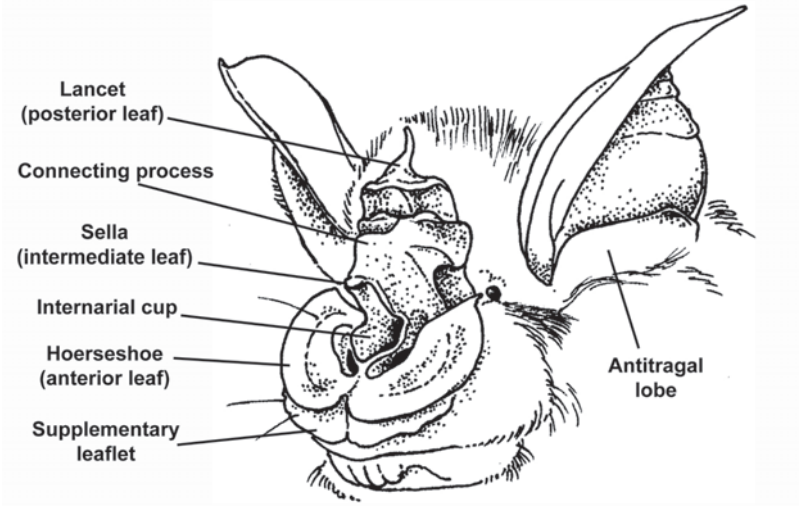


Fig. 17. Head of *Rhinolophus chaseni*, demonstrating details of noseleaf structure.

connecting process and posterior leaf (lancet); additional structures present in some species (lappets, internarial 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 no less than 80 recognized species and numerous named forms of contradictory status (Csorba et al., 2003), ca. 17 of them reported from Vietnam.

Key to the Vietnamese *Rhinolophus*

1 Sella with conspicuous basal lappets (Fig. 18h–i) **2**

– Sella without basal lappets (Fig. 18a–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. 133)

– 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 50 mm. Lancet broadly rounded. Margins of internarial cup passing beneath base of sella..... *R. paradoxolophus* (p. 134)

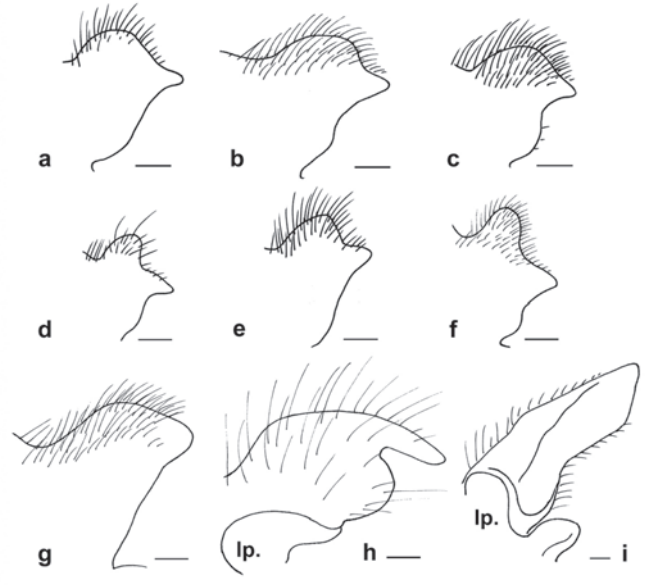


Fig. 18. Schematic profile of the connecting process and sella of selected *Rhinolophus* species, outlined from alcohol-preserved specimens (lateral view, scale to the right of each picture is 1 mm): a) *R. affinis*; b) *R. chaseni*; c) *R. sinicus*; d) *R. pusillus*; e) *R.* cf. *lepidus*; f) *R. acuminatus*; g) *R. pearsoni*; h) *R. luctus*; i) *R. paradoxolophus*. Lp – basal lappets.

– Size smaller. Forearm less than 47 mm. Lancet more or less triangular. Lateral margins of internarial cup conjoint with the margins of sella..... ..... *R. marshalli* (p. 135)

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. 130)

– 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..... **9**

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)

– 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..... **8**

7 Size larger: forearm usually more than 42 mm, CCL over 14 mm..... ..... *R. macrotis* (p. 131)

– Size smaller: forearm usually less than 41 mm, CCL no more than 14 mm ..... *R. siamensis* (p. 132)

8 Smaller: forearm less than 55 mm, condylocanine length less than 22 mm ..... *R. pearsoni* (p. 128)

– Larger: forearm over 54 mm; condylocanine length over 22 mm .... *R. yunnanensis* (p. 128)

9 Connecting process broadly rounded, sometimes very low (Fig. 18a–c); supplementary leaflets of horseshoe usually well-developed **10**

– 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 **16**

10 Lancet triangular in shape, its latral sides more or less stight (Fig. 19a).... **11**

– Lancet abruptly narrowed at center, its lateral sides concaved (Fig. 19b).. **15**

11 Size larger: forearm usually larger than 48 mm; CCL larger than 18.5 mm ..... *R. affinis* (p.115)

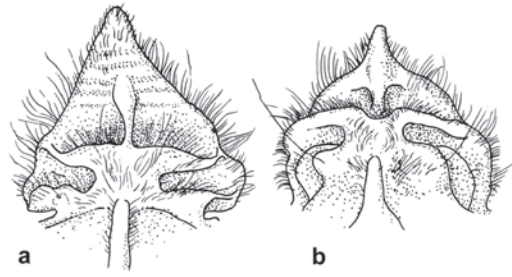


Fig. 19. Shape of posterior leaf (lancet) in a) *Rhinolophus malayanus*; b) *R. thomasi*.

– Size smaller: forearm no more than 48 mm; CCL no more than 18.5 mm **12**

12 Anterior rostral swellings moderate, less elevated (Fig. 20c, 21b). Sella pandurate .....*R. chaseni* (p. 116)

– On skull anterior median swellings greartly inflated and strongly elevated (Fig. 20a-b, 21a). Sella parallel-sided **13**

13 Posterior median rostral swellings inflated; in lateral view anterior median swellings shallowly concave posteriorly (Fig. 20b) . Postorbital constriction wider than 2 mm .....*R. malayanus* (p. 118)

– Postrior mediam rostral swellings not inflated; anterior median swellings in lateral view sharply concave posteriorly (Fig. 20a). Postorbital constriction about 2 mm or narrower **14**

14 Skull larger: CCL more than 16.8 mm, width across canines more than 4.9 mm. Postorbital constriction 1.8 mm or less .....*R. stheno* (p. 119)

– Skull smaller: CCL 16.7 mm or less, width across canines no more than 4.9 mm. Postorbital constriction about 2 mm in width .... *R. microglobosus* (p. 120)

15 Size smaller: forearm no more than 46 mm. Lancet short, with reduced tip. Second upper premolar removed from the tooth row ... *R. thomasi* (p. 123)

– Size larger: forearm more than 45 mm. Lancet normal, with unreduced tip. Second upper premolar in the tooth row .....*R. sinicus* (p. 121)

16 Size larger: forearm no less than 46 mm, CCL more than 17 mm .... *R. acuminatus* (p. 127)

– Size smaller: forearm no more than 42 mm; CCL less than 17 mm **17**

17 Connecting process very acute, slightly bent forward ("horn-like"). CM3 no more than 5.5 mm .....*R. subbadius* (p. 125)

– Connecting process variably acute, triangular, not bent forward. CM3 usually more than 5.4 mm.....**18**

18 Size on the averedge larger: forearm more than 37 mm (usually about 40), CM3 more than 6 mm; skull about 8 mm in width .. *R.* cf. *lepidus* (p. 126)

– Size on the averedge smaller: forearm less than 40 mm (usually no more than 37), CM3 no more than 6.2 mm; skull no more than 7.5 mm in width **19**

19 Sella relativel wide. Tibia longer than 16 mm ..... *R. cornutus*[8]

– Sella relatively narrow. Tibia no loger than 15 mm ..... *R. pusillus* (p. 123)

***Rhinolophus affinis* Horsfield, 1823**

Common names. Dơi lá đuôi, Intermediate horseshoe bat, Азиатский подковонос.

Material studied. Sixty seven specimens were examined originated from Lao Cai, Ha Tinh, Quang Tri, Lam Dong, Dong Nai, Kon Tum and Dak Lak provinces. Specimens from Vu Quang were kindly identified by Dr. Gabor Csorba, Hungarian Museum of Natural History.

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; App. II, Table 5). External appearance typical for *R.* "*megaphyllus*" 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 "*megaphyllus*" group, not extruded from toothrow.

This species could be distinguished from other Indochinese representatives of the "*megaphyllus*" group by definitely larger size; from larger speci-

[8] – See comments under *R. pusillus*.

Map 24. *Rhinolophus affinis*.

mens of *R. sinicus* – by larger condylocanine length and lancet shape; from similar-size *R. pearsonii* and *R. acuminatus* – by different shape of connecting process.

Distribution and collecting sites. See Map 24. Widely distributed from Nepal and northern India to south-eastern China, Malayan peninsula and Sunda Islands (Corbet, Hill, 1992). In Vietnam reported from Lao Cai, Lang Son, Ninh Binh and Lam Dong Provinces (Dang Huy Huynh et al., 1994). We found this species in Vu Quang Nature Reserve (Kuznetsov et al., 2001), in Nam Cat Tien, on Lang Bian (Da Lat) Plateau (Abramov et al., 2009), on Hoang Lien Son (Kruskop, Shchinov, 2010), Cu Yang Sin mountains and in Bao Lam. Kingsada et al. (2011) also report this bat for Bac Kan, Vinh Phuc, Kon Tum, Lai Chau, Dien Bien, Tuyen Quang, Vinh Phuc, Ha Tay, Thanh Hoa and Ho Chi Minh provinces. Supposedly, this species is distributed in mountainous territories throughout Vietnam. Specimens from Qung Tri are represented in the collection of ZISP (collected by A. Abramov, A. Tikhonov).

Comments on natural history. An 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 Chu Yang Sin – from 1000 to 1600 m a.s.l., on Langbian plateau – up to 1800 m a.s.l., in Hoang Lien – at ca. 1900 m a.s.l.. Roosts are presumably 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 chaseni Sanborn, 1939

Common names. Dơi lá sa đen; Chasen's horseshoe bat; Подковонос Чазена.

Material studied. Eighty nine specimens from Dong Nai, Binh Phuoc, Tay Ninh, Ba Ria – Vung Tau (mainland part) and Dak Lak provinces and from Con Dao islands.

IDENTIFICATION. A small to medium-sized horseshoe bat (weight ca. 8–11 g; forearm ca. 43.5–49.0 mm; CCL ca. 16.9–17.8 mm (in Con Son population – 5.7–8.0 g, 40.7–44.4 mm and 16.2–16.4 mm, respectively; App. II, Table 5), 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* (Fig. 20).

This bat, described from Con Dao archipelago (Sanborn, 1939) was for decades considered as a partial synonym of *R. borneensis* (Hill, Thonglongya, 1972). Species-level genetic difference between Indochinese specimens and *R. borneensis* s. str. was shown by Francis et al. (2010). Con Dao population appears to be genetically identical to that from the mainland showing that they are conspecifics (Kruskop, 2011a), though Con Dao specimens are smaller and in external measurements more close to *R. malayanus*.

DISTRIBUTION AND COLLECTING SITES. See Map 25. For many years this species (as R. borneensis chaseni) was restricted to Con Dao archipelago (e.g. Corbet, Hill, 1992). Now known distribution covers Cambodia, Southern Vietnam and Southern and Central Laos (Francis,

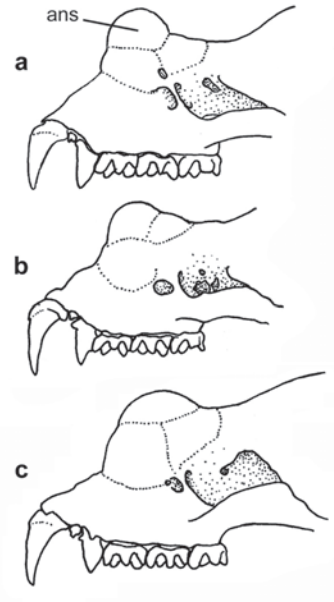


Fig. 20. Lateral shape of rostrum in *Rhinolophus*: a) *R. stheno*; b) *R. malayanus*; c) *R. chaseni*. ans – anterior nasal swellings.

Map 25. *Rhinolophus chaseni.*

2008). Dang Ngoc Can et al. (2008) reported this species (as *R. borneensis*) from Lai Chau, Tuyen Quang, Thua Thien-Hue, Dak Lak, Tay Ninh provinces and Con Dao islands. We found this bat in Binh Quoc (Bu Gia Map), Dong Nai (Cat Tien and Vinh Cuu, where this bat is quite numerous), Tay Ninh (Lo Go Xa Mat), Dak Lak (Yok Don) and Ba Ria – Vung Tau (Binh Chau) provinces and certainly on Con Dao.

Comments on natural history. Predominantly forest species at elevations from zero to 530 m a.s.l., though on Con Son Island it inhabits also bushes and agricultural lands. Maneuverable aerial hawker, forages usually at 1.5–5 meters above the ground along forest edges, bushes, roads etc., or under the forest cover, between the tree trunks. The specimens from Tay Ninh were captured while flying closely to the ground in secondary forest formations and *Acacia* plantations. Day roosts are variable. Probably this bat can use large hollows in trees. In Bu Gia Map this bat roosts in drainage pipes under the road; in Vinh Cuu they were found in old underground fortifications and in buildings. In Nam Cat Tien *R. chaseni* was recorded as a cave-dweller. Mating season falls on October; females give births probably from second half of April to the end of May. Echolocation calls are of high intensity; the CF component in Tay Ninh was detected around 80 kHz and on Con Son at ca. 102 kHz.

Rhinolophus malayanus Bonhote, 1903

Common names. Dơi lá Mã Lai, North Malayan horseshoe bat, Малайский подковонос.

Material studied. Five specimens from Quang Tri province and Phu Quoc Island.

Identification. A small horseshoe bat (weight ca. 6.7 g; forearm ca. 38–44 mm; CCL ca. 16.6 mm), in size and external appearance essentially similar to *R. chaseni* and extralimital *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. chaseni* and

extralimital *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. See Map 26. Indochinese species, inhabiting Vietnam, Laos, Thailand, adjacent parts of Myanmar, Cambodia and Malaya (Corbet, Hill, 1992; Bates et al., 2000; Hendrichsen et al., 2001). In Vietnam it was reported from Lai Chau, Bac Kan, Phu Tho, Ha Tinh, Quang Tri and Kon Tum provinces (Dang Huy Huynh et al., 1994; Dang Ngoc Can et al., 2008). Record from Ke Bang (Quang Binh province; Kruskop, 2000b) was based on misidentification. We found this bat only on Phu Quoc Island (Abramov et al., 2007), and also have processed specimens from Quang Tri province in ZISP collection.

Map 26. *Rhinolophus malayanus.*

Comments on natural history. Natural history in Vietnam poorly known. Probably, an aerial insectivore and cave dweller. On Phu Quoc animals were seen in lowland forest foraging over the bushes at 1.5–2 m above the ground (Abramov et al., 2007). Echolocation signals were reported at 75 kHz in Thailand (Csorba et al., 2003).

Rhinolophus stheno Andersen, 1905

Common names. Dơi lá mũi nam; Lesser brown horseshoe bat; Малазийский подковонос.

Material studied. Three specimens from Khanh Hoa, Dak Lak and Lam Dong provinces; also one specimen from Thailand. The diagnosis below greatly follows Soisook et al. (2008).

Identification. A small to medium-sized horseshoe bat (weight ca. 7–10 g; forearm ca. 43.2–48.1 mm; CCL ca. 16.7–18.3; App. II, Table 5). Sella parallel-sided or slightly concaved in mid-part, rounded at tip. Connecting process rounded. Lancet long, broadly triangular, with broad median septa and unreduced tip densely covered with hairs. Outer parts of the horseshoe well-pigmented in contrast to pale area around nostrils. Tail characteristically short, averages shorter than tibia (13–21 mm). Anterior medial nasal compartment of skull rostrum well-developed, while the posterior nasal compartments are weekly developed, forming a prominent concavity of the upper skull profile.

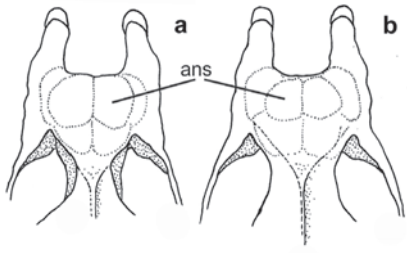


Fig. 21. Anterior part of skull in *Rhinolophus* (upper view): a) *R. stheno*; b) *R. chaseni*. ans – anterior nasal swellings.

Interorbital space is greatly narrowed, ca. 1.8 mm or less in width (Fig. 21a). Fur coloration is grayish-brown to chestnut-brown.

This species is unique in its proportions of nasal compartments and narrowed interorbital space, and may be clearly distinguished from all the species except to *R. microglobosus*. From the latter one it can be differ by larger skull proportions and brighter coloration. Externally *R. stheno* may be distinguished from similar-sized *R. chaseni* by parallel-sided (not pandurate) sella and shortened tail, from *R. thomasi* and *R. sinicus* also by triangular lancet; from *R. malayanus* – by slightly larger overall size and more massive median septa on lancet.

Distribution and collecting sites. See Map 27. Malayan species, inhabiting southern Thailand, Malacca, Java and Sumatra. Since *R. microglobosus* is now treated as separate species, there are only five known Vietnamese localities associated with this particular species: Kon Ka Kinh, Gia Lai province, Bach Ma, Thua Thien-Hue province (Soisook et al, 2008), Hon Ba, Khanh Hoa province (Borissenko et al., 2006), Chu Yang Sin, Dak Lak province, and Loc Bao, Lam dong province (orig. data).

Comments on natural history. Natural history poorly known. Mainly a cave-dweller, however netted in tall forest, far from known caves (Medway, 1978). In Thailand is known to associate with karst areas, covered with pristine forests. In Vietnam occurs on elevations up to 1700 m a.s.l.. Echolocation call CF, at about 84–88 kHz (Soisook et al., 2008)

Rhinolophus microglobosus Csorba, Jenkins 1998

Common names. Dơi lá mũi bắc; Indo-Chinese brown horseshoe bat; Индокитайский подковонос.

Material studied. Two males from Tuyen Quang province (ROM collection); the diagnosis below also follows Csorba and Jenkins (1998) and Soisook et al. (2008).

Identification. A small horseshoe bat (weight ca. 5–9 g; forearm ca. 41.4–46.3 mm; CCL ca. 15.1–16.8). Sella parallel-sided with rounded tip. Connecting process rounded. Lancet tall, triangular and straight-sided. Tail shorter than tibia (15–22 mm). Anterior medial nasal compartment of skull are well-developed

and inflated, but in less degree than in *R. stheno*; concavity of upper skull profile is shallower. Interorbital constriction about 2 mm in width. Fur is grayish to yellowish-brown; underparts are pale-brown.

This bat was initially described as a subspecies of *R. stheno*, with which it coexist in at least one locality in Vietnam. It can be distinguished from *R. stheno* by smaller cranial and dental size (CC no more than 4.9 mm; CM3 no more than 7.8 mm), shorter ears and duller coloration. From similar-sized *R. malayanus* it differs in narrower interorbital space, shape of sella, wider median septa on lancet and shorter tail; from *R. thomasi* – by the lancet shape.

Distribution and collecting sites. See Map 27. Sporadically distributed through South-East Asia north from Isthmus of Kra: in Thailand, Laos, Vietnam, Cambodia and south-west China (Soisook et al., 2008). In Vietnam it was reported from Tuyen Quang (Na Hang Nature Reserve, type locality), Phu Tho (Xuan Son), Nghe Anh (Pu Mat National Park), Thua Thien-Hue (Bach Ma), Quang Tri (Dak Rong) and Kon Tum (Chu Mon Ray) provinces (Soisook et al., 2008; Dang Ngoc Can et al., 2008).

Map 27. *Rhinolophus stheno* complex: *R. stheno* s.str. – black dots; *R. microglobosus* – gray shading; occurrence of both species – open circles.

Comments on natural history. Natural history poorly known. Known to inhabit areas with limestone karst and lowland to hill evergreen forests. Cave-dwelling colony of ca. 1200 individuals was reported from Thailand. Echolocation call peak frequency is around 95–100 kHz (Soisook et al., 2008). Mainly a cave-dweller, however netted in tall forest, far from known caves (Medway, 1978).

Rhinolophus sinicus Andersen, 1905

Common names. Dơi lá Rut; Chinese horseshoe bat; Южнокитайский подковонос.

Material studied. Four specimens from Khanh Hoa province; an additional specimen from Nepal, kindly identified by Dr. G. S. Csorba (Hungarian Natural History Museum). Description below also follows Csorba et al. (2003).

Identification. A small to medium-sized horseshoe bat (weight ca. 8.9–10.9 g; forearm ca. 45.5–47.6 [43.5–55.5 sensu Csorba et al.] mm; CCL ca. 17.0–18.0 mm; App. II, Table 5), similar to *R. affinis* and *R. thomasi*. Horseshoe of moderate size, connecting process is broadly rounded; sella is pandurate, with-

out supplementary lappets, ears also of moderate size. Lancet strongly hastate: wide at base but abruptly narrowed in distal third. 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 lancet and from *R. thomasi* (with which it belongs to the same species group) – by definitely larger size.

For decades this bat was accepted as a subspecies of *R. rouxii* (Corbet and Hill, 1992; Koopman, 1994; Bates, Harrison, 1997). However it was raised to the species level by Thomas (2000; see also Csorba et al., 2003). All mountainous populations, occurring from Western Himalayas to Indochina, were allocated to *R. sinicus*, while *R. rouxii* s. str. distribution was restricted to lowlands of India, Sri Lanka and Myanmar. Predominantly montane *R. sinicus* 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).

Distribution and collecting sites. See Map 28. *Rhinolophus sinicus* is distributed through mountainous part of South-East Asia from northern India and Nepal to south-east China and Indochina (Bates, Harrison, 1997; Csorba et al., 2003). In Vietnam it was recorded (as both *R. sinicus* and *R. rouxii*) from Lao Cai, Tuyen Quang, Bac Kan, Lang Son, Ninh Binh, Nghe An, Thanh Hoa, Gia Lai and Thua Thien-Hue provinces (Dang Huy Huynh et al., 1994; Hayes, Howard, 1998; Dang Ngoc Can et al., 2008). Record from Ke Bang, Quang Binh province (Kruskop, 2000b) was essentially based on misidentification. We found this species on Hon Ba mountain, Khanh Hoa province (Borissenko et al., 2006).

Map 28. *Rhinolophus sinicus*.

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. On Hon Ba these bats were captured in mountainous forest at ca. 1500 m a.s.l. Echolocation signal is low-intensity with CF component at ca. 80 kHz and additional harmonic at 40–45 kHz (Borissenko et al., 2006).

***Rhinolophus thomasi* Andersen, 1905**

Common names. Dơi lá Tôma; Thomas's horseshoe bat; Подковонос Томаса.

Material studied. Fourteen specimens from Quang Binh and Quang Tri provinces (ZMMU and ZISP).

Identification. A small horseshoe bat (weight ca. 6.6–14.1 g; forearm ca. 41.7–45.4 mm; CCL ca. 15.9–16.5 mm; App. II, Table 5) in external appearance similar to R. sinicus but smaller. Horseshoe of moderate size, connecting process is broadly rounded; sella is parallel-sided, without supplementary lappets. Connecting process distinctly notched. Lancet short and broadly hastate (Fig. 19), with reduced tip. P^2 reduced, but not extruded from toothrow.

Map 29. *Rhinolophus thomasi.*

Distribution and collecting sites. See Map 29. 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). In Vietnam was reported from Lai Chau, Lao Cai, Tuyen Quang, Bac Kan, Land Son, Ninh Binh, Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri, Thua Thien-Hue, Kon Tum, Binh Dinh and Dong Nai provinces and from some coastal islets in the Gulf of Tonkin (Kuznetsov, An', 1992; Huyinh et al., 1994; Dang Ngoc Can et al., 2008). We found this bat only in Ke Bang. Record from Con Dao very probably is based on misidentification (Kruskop, 2011a).

Comments on natural history. Natural history in Vietnam poorly known, probably in general similar to that of *R. sinicus*. Cave-dweller (Robinson, Smith, 1997). In Ke Bang karstic area these bats were common in both primary forest and secondary growth. Pregnant females were observed in the end of March and in April.

***Rhinolophus pusillus* Temminck, 1834**

Common names. Dơi lá muỗi; Least horseshoe bat; Карликовый подковонос.

Material studied. Twenty three specimens from Ha Tinh, Hai Phong, Dak Lak, Dong Nai and Lam Dong provinces and T.P. Ho Chi Minh; 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; App. II, Table 5). Ears and horseshoe not especially enlarged, supplementary leaflets present, but poorly developed; lancet not reduced; connecting process rather long, acutely pointed, its tip sometimes slightly bent foreword. Pelage fine and soft, light buffy brown or grayish-brown to darker brown above, paler below. Hairs with noticeably paler bases. In South Vietnam adult individuals often have yellowish faces, probably because of secretion of some facial glands.

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, wider connecting process and small premolars less displaced from tooth rows.

Actually, taxonomy of the "*R. pusillus*" species complex represents an extremely tangled case. Up to four species were reported from Vietnam (Dang Huy Huynh et al., 1994); meantime only *R. pusillus* itself was cited by Csorba et al. (2003). There are few species-level genetic lineages in South-East Asia and some of them can be assigned exactly with *R. pusillus* which in this case should be paraphyletic against at least *R. lepidus* and extralimital *R. monoceros* (unpubl.). At least northern and southern Vietnamese populations of *R. pusillus* are morphologically different though level of this difference still unclear (Abramov et al., 2012). While the whole species complex awaits revision, we suggest accepting three species in the Vietnamese fauna namely *R. pusillus* s. str., *R. subbadius* and *R.* cf. *lepidus*.

Another similar species once reported from Vietnam (Dang Huy Huynh et al., 1994) is *R. cornutus* which seems to be hardly distinguishable from *R. pusillus*. It differs slightly in the shape of the connecting process, which is very long and narrowly triangular, nearly horn-like; however this feature vary in different populations of *R. pusillus*. Allen (1938) cite *R. cornutus* for southern China, however this bat is treated as Japanese endemic (including Ryukyu) by Csorba et al. (2003). Until any significant evidences for the presence of *R. cornutus* in Vietnam will appear, we suggest excluding this bats from the Vietnamese faunal list.

Distribution and collecting sites. See Map 30. Widely distributed from northern India and Nepal (southern slopes of Himalayas) to south-eastern China, Hainan, Malaysia and Great Sunda Islands (Corbet, Hill, 1992). Dang Huy Huynh et al. (1994) indicate only two records (from Bac Thai and Ninh Binh provinces). According to Dang Ngoc Can et al. (2008) this species is also found in Lao Cai, Tuyen Quang, Bac Kan, Land Son, Son La, Phu Tho, Thai Nguyen, Vinh Phuc, Hai Phong, Nghe An, Ha Tinh, Quang Binh, Quang Tri,

Thua Thien-Hue, Kon Tum, Binh Dinh, Dak Lak, Dong Nai and Kien Giang provinces. Based on size comparison and preliminary molecular data we identify this species from further localities: Vu Quang Nature Reserve (Ha Tinh province; Kuznetsov et al., 2001), Nam Cat Tien (Dong Nai province), Cat Ba Island (Hai Phong province), Loc Bao (Lam Dong province), Chu Yang Sin (Dak Lak province) and T.P. Ho Chi Minh.

Map 30. *Rhinolophus pusillus.*

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 for 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); in Cat Tien this bat is also common in low elevations while in Chu Yang Sin it was captured in mountain mixed forest at ca. 1000 m a.s.l. Echolocation calls are of moderate intensity with the CF component around 110 kHz. Probably both hollow trees and caves can be used by this species as day roosts.

***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). Csorba et al. (2003) and Francis (2008) do not mention this species for Vietnam. According to available literature data (ibid.) *R. subbadius* differs

from the otherwise similar *R. pusillus* by smaller size (forearm length, skull dimensions) and more horn-like shape of the connecting process.

Once we supposed that both *R. subbadius* and *R. pusillus* may occur on Cat Ba Island (Abramov, Kruskop, 2012). However, all the available specimens from Cat Ba belong to the same genetic lineage of *R. pusillus*.

Distribution and collecting sites. Described from Myanmar. Sporadically found from Nepal to NE India, Myanmar (Csorba et al., 2003) and, supposedly, in North and Central Vietnam (Corbet, Hill, 1992). Records from Vietnam (Tuyen Quang, Thanh Hoa and Quang Binh provinces; Dang Huy Huynh et al., 1994; Dang Ngoc Can et al., 2008) 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 cf. *lepidus* Blyth, 1844

Common names. Dơi lá Ôgut; Blyth's horseshoe bat; Индийский подковонос.

Material studied. Sixteen specimens provisionally allocated to this species, from Khanh Hoa, Lam Dong, Dak Lak and Kon Tum provinces.

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; App. II, Table 5). 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. There are at least two genetic lineages tentatively associated with this species (Francis et al., 2010); however we found no morphological difference between these two lineages in Vietnam. Csorba et al. (2003) do not cite *R. lepidus* fro Vietnamese fauna. It is very probable that bats from Vietnam represent distinct species. Its valid name could be *R. osgoodi* Sanborn, 1939 (described from Yunnan). Final conclusion on this subject requires studies of the type material; until that we suggest to use open nomenclature for Indochinese individuals.

Distribution and collecting sites. See Map 31. Widely distributed through the Indomalayan region, from Kyrgyzstan, India to south-east China, Malaysia and Sumatra (Corbet, Hill, 1992; Benda et al., 2011). Questionably reported from Vietnam by Sokolov et al. (1986) and Dang Huy Huynh et al. (1994). Francis

(2008) cites this species for one unspecified locality in South Vietnam. However according to Dang Ngoc Can et al. (2008) this bat tentatively occurs in Lao Cai, Tuyen Quang, Phu Tho, Nghe An, Thua Thien-Hue, Quang Nam, Kon Tum, Gia Lai and Phu Quoc Island. We have identified this species from Khanh Hoa (Hon Ba mountain), Dak Lak (Chu Yang Sin), Lam Dong (Da Lat plateau) and Kon Tum (Ngoc Linh) provinces. Record from Con Dao Islands (Kuznetsov, 2000) is based on misidentification (Kruskop, 2011a).

Map 31. *Rhinolophus* cf. *lepidus*.

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.); found at ca. 1500 m a.s.l. on Hon Ba and at 1630 m a.s.l. on Chu Yang Sin. 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. Animals on Hon Ba and Dalat plateau were captured while hawking along the forest trails.

***Rhinolophus acuminatus* Peters, 1871**

Common names. Dơi lá mũi nhọn; Acuminate horseshoe bat; Серый подковонос.

Material studied. Twenty eight specimens from Tay Ninh, Binh Phuoc, Lam Dong and Dong Nai provinces.

Identification. A small to medium-sized horseshoe bat (weight ca. 8.3–13.5 g; forearm ca. 45–50 mm; CCL 17.7–19.5 ca. mm; App. II, Table 5). Ears and horseshoe not especially enlarged, supplementary leaflets well-developed; lancet not reduced; connecting process rather long and narrow, more or less pointed apically, but not horn-like. Pelage is thick and moderately long. There are two color phases: grayish, with smoky-gray main color of fur, and reddish, with yellow or pale orange fur coloration.

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 and different fur color.

Map 32. *Rhinolophus acuminatus.*

Distribution and collecting sites. See Map 32. Until recently 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). In Vietnam this bat is known from Lam Dong (Cat Loc), Dong Nai (Vinh Cuu and Ma Da), Tay Ninh (LO Go Xa Mat) and Binh Phuoc (Bu Gia Map) provinces (Borissenko, Kruskop, 2003; Dang Ngoc Can et al., 2008; Kruskop, 2010a).

Comments on natural history. Observations in Tay Ninh, Cat Loc and Ma Da indicate that this species has a typical slow and maneuverable flight pattern and powerful echolocation signal with the CF component around 90 kHz. It usually foraging at subcanopy level, several meters above the ground. However in Bu Gia Map few specimens were netted on the pebble shore of Dak A river, at about 1–1.5 meters above the ground. This bat was found to be rather common in lowland dipterocarp forests (especially in Ma Da); from there it may penetrate into secondary growth formations and even plantations, e.g. *Acacia* and *Anacardium*. Day roosts were found in drainage manifold under the road and in the old underground fortifications (in Vinh Cuu monument). Rut was observed in October; during this period adult males produce strong musky scent.

***Rhinolophus pearsoni* Horsfield, 1851**

Common names. Dơi lá Pecxôn; Pearson's horseshoe bat; Поковонос Пирсона.

Material studied. Twenty one specimens from Quang Binh, Khanh Hoa, Hai Phong, Vinh Phuc, Dak Lak and Lam Dong Provinces (including two specimens from unknown locality in Vietnam, collected by Dr. Dao Van Tien); also two specimens from Laos.

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; App. II, Table 5). Ears and horseshoe not enlarged (though horseshoe looks wider than in similar-size *R. affinis*). Sella without basal lappets. Connecting process at lateral view similar to that of *R. luctus*, very low and

broadly rounded (Fig. 18g). Pelage long, wooly, uniformly chestnut brown or dark 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. *R. affinis* which is very similar in size and sometimes occurs in the same locality, differs by the shape of connecting process, proportionally longer tail and by less wooly fur.

Map 33. *Rhinolophus pearsonii.*

Distribution and collecting sites. See Map 33. Distributed from Nepal and northern India to southern China and northern Indochina (Corbet, Hill, 1992; Francis, 2008). In Vietnam it was reported from Cao Bang, Lai Chau, Lao Cai, Tuyen Quang, Bac Kan, Lang Son, Son La, Phu Tho, Tay Nguyen, Vinh Phuc, Hai Phong, Ninh Binh, Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quanh Tri, Thua Thien-Hue, Quang Nam, Kon Tum, Binh Dinh, Gia Lai and Dak Lak provinces (Dang Ngoc Can et al., 2008). We found this in Ke Bang karstic area, on Cat Ba Island, on Hon Ba and Chu Yang Sin mountain and also in Loc Bao in Lam Dong province.

Comments on natural history. This species was found 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). On Cat Ba where limestone outcrops compose main part of the landscape, this species was common in different habitats, primary and disturbed. In Ke Bang one specimen was observed in a small limestone cavity, three individuals were netted nearby. Perching behavior was multiply observed on Cat Ba; however this bat can also forage as maneuverable aerial hawker.

***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. 20–22 g; forearm ca. 54–64 mm; CCL ca. 22–23 mm; after Corbet, Hill, 1992; Francis, 2008), in general appearance greatly similar to *R. pearsonii*, 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 north-eastern 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). Dang Ngoc Can et al. (2008) cite this species for Vietnam tentatively, providing no exact localities. Francis (2008) does not include this bat into Vietnamese fauna.

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. Two specimens from Phu Quoc Island; also one specimen from Cambodia.

Identification. A small horseshoe bat (weight ca. 10 g; forearm ca. 47.5 mm; CCL ca. 18.3 mm) of characteristic appearance. Connecting process is very characteristic – thickened and folded; its sides and tip are 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 is shallow, poorly developed, with narrow supraorbital ridges (prominent, moderately deep, and 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). Dang Ngoc Can et al. (2008) provide only three Vietnamese localities: Pu Mat (Nghe An province), Chu Mom Ray (Kon Tum province) and Phu Quoc Island.

Comments on natural history. Natural history is poorly known. Probably, a cave-dweller. The specimen from Cambodia was netted over a forest trail in highly disturbed forest. On Phu Quoc this bat was common in different types of lowland forest (Abramov et al., 2007); observed forage flight is flitting, with sharp changes in height and direction (ibid.).

***Rhinolophus macrotis* Blyth, 1844**

Common names. Dơi lá tai dài; Big-eared horseshoe bat; Длинноухий подковонос.

Material studied. Seven specimens were examined from Lao Cai, Tuyen Quang, Khanh Hoa, Dak Lak and Lam Dong provinces.

Identification. A small to medium-sized horseshoe bat (weight ca. 5–9.5 g; forearm ca. 43–48 mm; CCL ca. 16.6 mm; animals from southern populations are smaller, with forearm ca 39–44 mm; App. II, Table 5) of characteristic appearance. The horseshoe is wide (about 8–10 mm in width), covering muzzle and upper lip, with conspicuous notch in the middle. 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, buff-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.

Two subspecies were formerly accepted to Vietnam: *R. m. siamensis* Gyldenstolpe, 1917 and *R. m. caldwelli* Allen, 1923 (Osgood, 1932; Koopman, 1994). Now the first one is often treated as a separate species. Specimens from Northern Vietnam most probably could be assigned with the latter form while smaller southern specimens belong to a distinct genetic lineage and may represent an undescribed subspecies or even species.

Distribution and collecting sites. See Map 34. Distributed from Pakistan through Nepal to Southern and Central China, Malaysia and the Philippines (Csorba et al., 2003). In Vietnam this bat is known from Lai Chau, Lao Cai, Tuyen Quang, Lang Son, Cao Bang, Phu Tho, Thai Nguyen, Vinh Phuc, Thanh

Map 34. *Rhinolophus macrotis* – gray shading and black dot; verified locality for *R. siamensis* – open square.

Hoa, Nghe An, Quang Tri, Thua Thien-Hue, Kon Tum and Binh Dinh provinces (Hendrichsen et al., 2001; Dang Ngoc Can et al., 2008). We found this species in Loa Cai (Kruskop, Shchinov, 2010), Khanh Hoa (Borissenko et al., 2006), on Chu Yang Sin mountain and in Bao Lam (Dak Lak and Lam Dong provinces).

Comments on natural history. Confined to relatively high altitudes (Bates, Harrison, 1997; Csorba et al., 1998), inhabiting mountainous primary forests. In Lao Cai we found this bat at ca. 1950 m a.s.l.; specimens in Southern Vietnam were captured at 650–1500 m a.s.l. Roosting sites in caves and mines. Reported to be an aerial forager, feeding on small flying insects (Bates, Harrison, 1997), however external proportions suggest at least possibility for perch-hunting and foliage gleaning. Echolocation calls in Laos were reported at 51–52 kHz (Francis, 2008).

Rhinolophus siamensis Gyldenstolpe, 1917

Common names. Dơi lá mũi Thái Lan; Siamese horseshoe bat; Сиамский подковонос.

Material studied. No material was seen; the diagnosis below is based on Francis (2008).

Identification. A small horseshoe bat (weight ca. 4.5–6 g; forearm ca. 38–42 mm; CCL ca. 13.5–13.8 mm, after Hendrichsen et al., 2001) essentially similar to *R. macrotis*. The horseshoe is wide, covering muzzle and upper lip. The sella with very broad inferior surface. Connecting process is very broad-based, broadly rounded. Ears large, ca. $^1/_2$ of forearm length. Pelage soft and short but not wooly, brown above.

This bat species differs from other similar-sized horseshoe bats in the same way as *R. macrotis*. It was supposed to be a subspecies of the latter (Csorba et al., 2003). However both species were found in sympatry in Laos and, probably, in Tonkin (Hendrichsen et al., 2001; Smith, Xie, 2008). At least in the area of their sympatry, *R. siamensis* can be distinguished from R. macrotis by smaller external and cranial size and by the echolocation frequency (Francis, 2008). Meantime *R. siamensis* and *R. macrotis* from China and northern Indochina were found to be indistinguishable genetically (Francis et al., 2010).

Distribution and collecting sites. See Map 34. Known from Thailand, Laos and Vietnam (Francis, 2008). Of Vietnamese records only one from Pu Mat (Nghe An province) can be convincingly assigned to this species.

Comments on natural history. Natural history is almost unknown. Specimen in Pu Mat was captured in a large karstic cave at an altitude of 140 m a.s.l. (Hendrichsen et al., 2001). Echolocation calls in Laos were reported at 68–74 kHz (Francis, 2008).

***Rhinolophus luctus* Temminck, 1835**

Common names. Dơi lá lớn; Wooly, or Greater Eastern horseshoe bat; Гигантский подковонос.

Material studied. Eight specimens from Ha Tinh, Khanh Hoa and Dong Nai provinces.

Identification. A very large horseshoe bat (weight ca. 27–35 g; forearm ca. 65.5–80 mm; CCL ca. 14.8–16.2 mm; App. II, Table 5) of characteristic appearance. Horseshoe is wide, covering upper lip, with conspicuous notch in the middle. 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. Underparts and upper parts are almost equal in color. Noseleafs and ears are well-pigmented, blackish.

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.

Another essentially similar species, *R. beddomei*, is also mentioned for Vietnam by Dang Ngoc Can et al. (2008) though without exact locality. According to Csorba et al. (2003), *R. beddomei* distribution is restricted to India and Sri Lanka, however recently this bat was found in Thailand, far eastward of its known range (Soisook et al., 2010).

Distribution and collecting sites. See Map 35. Widely distributed through the Indomalayan region, from India and Nepal to Hainan, peninsular Thailand, Java and Borneo (Corbet, Hill, 1992; Csorba et al., 2003). In Vietnam it was reported from Bac Kan, Thai Nguyen, Vinh Phuc, Nghe An, Ha Tinh, Quang Binh, Thua Thien-Hue, Quang Nam, Binh Dinh provinces (Dang Huy Huynh et al., 1994; Hayes, Howard, 1998; Hendrichsen et al., 2001; Dang Ngoc Can et al., 2008) and Dong Nai province (Polet, Ling, 2004). Record on

Map 35. *Rhinolophus luctus.*

Con Dao Islands (Kuznetsov, An', 1992) is very questionable (Kruskop, 2011a). We found this species in Vu Quang Nature Reserve (Kuznetsov et al., 2001), on Hon Ba mountain (Borissenko et al., 2006) and in Cat Tien.

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. Multiply was found roosting in large hollow trees in Cat Tien. Echolocation calls are of high intensity with the CF component around 110 kHz.

Rhinolophus paradoxolophus (Bourret, 1951)

Common names. Dơi lá quạt; Big-leafed horseshoe bat; Большеухий подковонос.

Material studied. Two specimens from Quang Binh and Tuyen Quang provinces.

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. 18i). Sella very large (reaching antitragal lobes in height), leaf-like, with well-developed basal lappets. Internarial cup expanded, its sides forming prominent rounded leaflets.

Map 36. *Rhinolophus paradoxolophus.*

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. See Map 36. Indo-Chinese species of middle elevations. Except for Vietnam, *R. paradoxolophus* was found in Thailand, Laos and Southern China (Thonglongya, 1973; Csorba et al., 2003; Francis, 2008). In Vietnam it was reported from Sa Pa (Lao Cai province; type lo-

cality), Tuyen Quang, Bac Kan, Lang Son, Phu Tho, Thai Nguyen, Ninh Binh, Nghe An, Ha Tinh, Quang Binh and Thua Thien-Hue provinces (Hendrichsen et al., 2001; Dang Ngoc Can et al., 2008). We found this bat only in Ke Bang karstic area (Kruskop, 2000b).

Comments on natural history. Cave dweller; found in various forests, from dry deciduous to moist evergreen and pine, with limestone outcrops (Francis, 2008). The single individual captured in Ke Bang in April was netted in dense undergrowth in a primary deciduous forest. Based on ear and wing proportions, this bat could be a perch-hunter and foliage gleaner able to fly in highly-cluttered space of forest undergrowth. Echolocation signals are very low for horseshoe bats, at ca. 24–25 kHz (Francis, 2008).

Rhinolophus marshalli Thonglongya, 1973

Common names. Dơi lá Masan; Marshall's horseshoe bat; Подковонос Маршалла.

Material studied. Three individuals from Cat Ba island; the diagnosis below also follows Thonglongya (1973).

Identification. A small to medium-sized horseshoe bat (weight ca. 5.5 g.; forearm ca. 44–47 mm; CCL ca. 17 mm; App. II, Table 5) essentially similar to *R. paradoxolophus* in external appearance. Lancet reduced, broadly triangular with rounded tip. Sella very large. Internarial cup expanded, its sides forming prominent leaflets giving it trapezoid appearance and joint to the sides of sella. Ears very large with large well-definite antitragi.

Differs from *R. paradoxolophus* in smaller size and shape of sella (which is proportionally narrower) and more expanded internarial cup.

Distribution and collecting sites. See Map 37. This species distributed sporadically in Thailand, Malaya, Laos and Northern Vietnam (Corbet, Hill, 1992; Francis, 2008). In Vietnam it is known from Lao Cai, Bac Kan, Lang Son, Son La, Yen Bai, Bac Giang, Ha Nam, Hai Phong, Ninh Binh, Quang Ninh, Thanh Hoa and Nghe An provinces (Dang Ngoc Can et al. 2008). We found this bat only on Cat Ba Island (Hai Phong province).

Map 37. *Rhinolophus marshalli.*

Comments on natural history. Little data available for Vietnam. Supposedly, a cave-dwelling species (Bates et al., 2001). On Cat Ba this bat forages

in forests and over grass on forest edges; flight maneuverable and not too fast. Echolocation signal well-detectable at 45 kHz.

Suborder Yangochiroptera Koopman, 1985

General characteristics. Very diverse group, comprised by forms with adaptations towards using mainly FM echolocation and with well developed nasal branch of premaxilla. 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 both branches of Yinochiroptera. In comparison to Pteropodidae Yangochiroptera possess adaptations for echolocation as a primary way of orientation in flight, including morphology of larynx and large, well-developed tympanic bullae; also smaller eyes and well-developed interfemoral membrane should be mentioned. From Rhinolophoidea they can be easily distinguished in well-developed premaxilla and upper incisors and in lack of inflated swellings behind the nasal opening. The ears are rather complex with well-pronounced tragi and, sometimes, also antitragal lobes, their size varying from rather small to ca. forearm length. Noseleafs are characteristic for some members of the suborder, but absent in any Vietnamese species. 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. This group was initially suggested by Koopman (1985) as an infraorder of the microchiropters. It was raised to suborder level mainly as a result of genetic studies (Teeling et al., 2002; 2005) and Emballonuridae and Nycteridae were moved here from Yinochiroptera (Hutcheon, Kirsh, 2006). At present 14 families are recognized, for which grouping up to five superfamilies was suggested (Simmons, Gaisler, 1998). However multigene approach reveals three main branches within Yangochiroptera which can be accepted as three superfamilies (Hoofer et al., 2003; Teeling et al., 2005), of which two occur in Vietnam:

1. **Emballonuroidea** (nasal branch of premaxilla, though well developed, does not fused with maxilla, supraorbital processes are thing and long), with two families in South-East Asia, of which Emballonuridae is represented in Vietnam.

2. **Vespertilionoidea** (nasal branch of premaxilla fused with maxilla (at least in adults), supraorbital processes are reduced or absent), represented in

Vietnam by three of five families, namely Vespertilionidae, Miniopteridae and 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 Chiroptera 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 three (Koopman, 1994; Pavlinov et al., 1995) or two subfamilies (Simmons, 2005), 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. 142)

– Forearm length less than 62 mm. Radio-metacarpal wing pouch distinctive. Dorsal pelage brown without whitish patches..... .....*Taphozous longimanus* (p. 140)

3 Forearm 60–68 mm .....*Taphozous melanopogon* (p. 139)

– Forearm 70–76 mm ..... *Taphozous theobaldi* (p. 141)

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. 142)

– 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. 141)

– Condylocanine length not more than 21.6 mm; C–M^3 less than 9.2 mm..... ..... *Taphozous melanopogon* (p. 139), *Taphozous longimanus* (p. 140)

Genus *Taphozous* E. Geoffroy, 1818

Diagnosis. Skull on Fig. 49. Dental formula: $I^1/_2$ $C^1/_1$ $P^2/_2$ $M^3/_3 \times 2 = 30$. 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. Fourteen species are recognized, three of which have been reported from Vietnam (Dang Ngoc Can et al., 2008).

Taphozous melanopogon Temminck, 1841

Common names. Dơi bao đuôi nâu đen; Black-bearded tomb bat; Чернобородый мешкокрыл.

Material studied. Fourteen specimens from Dong Nai province and 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; App. II, Table 6). 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. See Map 38. Trans Indomalayan species with distribution ranging from eastern Pakistan to Vietnam, Malacca, Sunda and Philippine islands (Corbet, Hill, 1992). In Vietnam this bat is known from Tuyen Quang, Bac Kan, Vinh Phuc, Quang Ninh (islands of Ha Long Bay), Ninh Binh, Thanh Hoa, Nghe An, Thua Thien-Hue, Da Nang, T.P. Ho Chi Minh, Cat Ba, Phu Quoc and Con Dao Islands (Dang Huy Huynh et al., 1994; Kuznetsov, An', 1992; Vu Dinh Thong, Furey, 2008; Dang Ngoc Can et al., 2008). We found this species to be numerous in Ho Chi Minh City. There are two specimens in ZMMU collection captured by Dr. M. Kalyakin in Ma Da (Dong Nai province).

Map 38. *Taphozous melanopogon.*

Comments on natural history. Cave or house-dwellers, forming colonies from tens to several thousand individuals (Bates, Harrison, 1997). Fast-flying aerial insectivores. In Pu Mat and Cuc Phuong colonies were found in karstic caves (Hendrichsen et al., 2001). In Ho Chi Minh City small colonies of these bats inhabit crevices in buildings and attics. Mass ap-

pearance can be observed in some city blocks at ca. 5.30–5.50 PM. Newborns and pregnant females were found in the beginning of May.

Taphozous longimanus Hardwicke, 1825

Common names. Dơi bao đuôi cánh dài; Long-winged tomb bat; Длиннокрылый мешкокрыл.

Material studied. Two specimens from Soc Trang and Dac Lak provinces (ROM collection); also three specimens from Cambodia. Description below also follows Bates and Harrison (1997), Francis (2008).

Identification. A medium-sized emballonurid bat (forearm ca. 55.6–62 [54–63] mm; CCL ca. 19.2–21.6 mm). Gular sac well developed in males, represented in females by rudimentary skin fold. Dorsal color dark-brown to almost black, sometimes speckled with white. Wing membrane dark-brown, attaches to the ankle. Radio-metacarpal sack on wing moderately developed. Third metacarpal bone very long, slightly longer than forearm. Upper side of basal parts of membranes covered with short fur.

This species differs from similar-sized *T. melanopogon* by the presence of gular sac (at least in males), proportionally longer third metacarpal and place of wing membrane attachment; from *T. theobaldi* by distinctly shorter forearm and furred basal parts of membranes; from *Saccolaimus* by smaller size and presence of radio-metacarpal wing pouch.

Map 39. *Saccolaimus saccolaimus* – black dots; *Taphozous longimanus* – black squares.

Distribution and collecting sites. See Map 39. Distribution covers India, Sri Lanka, Great Sunda Islands, Flores, Bali, Malaysia, Myanmar, Thailand and Cambodia (Francis, 2008). Hendrichsen et al. (2001) and Francis (2008) did not mention this species for Vietnam. Matveev (2005) found this bat in Cambodia not far from Vietnamese border. Dang Ngoc Can et al. (2008) reported it for two Vietnamese localities: Ngoc Linh (Quang Nam province) and Can Gio; extra two unpublished localities are in the vicinity of Soc Trang and in Yok Don (publishing here by permission from Dr. Judith Eger).

Comments on natural history. This species is reported to be a very tolerant to habitat type. Through its distribution range it inhabits territories with different climate, from arid to humid, and wide variety of biotopes. It can use as day roosts caves, crevices,

building wells and hollow trees, living alone or in small colonies; sexes live together in breading season and segregate from July to September. These bats emerge early in the evening and fly very swiftly over canopies and buildings, ca. 30–60 m above the ground (Bates, Harrison, 1997).

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 examined.

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 (Corbet, Hill, 1992). Within Vietnam reported from Hoa Binh, Thua Thien-Hue, Quang Nam and Da Nang provinces and from Can Gio (Dang Huy Huynh et al., 1994; Dang Ngoc Can et al., 2008). Animals, attributable to this species, were visually observed by us in Ho Chi Minh City.

Comments on natural history. Fast-flying aerial insectivore, foraging over the canopies. Natural history essentially similar to that of *T. melanopogon*. According to Francis (2008), all known roosts were found in caves, forming colonies of over 1000 individuals. In Ho Chi Minh small colony of this species (no more than dozen individuals) was observed roosting in a technological slot of a block building.

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 ante-

Fig. 22. The throat of a male *Saccolaimus saccolaimus* showing gular sac.

riorly, 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. 22).

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. Formerly was sometimes treated as a subgenus of *Taphozous* (e.g., Corbet, Hill, 1992). Five species recognized, one of them known from Vietnam.

Saccolaimus saccolaimus (Temminck, 1838)

Common names. Dơi bao đuôi răng lớn; Pouch-bearing tomb bat; Мешкогорлый мешкокрыл.

Material studied. Five specimens from Tay Ninh and Ba Ria – Vung Tau provinces.

Identification. A medium to large emballonurid (weight ca. 31–37 g; forearm ca. 66–69 mm; CCL ca. 21.7–24.6 mm; App. II, Table 6). Gular sac present in both sexes, more prominent in males. Radio-metacarpal pouch on the wing is almost absent. Wing membrane attaches 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.

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. See Map 39. 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, on Phu Quoc Island (Dang Ngoc Can et al., 2008) and in the vicinity of Binh Chau (Ba Ria – Vung Tau province).

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). In Binh Chau were observed foraging over pasture, about 5–7 meters above the ground. 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 rut behavior, perching on individual trees and emitting social calls.

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 insect-eating 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. 23). 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**" (Menu, 1987).

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

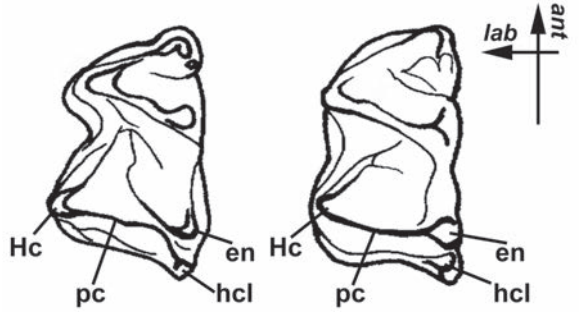


Fig. 23. Two basic types of cusp pattern of the lower molars in vespertilionid bats (first right molar). Left: nyctalodont (*Pipistrellus javanicus*) and right: myotodont (*Hypsugo pulveratus*). Hc – hypoconid, pc – postcristid, en – entoconid, hcl – hypoconulid; *ant* – anterior side, *lab* – labial side.

External appearance most variable. No leaf-like 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.

Penial bone (*os baculum*) plays significant role in Vespertilionid alfa-level taxonomy and diagnostic. It highly varies in shape within family, sometimes demonstrating morphological type common for particular genus (e.g. in *Eptesicus*) or even for several related genera (e.g. for subtribe Pipistrellina). In other cases it can be morphologically distinct in two closely related or morphologically similar species, such as in some species groups of *Myotis*. Bacular morphology in not known for all Vietnamese Vespertilionidae. That is because we may provide only general picture of morphological diversity in this structure (Fig. 25) and not incorporate it as a diagnostic feature into keys.

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.

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.

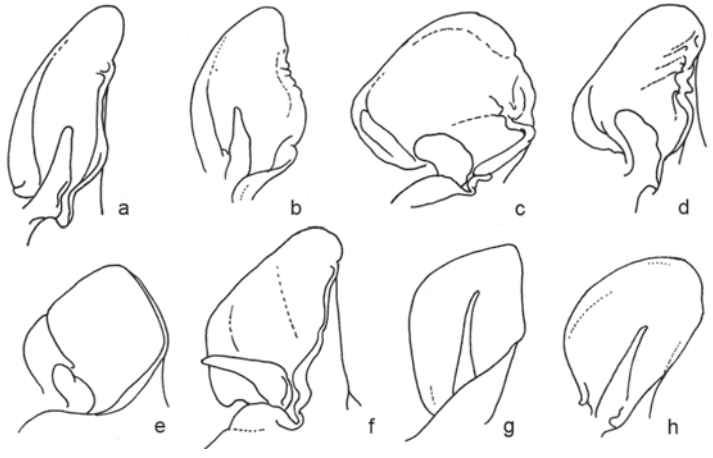


Fig. 24. Variations in ear shape in Vespertilionidae: a) *Eudiscopus denticulus*; b) *Myotis horsfieldii*; c) *Nyctalus noctula*; d) *Pipistrellus tenuis*; e) *Hesperoptenus blanfordi*; f) *Scotophilus heathi*; g) *Kerivoula picta*; h) *Murina fionae*.

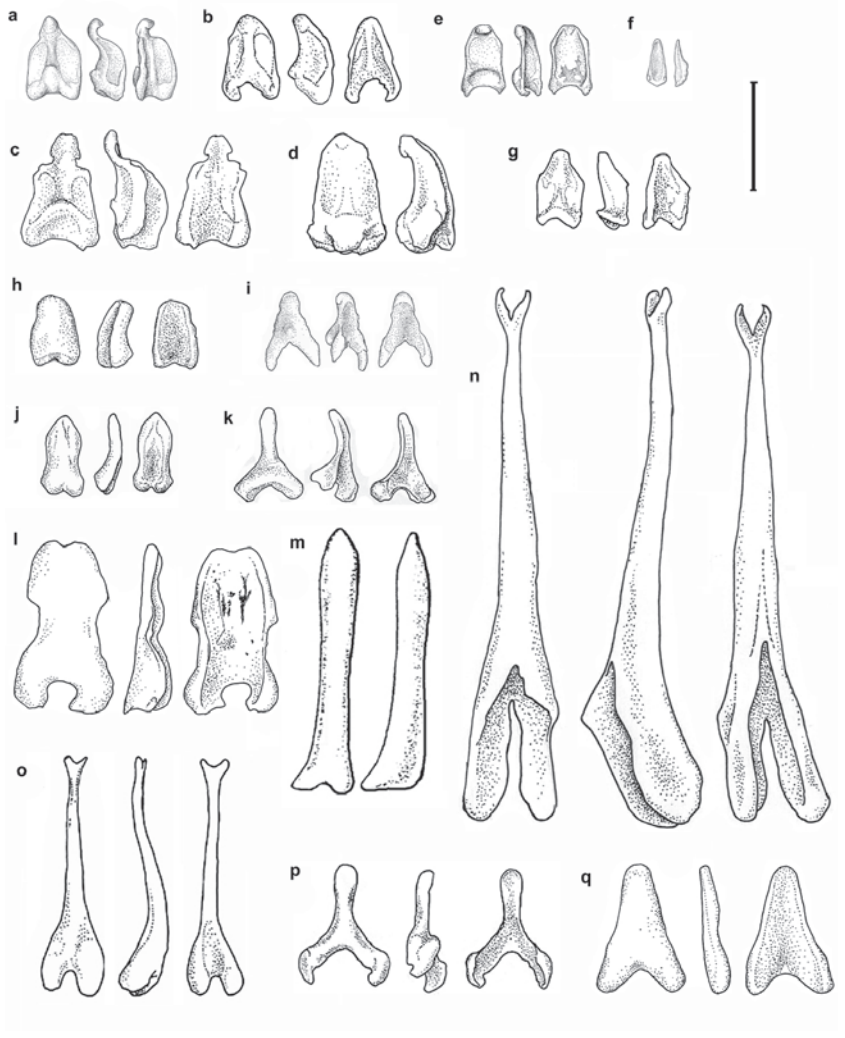


Fig. 25. Penial bone (*os baculum*) shape in selected Vespertilionid bats: a) *Myotis muricola*; b) *M. «annatessae»*; c) *M. ater*; d) *M. rosseti*; e) *M. montivagus*; f) *M. siligorensis*; g) *M.horsfieldii*; h) *M. laniger*; i) *Eudiscopus denticulus*; j) *Kerivoula hardwickei*; k) *Barbastella* cf. *darjelingensis*; l) *Scotophilus kuhlii*; m) *Hypsugo pulveratus* (after Hill, Harrison, 1978); n) *Pipistrellus coromandra*; o) *Glischropus bucephalus*; p) *Hypsugo joffrei*; q) *Eptesicus serotinus*. Scale bar 1 mm.

Taxonomical remarks. Taxonomically very complex group with ca. five subfamilies, ca. 45 genera and about 350 species, of which 57–59 species of 20 genera have been reported from Vietnam. The monotypic genus *Miniopterus* was formerly treated as a single member of its own subfamily within Vespertilionidae (e.g. Koopman, 1994) but was recently raised up to family level on the basis of morphological and genetic data (Mein, Tupinier, 1977; Tiunov, 1997; Miller-Butterworth et al., 2007). Also extralimital genus *Cistugo* was also raised up to family level and thus excluded from Vespertilionidae (Lack et al., 2010). The most problematic is the composition and taxonomic structure of the nominative subfamily. Traditionally, it was 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 division. For example, Myotini was suggested to be a separate subfamily, more close to Murininae and Kerivoulinae than to Vespertilioninae s. str. (Hoofer, Van den Busche, 2003). Genus *Eudiscopus* was provisionally allocated with Myotini.

In nominative subfamily, insufficient substantiation of the tribe Nycticeini was shown in a set of works (Menu, 1987; Hill, Harrison, 1987; Volleth, Heller, 1994), and various genera from this former taxon were united with different vespertilionine groups. At least, on the basis of karyological and molecular genetic data the nominative tribe was suggested to be divided to few different lineages (Heller, Volleth, 1984; Volleth, Heller, 1994; Hoofer, Van den Busche, 2003; Roehrs et al., 2010). Among them, lineage which includes genera *Nycticeius* and *Eptesicus* forms a sister clade to other former Vespertilionini. Thus here we are accepting three tribes within South-East Asian Vespertilioninae: Plecotini, Nycticeini (=Eptesicini) and Vespertilionini, of which the latter one can be divided into three subtribes.

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 (Fig. 24b, g, h).....**2**

– Tragus of various shape; if straight, blunt or rounded on top and commonly not narrow (Fig. 24c-e); if pointed, distinctly curved frontward (Fig. 24f).....**9**

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

– Nostrils not noticeably tubular. Interfemoral membrane not covered with fur or only at base.....**5**

3 Size larger: forearm commonly longer than 44 mm.....
.....*Harpiocephalus* (p. 177, one species, *H. harpia*)

– Size smaller: forearm commonly shorter than 44 mm.....**4**

4 Canine and both upper premolars almost equal in size (this is well seen even on alive animal) .....*Harpiola* (p. 175, one species, *H. isodon*)

– Second premolar smaller than corresponding canine..... *Murina* (p. 162)

5 Ears wide with their anterior edges very close to each other, joint at base. Nostrils on the upper side of the muzzle end .....
..... *Barbastella* (p. 201, one species, *B.* cf. *darjelingensis*)

– Ears of variable shape, but their anterior edges are always widely separated. Nostrils on lateral sides or anterior side of the muzzle end **6**

6 Ears funnel-shaped, their width subequal to their height (Fig. 24g). Height of tragus not less than $^{2}/_{3}$ of ear length. Fur soft and wooly, densely covering head and muzzle.....**7**

– 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 **8**

7 Tragus lacking notch in posterior margin. Dorsal fur with two or three color bands, hair tips usually not golden..... *Kerivoula* (p. 154)

– Tragus with distinct notch in posterior margin near base. Dorsal fur with four color bands, including pale-golden tips.....
.....*Phoniscus* (p. 160, one species, *P. jagori*)

8 Well-developed concave adhesive pads on hind feet and pads on thumb (Fig. 26a) (forearm 34–39 mm).....
.....*Eudiscopus* (p. 199, one species, *E. denticulus*)

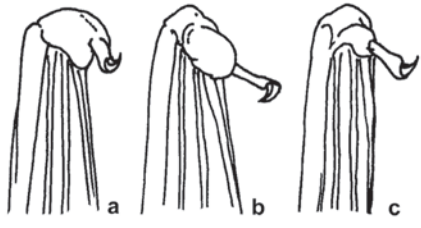


Fig. 26. Shape of the thumb pad in various representatives of Vespertilionidae: a) *Eudiscopus denticulus*; b) *Myotis rosseti*; c) *Myotis muricola*.

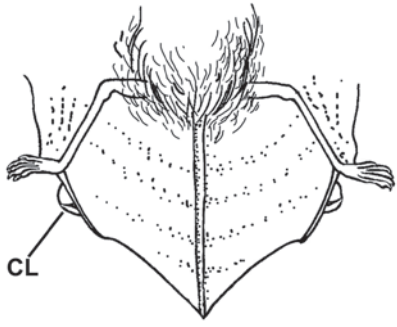


Fig. 27. Interfemoral membrane in *Hesperoptenus blanfordi*. CL – calcar lobe.

– No definite adhesive pads on feet, if present and thumb forearm less then 31 mm ..... *Myotis* (p. 178)

9 Calcar with a well-developed lobe or keel (*epiblema*), commonly possessing a transverse cartilaginous septum (Fig. 27) **10**

– Calcar lobe (epiblema) reduced or absent, if present, very narrow and without a transverse septum **13**

10 Forearm no less than 49 mm. 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. 213, one species, *N.* cf. *noctula*)

– Forearm less than 45 mm. 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 **11**

11 Tragus relatively long, its length ca. twice exceeding width. Frontal part of face more or less concave..... **12**

– Tragus short, its length subequal to width. Frontal part of face flat, without any flexure .....*Hesperoptenus blanfordi* (p. 230)

12 Well-developed not pigmented pads on the base of thumb.....
.....*Glischropus* (p. 211, one species, *G. bucephalus*)

– Adhesive pads on bases of thumbs absent; base of thumb usually well pigmented .....*Pipistrellus* (p. 203)

13 Dorsal pelage reddish with white spots on crown, back and shoulders. Forearm and metacarpals flesh-colored, membranes between them dark-brown. Tragus relatively long, curved forward.....
.....*Scotomanes* (p. 230, one species, *S. ornatus*)

– Dorsal pelage without contrast white spots. Wing has different coloration or, if similar, tragus is short and blunt and not visibly curved forward..... **14**

14 Tragus prominently deflected forward, its distal half narrower then basal, pointed.....*Scotophilus* (p. 232, two species):

14a Forearm usually less then 55 mm. Ventral pelage buffy-brown..... ..... *S. kuhlii* (p. 233)

14b Forearm always more then 55 mm. Ventral pelage with distinct yellowish tinge ..... *S. heathii* (p. 234)

– Tragus short, not definitely deflected forward, not pointed, its distal half equal in width or wider then basal **15**

15 Forearm length less then 30 mm. Head looks flattened. Distinctive adhesive pads (though not concaved) present on feet and thumb..... ..... *Tylonycteris* (p. 219, two species):

15a Pelage with distinct golden tinge, brown dorsally and pale golden-brown on throat ..... *T. pachypus* (p. 220)

15b Pelage without golden tinge, dark brown dorsally, and dull gray-brown on throat..... *T. robustula* (p. 221)

– Forearm more then 30 mm. Head not looks flattened. Usually no any adhesive pads **16**

16 Forearm not less then 70 mm ..... *Ia* (p. 224, one species, *I. io*)

– Forearm commonly less then 60 mm **17**

17 Ears with well-visible white margins. Dorsal pelage dark, tipped with cuprous-red or orange ..... *Arielulus* (p. 225, one species, *A. circumdatus*)

– Ears with no white margins. Dorsal pelage of various color, but not tipped with cuprous-red or orange **18**

18 Pale yellowish color on throat, contrast to the rest dark ventral pelage. Dorsal pelage dark-brown, tipped with mix of silver and pale-gold hairs .. .. *Thainycteris* (p. 227, one species, *T. aureocollaris*)

– Throat more or less same color as rest of ventral pelage. Dorsal fur has different color **19**

19 Forearm less then 40 mm ..... *Hypsugo* (p. 214)

– Forearm usually not less then 50 mm..... **20**

20 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. 229)

– Dorsal pelage without yellowish tinge, more or less dark, ears dark. Wings uniformly dark brown..... *Eptesicus* (p. 222, one species, *E.* cf. *serotinus*)

Cranial characters

1 Two small premolars (six cheek teeth) in each side of upper jaw (Fig. 28a–b) **2**

– No more then one small premolar (four or five cheek teeth) in each side of upper jaw (Fig. 28c–h) **4**

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 ..... **3**

– 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. 178), part.

3 Upper canine is distinctly elongated and flattened laterally, with groove on its outer surface (Fig. 29a)..... *Phoniscus* (p. 160, one species, *P. jagorii*)

– Upper canine is almost circular in cross section near base, lacking groove on outer surface (Fig. 29b) ..... *Kerivoula* (p. 154)

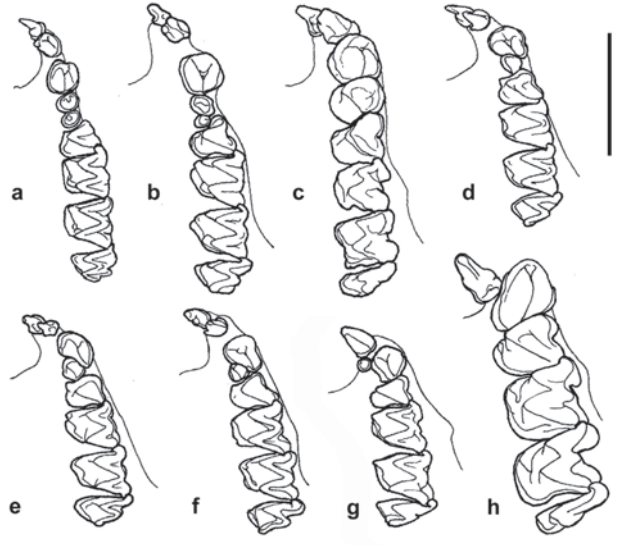


Fig. 28. Left upper toothrows in Vespertilionidae (ventral view), scale 3 mm. a) *Myotis muricola*; b) *Myotis hasseltii*; c) *Murina fionae*; d) *Pipistrellus coromandra*; e) *Glischropus bucephalus*; f) *Hypsugo pulveratus*; g) *Hesperoptenus blanfordi*; h) *Scotophilus kuhlii*.

4 Three premolars (six cheek teeth) in each side of lower jaw **5**

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

5 Second lower premolar displaced inward from the toothrow. Skull much flattened: height of braincase less then 60% of mastoid width..... ...*Eudiscopus* (p. 199, one species, *E. denticulus*)

– Second lower premolar not displaced from toothrow. Skull not flattened: height of braincase more then 70% of mastoid width .. *Myotis* (p. 178), part.

6 Skull very much flattened (Fig. 64): height of braincase ca. $^1/_2$ of mastoid width..... .... *Tylonycteris* (p. 219, two species):

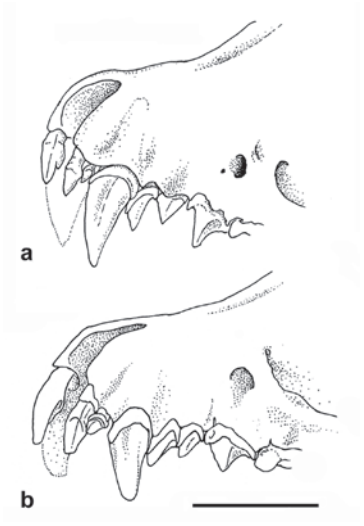


Fig. 29. Rostral and canine shape in a) *Phoniscus jagorii* and b) similar size *Kerivoula* (*K. kachinensis*) (scale bar 3 mm).

6a Nasal notch not expanded backwards to the level of infraorbital foramina. Condylo-canine length of scull less than 11 mm ..... *T. pachypus* (p. 220)

6b Nasal notch expanded backwards over the level of infraorbital foramina. Condylo-canine length of skull 12 mm or more... *T. robustula* (p. 221)

– Skull not distinctly flattened: height of braincase ca. 70% of mastoid width or more **7**

7 Two upper premolars in each side (Fig. 28c–f) **8**

– One upper premolar in each side (Fig. 28g–h) **19**

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 **15**

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 **13**

10 Anterior upper premolar distinctly smaller then posterior premolar, differs well from it in crown shape..... *Myotis* (p. 178), part.

– Anterior upper premolar (P^3) quite similar to posterior premolar (P^4) in crown shape (Fig. 28c), 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. 30a). M^3 much reduced, not exceeding $^1/_3$ of M^2 in crown width.....*Harpiocephalus* (p.177, one species, *H. harpia*)

– Upper molars with typical W-shaped crown structure (Fig. 30b). Posterior upper molar (M^3) not reduced, ca. $^1/_2$ of second molar (M^2) in width

12 Anterior upper premolar more or less smaller than posterior one, at least in crown area, and distinctly smaller than corresponding canine..... ..... *Murina* (p. 162)

– Both upper premolars are almost equal in size and shape to each other and to canine .....*Harpiola* (p. 175, one species, *H. isodon*)

13 Lower molars of nyctalodont-type (postcristid connected with hypoconulid) **14**

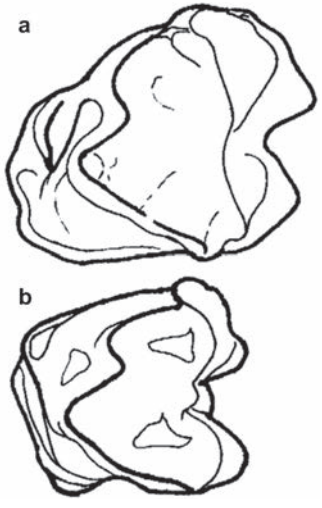


Fig. 30. First upper molars in *Murininae*: a) *Harpiocephalus harpia*; b) *Murina fionae*.

– Lower molars of myotodont-type (postcristid connected with entoconid) ....*Hypsugo* (p. 214), part

14 Outer upper incisor situated directly laterally from the inner one (Fig. 28e), all four incisors form an almost straight transverse row .....*Glischropus* (p. 211, one species, *G. bucephalus*)

– Outer upper incisor situated latero-posteriorly from the inner one ....*Pipistrellus* (p. 203)

15. Condylocanine length more than 25 mm ..... *Ia* (p. 224, one species, *I. io*)

– Condylocanine length less than 20 mm **16**

16 Lower molars of nyctalodont-type ... **17**

– Lower molars of myotodont-type..... **18**

17 Condylocanine length more than

16 mm. Rostral part of skull very massive, almost as high as anterior part of braincase ..... *Nyctalus* (p. 213, one species, *N.* cf. *noctula*)

– Condylocanine length less than 16 mm. Rostrum not massive, gradually steep to somewhat doomed braincase .... *Barbastella* (p. 201, one species, *B.* cf. *darjelingensis*)

18 Well-developed supraorbital crests protrude over the orbit profile in the shape of angular projections. Condylocanine length more than 14 mm .... *Arielulus* (p. 225, one species, *A. circumdatus*)

– Supraorbital crests poorly developed, no supra-orbital projections. Condylocanine length less than 14 mm..... *Hypsugo* (p. 214), part

19 Only one upper incisor in each side (Fig. 28h) **20**

– Two upper incisors in each side (outer incisor may be highly reduced and almost completely covered in gum) **21**

20 Anterior palatal emargination quite large and broad, extends backward to the level of upper premolars..... *Scotophilus* (p. 232, two species):

20a Larger: condylocanine length not less than 19 mm, upper toothrow ($C–M^3$) more than 7 mm ..... *S. heathii* (p. 233)

20b Smaller: condylocanine length not more than 18 mm, $C–M^3$ less than 7 mm..... *S. kuhlii* (p. 234)

– Anterior palatal emargination small and narrow, extending backwards to the level of the mid-line of upper canine .... *Scotomanes* (p. 230, one species, *S. ornatus*)

21 Outer incisor situated laterally from the inner one..... **22**

– Outer incisor situated almost directly behind the inner one (Fig. 28g)..... ..... *Hesperoptenus* (p. 229, two species):

21a Size considerably larger: upper toothrow ($C–M^3$) not less than 7 mm . ..... *H. tickelli* (p. 229)

21b Size very small: upper toothrow less than 4.5 mm.... *H. blanfordi* (p. 230)

22 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. 222, one species, *E.* cf. *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..... ..... *Thainycteris* (p. 227, one species, *T. aureocollaris*)

Genus *Kerivoula* Gray, 1842

General characteristics. Small to medium-sized vespertilionid bats with some archaic morphological features.

Diagnosis. Skull on Figs. 50–51. 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 is 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 Bismarck 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 additional one needs further substantiation.

Key to the species of Vietnamese *Kerivoula*

External characters:

1. Larger: forearm exceeds 39 mm *K. papillosa* (p. 159); *K. kachinensis* (p. 158)

– 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. 155)

– Fur on back brown or grey (hairs sometimes with russet tips), membranes more or less uniform brown. Fringe of hairs on uropatagium poorly developed **3**

3. Larger: forearm usually more than 33 mm, tibia longer than 18 mm. .... *K. titania* (p. 158)

– Smaller: forearm usually less than 34 mm, tibia less than 18 mm. ....*K. hardwickii* (p. 156)

Cranial characters

1. Larger: CBL over 15 mm, C–M^3 over 6.5 mm. **2**

– Smaller: CBL less than 14.5 mm, C–M^3 less than 6.5 mm. **3**

2. Braincase doomed, with deeply concaved frontal profile; occipital height more than 80% of mastoid width .....*K. papillosa* (p. 159)

– Braincase proportionally flattened, with shallow frontal profile (Fig. 31a); occipital height less than 70% of mastoid width.....*K. kachinensis* (p. 158)

3. Smaller: CBL less than 14 mm; C–M^3 usually less than 6 mm (5.2–6.2).. **4**

– Larger: CBL over 14 mm; C–M^3 usually over 6.2 (6.0–6.5) .... *K. titania* (p. 158)

4. Inner upper incisor noticeably bicuspid .....*K. picta* (p. 155)

– Inner upper incisor unicuspid.....*K. hardwickii* (p. 156)

***Kerivoula picta* (Pallas, 1767)**

Common names. Dơi mũi nhẵn đốm vàng; Painted bat; Пестрокрылый воронкоухий гладконос.

Material studied. Four specimens, supposedly from Vietnam; two additional specimens from extralimital 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.

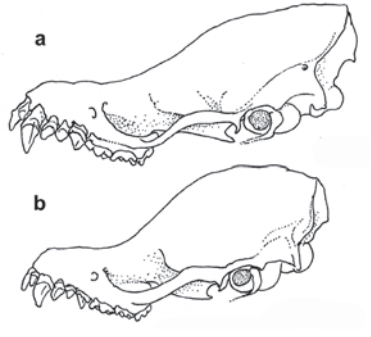


Fig. 31. Skull profiles of Kerivoula: a) *K. kachinensis*; b) *K. titania*.

Map 40. *Kerivoula picta* – gray shading, black dot; *K. kachinensis* – black squares; *Phoniscus jagorii* – black asterisks.

Distribution and collecting sites. See Map 40. Widely but sporadically distributed from southwest India and Sri Lanka to Hainan, Malacca, Great Sunda Islands and Moluccas (Corbet, Hill, 1992). In Vietnam it also has sporadic distribution being recorded in Lao Cai, Thai Nguyen, Thua Thien-Hue, Na Noi, Da Nang, Khanh Hoa, Kien Giang and Ca Mau provinces (Dang Huy Huynh et al., 1994; Dang Ngoc Can et al., 2008). We observed this species once in Yok Don (Dak Lak province), but without capture of a specimen.

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). We observed this bat in dry dipterocarp forest and noticed that dry *Dipterocarpus* leaves well resemble *K. picta* wing coloration pattern; thus they probably could be used by this bat as day roosts. 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 for ground or foliage gleaning (Kruskop, 1999).

Kerivoula hardwickii (Horsfield, 1824)

Common names. Dơi mũi nhẵn; Hardwicke's forest bat; Воронкоухий гладконос Хардвика.

Material studied. Ten adult and subadult specimens from Dong Nai and Binh Phuoc provinces and Con Dao archipelago.

Identification. A small vespertilionid (weight ca. 3.5–8 g; forearm ca. 29.6–34.6 mm; CCL ca. 11.4–13.2 mm; App. II, Table 7). In general appearance similar to *K. picta*, except for coloration pattern, and to *K. titania*. Interfemoral membrane not conspicuously haired; there is no distinct fringe of hairs on its edge. Pelage long and woolly, buff brown to dark brown above with dark grey hair basis; hairs on the belly more pale and grayish. Subadult individuals are grey. Membranes uniform brown. Skull

with moderately doomed braincase and distinctly concaved frontal profile.

Differs from *K. titania* in smaller size and more doomed braincase (though this feature is seen just during direct comparison of skulls). Similar size *K. picta* has definitely different coloration pattern; *K. papillosa* and *K. kachinensis* are distinctly larger. Small *Kerivoula* species may be occasionally confused with small *Myotis* species, like *M. siligorensis*, from which they could be distinguished by intensively haired muzzle, funnel-shaped ears and the nearly equal size of the first and second small upper premolars.

According to genetic data bats, currently referred to *K. hardwickii* actually represent a complex of cryptic species (Francis, 2008; Francis et al., 2010).

Map 41. *Kerivoula hardwickei.*

Distribution and collecting sites. See Map 41. Widely distributed from southern India and Sri Lanka to south and eastern China, Vietnam, Malaysia, Sunda and Philippine Islands (Corbet, Hill, 1992). Most widespread species of Vietnamese *Kerivoula*. It is known from Dak Lak (Dang Huy Huynh et al., 1994), Nghe An (Hayes, Howard, 1998), Lai Chau, Tuyen Quang, Lang Son, Thai Nguyen, Vinh Phuc, Ninh Binh, Thanh Hoa, Thua Thien-Hue, Kon Tum, Binh Dinh, Gia Lai, Dong Nai (Dang Ngoc Can et al., 2008) and Ba Ria–Vung Tau (Vu Dinh Thong et al., 2010) provinces.

Comments on natural history. Natural habits in Vietnam not well 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), hollow trees and in foliage (Francis, 2008). In Vietnam animals were netted in various types of pristine and secondary forests in the altitude range from 30 to 1600 m a.s.l., sometimes over the forest roads (Hendrichsen et al., 2001; orig.). On Con Son island all individuals were captured over a small artificial water pool, matching importance of the water source for this species. As in other *Kerivoula* species flight is highly maneuverable, but not fast. Judging by wing morphology, it may be a ground or foliage gleaner (Kruskop, 1999; Kruskop, 2010b).

Kerivoula titania Bates, Struebig, Hayes, Furey, Khin Mya Mya, Vu Dinh Thong, Pham Duc Tien, Nguyen Truong Son, Harrison, Francis & Csorba, 2007

Common names. Dơi mũi nhắn lớn; Titania's woolly bat; Воронкоухий гладконос Титании.

Material studied. One specimen from Khanh Hoa province; the diagnosis below also follows Bates et al. (2007) and Francis (2008).

Identification. A small vespertilionid (weight ca. 4–8 g; forearm ca. 32.4–36 mm; CCL ca. 13.4–13.9 mm). In general appearance resembles *K. hardwickii* and extralimital *K. flora* (with which it was once confused; see Hendrichsen et al., 2001; Borissenko et al., 2006). Interfemoral membrane not conspicuously haired, without fringe of hairs on its edge. Pelage brownish-grey, with blackish bases and pale middles of individual hairs. Membranes are translucent grey. Skull moderately doomed.

This species can be distinguished from *K. hardwickii* s. lato by larger overall size and larger skull. It differs from *K. picta* in coloration pattern, from *K. papillosa* and *K. kachinensis* in definitely smaller size.

Distribution and collecting sites. See Map 42. Widely distributed in South-East Asia: Myanmar, Laos, Thailand, Cambodia and Vietnam. In Vietnam was reported for Ba Be and Kim Hy (Bac Kan province), Ben En (Thanh Hoa province), Pu Mat and Pu Huong (Nghe Anh province), Dak Rong (Quang Tri province), Kon Ka Hinh (Gia Lai province) (Dang Ngoc Can et al., 2008) and Hon Ba (Kanh Hoa province; as *K.* cf. *flora* – Borissenko et al., 2006).

Map 42. *Kerivoula titania* – gray shading; *K. papillosa* – black squares.

Comments on natural history. Found in evergreen forests, both primary and secondary, often near limestone and rivers, in the elevation range from 260 to 1600 m a.s.l.. Specimen from Hon Ba was netted over a brook, flying at 1–1.5 m above the water (Borissenko et al., 2006).

Kerivoula kachinensis Bates, Struebig, Rossiter, Kingston, Sai Sein Lin Oo & Khin Mya Mya, 2004

Common names. Dơi mũi nhẵn Mi-an-ma; Kachin woolly bat; Качинский воронкоухий гладконос.

Material studied. One specimen from Binh Phuoc province; the diagnosis below also follows Bates et al. (2004).

Identification. A medium-sized vespertilionid (weight ca. 6.5–9.5 g; forearm ca. 40.1–43.2 mm; CCL ca. 14.8–16.1 mm; Soisook et al., 2007). Interfemoral membrane not conspicuously haired. Fur above long and woolly, grey-brown with dark-grey bases; belly slightly paler. Membranes uniform dark grey-brown. Ears moderately large, semi-translucent. Muzzle pale pinkish-brown, covered with fur except for nostrils. Skull characteristically flattened, with very scarcely concaved frontal profile (Fig. 31a); occipital height counts only 63–71% of mastoid width (Soisook et al., 2007).

Externally this species can be easily confused with similar-sized *K. papillosa*, from which it differs by the skull shape. All other Vietnamese *Kerivoula* are definitely smaller. Differs from the remainder Vietnamese *Kerivoula* by larger size. From medium-sized *Myotis* differs clearly in skull shape, relative size of small upper premolars, shape of ears and muzzle.

Distribution and collecting sites. See Map 40. Known from Myanmar, Thailand, Laos and Vietnam. In the latter was found for the first time in Chu Mom Ray NP and Muong Muon, Kon Tum and Lai Chau Provinces (Vu Dinh Thong et al., 2006). Also reported from Pu Huong, Nghe Anh Province (Dang Ngoc Can et al., 2008) and Bu Gia Map, Binh Phuoc Province (Kruskop, 2010a, b).

Comments on natural history. Confined to evergreen forests on middle elevation, often with bamboo growth (Bates et al., 2004; Soisook et al., 2007; Kruskop, 2010b). Specimen from Bu Gia Map was netted over the road passing through bamboo forest. Flat braincase suggests that this species use some narrow crevices as day roosts (Bates et al., 2004). Females give births most probably in the end of April. Echolocation calls are low intensity and short duration FM with peak frequency at ca. 124 kHz (Soisook et al., 2007).

Kerivoula papillosa Temminck, 1840

Common names. Dơi mũi nhẵn Java; Papillose bat; Яванский воронкоухий гладконос.

Material studied. Two adults from Binh Phuoc and Dong Nai Provinces; also two specimens of *K. papillosa* and one specimen of *K.* cf. *lenis* from Malaysia (ROM collection). The diagnosis below also 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 uniform brown.

Differs from the remainder Vietnamese *Kerivoula* by larger size. Overlap in external measurements with *K. kachinensis* from which differs easily by more bulbous braincase. 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.

Indian woolly bat, *K. lenis*, is very similar in general appearance and overlaps in external dimensions, but has smaller skull (CCL ca. 14.5–15.1; C–M^3 ca. 6.6–6.8; Bates et al., 2004). This species is not currently known for Vietnam (Francis, 2008). However available genetic data (Bates et al., 2007; Francis et al., 2010) suggest that the border between *K. papillosa* and *K. lenis* in South-East Asia is not clear and there is a huge possibility of new findings as well as misidentifications.

Distribution and collecting sites. See Map 42. This bat has disrupted distribution area which includes 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 Dak Lak (Dang Huy Huynh et al., 1994), Tuyen Quang, Nghe An, Thua Thien–Hue and Dong Nai (Dang Ngoc Can et al., 2008) provinces. We found this bat in Bu Gia Map (Binh Phuoc province; Kruskop, 2010a)

Comments on natural history. A forest-dwelling species; roosts in small hollows within alive trees (Francis, 2008). Natural history in Vietnam virtually unknown.

Genus *Phoniscus* Miller, 1905

General characteristics. Small vespertilionid bats, similar to *Kerivoula* in external appearance, but with different tooth shape.

Diagnosis. Skull on Fig. 52. Dental formula: $I^2/_3$ $C^1/_1$ $P^3/_3$ $M^3/_3 \times 2 = 38$. Upper small premolars (P2–3) have similar size and about 2/3 of the posterior premolar. All three lower premolars are more or less similar in size. Upper canine is large and strong, with longitudinal grooves on its outer surface. Lower molars with talonid and trigonid almost equal in size or talonid slightly larger. Braincase somewhat doomed. Ear funnel-shaped, with emargination on posterior edge close to ear tip. Tragus narrow and pointed, with distinct basal notch on posterior edge, whitish in contrast to well-pigmented ear conch. Fur thick and fluffy, with four color zones, tipped with gold over the wide dark band.

Distribution. Sporadic distribution from Peninsular Malaysia through Sunda Islands to the Philippines, New Guinea and East Australia; also Laos and Vietnam (Corbett, Hill, 1992; Simmons, 2005; Vu Dinh Thong et al., 2006).

Natural history. Inhabit mainly primary forests on middle elevations. Foraging habits seems to be similar to that of *Kerivoula*.

Taxonomical remarks. Four species are currently recognized, one of them occurs in Vietnam.

Phoniscus jagorii Peters, 1866

Common names. Dơi tai loa kèn; Peters's trumpet-eared bat; Воронкоухий гладконос Ягора.

Material studied. One adult female from Dong Nai province; also three specimens from extralimital territories, including the holotype (in the ROM and ZMB collections).

Identification. A small vespertilionid bat (mainland specimens have weight of ca. 5.8–8 g, forearm ca. 35–38 mm, CCL ca. 14.4–15.3 mm; Robinson, Webber, 2000; Vu Dinh Thong et al., 2006; orig.), in general appearance greatly similar to *Kerivoula* species. Pelage long, thick and fluffy, with four color zones on the upperparts: individual hairs have blackish basal half, followed by pale band and black band and then tipped with orange. Limbs along bones (including calcar) are covered with orange hairs. Tragus is narrowly pointed, whitish or pinkish in contrast to brown main part of ear. Upper canine large and somewhat flattened laterally. Upper incisors with pointed cusps, outer one about twice smaller than inner, compressed to canine. Anterior upper premolar large, almost equal to posterior, middle premolar somewhat shorter than anterior, bat equal in crown area. Lower premolars large, equal in size, with somewhat elongated bases.

This bat can be distinguished from all *Kerivoula* species by four color bands on pelage and by very massive upper canines. In pelage coloration it somewhat resembles *Harpiola isodon* and *Murina harpioloides*, from which it easily differs by larger size, and not tubular nostrils.

Distribution and collecting sites. See Map 40. Sporadic distribution covers Java, Borneo, Sulawesi, Lesser Sunda Islands, the Philippines, Malayan peninsula and Indochina (Simmons, 2005). In Vietnam known from Xuan Son (Phu Tho province; Vu Dinh Thong et al., 2006) and from Cat Tien (Dong Nai province; our data).

Comments on natural history. Inhabiting lowland evergreen and dry dipterocarp forests; presence of karst in the area probably preferable (Robinson, Webber, 2000; Vu Dinh Thong et al., 2006; Francis, 2008). Xuan Son speci-

men was captured over the path in semi-evergreen forest with elevation 400 m a.s.l. (Vu Dinh Thong et al., 2006). Cat Tien specimen was netted near the small water source surrounded by secondary growth from one side and from another side by seasonally flooded low-canopy forest (Kruskop, 2011b). Flight is very maneuverable, sometimes close to ground. Echolocation calls are low intensity FM at 77–140 kHz, with peak frequency at ca. 88 kHz (Vu Dinh Thong et al., 2006).

Genus *Murina* Gray, 1842

General characteristics. Small to medium-sized vespertilionid bats with tubular nostrils and dense wooly pelage.

Diagnosis. Skull on Fig. 53–54. 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 is bicuspidate. Upper molars with variably reduced mesostyles, but always with distinctive W-shaped pattern of ectoloph

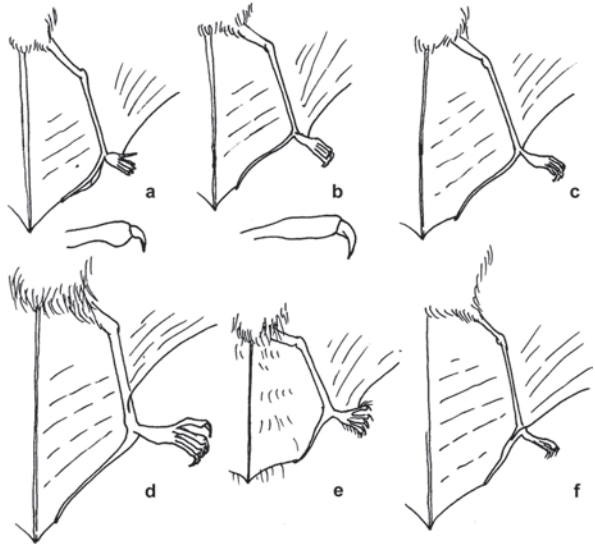


Fig. 32. Variations in hind foot proportions and the pattern of attachment of the wing membrane in Vespertilionidae and Miniopteridae: a) *Myotis muricola*; b) *Myotis horsfieldii*; c) *Myotis hasseltii*; d) *Myotis ricketti*; e) *Murina harpioloides*; f) *Miniopterus magnater*.

(Fig. 30b). 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. 32e). 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 often completely covering the upper surface of the interfemoral membrane and hind limbs up to the toes.

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. Number of species is very questionable: more than dozen of species were newly described or revealed by revisions of collection material in only last decade (Csorba et al., 2007; Kruskop, Eger, 2009; Kuo et al., 2009; Csorba et al., 2011; Eger, Lim, 2011; Francis, Eger, 2012), about twice increasing genus content. Meantime it was understood that traditional deviation into two major species groups (“*cyclotis*” and “*suilla*” groups sensu Koopman, 1994) has no support from genetic data (Francis et al., 2010). *Harpiola* formerly was treated as a subgenus of *Murina*; recently it was raised to full genus (Bhattacharyya, 2002; Kuo et al., 2006). At least eleven species can be recognized in Vietnamese fauna, though taxonomic position of some of them needs revision and some new undescribed forms may be revealed.

Identification keys to Vietnamese *Murina*

1 Fur coloration does not includes any yellow, reddish or brown **2**

– Fur coloration includes variety of brownish, yellowish or reddish colors **3**

2 Dorsal pelage is ashy-gray; less than half of hairs at basis are blackish. Smaller: CCL is 14.3 or less ..... *M. feae* (p. 170)

– Dorsal pelage looks blackish; hair basis are blackish on distinctly more than half of hair length. Larger: CCL 14.5 or more .. *M. beelzebub* (p. 171)

3 Size larger: forearm not less than 33.5 mm (usually exceed 35 mm), CCL more than 15.5 mm. 4

– Size smaller: forearm less than 34 mm, CCL 15,5 mm or less **7**

4 Well-defined contrast between upper- and underparts: first are reddish or bright-brown, latter are white or yellow. Forearm 36 mm or more. Dentition looks gracile and proportionally small, tooth rows are convergent anteriorly. Postorbital constriction is 5 mm or wider ..... *M. leucogaster* (p. 171)

– Pelage coloration is not contrast; underparts are slightly paler than upperparts. Forearm usually less than 37 mm. Dentition looks robust; tooth rows are sub-parallel. Postorbital constriction width less than 5 mm..... **5**

5 Talonid on m1–2 twice smaller than trigonid; hypoconulid almost absent.. ..... *M. fionae* (p. 166)

– Talonid on m1–2 only slightly smaller than trigonid; hypoconulid present though joint to entoconid ("murinodont" type of dentition) **6**

6 Underparts are grayish-brown; coloration in general looks dull. Frontal profile of skull concaved; occipital height less than 6.6 mm .... *M. huttoni* in part (p. 167)

– Underparts are pale? Reddish, or brownish; coloration in general looks more bright. Frontal profile of skull more or less straight; occipital height more than 6.5 mm ..... *M. harrisoni* (p. 168)

7 Talonid on m1–2 twice smaller than trigonid; hypoconulid almost absent.. ..... *M. cyclotis* (p. 165)

– Talonid on m1–2 no only somewhat smaller than trigonid..... **8**

8 Dorsal pelage looks bicolored: very dark underfur is covered with shiny golden guard hairs. Tubular nostrils noticeably long, their length exceeds their thickness..... **9**

– Dorsal pelage reddish or brown and does not looks bicolored. Length of tubular nostrils does not exceeds their thickness **10**

9 Muzzle tip, nostrils and ear edges are blackish. Guard hairs with orange tinge. Ear with small emargination on posterior edge..... ..... *M. harpioloides* (p. 173)

– Muzzle tip and ears are more pale, brownish. Guard hairs are more yellowish than ornge. Ear almost without emargination on postatior edge .... *M. chrysochaetes* (p. 174)

10 Size very small: forearm usually less than 30 mm, CCL less than 13.1 mm. Canine small, subequal to P4 in height. ..... *M. eleryi* (p. 172)

– Size larger: forearm usually over 30 mm, CCL over 13 mm. Canine of moderate size, higher than large premolar (P4). **11**

11 Ear with distinct posterior emargination. Pelage with pale hair basis; ventral fur almost white. P2 twice shorter than P4 ..... *M. walstoni* (p. 175)

– Ear with smoothly convex posterior border, or with just vestigial emargination. Pelage with dark hair basis, ventral pelage brownish or grayish. P2 equal to P4 in height or only slightly shorter **12**

12 Size larger: CCL more than 14.6 mm..... *M. huttoni* in part (p. 167)

– Size smaller: CCL less than 14.5 mm .....*M. annamitica* (p. 169)

Murina cyclotis Dobson, 1872

Common names. Dơi ống tai tròn; Round-eared tube-nosed bat; Круглоухий трубконос.

Material studied. Eleven specimens from Binh Phuoc, Lam Dong, Ba Ria – Vung Tau, Vinh Phuc, Tuyen Quang and Quang Nam provinces; one specimen from unknown locality in Northern Vietnam (ZMB); also thirteen specimens from other parts of Indochina and from China (in ROM and GNHM collections).

Identification. A small to medium-sized vespertilionid bat (weight ca. 6–11 g, forearm ca. 29.3–34.7 mm, CCL ca. 13.9–15.5 mm; App. II, Table 7), of typical appearance. Fur dense and wooly, reddish-brown to orange on upperparts and pale brownish-gray with distinctly darker roots on the belly. Wing membranes grayish-brown. Ears and muzzle pale. Ears of medium size, ca. 13–15 mm in length, and widely rounded, lacking any emargination on posterior border. Dentition with characteristically reduced mesostyles on the upper molars. Talonids on lower molars are twice smaller than trigonids; hypoconulid virtually absent and postcristid joint to a single small entoconid. Anterior and posterior premolars in each jaw almost equal in size.

This species is very similar in general appearance and dentition structure to *M. fionae* and extralimital *M. peninsularis*, which are noticeably larger. From *M. huttoni* it could be distinguished by more rounded ears and peculiar dentition. From *M. tiensa* it could be distinguished by dental characters and smaller overall size. From *Harpiocephalus* it differs in smaller overall size and less reduced crown structures on molars.

Distribution and collecting sites. See Map 43. 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). One of the most widespread *Murina* in Vietnam: it was found in Lai Chau (Osgood, 1931), Nghe An

Map 43. *Murina cyclotis* – gray shading, black dot; *M. fionae* – black squares.

(Hayes, Howard, 1998), Quang Binh (Timmins et al., 1999), Gia Lai, Ninh Binh (Hendrichsen et al., 2001), Binh Phuoc (Kruskop, 2010a), Lao Cai (Kruskop, Shchinov, 2010), Tuyen Quang, Bac Kan, Lang Son, Phu Tho, Thai Nguyen, Thanh Hoa, Quang Tri, Thua Thien-Hue, Quang Nam, Kon Tum, Binh Dinh, Dak Lak and Lam Dong provinces (Dang Ngoc Can et al., 2008), Ba Ria – Vung Tau province (orig.), in Can Gio, on Cat Ba Island (Thong, Furey, 2008) and Bai Tu Long archipelago (Vu Dinh Thong et al., 2010). Report from Ke Bang (Kruskop, 2000b) was based on misidentification of *M. fionae*.

Comments on natural history. Extralimitally this bat is confined to forests, and 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.). In Vietnam it was found in various types of forests, including highly disturbed growth in vicinity of villages; also in submontane forests at elevations from 150 to 1620 m a.s.l. (Hendrichsen et al., 2001). Two specimens were netted over the stream in bamboo forest in Bu Gia Map (Binh Phuoc province) at elevation of ca. 530 m a.s.l. (our data).

Murina fionae Francis, Eger, 2012

Common names. Dơi mũi ống lớn; Fiona's tube-nosed bat; Трубконос Фионы.

Material studied. Two specimens from Quang Nam and Quang Binh provinces; also two specimens from Laos (holotype and paratype, ROM) were examined.

Identification. A relatively large tube-nosed bat (weight ca. 7 g, forearm ca. 34.4–39.6 mm, CCL ca. 15.7–17.2 mm), of typical appearance. Fur dense and wooly, reddish-brown on upperparts and somewhat paler and duller on the belly. Wing membranes grayish-brown. This bat looks very similar to M. cyclotis including rounded ear shape and very specific dentition structure, besides it is larger and more dull-colored.

From similar-size *M. huttoni* and *M. harrisoni* it could be distinguished by more rounded ears and peculiar dentition. From *M. leucogaster* it is easily differ by coloration pattern and by dental characters, including more massive

teeth. From *Harpiocephalus* it differs in less reduced crown structures on molars and duller coloration.

Distribution and collecting sites. See Map 43. Described from Laos; in Vietnam is known from Quang Nam and Quang Binh provinces (Francis, Eger, 2012). Distribution in Vietnam as well as in other countries poorly known; probably also occurs in Cambodia. It seems possible that some localities associated with *M. cyclotis* could actually belong to this species, as it was already found for Ke Bang (Quang Binh).

Comments on natural history. Life history is not well known. Specimen in Ke Bang was netted in riverine forest over small backwater in the late evening (Kruskop, 2000b). The holotype was captured in evergreen hill forest at altitude 1140 m a.s.l. (Francis, Eger, 2012).

Murina huttoni (Peters, 1872)

Common names. Dơi mũi ống; Hutton's tube-nosed bat; Трубконос Хаттона.

Material studied. Six specimens from Khanh Hoa, Lao Cai, Dak Lak and Quang Nam provinces (the latter are in ROM collection); also seven specimens from China in ROM collection were examined.

Identification. A small to medium-sized tube-nosed bat (weight ca. 5.9–6.5 g, forearm ca. 32.7–36.5 mm, CCL ca. 14.7–16.1 mm; App. II, Table 7), in general appearance similar to *M. cyclotis*. Ears more slender and long, ca. 15–16 mm, lacking posterior emargination. Pelage coloration brown above and pale below, with dark hair roots. Dentition massive, with somewhat less reduced mesostyles on the upper molars than in *M. cyclotis* and *M. peninsularis* and with relatively large talonids on lower, comparable in size to corresponding trigonids. Anterior upper premolar proportionally smaller, about 2/3 of posterior one.

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. feae* it differs in fur coloration, ear shape, proportions of skull and dentition.

Map 44. *Murina huttoni* – gray shading, black dot; *M. chrysochaetes* – black square; *M. harpioloides* – open square.

Distribution and collecting sites. See Map 44. 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 Dang Huy Huynh et al. (1994) for Buon Ma Thuot (Dak Lak province). Dang Ngoc Can et al. (2008) mention this bat for Quang Ninh and Gia Lai provinces. Also known in Vietnam from Quang Nam, Khanh Hoa (Borissenko et al., 2006; erroneously as *M. tubinaris*) and Lao Cai (Kruskop, Shchinov, 2010) provinces and from Bai Tu Long Islands (Vu Dinh Thong et al., 2010).

Comments on natural history. Supposed to be confined to forested middle elevations (Smith, Xie, 2008). Vietnamese specimens were captured in primary mountainous and riverine forests at elevations from 1500 to 1900 m a.s.l. (Hendrichsen et al., 2001; Borissenko et al., 2006; Kruskop, Shchinov, 2010).

Murina harrisoni Csorba, Bates, 2005

Common names. Dơi mũi ống tien sa; Fairy tube-nosed bat; Трубконос-фея.

Material studied. Six specimens from Bac Kan (including paratype of *M. tiensa* from Kim Hy; collection of HNHM) and Dak Lak provinces; also three specimens from China (ROM collection).

Identification. A large tube-nosed bat (forearm 33.6–40.1 mm, CCL ca. 15.3–17.8 mm), in general appearance akin large *M. huttoni*. Ears relatively slender and long, 15.6–17.2 mm (Csorba et al., 2007), without posterior emargination or with small one close to ear base. Dorsal pelage uniformly yellowish-red to reddish-brown without definite color banding; ventral pelage is uniformly dirty-white or pale-orange. Skull not doomed, with relatively graduate frontal profile. Dentition robust, tooth rows are almost parallel. Anterior upper premolar about same height as posterior one.

This species was previously confused with *M. huttoni* (Hendrichsen et al., 2001). Border between these two species still not obvious; *M. harrisoni* is usually larger and possess more bright reddish coloration and more reduced mesostyles on upper molars. From *M. cyclotis* it differs in longer ears, larger skull measurements and structure of lower molars (trigonid/talonid ratio). From *M. leucogaster* it differs in coloration pattern and distinctly more robust skull and dentition. From *Harpiocephalus* it can be distinguished by less reduced crown structure on molars and less robust skull.

This bat was mentioned in latest scientific literature mainly as *M. tiensa* (Dang Ngoc Can et al., 2008; Vu Dinh Thong et al., 2011) while *M. harrisoni* thought to be Cambodian endemic. However latest studies have shown these two to be conspecifics (Francis, Eger, 2012).

Distribution and collecting sites. See Map 45. This bat has sporadic distribution in Cambodia, Laos, Thailand, eastern Myanmar, Southern China and Vietnam (Francis, Eger, 2012). In Vietnam it is known from Bac Kan, Nghe Anh (Csorba et al., 2007), Dak Lak (orig.), Phu Tho, Son La provinces, Cat Ba and Bai Tu Long Islands (Vu Dinh Thong et al., 2010; 2011).

Comments on natural history. Life history poorly known. Specimens from Kim Hy and Pu Mat were captured in variably disturbed evergreen submontane forest (Csorba et al., 2007).

Map 45. *Murina harrisoni* – gray shading; *M. annamitica* – black squares.

Murina annamitica Francis, Eger, 2012

Common names. Dơi mũi ống Trường Sơn; Annamite tube-nosed bat; Крупнозубый малый трубконос.

Material studied. Three specimens from Binh Phuoc, Quang Nam and Lam Dong provinces; also three specimens from Laos (ROM collection).

Identification. A small tube-nosed bat (weight ca. 4.3, forearm ca. 29.7–31.2 mm, CCL ca. 14.1–14.5 mm), in general appearance similar to *M. eleryi* and extralimital *M. aurata*. Ears rounded ca 14 mm, with poorly developed posterior emargination. Pelage coloration uniformly reddish-brown above; ventral part is dirty-whitish with dark-brown hair roots. Naked facial parts, ears (except for ear bases) and wing membranes are brown. Dentition relatively robust; maxillary tooth rows are subparallel. Talonids on m1–2 not reduced, equal to corresponding trigonids. Anterior upper premolar subequal to posterior one.

This species can be divided from *M. cyclotis* by structure of lower molars (trigonid/talonid ratio). From *M. eleryi* it differs in somewhat duller pelage coloration, more robust teeth and canines which exceed corresponding posterior premolars in height. From *M. feae* it can be easily distinguished by fur coloration.

Distribution and collecting sites. See Map 45. Poorly known. Was described from Laos; in Vietnam it was reported for Quang Nam and Binh Phuoc provinces (Francis, Eger, 2012). We found this bat in Bu Gia Map, Binh Phuoc province (Kruskop, 2010a) and in Loc Bao, Lam Dong province.

Comments on natural history. Almost not known. In Bu Gia Map single female was netted over the small stream in palm-bamboo forest at ca.

500 m a.s.l.. In Loc Bao specimen was captured over the trail in tall primary forest at ca. 650 m. a.s.l.

Murina feae (Thomas, 1891)

Common names. Dơi mũi ống lông chân; Ashy-gray tube-nosed bat; Пепельный трубконос.

Material studied. Two specimens from Quang Nam province; also twelve specimens from Laos and S. China (all in ROM collection).

Identification. A small tube-nosed bat (forearm ca. 28.4–32.4 mm, CCL ca. 13.3–14.4 mm). Ears relatively short and broad, lacking emargination on posterior border. Pelage thick and soft, ashy-gray above, pale gray with dark gray roots on the underparts. Dentition relatively gracile; tooth rows are slightly convergent anteriorly. Anterior upper and lower premolars conspicuously smaller than correspondent posterior premolars. Talonids of lower molars are similar in size with trigonids.

This species can be mixed with *M. beelzebub* because both bats lack any shades of yellow, brown or red in coloration; *M. feae* can be distinguished by smaller size, conspicuously lighter pelage coloration and outer upper incisor which is somewhat lower than inner one (Csorba et al., 2011). From similar-sized *M. cyclotis* and *M. huttoni* it differs in smaller skull dimensions, dental structure and fur coloration. From the generally similar *M. eleryi* it differs in larger size, pelage coloration pattern and more long canines exceeding in height corresponding posterior premolars.

Map 46. *Murina feae* – grayshading; *M. beelzebub* – black dots.

This bat was formerly treated as a part of *M. tubinaris* (Corbet, Hill, 1992; Hendrichsen et al., 2001; Borissenko, Kruskop, 2003). After reinvestigation of the *M. tubinaris* type material from Pakistan it was described as a separate species under the name *M. cineracea* (Csorba et al., 2011). Further studies of old collections have shown that name "*cineracea*" is a junior synonym of *M. feae* (Francis, Eger, 2012).

Distribution and collecting sites. See Map 46. Sporadically from northern India to Thailand and Vietnam (Corbet, Hill, 1992; but see Csorba et al., 2011). Was reported by Dang Huy Huynh et al. (1994) for Dak Lak Province; known from Lai Chau (Hendrichsen et al., 2001), Thanh Hoa, Nghe Anh, Tai Nguyen, Bak Kan, Kon Tum, Son La, Phu To,

Thua Thien-Hue and Ha Tinh (Csorba et al., 2011) Provinces. Dang Ngoc Can et al. (2008) also reported this bat Binh Dinh and Quang Nam; record from Kon Ka Kinh (Gia Lai) probably should be referred to *M. beelzebub*.

Comments on natural history. Despite extensive distribution, natural history is poorly known. Confined to forested mountainous areas with altitude range from 340 to 1250 m (Csorba et al., 2011); in Pu Mat single animal was captured in secondary growth in river valley (Hendrichsen et al., 2001).

Murina beelzebub Son, Furey, Csorba, 2011

Common names. Dơi mũi ống lông đen; Black tube-nosed bat; Черный трубконос.

Material studied. No material was seen; description is based on (Csorba et al., 2011).

Identification. A medium-size tube-nosed bat (forearm ca. 33.7–36.3 mm, CCL ca. 14.5–15.0 mm). Ears are relatively short and broad, smoothly rounded without emargination. Pelage thick and soft, very dark-gray, almost black, with whitish hair tips on the ventral side. Tooth rows are slightly convergent anteriorly. Anterior upper and lower premolars twice smaller than correspondent posterior premolars.

This species can be mixed with *M. feae* because of lacking any yellow, brown or red shades; *it* can be distinguished by larger size, very dark pelage coloration and equal height of outer and inner upper incisors (Csorba et al., 2011). From all similar-size *Murina* species as well as from *Harpiocephalus* it differs first of all by very specific coloration and also by less robust dentition.

This bat was formerly treated as a part of *M. tubinaris* (Hendrichsen et al., 2001).

Distribution and collecting sites. See Map 46. Known only from Quang Tri (type locality) and Gia Lai Provinces (Csorba et al., 2011).

Comments on natural history. Poorly known; in Kon Ka Hinh was found in primary forest at elevation of 1600 m a.s.l. (Hendrichsen et al., 2001).

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; ten adult specimens from China were studied (collections of ROM and SDM).

Identification. A medium-sized vespertilionid bat (weight ca. 7–13 g, forearm ca. 36–44 mm, CCL ca. 15.1–16.6 mm). Fur dense and ruffled, reddish-brown to orange on upperparts (however some color variations may be found)

Map 47. *Murina eleryi* – gray shading; *M. walstoni* – black dots; *M. leucogaster* – black squares.

and very pale on the belly, with almost equal coloration between hair roots and tips. Wing membranes grayish-brown. Muzzle dark. Ears are relatively short and wide, broadly rounded on tips, with conspicuous emargination on posterior border. Dentition, compared to that of similar-size species, is relatively light and gracile. Anterior upper premolar greatly smaller than posterior one. Mesostyles on upper molars present. Talonids on lower molars smaller than corresponding trigonids. Skull is variably doomed, without sagittal crest or with weak one.

From other similar size *Murina* species (*M. harrisoni, M. peninsularis*), this bat can be distinguished by contrast pale underparts and more light dentition. From *Harpiocephalus* it differs in gracile rostral part of skull and less reduced tooth structures (in particular – mesostyle). All other Vietnamese tube-nosed bats are distinctly smaller.

Distribution and collecting sites. See Map 47. Disrupted distribution from North-East India through eastern and southern China to Thailand and Vietnam (Simmons, 2005). In Vietnam is known only from two localities in Nghe An province (Hendrichsen et al., 2001; Dang Ngoc Can et al., 2008).

Comments on natural history. Single female was captured in Pu Mat over the stream in secondary growth (Hendrichsen et al., 2001). Extralimitally to Indochina this species inhabits hilly areas with variable type of forest and with underground cavities; may live in mountains up to 1600 m a.s.l.. Forages in both forested and open areas (Bates, Harrison, 1997; Smith, Xie, 2008). Probably, similarly to closely related *M. hilgendorfi*, roosts on trees and in caves and capable to glean prey items from the ground (see Tiunov, 1997).

Murina eleryi Furey, Thong, Bates, Csorba, 2009

Common names. Dơi mũi ống nhỏ; Elery's tube-nosed bat; Южный малый трубконос.

Material studied. Six specimens from Bac Kan province (holotype and one paratype from Kim Hy; collection of HNHM) and Quang Nam province (ROM collection); also two specimens from China and one from Laos (ROM).

Identification. A small vespertilionid bat (weight 4.0–5.5 g, forearm ca. 27.7–31.8 mm, CCL ca. 12.1–13.1 mm), one of the smallest within the genus.

Ear broad, lacking emargination on posterior edge. Dorsal pelage is copper-reddish, with dark grayish-brown hair roots and scattered long shiny golden guard hairs. Underparts are creamy-white with dark-gray hair roots. Naked parts of muzzle, ears and wing membranes are pale grayish-brown; wing portions along forearms and digits are less pigmented. Dentition not robust, canines are equal in height to corresponding posterior premolars. Anterior upper premolar about twice smaller than posterior one.

This species was previously mixed with *M. aurata*, from which it was separated after reinvestigation of *M. aurata* holotype (Furey et al., 2009). From similar size *M. feae* and *M. harpioloides* this species differs by pelage coloration and less reduced mesostyles on upper molars. From *M. annamitica* it can be distinguished also by fur coloration and by less robust dentition and distinctly smaller canines and anterior premolars. From *M. walstoni* it differs in ventral pelage coloration and absence of sagittal crest on skull.

Distribution and collecting sites. See Map 47. Three localities in North Vietnam were mentioned for this species in the original description: Bac Kan, Ha Giang and Son La provinces (Furey et al., 2009). Probably all the specimens from Indochina previously attributed to *M. aurata* should be allocated to this species. In this case its distribution range also includes Thanh Hoa, Thua Thien-Hue Provinces and Ngoc Linh Mountains (Dang Ngoc Can et al., 2008).

Comments on natural history. This species is known to inhabit variably degraded mountainous forests (from primary to highly disturbed and partly cut) on the middle elevations. Specimens from Laos were captured in evergreen primary forest at 1000–1140 m a.s.l. (Francis, Eger, 2012). However at least one specimen in Vietnam (Quang Nam) was captured in secondary growth at ca. 200 m a.s.l. (ibid.).

Murina harpioloides Kruskop, Eger 2008

Common names. Dơi mũi ống Lang Bian; Dalat tube-nosed bat; Далатский трубконос.

Material studied. Holotype and paratype from Lam Dong province.

Identification. Tiny tube-nosed bat (weight 3.0–4.2 g, forearm ca. 28.4–29.7 mm, CCL ca. 12.3 mm), one of the smallest tube-nosed bats. Ear broad and rounded, with small emargination on posterior edge. Pelage on the upperparts looks bicolor because of dark underfur and very bright shiny golden-orange tips of guard hairs; underparts are pale gray with dark hair bases. Tubular nostrils are proportionally long, about 2.5 mm from midpoint to tip. Nostrils, end of the muzzle, ears and wing membranes are dark, rich pigmented. Upper

anterior premolar is very small, about 1/4 in crown area of posterior one. Lower canine with small but well seen supplementary anterior cusp.

This species overlap in size with *M. eleryi*, from which it differs in pelage coloration, dark muzzle and ears and proportionally smaller anterior premolar. Externally *M. harpioloides* is akin to *Harpiola isodon*, from which it can be easily distinguished by longer nostrils and different teeth proportions. M. harpioloides is hardly distinguishable from its closest relative, *M. chrysochaetes*, which is differs in paler muzzle, more yellowish than orange guard hairs and more swollen braincase.

Distribution and collecting sites. See Map 44. To the present time this species was found only on Da Lat Plateau in Southern Vietnam (Kruskop, Eger, 2008; Abramov et al., 2009).

Comments on natural history. On Da Lat plateau two specimens were captured in mixed (broad-leafed and coniferous) primary forest at 1450 and 1800 m a.s.l.. The place is relatively moist probably through the whole year, sometimes with relatively low night temperatures, at about 11–13 C° (Abramov et al., 2009).

Murina chrysochaetes Eger, Lim 2011

Common names. Dơi mũi ống lông vàng; Golden-haired tube-nosed bat; Золотистый трубконос.

Material studied. One specimen from Lao Cai province; also holotype from China (ROM).

Identification. Tiny tube-nosed bat (weight 3.0–4.4 g, forearm ca. 26.4–29.8 mm, CCL ca. 11.9 mm), probably smallest within the genus. It is very similar to M. harpioloides which seems to be its closest relative, and museum specimens can be easily misidentified. Ear broad and rounded, almost without emargination on posterior edge. Underfur is dark on both upper and lower sides of the body; shiny tips of the guard hairs on back are yellowish-golden. Tubular nostrils are proportionally long. Nostrils and tip of the muzzle are well pigmented but not very dark, mid-brown. Braincase is swollen, forming concaved frontal profile.

This species may occur in the same biotopes as *Harpiola isodon*, from which it can be easily distinguished by longer nostrils and different teeth proportions. *M. harpioloides* has darker muzzle tip, more orange tinge of the guard hairs and less swollen braincase.

Distribution and collecting sites. See Map 44. This species was recently described from Guangxi Zhuang Autonomous Region, China (Eger, Lim, 2011), not far from the Vietnamese border. The only other locality of this bat is Hoang Lien Son range in Northern Vietnam from where it was reported as *M.* cf. *harpioloides* (Kruskop, Shchinov, 2010).

Comments on natural history. Type locality of this species is situated at 978 m a.s.l.. In Hoang Lien Son one female was hand netted over stream in disturbed broad-leafed forest at 1950 m a.s.l.. Flight is fluttering, highly maneuverable, but slow.

Murina walstoni Furey, Csorba, Son 2011

Common names. Dơi mũi ống bụng trắng; Walston's tube-nosed bat; Трубконос Уолстона.

Material studied. Three adult females from Dong Nai and Dak Lak provinces; nine specimens from Laos; description below is also follows Csorba et al. (2011).

Identification. A small vespertilionid bat (forearm ca. 31.5–33.7 mm, CCL ca. 13.0–14.3 mm). Ear proportionally narrow, with distinct emargination on posterior edge, on the level of the tragus tip. Dorsal pelage worm-brown, with pale hair roots; ventral fur is uniformly white. Facial mask is pink, end of muzzle, ears and membranes are pale brown. Unlike most tube-nosed bats, tail membrane almost naked. Skull profile is somewhat concaved above the orbits. Anterior upper premolar twice smaller than posterior one. Talonids on lower molars are equal to corresponding trigonids. Mesostyles on upper molars are not reduced.

This species well-differ from all the similar-size Vietnamese *Murina* by pure-white ventral coloration. It also can be distinguished from *M. eleryi* by larger external size and better developed sagittal crest on skull; from *M. harpioloides* and *M. feae* – by less reduced mesostyles on molars; and from *M. annamitica* – by proportionally smaller canines and distinctly smaller anterior upper premolar.

Distribution and collecting sites. See Map 47. This species was described on the basis of specimens came from two localities in Cambodia and from Yok Don National Park (Dak Lak province, Vietnam) (Csorba et al., 2011). We recorded this bat in Cat Tien (Dong Nai Province); other localities unknown.

Comments on natural history. Not much data available; specimens from Cambodia and Yok Don came from mixed semi-evergreen forests of low elevations (Csorba et al., 2011). We capture this bat in Yok Don on the edge of dry dipterocarp forest; in Cat Tien it was netted nearby the water source, also on the forest edge.

Genus *Harpiola* Thomas, 1915

General characteristics. Small tube-nosed vespertilionid bats, similar to small *Murina*, with characteristically large upper premolars.

Diagnosis. Skull on Fig. 55. Dental formula: $I^2/_3\ C^1/_1\ P^2/_2\ M^3/_3 \times 2 = 34$. Both upper premolars and corresponding canine are similar in shape; anterior upper premolar somewhat larger than posterior one, thus all three teeth form straight row. Anterior lower premolar also slightly larger than posterior. Outer upper incisor equal in height and slightly smaller in crown area than inner one. Lower molars with talonid and trigonid almost equal in size. Braincase somewhat doomed, without sagittal crest. Lower jaw with specific lobe anterior to angular process. Nostrils are tubular in shape and turned sideward, and upper side of the interfemoral membrane covered with fur – as in other tube-nosed bats.

Distribution. Sporadic known distributed in India, Vietnam and on Taiwan.

Natural history. Inhabit mountainous forests on middle elevations. Foraging habits seems to be similar to that of similar size *Murina*.

Taxonomical remarks. Two species are currently recognized, one of them occurs in Vietnam.

Harpiola isodon Kuo, Fang, Csorba, Lee, 2006

Common names. Dơi mũi ống răng đều; Even-toothed tube-nosed bat; Равнозубый трубконос.

Material studied. Five individuals from Kon Tum and Lao Cai provinces; also three specimens from *terra typica* on Taiwan (in the collection of HNHM).

Map 48. *Harpiocephalus harpia* – gray shading, black dot; *Harpiola isodon* – black squares.

Identification. A small tube-nosed bat (weight ca. 3.4–8 g, forearm ca. 30–35.6 mm, CCL ca. 13.8 mm; App. II, Table 7), in general appearance greatly similar to small *Murina* species. Pelage with dark-brown underfur, covered on back with bright gold guard hairs. Ear and tragus as in *Murina*. Tragus is tapering to the tip, which is slightly curved backward, almost reaching the ear notch. Last caudal vertebra is free from tail membrane. Tail membrane is covered with thick hairs right to the margin. Orange-golden hairs also cover the upper sides of the forearms. Lower molar structures look less reduced than in most of *Murina*; hypoconulid small but distinct from entoconid. Formally molar type could be regarded as "myotodont".

In pelage coloration *H. isodon* is most similar to *Murina harpioloides*, from which it differs by larger size, paler muzzle tip and other naked parts,

shorter nasal tubes and by tooth proportions. The latter feature significantly divides *Harpiola* from all the similar-size *Murina*: *M. eleryi*, *M. feae*, *M. annamitica* and *M. walstoni*, of which it also differs by fur coloration.

Distribution and collecting sites. See Map 48. Was described from Taiwan (Kuo et al., 2006). Outside of Taiwan at present it was found only in Vietnam: in Ngoc Linh (Kon Tum province) and Hoang Lien (Lao Cai province) mountains (Kruskop et al., 2006; Kruskop, Shchinov, 2010).

Comments on natural history. Known only from mountain areas at the elevation range from 1000 to 2400 m a.s.l.. All Vietnamese specimens were captured over the streams in deciduous moss forests at elevation between 1950 and 2250 m. Animals foraged over the stream backwaters and shallows, flying at about 0.2 – 2 meters above the water or ground. Flight is variably fast, dodged and very maneuverable (Kruskop, Shchinov, 2010).

Genus *Harpiocephalus* Gray, 1842

General characteristics. Includes large tube-nosed bats with highly modified dental structure.

Diagnosis. Skull on Fig. 56. 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. 31a). Canine and cheek teeth are 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. One adult male from Lam Dong province; also four specimens from Cambodia and China were examined.

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 is brightly red-brown; hairs on the back with gray bases, hairs on under parts are 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 is more expanded; zygomatic width exceeds 14 mm (less than 14 mm in *H. harpia*). Forearm 48 mm or longer (less than 50 mm in *H. harpia*). Mateveev (2005) suggested to treat this difference as a case of huge sexual dimorphism, with males distinctly smaller than females. Dang Ngoc Can et al. (2008), probably following Hendrichsen et al. (2001), reported for Vietnam both species separately, with five localities in *H. harpia* and two in *H. mordax*. Meantime, male from the Dalat Plateau demonstrate size characters of the "*mordax*" morphotype (Abramov et al, 2009). All specimens involved into molecular studies are very similar to each other genetically (Francis et al., 2010).

Distribution and collecting sites. See Map 48. Sporadically found throughout the Indomalayan region, from southern India to Taiwan and Great Sunda Islands. In Vietnam firstly reported by Hendrichsen et al. (2001) from Phong Nha, as both *H. harpia* (male) and *H. mordax* (female). Dang Ngoc Can et al. (2008) reported this bat also from Bac Kan, Tuyen Quang, Lang Son, Hai Phong, Quang Tri and Nghe An Provinces (from the latter – as *H. mordax*). *Harpiocephalus* is also known from Lao Cai Province (see Kruskop, Shchinov, 2010) and from the Dalat Plateau (Abramov et al., 2009).

Comments on natural history. On Da Lat Plateau the single male was mist-netted over a small stream in disturbed primary mountainous forest, at ca. 1450 m a.s.l. In Phong Nha and Huu Lien it was found in highly disturbed vegetation while in Ke Bang it was captured in wet pristine forest (Hendrichsen et al., 2001). No other data is available for Vietnam.

Genus *Myotis* Kaup, 1829

General characteristics. Small to large "typical" vespertilionid bats, usually with two small premolars in each jaw.

Diagnosis. Skulls on Figs. 57–58. Dental formula: $I^{2}/_{3}\ C^{1}/_{1}\ P^{2-3}/_{2-3}\ M^{3}/_{3} \times 2 = 34–38$. 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. 32).

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 were virtually raised to generic rank. System which was the most popular until recently divides the genus into four major groups (Koopman, 1994): *Myotis* s. str., *Selysius*, *Leuconoe* and *Cistugo*. However, this point of view was based mainly on adaptive features and there are many molecular (Reudi, Mayer, 2001; Stadelmann et al., 2004, 2007) and a number of morphological evidences which strongly contradict this point of view. Hoofer and Van den Bussche (2003) suggested to divide the genus in only two subgenera: Old World *Myotis* s. str. and American *Aeorestes*, however this system obviously does not reflects huge diversity within Eurasian mouse-eared bats. Finally, African *Cistugo* was raised to the genus level (Stadelmann et al., 2004) and then excluded from Vespertilionidae, and Taiwanese *M. latirostris* was suggested to be removed to genus of its own (Lack et al., 2010). Until comprehensive taxonomical studies of *Myotis* are carried out, we suggest using for Indochina the system offered by Kruskop (2012), placing former "*myotis*" and "*nattereri*" species groups into *Myotis* s. str. and combining most of

other Old World species into taxon with uncertain rank *Leuconoe*. There are 16–17 *Myotis* species known to date for the Vietnamese fauna. Two additional species which may be found in Vietnam and therefore included into identification key are *M. altarium* and *M. formosus* (Dang Ngoc Can et al., 2008; Francis, 2008).

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. 32bcd). 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. 32a). 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. 199)

– 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. Lower molars of nyctalodont type..... *M. annamiticus* (p. 195)

– Larger: forearm over 35 mm, CCL over 12.5 mm, C–M^3 usually over 5.5 mm. Lower molars of myotodont type **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. 28b), P3 not visible at lateral view..... ..... *M. hasseltii* (p. 197)

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. horsfieldii* (p. 196)

– Canines relatively reduced, about the same height as P^4. Wingtip index less than 1.8 ..... *M. laniger* (p. 194)

6 Larger: forearm usually over 37 mm, CCL over 13.5 mm..... **7**

– Smaller: forearm less than 37 mm, CCL less than 13.5 mm..... **12**

7 Very large: forearm over 60 mm, CCL over 20 mm .. *M. chinensis* (p. 183)

– 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: forearm 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. Skull wih definitely concaved upper profile. P^3 not intruded from toothrow .... *M. altarium*

– Ears shorter than 16 mm, when laid forward not extending beyond muzzle. P^3, if present, strongly intruded from toothrow, P^2 compressed against P^4 ..... **10**

10 Smaller: CCL less than 15 mm. Pelage dark brown .... *M. montivagus* type 1 (p. 183)

– Larger: CCL over 15 mm. Pelage more pale, grayish-brown **11**

11 P^3 usually present, seen at least from the occlusial view. Anterorbital foramen over the P^4, maxillar channel long ..... *M. montivagus* type 2 (p. 183)

– P^3 usually absent or minute and covered in gum. Anterorbital foramen situated posterior to P^4, maxillar channel short ..... *M. annectens* (p. 185)

12 Forearm 27–31 mm. Conspicuous inflated pads at the bases of thumbs. P^3 and P_3 absent ..... *M. rosseti* (p. 190)

– Forearm over 30 mm. Bases of thumbs without pads. P^3 and P_3 variously reduced but always (typically) present..... **13**

13 Smaller: forearm ca. 31–36 mm, CCL less than 11.7 mm, C–M^3 usually less than 5 mm. Canines small, longitudal diameter of the upper canine at base less then 7 mm **14**

– Larger: forearm ca. 32–37 mm, CCL usually over 11.5 mm, C–M^3 usually over 5 mm. Canines large; longitudal diameter of the upper canine at base ezceed 7 mm..... **16**

14 Upper skull profile moderately concaved. Canines slightly exceed corresponding large premolars in height. Lower molars of myotodont type .... *M. "annatessae"* [9]

– Upper skull profile conspicuously concaved (Fig. 33a; 35b), braincase doomed. Lower molars of nyctalodont type. Canines equal to corresponding large premolars in height or even smaller **15**

15 CCL more than 11 mm, CM^3 more than 4.8 mm .... *M. phanluongi* (p. 193)

[9] See comments under *M. muricola*.

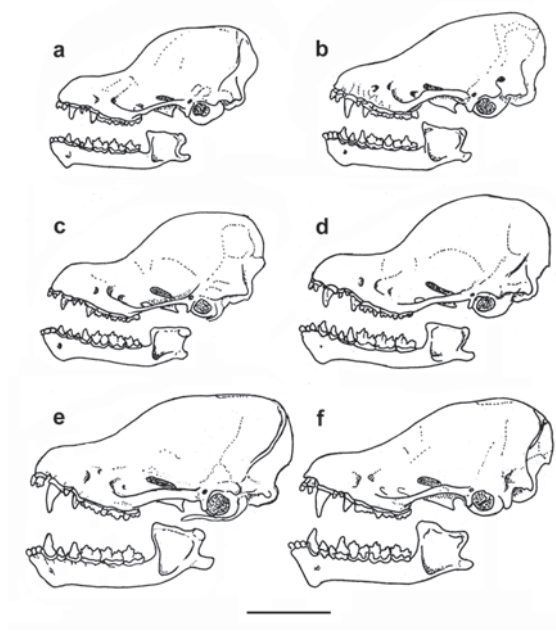


Fig. 33. Skull profiles of selected small Vietnamese Myotis: a) *M. siligorensis*; b) *M. rosseti*; c) *M. annamiticus*; d) *M. laniger*; e) *M. hasseltii*; f) *M. horsfieldii*.

– CCL less than 11 mm, CM^3 less than 11.6 .....*M. siligorensis* (p. 191)

16 Pelage mid-brown, grayish-brown or gray; naked parts brownish. Smaller: forearm usually less than 35 mm, CCL usually less than 12.7 mm, $C–M^3$ usually less than 5.5 mm. Posteror small premolar usually in tooth row....**17**

– Pelage dark gray or blackish, naked parts almost black. Larger: forearm ca. 34–37 mm, CCL usually over 12.5 mm, $C–M^3$ usually over 5.4 mm. Posterior small premolar displaced from the tooth row .....*M. ater* (p. 188)

17 Fur on the underparts conspicuously lighter than on back. Calcar lobe not developed .....*M. nipalensis* (p. 189)

– Uderparts are only slightly paler than back. Calcar lobe usually well-developed .....*M. muricola*[10] (p. 186)

[10] 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*.

Myotis chinensis (Tomes, 1857)

Common names. Dơi tai lớn; Chinese mouse-eared bat; Южнокитайская ночница.

Material studied. No material from Vietnam was seen. Only one specimen from S.-E. China was studied (collection of SDM).

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 is ca. $^1/_2$ of P^2, slightly intruded from the toothrow. Pelage color uniform olive brown or dark gray above and slightly paler below. Membranes, ears and muzzle dark gray.

Map 49. *Myotis chinensis*.

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. See Map 49. 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). Dang Ngoc Can et al. (2008) also reported this bat for Bac Kan, Phi Tho and Thua Thien-Hue Provinces. Probably this *Myotis* inhabits 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. Eight adults from Ha Tinh and Lao Cai provinces; also four additional specimens from Laos and Southern China (ROM collection).

Identification. Medium-sized vespertilionid bats (weight ca. 8–12 g; forearm ca. 36–47 mm; CCL ca. 13.6–16.5 mm; App. II, Table 7), largest of

Vietnamese “whiskered bats”. Pelage soft and thick, with almost black roots and with tips dark brown dorsally and buff-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 (P^3) variably displaced from toothrow, thirst and third premolars often almost in contact.

There are two distinct morphological types represented within this species (both occur in Vietnam): smaller one, with CCL 14 mm or less; and larger, with CCL exceeding 15 mm (Fig. 34). The first one agrees in skull dimensions with the type specimen (Benda, 2010) and therefore should be treated as *M. montivagus* s. str. We may provisionally propose the name *M. m. federatus* (described from Malaysia; Hill, Francis, 1984; Corbett, Hill, 1991) as valid for the second type, though clarification of this subject requires investigation of the type material.

The presence of a lobe on the calcar and somewhat shortened toothrow makes this species possible to be confused 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). Smaller type of *M. montivagus* can be confused with *M. ater*, but has definitely larger skull dimensions and dark-brown, not black, fur coloration. Larger type looks similar to *M. adversus* but always possesses second small upper premolar (P2) though leaned from the tooth row, and has distinctly longer maxillary channel.

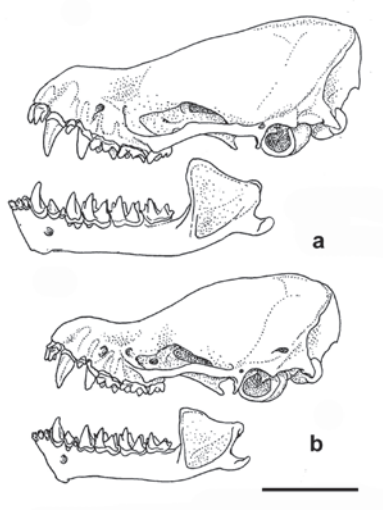


Fig. 34. Skull lateral views of the two *Myotis montivagus morphotypes*: a) large form, based of specimen from Vu Quang, and b) typical form base on specimen from Lao Cai.

Distribution and collecting sites. See Map 50. As accepted here, trans Indo-Malayan species, though possessing disruptive distribution area. Distributed from India and Myanmar to South-East China and Borneo (Corbet, Hill, 1992; Francis, 2008). In Vietnam it known from Pu Mat, Nghe An province (Bates et al., 1999), Vu Quang, Ha Tinh province (Kuznetsov et al., 2001) and Hoang Lien mountain range, Lao Cai province (Kruskop, Shchinov, 2010). It is also reported for Ninh Binh province (Dang Ngoc Can et al., 2008).

Map 50. *Myotis annectans* – black dots; *M. montivagus* – black squares.

Comments on natural history. *M. montivagus* was 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. In Hoang Lien was netted and multiply observed foraging over a stream in disturbed primary mountainous forest at ca. 1900 m a.s.l. Echolocation calls tonal and relatively 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 annectans (Dobson, 1871)

Common names. Dơi tai lông mặt; Hairy-faced mouse-eared bat; Шерстомордая ночница.

Material studied. Two specimens from Lam Dong and Dak Lak provinces; three additional specimens from Laos (ROM collection) were examined. Description below is also based on Francis (2008)

Identification. Medium-sized vespertilionid bats (weight ca. 8–13 g; forearm ca. 43–49 mm; CCL ca. 14.9–15.5mm; App. II, Table 7). Pelage very soft, thick, moderately long, with dark-brown bases. Hair tips are shiny pale on back, giving frosted effect, silvery-white on most of underparts and orange-brown on the middle of belly. Naked parts are almost black. Facial mask is covered with hairs. Calcar with little or no keel. Ears moderately large, with long and slender tragus. Foot of moderate size, ca. $^1/_2$ of tibia length. Skull with robust rostrum and smooth upper profile. Second upper premolars (P^3, P_3) minute, less than ¼ of corresponding anterior premolars, highly displaced

from toothrow, often absent, at least in one side of the jaw. Canines robust and short, about equal to corresponding posterior premolars in height. Anterorbital channel is proportionally short; its anterior end opens behind roots of P4.

Shortened toothrow occasionally with only two pairs of premolars makes this species confusable with small serotines or large pipistrelles (even more it was initially described as a pipistrelle), from which it clearly differs by tragus shape, typical of *Myotis*. From similar-sized *Myotis* species from "*adversus*" group, it may be distinguished by somewhat smaller foot and more massive and shortened rostrum of skull (and also by more massive and broad muzzle). From very similar externally *M. montivagus* it can be distinguished by paler fur and by middle premolars, commonly absent or covered in gum.

Distribution and collecting sites. See Map 50. Ranges from north-east India to N. Thailand, Laos, Cambodia and Vietnam (Francis, 2008). Hendrichsen et al. (2001) did not mention this bat for Vietnam at all; however Francis (2008) includes *M. annectans* to Vietnamese fauna. This species is reported in Vietnam by Dang Ngoc Can et al. (2008) from Tam Dao, Pu Hoat and Bach Ma (Vinh Phuc, Nghe Anh and Thua Thien-Hue provinces respectively). We found this bat in Chu Yang Sin and Loc Bao (Dak Lak and Lam Dong provinces).

Comments on natural history. In Laos *M. annectans* occurs in hilly forests. In West Bengal these bats were captured at 1077 and 923 m a.s.l. (Bates, Harrison, 1997). In Chu Yang Sin this *Myotis* was observed and captured at ca. 1100 m a.s.l. over the forest trail. Forest in that place is wet pristine mixed (broad-leaf and coniferous) forest with many seasonal and permanent streams. *M. annectans* seems to be an aerial hawker, with powerful flight similar to that of medium-size serotines.

Myotis muricola (Gray, 1846)

Common names. Dơi tai chân nhỏ; Nepalese whiskered bat; Малая ночница, Непальская усатая ночница.

Material studied. Eighty specimens from Ha Tinh, Lam Dong, Binh Phuoc, Dong Nai, Dak Lak and Ba Ria – Vung Tau provinces; additionally, thirty three specimens from India, Nepal, peninsular Malaysia, Sumatra, Java, Borneo and Southern China (ROM, HNHM, ZISP, ZMMU).

Identification. Small vespertilionid bat (weight ca. 3.2–6.5; forearm ca. 32.4–38.3 mm; CCL ca. 11.9–12.5 mm; App. II, Table 7). Externally similar to *M. siligorensis* and *M. ater* with which can be confused in the field. Different populations (also inside Vietnam) demonstrate some variability in average size and coloration. Cranial profile relatively smooth with less pronounced

flexure between rostrum and brain case (in comparison to that of *M. siligorensis*; Fig. 35). Lower canine not less in height than p4; upper canine is definitely higher that P4. There are no protoconules on upper molars. Pelage is soft and thick, from pale brownish gray or light gray in subadults to brown in some adult females. Underparts are paler than back, usually dirty-white with blackish hair roots. Ears of moderate size, only slightly exceeding the tip of muzzle if folded forward.

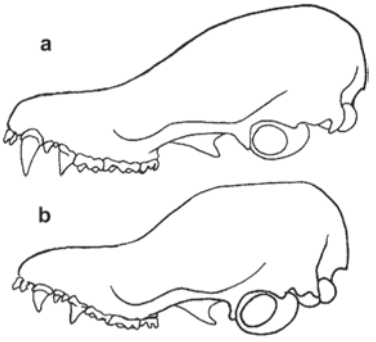


Fig. 35. Skull profiles of *Myotis*: a) *M. muricola*; b) *M. siligorensis.*

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 *M. siligorensis* by somewhat larger size, skull shape and myotodont lower molars. From *M. ater* it differs in smaller average size, both external and cranial (CCL in *M. muricola* rarely exceeds 12.4 mm while usually over 12.5 mm in *M. ater*), and by lighter coloration. From other similar-sized *Myotis*, *M. muricola* may be distinguished by smaller hind foot, place of attachment of wing membrane, and by absence of paraconules on upper molars.

Taxonomy of this bat is highly tangled and awaits further studies. It is probable that there are more than one species hidden under the name "*muricola*" and that Indochinese populations should represent species distinct from *M. muricola* s. str. from Nepal and North India (Benda, 2010; orig. data).

One more species was recently revealed on grounds of morphology and molecular genetics and its formal description is in press (Kruskop, Borisenko, in press). This bat, describing under the name "*M. annatessae*" is essentially similar to *M. muricola* but differs in smaller skull size (CCL usually no more than 12.1) and proportionally smaller canines. From *M. siligorensis M.* "*annatessae*" differs in more smooth cranial profile and in myotodont lower molars. This form is known only form Vu Quang (where it lives in sympatry with *M. muricola*) and from adjacent territory of Laos.

Distribution and collecting sites. See Map 51. As traditionally accepted, this species has trans Indo-Malayan distribution and inhabits wide variety of landscapes and 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 con-

Map 51. *Myotis muricola.*

firmed localities is limited. It was indicated for Dak Lak province by Dang Huy Huynh et al. (1994; as *M. mystacinus*) and for Nghe An province by Bates et al. (1999). Dang Ngoc Can et al. (2008) cite this species also for Tuyen Quang, Bac Kan, Hai Phong, Ninh Binh, Ha Tinh, Quang Tri, Thua Thien-Hue, Quang Nam, Kon Tum, Gia Lai, Lam Dong, Dong Nai, Tay Ninh and Kien Giang. We found this species in Vu Quang (Ha Tinh province; Kuznetsov et al., 2001), Lo Go Xa Mat (Tay Ninh province; Borissenko, Kruskop, 2003), Bu Gia Map (Binh Phuoc province; Kruskop, 2010a); Cat Tien National Park and Vinh Cuu (Dong Nai province), on Da Lat plateau and in Loc Bao (Lam Dong province), in Yok Don (Dak Lak province) and in Ba Ria – Vung Tau province.

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 and its tributaries (Abramov et al., 2009). 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. Lactating females were also observed in Cat Tien in November suggesting two peaks of births in this species. We observed this bat using young banana leafs as day roosts.

Myotis ater (Peters, 1866)

Common names. Dơi tai nam á; Moluccan whiskered bat; Тёмная ночница, Молукская усатая ночница.

Material studied. Forty one specimen from Lam Dong, Dong Nai, Dak Lak, Tay Ninh and Ba Ria – Vung Tau provinces.

Identification. Small *Myotis* (weight ca. 4.3–6 g, forearm ca. 32–40 mm, CCL ca. 12.5–13.3 mm; App. II, Table 7). Pelage soft and thick, with black roots and tips brown on ventral side and blackish brown on dorsal. Naked parts are also almost black. In all other external characters *M. ater* resembles *M. muricola*. Skull with very shallow concavity posterior to rostrum, latter is rela-

tively 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 is often 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 darker coloration, more robust dentition and larger skull proportions.

Map 52. *Myotis ater.*

Distribution and collecting sites. See Map 52. Sunda-Malayan species of low and probably middle elevations. Was included in *M. muricola* by Koopman (1994). Not cited 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). Was indicated in Vietnam for the first time by Bates et al. (1999), based on records from Cuc Phuong NP, Pu Mat and Phong Nha. Reported by Dang Ngoc Can et al. (2008) from Tuyen Quang, Ninh Binh, Nhge An, Quang Binh, Thua Thien-Hue and Gia Lai provinces. We found this species in Tay Ninh (Lo Go Xa Mat), Lam Dong (Cat Loc), Dong Nai (Nam Cat Tien and Vinh Cuu), Dak Lak (Yok Don) and Ba Ria – Vung Tau (Binh Chau) provinces. In Cat Tien this bat was firstly 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 and Vinh Cuu, 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. Meantime in Nam Cat Tien records of this bat were made mainly in antropogenically transformed landscapes. Aerial forager. Probably a tree dweller. In Cat Tien one animal was found roosting in a tube of young banana leaf.

Myotis cf. *nipalensis* (Dobson, 1871)

Common names. Dơi tai nê-pan; Pallid whiskered bat; Бледная усатая ночница.

Material studied. No material was seen from Vietnam; description below is based on specimens from Central Asia.

Identification. Small vespertilionid bat (weight ca. 6 g.; forearm ca. 31–37 mm; CCL ca. 12.7–14.0 mm), somewhat similar to *M. muricola*. Pelage soft and thick, pale buff or sandy brown on back, pale gray to white on underparts, with darker hair roots. Naked parts pale pinkish-brown. Wing membrane also pale, attached to the base of outer toe. Foot small, less than $^1/_2$ of tibia length. Calcar lobe usually absent. Skull similar to that of *M. muricola*, with moderately low rostrum and not inflated braincase with relatively low frontal part. Small upper premolars compressed between canine and P4, second one (P3) variably displaced from the toothrow. Canines slightly higher than correspondent large premolars (P4 and This bat was long time thought to be a part of *M. mystacinus* until revision by Benda and Tsytsulina (2001). *Myotis mystacinus* s. lato was regularly mentioned in Vietnamese mammalian checklists (Dang Huy Huynh et al., 1994; Dang Ngoc Can et al. 2008). Though it is thought to be a misidentification of *M. muricola* (Borissenko, Kruskop, 2003), there is a possibility of presence of this species group in north-eastern part of Northern Vietnam. In this case it most probably represented just by *M. nipalensis* (Smith, Xie, 2008). This question could be clarified only after examining the appropriate collection material. From *M. muricola* pallid whiskered bat can be distinguished by paler fur coloration and larger skull; from *M. siligorensis* – also by larger canines and myotodont lower molars.

Distribution and collecting sites. Widely distributed in mountain areas of Asia: from Iran and Turkmenistan through Himalayas to Southern China. It may penetrate to Northern Indochina through south-eastern spurs of the Himalayan mountain country. However Francis (2008) does not cite this species for Vietnam. The most frequently mentioned Vietnamese record was made in the vicinity of Buen Ma Thot (Dac Lac; see Bates et al., 1999); however our material from that area undoubtedly represents *M. muricola*. This species (as "*M. mystacinus*") was reported for Cao Bang province by Kuznetsov (2006) with reference on personal communication of Dr. Cao Van Shung.

Comments on natural history. Natural history in tropical Asia is unknown. Outside of Indochina inhabits arid or semiarid landscapes, preferring dry foothills or middle elevations. Day roosts in human buildings, rock crevices and caves. Forages in the air, usually not far from ground; flight swift and maneuverable (e.g., Yanushewicz et al., 1972).

Myotis rosseti (Oey, 1951)

Common names. Dơi tai ngón lớn; Thick-thumbed mouse-eared bat; Толстопалая ночница.

Material studied. Twenty specimens from Lam Dong and Dong Nai provinces.

Identification. A small *Myotis* species (weight ca. 4.5–5.5 g, forearm ca. 29–31 mm, CCL ca. 10.9–11.1 mm; App. II, Table 7) with characteristic thickened pink pads on feet and especially at the bases of thumbs (Fig. 26b). Lobe on the calcar is more or less well-developed. Posterior small premolars (P^3 and p3) 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.

Map 53. *Myotis ricketti* – gray shading; *M. rosseti* – black dots.

Distribution and collecting sites. See Map 53. Indochinese species. Abroad Vietnam it inhabits Cambodia, Laos and southern Thailand north from Isthmus of Kra (Corbet, Hill, 1992; Francis, 2008). In Vietnam was initially reported by Sokolov et al. (1986), but without references to any localities. Was found in Cat Tien National Park by B.Hayes (Hayes, in: Pham Nhat et al., 2001); known from Nam Cat Tien and Cat Loc.

Comments on natural history. 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). In Nam Cat Tien this bat is most common in semi-open landscapes with large number of tall bamboo. Strong infestation with ectoparasites (nycteribiid flies) suggests gregarious habits. In Cat Loc and Cat Tien *M. rosseti* was observed foraging at 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; one pregnant female was captured in the beginning of November. This suggests a middle autumn birth peak and thus possibly polyestrous reproductive cycles.

Myotis siligorensis (Horsfield, 1855)

Common names. Dơi tai sọ cao; Himalayan whiskered bat; Гималайская усатая ночница.

Material studied. Twenty nine specimens from Khanh Hoa, Quang Binh,

Tuyen Quang, Lai Chau (including three paratypes of *M. s. alticraniatus* from Muong Muon; collection of FMNH), Lao Cai provinces and from Cat Ba Island; also two specimens from S-E China (ROM collection).

Identification. Small and very light-built vespertilionid bat (weight ca. 2.6–4.0 g.; forearm ca. 30.4–35.6 mm; CCL ca. 10.2–10.8 mm; App. II, Table 7). Pelage soft and thick, buff to dark brown, with darker roots. Naked parts dark brown to black. Ears moderately long and narrow, reaching or slightly extending tip of muzzle if laid forward, with narrowly pointed tragus. Wing membrane attached to the base of outer toe or 1 mm higher. Foot small, less than $^1/_2$ of tibia length, with small claws. Skull with light and low rostrum, steep frontal profile and definitely doomed braincase. 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). Lower molars of seminyctalodont or nyctalodont type.

This bat can be confused with small individuals of *M. muricola*, from which may be reliably distinguished by cranial and dental shape (minute canines, type of lower molars) and by tiny baculum (Fig. 25). From closely related *M. phanluongi* it can be differ in smaller skull proportions and baculum shape. From *M. annamiticus* this species differs by smaller hind foot and claws, and by some dental characters, from *M. laniger* – also by type of lower molars. Amongst other genera, *M. siligorensis* is quite similar to small *Kerivoula*, from which it could be distinguished by proportionally shorter tail and tibiae, and not funnel-shape ears.

Map 54. *Myotis siligorensis* – gray shading, black dot; *M. phanluongi* – black squares.

Distribution and collecting sites. See Map 54. Trans-Himalayan species of middle elevations, distributed from North-West India trough Nepal, northern Thailand and Laos 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. Subspecies *M. s. alticraniatus* Osgood, 1932 was described from Moung Muon (Lai Chau province). Dang Huy 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), Hon Ba mountain (Borisenko et al., 2008), and from Thua Thien-Hue and Binh Dinh Provinces (Dang Ngoc Can et al., 2008). This bat was reported from Cat Ba island in Halong Bay by Vu Dinh Thong and Furey (2008). Report from Cat Tien is most likely based on error in identification.

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 from low elevations to 2000 m a.s.l. (Bates et al., 1999; our data). They are typical aerial foragers, they have been observed flying near vegetation or over riverbeds, at an altitude of ca. 0.5–3 m. In Minh Hoa (Quang Binh province) these bats were observed foraging in the populated place, just near or over buildings. On Hon Ba mountain and in Hoang Lien Son *M. siligorensis* were netted over small streams in the moderately disturbed pristine evergreen forest. On Cat Ba island formed by karstic ridges and valleys, this bat was one of the most common in different biotopes, from primary forest to half-open disturbed areas. The echolocation calls are FM signals of very low intensity with maximum energy at 45–50 kHz, frequency range not evaluated (our data).

Myotis phanluongi Borisenko, Kruskop, Ivanova, 2008

Common names. Dơi tai Phan Luong; Phanluong's whiskered bat; Ночница Фан Лыонга.

Material studied. Five specimens from Khanh Hoa (Hon Ba; the type series of four specimens) and Lam Dong provinces.

Identification. Small and light-built *Myotis* (weight ca. 4.0 g.; forearm ca. 33.5–36.9 mm; CCL ca. 11.2–11.9 mm), very similar to *M. siligorensis*. Pelage soft and thick, brown with darker roots. Naked parts pale brown, paler than in *M. siligorensis*. Wing membrane attached slightly higher than the base of outer toe. Foot small, about $^{1}/_{2}$ of tibia length. Skull with light and low rostrum, somewhat curved up in lateral view, steep frontal profile and globular doomed braincase. Both upper small premolars loosely in toothrow. Canines are small, equal in height to correspondent large premolars (P4 and p4). Lower molars of seminyctalodont or nyctalodont type.

This bat was confused with *M. siligorensis* (Borissenko, 2006), from which it can be distinguished by larger cranial size and paler muzzle and limbs. From all other Vietnamese *Myotis* except for *M. annamiticus* it well differs by lower molar morphology.

Distribution and collecting sites. See Map 54. Still known only from highlands (elevation of about 1300–1500 m a.s.l.) of Hon Ba massif and Dalat Plateau (Borisenko et al., 2008; Abramov et al., 2009), but probably inhabits similar elevations in other parts of Central Vietnam.

Comments on natural history. All know specimens were netted or observed over streams and brooks in or on the border of mountainous primary mixed forest. Bats were foraging over shore line or close to water surface. The echolocation calls are FM signals of very low intensity with maximum energy at about 45 kHz (Borisenko et al., 2008).

Myotis laniger (Peters, 1870)

Common names. Dơi tai bắc việt; Indochinese water bat; Индокитайская водяная ночница.

Material studied. Twelve specimens from Lao Cai, Quang Nam and Tuyen Quang provinces and from uncertain locality in Vietnam; also three specimens from India (ROM, ZMMU, HNHM).

Identification. A small vespertilionid bat (weight ca. 3.5–4 g.; forearm ca. 31–36 mm; CCL ca. 12.4–13.1 mm), externally in general appearance resembling small *M. horsfieldii*, and even more the extralimital Palaearctic species *M. daubentonii* and *M. longipes*. Hind foot slightly exceeding $^1/_2$ of tibia length. Wing membrane attaches to the outer metatarsal. Fur is grey or pale grayish-brown. Ears long and narrow, exceeding on 4–5 mm beyond nostrils if folded forwards. 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 p4. Skull with relatively low rostral part, abruptly elevated in the frontal region of somewhat doomed braincase (Fig. 33d).

M. laniger differs from *M. hasseltii* by the place of attachment of the wing membrane and smaller size, from *M. horsfieldii* by shortened canines and small premolars not extruded from toothrow; from essentially similar *M. annamiticus* by larger size, full cingulum on upper canine and myotodont lower molars.

Tate (1941) placed *M. laniger* in the same group with *M. daubentonii* (including *M. petax*), and supposed it could be only a race of the Daubenton's bat. Later for decades *M. laniger* was treated as a subspecies of *M. daubentonii* until G. Topal (1997) substantiated its specific distinctness based on a series of specimens collected in Vietnam. 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* or *M. longipes*). Bates et al. (1999) indicate both *M. daubentonii* and *M. laniger* for Vietnam; however the characters provided therein cannot ensure clear identification of the two taxa. This was accepted by Dang Ngoc Can et al. (2008), who also mentioned both bats

in Vietnamese fauna. Direct investigation of specimens have shown that *M. laniger* (as understood be C. Francis; see Francis, 2008) obviously differs from *M. daubentonii* being closely related with *M. annamiticus* and *M. siligorensis* s. lato. (see Francis et al., 2010) and therefore should be treated within the "*siligorensis*" species group (Tiunov et al., 2011).

Distribution and collecting sites. See Map 55. Known from Indochina (Laos, Vietnam) and southern China (Francis, 2008). In Vietnam is known in Ngoc Linh (Quang Nam province), Na Hang Nature Reserve (Tuyen Quang province) and Hoang Lien Son (Lao Cai province); reported by Bates et al. (1999) from Cuc Phuong National Park as *M. daubentonii* and from Ta-Phinh as *M. laniger*. Also reported from Bach Ma (Thua Thien-Hue province) as *M. daubentonii* by Dang Ngoc Can et al. (2008).

Map 55. *Myotis laniger* – gray shading; *M. annamiticus* – black dot.

Comments on natural history. Not well known. The specimen from Cuc Phuong was caught in an agricultural landscape with small ponds (Hendrichsen et al., 2001). In Hoang Lien specimens were captured over a small stream in a disturbed pristine forest at elevation of ca. 1850 m a.s.l., however that presumably was not their foraging site. Foraging behavior may be similar to that of the European *M. daubentonii* (Jones, Rayner, 1988; Kalko, Schnitzler, 1989).

Myotis annamiticus Kruskop, Tsytsulina, 2001

Common names. Dơi tai Trường Sơn; Annamite water bat; Аннамская ночница.

Material studied. Thirteen specimens (including the holotype) from 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; App. II, Table 7). 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 ventral part. 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 (Fig. 33) this species resembles *M. siligorensis*, from which it differs by the larger hind foot, place of wing membrane attachment and some dental features. *M. annamiticus* was shown to be almost indistinguishable from *M. laniger* by mtDNA sequences (Francis et al., 2010), but these two bats, though looking alike externally, can be easily separated by size, upper canine shape and morphology of lower molars (clearly myotodont in *M. laniger*, nyctalodont to submyotodont in *M. annamiticus*).

Distribution and collecting sites. See Map 55. Though *M. longipes* is usually thought to be restricted to Afghanistan and North India (e.g. Koopman, 1994), it was reported to Lai Chau and Hoa Binh provinces (Dang Huy Huynh et al., 1994). These records were subsequently attributed to misidentified *M. laniger* (Topal, 1997), however from the standpoint of the description of *M. annamiticus*, these two sites, or any one of them may be referred to this latter species (Borissenko, Kruskop, 2003). We found this species only in Ke Bang (Kruskop, 2000b; Kruskop, Tsytsulina, 2001; Dang Ngoc Can et al., 2008), but probably this bat inhabiting valleys of small streams in middle elevations through the whole Central Vietnam. Francis (2008) also cites this bat for Laos and tentatively for southern China.

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 horsfieldii (Temminck, 1840)

Common names. Dơi tai Đâynan; Horsfield's bat; Ночница Хорсфилда.

Material studied. Six specimens from Ha Tinh and Lam Dong provinces; four specimens from unknown locality in Northern Vietnam (ZMB).

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; App. II, Table 7). 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 (Fig. 32) and in position of second upper premolar. From *M. laniger* as well as from extralimital *M. petax* 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. petax*).

Map 56. *Myotis horsfieldii* – gray shading; *M. hasseltii* – black dots.

Distribution and collecting sites. See Map 56. 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 even included in Vietnamese fauna by Dang Huy Huynh et al. (1994). However, it is very likely that records of *M. adversus*, reported in the latter publication (Lao Cai province and Hanoi City) should be referred to this species. Bates et al. (1999) reported *M. horsfieldii* to Phong Nha – Ke Bang National Park and Pu Mat Nature Reserve (Nghe An and Quang Binh provinces). This bat is also reported for Quang Tri, Thua Thien-Hue, Gia Lai and Dak Lak provinces by Dang Ngoc Can et al. (2008). We found this bat in Vu Quang, Ha Tinh province (Kuznetsov et al., 2001) and on Langbian plateau, Lam Dong province (Abramov et al., 2009).

Comments on natural history. Confined to rivers and streams and in Vietnam usually 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. However on Da Lat plateau these bats were once observed foraging in the air, in a manner similar to that of *M. muricola* (Abramov et al., 2009). 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 hasseltii (Temminck, 1840)

Common names. Dơi tai Hátxen; Van Hasselt's bat; Ночница Хасселта.

Material studied. Seven specimens from Soc Trang province and T.P. Ho Chi Minh (ROM collection); also four specimens from Cambodia, Pnom-Penh.

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, slightly more pale coloration and place of wing membrane attachment (Figs. 32–33). However the latter two features are not too durable, especially speaking on museum specimens.

Differentiation of *Myotis hasseltii* from extralimital *M. adversus* (reported from Vietnam by Dang Huy Huynh et al. (1994) and Dang Ngoc Can et al. (2008), 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. See Map 56. 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 it was initially reported by Sokolov et al. (1986) without specifying of localities. However, Dang Huy Huynh et al. (1994) reported this bat from Ha Noi Province, with reference to the Sokolov's paper. Bates et al. (1999), on the basis of the collection of HNHM, reported *M. hasseltii* to Co-Loa. This bat was reported by Dang Ngoc Can et al. (2008) for the vicinity of Hanoi and for Cat Tien; however it was not mentioned for the latter place by Polet and Ling (2004). Seen specimens in ROM collection are originated from vicinity of Soc Trang and from T.P. Ho Chi Minh.

Comments on natural history. Probably, confined to large water surfaces. In Cambodia (observations of A. Borissenko) these bats were seen while hunting over Bassak River at 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).

***Myotis ricketti* (Thomas, 1894)**

Common names. Dơi tai chân dài; Rickett's big-footed bat; Азиатская рыбоядная ночница, Рикеттия.

Material studied. Two specimens from China (collections of the SDM and ZMMU); no specimens from Vietnam have been examined.

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 specimen in SDM) of characteristic appearance. Hind foot greatly enlarged, about 80% of tibia length or even larger, 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. See Map 53. *M. ricketti* is distributed in eastern China, Lao and Vietnam (Hendrichsen et al., 2001; Francis, 2008). 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). Also reported from Bac Kan province, Ba Be (Dang Ngoc Can et al., 2008).

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). In Vietnam these Myotis were found in karstic caves or were netted over large slow streams, surrounded by open habitats or heavily disturbed vegetation (Hendrichsen et al., 2001).

Genus *Eudiscopus* Consbee, 1953

General characteristics. A small *Myotis*-like bat with adhesive disks.

Diagnosis. Skull on Fig. 59. 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 pre-

molars 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 cingulum. 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 to allocate provisionally this genus to Myotini. Available provisional molecular data at least not contradict this point of view (Kruskop et al., 2003; Borisenko et al., 2008). More refined taxonomic studies which can finaly clarify taxonomic position of *Eudiscopus* are ongoing.

Eudiscopus denticulus (Osgood, 1932)

Common names. Dơi chai chân; Disc-footed bat; Дисконог, Розетконогий гладконос.

Material studied. Thirteen specimens from Lam Dong and Binh Phuoc provinces.

Identification. A small-sized vespertilionid bat (weight ca. 4.6–7.8 g, forearm ca. 35.0–37.4 mm, CCL ca. 13.4 mm; App. II, Table 7) 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 (Fig. 36); 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 or reddish-brown at dorsum, paler below. The membranes are dark; ears and muzzle are paler, not as well-pigmented.

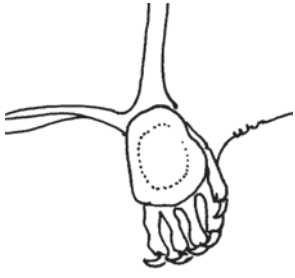


Fig. 36. Left hind foot of *Eudiscopus denticulus*, showing adhesive disc (ventral view).

Easily distinguishable by it's very well developed disk-like pads on feet, by flattened braincase and also by number of small premolars. From another Vietnamese bats with pads on feet (*Tylonycteris*) *Eudiscopus* is well distinguished by the ear and tragus shape and by overall size.

Map 57. *Eudiscopus denticulus* – black dots; *Barbastella* cf. *darjelingensis* – black square.

Distribution and collecting sites. See Map 57. A rare species known previously from three collecting sites (Northern Laos, Southern Burma and, more recently, Thailand; Koopman, 1972; Kock, Kovac, 2000; Schliemann, Kock, 2000). The first claimed record of this species from Vietnam (Cao Van Sung, 1976, subsequently listed in Dang Huy Huynh et al., 1994) is apparently erroneous and, according to the features in the publication, may be actually allocate to *Tylonycteris* species. The first documented record therefore is an adult female of *E. denticulus* captured in Cat Loc in 2001, representing the fourth known locality of this species. Dang Ngoc Can et al. (2008) also listed this bat in Son La and Nghe An provinces. We found this species in Bu Gia Map (Binh Phuoc), where it seems to be abundant (Kruskop, 2010a).

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. Cat Loc specimen was captured with mobile trap 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. In Bu Gia Map these bats forage over the road and stream beds along the edges of thicket. All sightings were made close to bamboo growths and no *Eudiscopus* were recorded in the neighboring primary forest. Newborns probably appear in the end of April.

Genus *Barbastella* Gray, 1821

General characteristics. Small to medium size vespertilionid bats with characteristically wide ears, joint on the forehead.

Diagnosis. Skull on Fig. 60. Dental formula: $I^2/_3$ $C^1/_1$ $P^2/_2$ $M^3/_3 \times 2 = 34$. Anterior upper premolars are tiny, completely displaced inwards and usually not seen in lateral view; canine and corresponding posterior premolar in contact. Outer upper incisor slightly smaller in crown area and about three times smaller in height than inner one; both are bicuspid and well separate from canine. Lower molars are of nyctalodont type. Facial part of skull narrow and short, upper skull profile gradually slopes from low facial part to doomed braincase. Zygomatic arches narrow; zygomatic width of skull equal to mastoid width. Ears very broad, faced forward and joint on the forehead by their inner margins. Face between muzzle tip and ears naked, with distinct inflations and nostrils turned upward.

Distribution. Widely distributed from West Europe and North-East Africa trough Caucasus and Middle East to Japan, Central China and Indochina (Wallin, 1969; Benda et al., 2008; Francis, 2008).

Natural history. Inhabit various types of mountainous forests. Aerial hawking foragers.

Taxonomical remarks. Four species are currently recognized, one of them occurs in Vietnam.

Barbastella cf. *darjelingensis* Hodgson, 1855

Common names. Dơi muỗi tai to; Eastern barbastelle; Азиатская широкоушка.

Material studied. Two specimens from Lao Cai province; also one specimen from Nepal.

Identification. Medium-size vespertilionid bat (forearm ca. 38.7–42.1 mm, CCL ca. 13.4–14.2 mm, Bates, Harrison, 1997; weight ca. 8–9 g; App. II, Table 7), of very characteristic general appearance. Pelage very dark, blackish-brown, tipped with buff-brown, and almost same in color on dorsal and ventral side. Ear very wide, with thickened bow-curved anterior edge, and well-seen transverse ridges or folds on posterior. Ears are faced forward and stand very close to each other, joint on the forehead. Outer upper incisor similar or somewhat smaller than inner one in crown area and greatly smaller in height. Both incisors possess additional cusps though on the outer one secondary cusp could become obliterated in adults. Anterior upper premolar minute, entirely hidden by the canine base in lateral view. Skull with low and gracile rostrum and doomed brain case; upper profile of facial and frontal part of skull is straight, not concaved.

The only known representative of plecotine bats (Plecotini) in Indochina. No other vespertilionid bat in the region possesses same ear shape as *Barbastella*,

so there is no way for confusion. The border between *B. darjelingensis* and *B. beijingensis* from Central China (Zhang et al., 2007) is poorly known as well as distribution of the latter species. Besides ear shape, *Barbastella* can be distinguished from all Vietnamese vespertilionids of similar size by narrow position of zygomatic arches (width across them equal or even smaller than width across mastoids). It may be treated similar to some round leaf bats (*Hipposideros*) from which well differs by developed tragus and absence of nose leaves.

Distribution and collecting sites. See Map 57. Widely distributed mainly in mountainous areas of Asia, from Transcaucasia and Iran through Central Asia and Himalayas to Central and Southern China and Northern Indochina (Benda et al., 2008; Francis, 2008; Duckworth, Pons, 2011). In Vietnam still known only from Hoang Lien mountain range (Lao Cai province; Kruskop, Shchinov, 2010) though may inhabit other mountain massifs close to Chinese border.

Comments on natural history. Known mainly from mountain areas up to elevation of 2350 m a.s.l. or even more. Day roosts probably in hollows under bark as well as in the rock crevices; hybernaculas (in non-tropical part of range) – in caves or old mines (Bates, Harrison, 1997). Vietnamese specimens were netted over the stream in deciduous forest at elevation of about 2000 m. Flight is fast and not very maneuverable. One of the captured animals was subadult male possibly born in mid-winter (Kruskop, Shchinov, 2010).

Genus *Pipistrellus* Kaup, 1829

General characteristics. Small vespertilionid bats of typical to the family appearance and nyctalodont lower molars.

Diagnosis. Skull on Fig. 61. 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 is long and thin, commonly curved in lateral view, slightly widened and notched at base and gradually narrowing to the weakly bifurcated tip (Hill, Harrison, 1987; Volleth, 1989; Fig. 25n); within genus it varies mainly in size.

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.

NATURAL HISTORY. Typically low to medium-altitude aerial insectivores with moderately fast maneuverable flight. Roosts are located in various crevices, from cracked trees to man buildings.

TAXONOMICAL REMARKS. Very complex group with discussed affinities to several other taxa, regarded as subgenera of *Pipistrellus* (e.g. see Koopman, 1994) or as separate genera (part of which not even closely related to the *Pipistrellus* s. str.; Volleth, Heller, 1994; Hoofer, Van den Busche, 2003). 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. 205)

– 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. 206)

– 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. 206)

– 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. 208)

5 Larger: forearm 26–35 mm, CCL ca. 10.6–11.9 mm..... .....*P. coromandra* (p. 210)

– Smaller: forearm 25–31 mm, CCL ca. 9.3–10.7 mm.....*P. tenuis* (p. 209)

***Pipistrellus ceylonicus* (Kelaart, 1852)**

Common names. Dơi muỗi Xây Lan; Kelaart's pipistrelle; Цейлонский нетопырь.

Material studied. No specimens from Vietnam were examined; ten specimens from India (ROM and GMNH collections) and one specimen of the form *raptor* from Hong-Kong (HNHM) were seen; the diagnosis below also follows Bates, Harrison, (1997).

Identification. A small to medium-sized vespertilionid bat (weight ca. 7–8 g, forearm ca. 33–42 mm; Bates, Harrison, 1997CCL ca. 13.3–14.2 mm in *ceylonicus*, ca. 14 mm in *raptor*), largest within the Vietnamese *Pipistrellus*. 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.

Map 58. *Pipistrellus ceylonicus* – black dots; *Glischropus bucephalus* – black squares.

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 by nyctalodont lower molars.

Distribution and collecting sites. See Map 58. Distributed through the Indian subcontinent, from Pakistan to Sri Lanka (Bates, Harrison, 1997), and than eastward to Vietnam and Hainan I. (Corbet, Hill, 1992). Listed for the mainland North Vietnam (without exact localities) and coastal islands, by Sokolov et al. (1986), Kuznetsov and An' (1992), Corbet and Hill (1992) and Dang Huy Huynh et al. (1994). Was reported in Phong Nha – Ke Bang National Park, Quang Binh province (Timmins et al., 1999), and in Nam Cat Tien National Park (Hayes, in: Pham Nhat et al., 2001). Also cited for Thanh Hoa and Thua Thien-Hue provinces by Dang Ngoc Can et al. (2008).

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

Map 59. *Pipistrellus paterculus.*

Common names. Dơi muỗi Mianma; Burmese pipistrelle; Бирманский нетопырь.

Material studied. Six specimens from Ba Ria – Vung Tau and Dak Lak provinces.

Identification. A small vespertilionid bat (weight ca. 4.3–5.7 forearm ca. 29.6–31.2 mm [29–34 mm], CCL ca. 10.6–11.6 mm; orig., Bates, Harrison, 1997; App. II, Table 7). Upper canine usually unicuspid which is uncommon for Asiatic *Pipistrellus*. Small upper premolar not reduced, variably intruded from the toothrow, and clearly visible at lateral view. Penis extremely long, over 10 mm in length. Pelage, ears, face and membranes uniformly dark brown, ventral hairs are 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 possible only by shape of canine. 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. See Map 59. Sporadically distributed from northern Pakistan to Thailand, Vietnam and southern China (Corbet, Hill, 1992; Smith, Xie, 2008). From Vietnam it was reported for the first time by Bates et al. (1999) from Cuc Phuong National Park, Ninh Binh province. Dang Ngoc Can et al. (2008) cite this pipistrelle for Lang Son, Ninh Binh, Ha Tinh, Quang Tri Thua Thien-Hue and Gia Lai provinces. We captured this bat in Binh Chau and Yok Don (Ba Ria – Vung Tau and Dak Lak provinces).

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. In both Yok Don and Binh Chau these pipistrelles were netted just nearby artificial water sources, surrounded by forest. Foraging behavior was not observed but supposed to be similar to that of other small pipistrelles.

Pipistrellus javanicus (Gray, 1838)

Common names. Dơi muỗi Java; Javan pipistrelle; Яванский нетопырь.

Material studied. Twenty two specimens from Ha Tinh, Dak Lak provinces, T.P. Ho Chi Minh and 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; App. II, Table 7). 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.

For decades *P. abramus* was treated as a subspecies of *P. javanicus* (e.g. Koopman, 1994). However the two forms have different penial and bacular morphology and they are distinct genetically (Francis et al., 2010). Both species are reported to be sympatric in at least two Vietnamese localities: Vu Quang and Cat Ba Island (Kuznetsov et al., 2001; Vu Ding Thong, Furey, 2008). Moreover, there are two distinct genetic lineages (mtDNA) of *P. javanicus* in Indochina and thus there is possibility for presence of cryptic species in the complex.

DISTRIBUTION AND COLLECTING SITES. See Map 60. 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 Bac Kan, Phu Tho, Son La, Ninh Binh, Thanh Hoa, Nghe An, Quang Tri and Thua Thien–Hue provinces (Dang Huy Huynh et al., 1994; Dang Ngoc Can et al., 2008; some of northern records could be assigned to *P. abramus*); Cu Lao Cham Island in Quang Nam province (Kuznetsov, 2000), from Nam Cat Tien National Park (Hayes, in: Pham Nhat et al., 2001) and from Cat Ba Island (Vu Dinh Thong, Furey, 2008). We found this species in Vu Quang Nature Reserve (Kuznetsov et al., 2001), in Yok Don (Dak Lak province) and in Ho Chi Minh City, where this species is very abundant.

Map 60. *Pipistrellus javanicus.*

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 fifty six specimens from T.P. Hanoi (most of them collected by G.V. Kuznetsov, skulls not extracted) and 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; App. II, Table 7), 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.

Map 61. *Pipistrellus abramus.*

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. See Map 61. Distributed from the Russian Far East, Korea and Japan to southern China and Vietnam (Corbet, Hill, 1992; Tiunov, 1997). In Vietnam was reported

from Son La and Bac Kan ("Bac Thai") provinces and from Hanoi city (Dang Huy Huynh et al., 1994); from Cat Ba and Kaitien Islands (Kuznetsov, 2000; Vu Ding Thong, Furey, 2008); from Cuc Phuong National Park, Ninh Binh Province (Bates et al., 1997); from Thanh Hoa and Thua Thien-Hue provinces (Dang Ngoc Can et al., 2008) and from Vu Quang, Ha Tinh Province (Kuznetsov et al., 2001).

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*. We observed these pipistrelles in Hanoi for many time while they forage along the driveways nearby block buildings or drinking from the swimming pool. Foraging nearby streetlamps was also observed.

Pipistrellus tenuis (Temminck, 1840)

Common names. Dơi muỗi mắt; Least pipistrelle; Изящный нетопырь.

Material studied. Thirteen specimens from Quang Binh, Dak Lak, Binh Phuoc provinces and T.P. Hanoi.

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; App. II, Table 7). 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.

Koopman (1994) accepted the deviation of this species to *P. tenuis* and *P. mimus* Wroughton, 1899, and reported the latter species from Vietnam. This point of view was accepted by Dang Huy Huynh et al. (1994). Here we assigned all Vietnamese records to *P. tenuis*, because of uncertain distinctive characters of these species. Previously we wrote that, taking into account some difference between Hanoi and Vu Quang individuals, once may suppose occurrence of both species in Vietnam (Borissenko, Kruskop, 2003). However all the analyzed *P. tenuis* from different sited in Vietnam are genetically very similar (orig.).

Distribution and collecting sites. See Map 62. This complex taxon is often divided into several distinct species (e.g., Flannery, 1995); therefore dis-

Map 62. *Pipistrellus tenuis.*

tribution 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 Phuc and Quang Tri provinces (Dang Huy Huynh et al., 1994; as *P. mimus*), Ninh Binh province (Bates et al., 1997), Ha Tinh province (Kuznetsov et al., 2001), Lao Cai, Tuyen Quang, Bac Kan, Yen Bai and Hai Phong Provinces (Dang Ngoc Can et al., 2008). We found this bat also in Bu Gia Map (Kruskop, 2010a), in Hanoi city, in Yok Don National Park and in the vicinity of Dong Hoi.

Comments on natural history. Probably characteristic of agricultural and heavily disturbed landscape (including cities, e.g., Hanoi), where it may prove to be abundant. Nearby Dong Hoi two males were captured in coastal *Casuarina* plantations. The only known specimen from Bu Gia Map was captured over the forest clearing were it could penetrate from agricultural lands via the road. However in Yok Don these bats were netted and observed in pristine dry dipterocarp forest. 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. Forty four specimens from Khanh Hoa, Lam Dong, Lao Cai and Dak Lak provinces.

Identification. A small vespertilionid bat (weight ca. 4.3–8.3 g, forearm ca. 33–34.1 mm, CCL ca. 11.7–12.2 mm; App. II, Table 7). 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. Though the border between latter species and *P. coromandra* is not absolutely clear, the two species are well divided by mtDNA sequences.

Distribution and collecting sites. See Map 63. 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 report 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 Kan, Thai Nguyen, Vinh Phuc, Ha Noi, Nghe An, Quang Tri, Thua Thien-Hue, Da Nang, Quang Nam, Khanh Hoa, Dak Lak, Lam Dong and Dong Nai provinces (Dang Huy Huynh et al., 1994; Dang Ngoc Can et al., 2008). Known from Nam Cat Tien National Park (Hayes, in: Pham Nhat et al., 2001). We found this bat on Hon Ba mountain, on Da Lat plateau and on Chu Yang Sin (Khanh Hoa, Lam Dong and Dak Lak provinces), where it seems to be very abundant; and on Hoang Lien Son mountain range (Kruskop, Shchinov, 2010).

Map 63. *Pipistrellus coromandra.*

Comments on natural history. Hitherto found in primary and secondary forest formations at high altitudes (up to 2000 m). In Hoang Lien Son adult males were recorded in disturbed mountainous forest at *ca*. 1900–2000 m a.s.l., while females and immatures were common in highly disturbed and agricultural landscapes at ca. 1300 m a.s.l. The flight pattern is typical of pipistrelles, fast and maneuverable. On Da Lat Plateau foraging was observed at ca. 8–12 above land or water surface. The echolocation signal is high-intensity FM with maximum energy around 40–42 kHz.

Genus *Glischropus* Dobson, 1875

General characteristics. Small pipistrelle-like vespertilionid bats with pads on thumbs and hind feet.

Diagnosis. Skull on Fig. 62. 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. 28e), 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. Three species are currently recognized, one of them occurs in Vietnam (Csorba, 2011).

Glischropus bucephalus Csorba, 2011

Common names. Dơi muỗi ngón lớn; Thick-thumbed pipistrelle; Толстопалый нетопырь.

Material studied. Thirty three specimens from Lam Dong and Binh Phuoc provinces.

Identification. A small *Pipistrellus*-like bat (weight ca. 4–5 g, forearm ca. 33–36 mm, CCL ca. 11.7–12.2 mm; App. II, Table 7) with moderately-sized pads on thumbs. Lobe on the calcar is well-developed. Ear and tragus are as in *Pipistrellus*. Pelage is 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*), absence of pads on feet and less flattened skull.

This bat was for long time known as *G. tylopus* (Corbet, Hill, 1992; Simmons, 2005; Francis, 2008). However recent studies have shown that animals living north from the Isthmus of Kra should be treated s a separate species (Csorba, 2011).

Distribution and collecting sites. See Map 58. Inhabited Thailand, Myanmar, Cambodia and Southern Vietnam (Corbet, Hill, 1992; Csorba, 2011). In Vietnam was found by us in Cat Loc and Loc Bao (Lam Dong province) and Bu Gia Map (Binh Phuoc province), also reported for Vinh Cuu (Dong Nai province; Nguyen Trong Son et al., 2009).

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*. In Bu Gia Map these bats represent the most numerous species in the vicinity of bamboo growths, at ca. 500–530 m a.s.l. They were captured mainly over road but also over the bed of forest stream. In Loc Bao these bats were not

numerous but quite common on the cuttings and clearings in disturbed primary evergreen forest. Lactating females were reported in the second half of April.

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 occipital 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 (Corbet, Hill, 1992; Smith, Xie, 2008; Francis, 2008).

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 Vespertilioninae. 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). According to genetic data, *Nyctalus* s. str. is also closely related to *Pipistrellus* (e.g. Roehrs et al, 2010). 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 externally to *Scotophilus kuhlii*, 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.

This species complex very probably includes more than one species; at least Japanese *N. furvus* and Chinese *N. plancei* are often treated as separate species (Simmons, 2005). Since we have examined no specimens from Indochina, we can not convincingly affirm Indochinese population to exact form. Until the examination of the original material we suggest to cite Vietnamese noctule as *N.* cf. *noctula*.

Distribution and collecting sites. *Nyctalus noctula* species complex is distributed through temperate and semiarid zone of Palaearctic and north of Indo-Malayan region (Corbet, 1978; Corbet, Hill, 1992; Francis, 2008). *N. plancei* is treated to be endemic of eastern and southern China (Smith, Xie, 2008) but, probably, exist in north of Indochina. In Vietnam this species possibly inhabit middle elevations close to Chinese and Lao borders (Corbet, Hill, 1992). No exact localities were cited by Dang Ngoc Can et al. (2008).

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 with myotodont lower molars.

Diagnosis. Skull on Fig. 63. Dental formula: $I^{2}/_{3}$ $C^{1}/_{1}$ $P^{1-2}/_{2}$ $M^{3}/_{3}$ ×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 usually without supplementary cusps (except of "*joffrei*" species group). 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 or strongly bifurcated at base with thick basal projections and variably widened (sometimes bulbous) at tip (Hill, Harrison, 1987; Volleth, 1989; Fig. 25m); in H. joffrei bacular morphology different than in other species (Fig. 25p).

Distribution. Southern Palaearctic, most of Africa and Indomalayan region south to Lesser Sunda Islands.

Natural history. Fast and maneuverable aerial foragers, essentially similar to pipistrelles or even small noctules 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; Volleth, Heller, 1994; Horacek, Hanak, 1985–86). According to molecular genetic data they are obviously distant from the Pipistrellina brunch (Hoofer, Van den Busche, 2003; Roehrs et al., 2010). The "*joffrei*" species group definitely differs from all other *Hypsugo* and probably should be allocated to distinct genus. As accepted here, *Hypsugo* includes ca. 15 species, divided into several species groups. At least four species occur in Vietnam.

Key to the species of Vietnamese *Hypsugo*

External characters

1 Forearm less then 38 mm. Fifth metacarpal equal or slightly smaller in length than fourth and third **2**

– Forearm 38 mm or more. Fifth metacarpal distinctly shorter than fourth and third ..... *H.* cf. *joffrei* (p. 218)

2 Dorsal pelage essentially black, tipped with golden-brown. Ears lacking any cartilaginous ridges on posterior edge, sometimes with pale margins .. .. *H. pulveratus* (p. 216)

– Pelage paler, not tipped with golden or buff-brown. Ears with cartilaginous ridges on posterior edge, though sometimes poorly seen; never have pale margins **3**

3 Pelage grayish-brown, wing membranes and ears relatively pale ....*H. sp.* [*H. cf. lophurus*] [11]

– Pelage deed chestnut-brown, wing membranes and ears dark-colored .... *H. cadornae* (p. 217)

Cranial characters

1 Upper canine with more or less straight posterior edge. Inner upper incisor about 3/2 of outer one in crown area.....**2**

– Upper canine with more or less distinct additional cusp on posterior edge. Inner upper incisor no less then twice exceed outer one in crown area ....*H.* cf. *joffrei* (p. 218)

2 Anterior upper premolar similar in crown area to corresponding outer incisor; it is displaced inward the tooth row, but usually seen in lateral view ... . *H. cadornae* (p. 217)

– Anterior upper premolar no more than 1/2 of outer incisor in crown area, usually entirely covered in lateral view behind the canine base **3**

3 Upper skull profile slightly but visibly concaved. Nasal opening expanding backward to the level of midline of upper canine root .... *H. pulveratus* (p. 216)

– Upper skull profile straight. Nasal opening expanding backward over the level of canine root, almost to the anterior edge of anterorbital foramina ... .*H. sp.* [*H. cf. lophurus*][11]

***Hypsugo pulveratus* (Peters, 1871)**

Common names. Dơi muỗi Trung Quốc; Chinese pipistrelle; Китайский кожановидный нетопырь.

Material studied. One adult female from Quang Binh province.

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, invis-

[11] – See comments under *H. pulveratus*.

ible 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.

There is another species of *Hypsugo* known from Vietnam, generally similar to *H. pulveratus*. It differs in duller, grayish, coloration, more straight upper skull profile and deeper nasal opening of the skull. This bat is currently known by few specimens from Dong Nai province and, though distinct from other Vietnamese *Hypsugo*, is still unnamed. It has some common traits with extralimital *H. kitcheneri* and *H. lophurus* however we were unable to make direct comparison.

Map 64. *Hypsugo cadornae* – black dots; *H. pulveratus* – black squares.

Distribution and collecting sites. See Map 64. 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, Bac Kan province, Cuc Phuong, Ninh Binh province (Bates et al., 1997); Phong Nha – Ke Bang National Park, Quang Binh province (Kruskop, 2000b); Pu Mat, Nghe An province and Bach Ma, Thua Thuen-Hue province (Dang Ngoc Can et al., 2008).

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. Five specimens from Lao Cai, Dong Nai and Tuyen Quang Provinces (ZMMU, ROM collections); one specimen from Laos (GMNH); the given description is also based 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; App. II, Table 7), of pipistrelle-like appearance, but with reduced calcar lobe. Ears broad with rounded tips. Tragus in height is slightly less than $^1/_2$ of very broad ear pinna and 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, proportionally smaller P^2.

Distribution and collecting sites. See Map 64. Sporadically in north-east India (west Bengal), northern Myanmar, Thailand, Laos and Vietnam (Robinson, Smith, 1997; Bates et al., 1997, 2000; Francis, 2008). In Vietnam it was reported from Cuc Phuong, Ninh Binh province, and Na Hang, Tuyen Quang province (Bates et al., 1997). We found this bat in Nam Cat Tien (Dong Nai province; Kruskop, 2011b) and on Hoang Lien Son (Lao Cai province; Kruskop, Shchinov, 2010).

Comments on natural history. Very few data are available for Vietnam. The specimen in Cuc Phuong was captured in disturbed environment, near the national park headquarters (Bates et al., 1997). In Lao Cai Province adult female was netted over a small stream in moderately disturbed montane forest, at the elevation of about 1950 meters a.s.l. In Nam Cat Tien one specimen was captured nearby the small water source on the edge of primary and secondary growth. In north-east Thailand remains of one specimen were found inside a cave (Robinson, Smith, 1997).

Hypsugo cf. *joffrei* (Thomas, 1915)

Common names. Dơi muỗi miến điện; Joffrei's pipistrelle; Нетопырь Жоффре.

Material studied. Four adult specimens from vicinity of Sapa (Lao Cai Province); the given description also follows Hill (1966).

Identification. A small vespertilionid bat (weight ca. 12 g.; forearm ca. 35.7–39 mm; CCL ca. 14.0–14.3 mm; App. II, Table 7), externally somewhat resembling very small noctule. Muzzle is wide, blunt and massive. Ears broad and rounded, with short and broad tragi. Dorsal pelage moderately long, very thick, velvety, dark chestnut brown; ventral side is paler. Naked parts are brown, somewhat paler than dorsal fur. Wings are narrow and pointed, with third metacarpal distinctly longer than fifth. Skull wide and robust, with distinct supraorbital projections. Upper canine large, with secondary cusp on

posterior blade. Upper small premolar present though minute and displaced from the toothrow.

In general appearance this species looks similar to *Hesperoptenus blanfordi* and extralimital *Philetor brachypterus*, distinguishing from the former by larger size and presence of upper small premolar and from the latter by myotodont lower molars. From *Pipistrellus ceylonicus* (the only "true" pipistrelle of comparable size in Vietnamese fauna) it differs by definitely more robust skull, shape of canines and type of lower molars; from other *Hypsugo* species – by robust skull and narrow wing. Shape of baculum in this bat is very specific and differs from all other known Vietnamese vespertilionines.

Distribution and collecting sites. This bat is currently known from type locality in Myanmar (Burma) (Hill, 1966; Francis, 2008); and from Hoang Lien Son mountains in Northern Vietnam (Kruskop, Shchinov, 2010).

Comments on natural history. Probably confined to forested biotopes at elevations over 1300 m a.s.l.. In Hoang Lien males were captured over a stream in humid primary forest at ca. 1900 m a.s.l., and single female was netted over a small river surrounded by mainly agricultural landscapes and secondary growth. According to visual observations this bat is typical aerial hawker with powerful high speed flight (Kruskop, Shchinov, 2010).

Genus *Tylonycteris* Peters, 1872

General characteristics. Very small vespertilionid bats with thumb and feet pads and characteristically flattened skull.

Diagnosis. Skull on Fig. 64. 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. *Tylonycteris* is 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 *Hesperoptenus blanfordi*, however, differing in the position of upper incisors, uneven pelage coloration, presence of pads on feet. Though this genus is very distinct in morphology from all other Vespertilionines, it supposed to be closely related to *Hypsugo* due to genetic data (Hoofer, Van den Busche, 2003; Roehrs et al., 2010).

Tylonycteris pachypus (Temminck, 1840)

Common names. Dơi chân đệm thịt; Lesser flat-headed bat, Club-footed bat; плоскоголовый кожанок.

Material studied. Nineteen specimens from Lam Dong, Dong Nai Binh Phuoc and Dak Lak provinces and from the T.P. Hanoi.

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; App. II, Table 7), 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.

Map 65. *Tylonycteris pachypus.*

Distribution and collecting sites. See Map 65. Distribution nearly coinciding with that of genus. Isolated locality is known in southwestern India; distributed from northeastern India to southern China, in 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 Dang Huy Huynh et al. (1994) from Lai Chau, Lao Cai and Kon Tum provinces. Later was captured in Pu Mat, Nghe An province (Hayes, Howard, 1998), Cat Tien NP, Dong Nai province (Hayes in Pham Nhat et al., 2001) and Cat Loc, Lam Dong province (Borissenko, Kruskop, 2003; Polet, Ling, 2004). Dang Ngoc Can et al. (2008) also reported this bat from Tuyen Quang, Son La, Phu Tho, Ninh Binh, Quang Thi, Thua Thien-Hue and Binh Dinh provinces. More recently we found this bat in Hanoi city, in Bu Gia Map (Binh Phuoc

province), in Loc Bao (Lam Dong province) and on Ch Yang Sin mountains. Apparently it should be expected to be common in areas with suitable habitats.

Comments on natural history. Within Cat Loc and Bu Gia Map this was one of 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 from the ground. Sometimes they formed rather dense aggregations. *T. pachypus* emit characteristic rather powerful tonal echolocation calls with maximal energy around 60 kHz. Pregnant females were observed in late April – early May; one from Cat Tien contained two embryos.

Tylonycteris robustula Thomas, 1915

Common names. Dơi rô bút; Greater flat-headed bat; Косолапый кожанок.

Material studied. Eight specimens from Binh Phuoc and Dong Nai provinces; the diagnosis below also follows 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; App. II, Table 7), in external appearance essentially similar to *T. pachypus*. Adhesive disc-shaped pad on the base of thumb seems to be better developed. Coloration is mid-brown, without any yellowish color on neck and throat.

The main differences from *T. pachypus* are in pelage coloration and deeper nasal emargination of skull; skull is larger and more massive.

Distribution and collecting sites. See Map 66. From easternmost India to Vietnam, peninsular Thailand, Sunda, Philippine Islands, Sulawesi and Timor. In Vietnam it is reported from Quang Tri province (Dang Huy Huynh et al., 1994) and Pu Mat, Nghe An province (Hayes in Pham Nhat et al., 2001). Dang Ngoc Can et al. (2008) also report this bat from Tuyen Quang, Bac Kan, Phu Tho, Ninh Binh, Thua Thien-Hue, Quang Nam and Kon Tum provinces. We found this species in Bu Gia Map (Binh Phuoc; Kruskop, 2010a) and in Nam Cat Tien, Dong Nai; in the same province it was also reported for Vinh Cuu by Son et al. (2009).

Map 66. *Tylonycteris robustula*.

Comments on natural history. Habits, supposedly, are essentially similar to those of *T. pachypus* (Medway, 1972; Bates, Harrison, 1997). However observations in Bu Gia Map shown that this species, commonly foraging as aerial hawker, may take food also from the ground. Two females captured in Bu Gia Map in late April were pregnant; one of them occasionally killed contained two large embryos.

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. 30 species, divided into two or three subgenera (Hill, Harrison, 1987; Pavlinov et al., 1995; Hoofer, Van den Busche, 2003; but see Artyushin et al, 2009). Despite the *Eptesicus* forming rather well bordered group, its interrelations with some other taxa still uncertain; some of them were formerly included in this genus under various ranks, namely *Arielulus* (Heller, Volleth, 1984) and *Neoromicia* (McBee et al., 1987). According to molecular genetic data, *Eptesicus* belongs to the same lineage as *Nycticeius* and *Scotomanes* (Roehrs et al., 2010) and therefore to Nycticeiini being the largest genus within this tribe.

One species is documented from Vietnam; however there is still possibility for finding of some additional species in future since there are at least two

additional species known from South-East Asia, namely *E. pachyotis* and *E. dimissus* (Francis, 2008).

***Eptesicus* cf. *serotinus* Schreber, 1774**

Common names. Dơi nâu; Serotine; Поздний кожан.

Material studied. One adult female from Phu Tho province (collection of HNHM); also thirty two individuals from Taiwan, South Korea and China (in collections of ROM, HNHM, ZMMU and NIBR).

Identification. A large vespertilionid bat (forearm in East Asian specimens ca. 48.2–55.8 mm; CCL ca. 18.4–20.6 mm; Vietnamese individual is the largest of measured). The ears are short, subtriangular in shape, with a moderate bluntly pointed tragus. Lobe on the calcar usually poorly developed. Pelage is dark brown above (almost black in the only examined Vietnamese specimen), 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. Another South Asian species of the genus *Eptesicus*, *E. pachyotis* (Dobson, 1871), hitherto known from north-east India, Myanmar and Thailand (Corbet, Hill, 1992; Francis, 2008), differs from *E. serotinus* by distinctly smaller size (forearm less than 40 mm; Lekagul, McNeeley, 1977).

There are preliminary evidences that serotines from East Asia belong to special genetic lineage, distinct from west Palaearctic *E. serotinus* s. str. (Artyushin et al., 2011); senior name for this lineage should be *andersoni* Dobson, 1871. Vietnamese specimen can be tentatively allocated to that taxon just on the geographical grounds. However, specific status of *E. andersoni* still awaits confirmation. Thus in this book we retain the name *serotinus* for the Vietnamese bats.

Distribution and collecting sites. See Map 67. *E serotinus* s. lato is widely distributed across the Palaearctic (Corbet, 1978). Eastern form ("*andersoni*") inhabits C., E. and N.-E. China, Taiwan, Korea, N.-E. India, Myanmar, Thailand and Laos (Corbet, Hill, 1992; Bates, Harrison, 1997; Francis, 2008;

Map 67. *Eptesicus* cf. *serotinus* – black dot; *Hesperoptenus blanfordi* – black squares; *H. tikkeli* – open squares.

Smith, Xie, 2008). Francis (2008) includes about half of North Vietnam to the species distribution. However, actually there is still only one known record from Phu Tho province (Dang Ngoc Can et al., 2008; G. Csorba, pers. comm.).

Comments on natural history. Aerial hawker with maneuverable powerful flight, nonetheless capable to take insects from ground or tree brunches. Seems to be very adaptive for different landscapes and environments. Echolocation signal lowed FM at 15–65 kHz with maximum energy at about 30 kHz. No data available for Vietnam but apparently similar to that from other territories.

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 were reviewed by G. Topal (1970). According to genetic data, it is supposed to be related with *Eptesicus* and *Scotomanes* (Hoofer, Van den Busche, 2003; Roehrs et al., 2010).

Ia io Thomas, 1902

Common names. Dơi iô; Great evening bat; Большой кожан, Бархатный кожан.

Material studied. No collection material from Vietnam was examined; four individuals from China (SDM collection).

Identification. A very large vespertilionid bat (weight ca. 50–63 g.; 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 and well-pigmented (the interfemoral membrane is paler below).

Distribution and collecting sites. See Map 68. Sporadically in Nepal (Csorba, 1996), Assam, southern China, Thailand, Laos and Vietnam (Corbet, Hill, 1992). In North Vietnam reported from Son La, Tuyen Quang, Bac Kan, Lang Son, Phu Tho and Ninh Binh provinces (Topal, 1970; Dang Huy Huynh et al., 1994; Dang Ngoc Can et al., 2008). Also found in Phong Nha – Ke Bang National Park (Timmins et al., 1999; Kruskop, 2000b; Hendrichsen et al., 2001).

Map 68. *Ia io.*

Comments on natural history. Slow flying medium to high-altitude aerial insectivore with characteristic heavy flight. Roosting is conferred to caves, where *I. io* forms small colonies of several individuals (Topal, 1970; Csorba et al., 1998). Following Topal (1970) this bat occurs at altitudes from 400 to 1700 m a.s.l., though in Phong Nha – Ke Bang bats wee recorded at ca. 200 m a.s.l. (Hendrichsen et al., 2001). Echolocations calls shallow FM, at 44–16 kHz, with maximum energy at ca. 24–30 kHz, sometimes audible to the unaided ear (Thabah et al., 2007). Diet in China consists mainly of insects (predominantly Coleoptera, followed up by Lepidoptera and Diptera), but in March and November also contains considerable number of small birds (ibid.).

Genus *Arielulus* Hill, Harrison, 1987

General characteristics. Small to medium-sized vespertilionid bats, similar to *Eptesicus* and *Hypsugo*, with very distinctive coloration.

Diagnosis. 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 are 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 copper) 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. Not well 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*; but see commnets under *Thainycteris*.

Arielulus circumdatus (Temminck, 1840)

Common names. Dơi muỗi đen; Black gilded serotine; Бронзовый кожанок.

Material studied. Eleven specimens from Lam Dong, Khanh Hoa and Quang Nam provinces (ZMMU and ROM collections).

Identification. A medium-size vespertilionid bat (weight ca. 8–11 g, forearm ca. 39.4–43.5 mm, CCL ca. 14.8–15.2 mm; App. II, Table 7) with distinct coloration pattern. In general appearance somewhat resembling serotines, but with more broad and short muzzle and very distinct pelage. Ear moderate in size, 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 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.

Map 69. *Thainycteris aureocollaris* – black dots; *Arielulus circumdatus* – black squares.

This species could be easily distinguished from all other Vietnamese bats by the unique combination of cranial characters and characteristic color pattern. From generally similar *Hypsugo pulveratus* it differs by more prominent orange tips on dorsal pelage, whitish ear margins and larger size, from *Thainycteris aureocollaris* – by smaller size, dorsal coloration and lacking of yellowish “collar”. Available specimens

from Vietnam differ from Nepalese in somewhat smaller external size and less red tinge in pelage coloration.

Distribution and collecting sites. See Map 69. 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 *A. circumdatus* was found by us in Vu Quang (Kuznetsov et al., 2001; first published record), on Da Lat plateau (Abramov et al., 2009) and on Hon Ba mountain (Borissenko et al., 2006).

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 Da Lat plateau these bats were recorded in primary mixed (broad-leafed and coniferous) forest at ca. 1400–1700 m a.s.l. Animals were usually observed soon after sunset, foraging along the forest edges or over clearings and corn fields at about 5–20 m above the ground. Flight is fast and moderately maneuverable. Echolocation signal is lowed FM with maximum energy at ca. 30 kHz. Day roosts were not found but most probably situate somewhere in primary forest. Feaces contain fragments of thick chitin, sometimes – of bright green color, demonstrating presence of middle-size *Anomala* beetles in the *Arielulus* diet (Borissenko et al., 2006; Abramov et al., 2009).

Genus *Thainycteris* Kock, Storch, 1996

General characteristics. Medium-sized vespertilionid bats, similar to *Eptesicus* and *Arielulus*, with very distinctive coloration.

Diagnosis. Skull on Fig. 65. Dental formula: $I^{2}/_{3}$ $C^{1}/_{1}$ $P^{1-2}/_{2}$ $M^{3}/_{3} \times 2$ = 32–34. Small upper premolar usually absent or tiny and completely unseen in lateral view. Inner upper incisor large, about half of corresponding canine in height, virtually unicuspide; outer upper incisor tiny, scarcely exceeds cingulum of inner incisor in height, partly hidden in gum. Upper canine without supplementary cusps. Posterior upper molar not reduced. Lower molars are of myotodont-type. Skull with very broad and massive rostrum. Supra-orbital crests well-developed, continuous out of skull profile into large supra-orbital projections. Coloration of dorsal pelage very distinctive, almost black with bright silver and golden hair tips. Fur on throat and sides of neck forms yellowish collar, contrasting to other dark coloration. Baculum small, triangular in shape, with elongated main shaft, ventrally concave, without basal notch (Eger, Theberge, 1999).

Distribution. Restricted to mountainous areas of Thailand, Cambodia and Vietnam; probably also Taiwan.

Natural history. Poorly known. Fast-flying high to medium-altitude aerial insectivores, confined to primary and secondary forest formations.

Taxonomical remarks. *Thainycteris* was described from Thailand as a new genus and species (Kock, Storch, 1996). Soon after that it was synonymized with *Arielulus* on the basis of generally similar craniodental features (Csorba, Lee, 1999). However, provisional molecular data demonstrate that *Arielulus* s. str. and *Thainycteris* could be genetically distant (Francis et al., 2010), thus until further studies we prefer to treat *Thainycteris* as a separate genus. It is regarded as monotypic, but *Arielulus torquatus* from Taiwan (Csorba, Lee, 1999) seems to be more similar with this genus rather than to *Arielulus* s. str.

Thainycteris aureocollaris Kock, Storch, 1996

Common names. Dơi muỗi cổ vàng; Collared serotine; Ошейниковый кожан.

Material studied. Two specimens Ha Tinh and Lao Cai provinces.

Diagnosis. Relatively large bat (weight ca. 13–15.5 g, forearm ca. 47–52 mm, CCL ca. 16.8 mm; App. II, Table 7), serotine-like in general appearance. Pelage relatively long, almost black, conspicuously tipped on back with mix of silver and pale-gold guard hairs. Throat, chin 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. Upper skull profile is almost straight. Deep medial depression situated between these crests, in the part of their bifurcation. Upper small premolar absent or very tiny, in some individuals present only on one side. Dentition in general robust and massive.

In pelage coloration among Vietnamese bats *Thainycteris* to some extant resembles only *Arielulus circumdatus* which is much smaller. In skull shape it differs from *Eptesicus* species by smaller outer upper incisor and from *Scotomanes ornatus* – by presence of outer upper incisor; from both by pronounced medial rostral depression and supra-orbital projections.

Distribution and collecting sites. See Map 69. Indo-Chinese species, found in Thailand, Cambodia and Vietnam (Kock, Storch, 1996; Eger, Theberge, 1999). In Vietnam it was found in Na Hang (Tuyen Quang province), Vu Quang (Ha Tinh province), Bach Ma (Thua Thien-Hue province), Tam Dao (Vinh Phuoc province) and Hoang Lien (Lao Cai province) (Eger, Theberge, 1999; Kuznetsov et al., 2001; Dang Ngoc Can et al., 2008; Kruskop, Shchinov, 2010).

Comments on natural history. Probably confined to primary or moderately disturbed forest habitats in mountain areas (Eger, Theberge, 1999); all Vietnamese specimens (males) captured over streams. Supposedly a fast-flying aerial insectivore (Borissenko et al., 2001). Roosting habits unknown.

Genus *Hesperoptenus* Peters, 1868

General characteristics. Small to large serotine-like vespertilionid bats with characteristic position of upper incisors.

Diagnosis. Skull on Fig. 66. Dental formula: $I^2/_3$ $C^1/_1$ $P^1/_2$ $M^3/_3 \times 2 = 32$. Upper small premolar absent. Outer upper incisor greatly reduced, equal in height to cingulum of inner incisor, and situated almost directly behind it (Fig. 28g). Inner upper incisor large, unicuspid. Upper canine without supplementary cusps. Anterior and middle lower molars are of myotodont type; with talonids exceed trigonids 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 medium-speed aerial insectivores.

Taxonomical remarks. Five species are currently recognized, divided into two subgenera. Two species of subgenus *Milithronycteris* occur in Vietnam.

Hesperoptenus tickelli (Blyth, 1851)

Common names. Dơi răng cửa to; Tickell's bat; Кожан Тикелля.

Material studied. Three specimens from Dak Lak province; also one specimen from India.

Diagnosis. A medium to large-sized vespertilionid bat (weight ca. 16–20 g, forearm ca. 50–61 mm, CCL ca. 17.2–19.6; App. II, Table 7), most similar in external appearance to *Eptesicus* and *Scotophilus*. No pads on thumbs or feet; calcar with poorly developed lobe. Ears short, subtriangular 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* and *Scotophilus* – by pelage coloration and the presence of second upper incisor.

Distribution and collecting sites. See Map 67. Indian species of middle elevations. Sri Lanka and Andaman islands, Indian peninsula to Myanmar, Thailand and Cambodia (Corbet, Hill, 1992; Francis, 2008). In Vietnam was reported from Kon Cha Rang, Gia Lai province (Hendrichsen et al., 2001). We found this bat in Yok Don (Dak Lak province).

Comments on natural history. Aerial insectivore roosting in tree canopy (Bates, Harrison, 1997) or, probably, in hollow trees (Francis, 2008). Forages presumably over canopies. In Yok Don two individuals were netted near the artificial pool in the patch of *Lagerstroemia* forest.

Hesperoptenus blanfordi (Dobson, 1877)

Common names. Dơi răng cửa nhỏ; Blanford's bat; Кожан Бланфорда.

Material studied. Eleven specimens from Dong Nai and Ba Ria – Vung Tau provinces and from Phu Quoc Island.

Identification. A very small bat (weight ca. 5.9–6.7 g, forearm ca. 25–28 mm, CCL ca. 11.8 mm; App. II, Table 7), in general appearance similar to *Tylonycteris.* Thumbs with well developed pads, but no pads on feet. Pelage mid-brown with pale tinges to dark-brown above, paler on underparts. Fur looks very smooth, with silk shine. Forearm looks proportionally short in respect to body size. 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 position, poor development of feet pads, and by well developed calcar lobe with transverse septum.

Distribution and collecting sites. See Map 67. Southern Burma and Thailand, whole Malacca peninsula, also on northern Borneo (Corbet, Hill, 1992). In Indochina was first found in Cambodia by V. Matveev (Matveev, 2005; voucher specimens revised). In Vietnam it is known from the former Ma Da forestry, Dong Nai Province (Borissenko, Kruskop, 2003), Phu Quoc Island (Abramov et al., 2007), Nam Cat Tien and Bing Chau (Dong Nai and Ba Ria – Vung Tau provinces, original data).

Comments on natural history. Specimen in Ma Da was captured in a heavily disturbed agricultural landscape, over a shore of Ma Da river. In Cat Tien bats were observed over the abandoned quarry and over the grassland. The flight is fast and maneuverable, ca. 7–15 m above the ground, usually in open places. Roosting habits unknown, the presence of thumb pads and pelage structure suggests adaptations towards clinging to smooth surfaces. Pregnant female was recorded in Cat Tien in the end of April.

Genus *Scotomanes* Dobson, 1875

General characteristics. Large vespertilionid bat with characteristic coloration pattern.

Diagnosis. Skull on Fig. 67. 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 molar reduced. Anterior and middle lower molars of myotodont-type, with talonid larger than trigonid. Anterior palatal emargination small, not projected backward beyond the level of canines. 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.

Formerly this genus was treated to be closely related with other vespertilionines with single pair of upper incisors (in particular with *Scotophilus*; Koopman, 1994; Simmons, 2005). According to genetic data, this genus is closely related to *Ia* and *Eptesicus* (Roehrs et al., 2010).

Scotomanes ornatus (Blyth, 1851)

Common names. Dơi đốm hoa; Harlequin bat; Гладконос-арлекин, украшенный гладконос.

Material studied. Twelve specimens from Ha Tinh, Quang Binh, Tuyen Quang, Ha Noi and Lam Dong provinces (ZMMU and ROM); also one specimen from Nepal was examined.

Diagnosis. A large vespertilionid bat (weight ca. 23–39 g; forearm 50–64 mm; CCL ca. 19.4–19.9 mm; ; App. II, Table 7), 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 heathii* 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. See Map 70. Himalayan species of middle altitudes, distributed from Central Nepal (Csorba et al., 1998) to South China and Vietnam (Francis, 2008). In Vietnam it was found in middle

Map 70. *Scotomanes ornatus.*

elevations in Lao Cai (Hoang Lien), Tuyen Quang (Na Hang), Bac Kan (Ba Be), Lang Son (Huu Lien), Vinh Phuc (Tam Dao), Ninh Binh (Cuc Phuong), Gia Lai (Kon Ha Nung, Kon Ha Rang), Thua Thien-Hue (Bach Ma), Ha Tinh (Vu Quang), Quang Binh (Phong Nha – Ke Bang), Binh Ding and Lam Dong (Bi Doup) provinces (Dang Huy Huynh et al., 1994; Hendrichsen et al., 2001; Kuznetsov et al., 2001;Kruskop, 2000b; Dang Ngoc Can et al., 2008; Abramov et al., 2009).

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 species seems very abundant at certain localities (e.g., Vu Quang, Da Lat plateau) 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. Feacal pellets contain fragments of thick chitin, sometimes – of bright green color, demonstrating presence of middle-size *Anomala* beetles in the *Scotomanes* diet (Abramov et al., 2009).

Genus *Scotophilus* Leach, 1821

General characteristics. Large vespertilionid bats, externally similar to *Eptesicus* and *Nyctalus*, with characteristic dentition.

Diagnosis. Skull on Fig. 68. 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 are of myotodont type, with trigonids equal or exceed talonids 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. Twelve to fourteen species are currently recognized (Robbins et al., 1985; Bates, Harrison, 1997; Simmons, 2005; Vallo et al., 2011), two of which occur in Vietnam.

Scotophilus heathii Horsfield, 1831

Common names. Dơi nghệ; Greater Asiatic yellow bat; Большой домовый гладконос.

Material studied. Nine specimens from Ha Noi, Dak Lak, Ba Ria – Vung Tau and Soc Trang provinces (ZMMU and ROM).

Identification. A large vespertilionid bat (weight ca. 37–46 g; forearm 54–69 mm; CCL ca. 20.7 mm; App. II, Table 7), externally similar to *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. See Map 71. Trans Indomalayan species, which probably concerned with human buildings. Distributed from Afghanistan and western India to South-East China and Indochina (Corbet, Hill, 1992). In Vietnam it was reported from Cao Bang, Thai Nguyen, Vinh Phuc, Ninh Binh, Quang Tri, Thua Thien-Hue, Kon Tum, Gia Lai, Dak Lak, Lam Dong and Khanh Hoa provinces, on Phu Quoc Island and also in cities of Hanoi and Ho Chi Minh (Dang Huy Huynh et al., 1994; Dang Ngoc Can et al., 2008). We captured S. heathii in Ba Ria – Vung Tau (Binh Chau) and Dak Lak (Yok Don) provinces and also observed tentatively this species in Ke-Bang (Kruskop, 2000b) and in Hanoi. Examined specimen in ROM collection came from Soc Trang province.

Map 71. *Scotophilus heathii.*

Comments on natural history. This is a high to medium altitude fast flying aerial hawker (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 kuhlii Leach, 1821

Common names. Dơi nâu; Lesser Asiatic yellow bat; Азиатский домовый гладконос.

Material studied. Nine specimens from Lam Dong, Dong Nai and Ba Ria – Vung Tau provinces and from T.P. Ho Chi Minh; eleven additional specimens from Sumatra and the Philippine Islands were examined (in ZMMU collection).

Identification. Medium-size vespertilionid bat (weight ca. 16–25 g; forearm 45–55 mm, CCL ca. 18.5 mm; App. II, Table 7). Similar to *S. heathii* in most external and cranial characteristics but definitely smaller. Apart from size, differ by buff-brown ventral pelage without yellowish tints. From *Nyctalus* this species differs, like *S. heathii*, by one pair of upper incisors, lacking the calcar lobe and shape of ear and tragus.

Map 72. *Scotophilus kuhlii.*

Distribution and collecting sites. See Map 72. 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 Tuyen Quang, Bac Kan, Land Son, Ha Tinh, Quang Binh, Quang Tri, Quang Ngai, Thua Thien-Hue, Kon Tum, Lam Dong and Kien Giang provinces and in T.P. Hanoi and Ho Chi Ming, including Ca Mau (Dang Huy Huynh et al., 1994; Dang Ngoc Can et al., 2008). According to Corbet and Hill (1993), inhabiting all the territory of Vietnam. We captured this species in Ho Chi Minh City, in Nam Cat Tien (Dong Nai province) and in Binh Chau (Ba Ria – Vung Tau province) 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 roosts, forming colonies of several to hundreds of individuals. In flight they emit high intensity FM echolocation signals; vocalizations often can be audible to the unaided ear. The flight pattern is similar to that of *S. heathii*; however the latter is conspicuously larger, especially noticeable by comparison.

Family Miniopteridae Dobson, 1875

Common names. Họ dơi cánh; Bent-winged bats; Длиннокрыловые.

General characteristics. Small to medium-sized plain-nosed bats, related to family Vespertilionidae, with characteristically elongated distal phalanx of the third digit. Diagnosis and distribution are given in the description of the single genus.

Taxonomical remarks. Contains only one genus, *Miniopterus*. This group was formerly treated as a subfamily of Vespertilionidae (Koopman, 1994); however their higher status was supposed because of specific dental features (Mein, Tupinier, 1977) and that was confirmed by recent genetic studies (Miller-Butterworth et al., 2007; Lack et al., 2010).

Genus *Miniopterus* Bonaparte, 1837

General characteristics. Small to medium-sized bats with characteristically inflated braincase and elongated distal phalanx of the third digit. Contains species very similar in external appearance, differing predominantly in size.

Diagnosis. Skull on Fig. 69. 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. 37). 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 inflated 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. 38). Proximal part of interfemoral

Fig. 37. First left upper molar of *Miniopterus*; hb — hypocone basin.

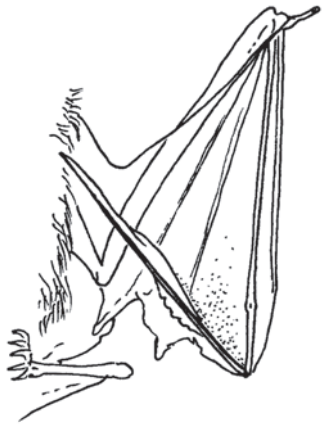


Fig. 38. Folded left wing of *Miniopterus* in ventral view.

membrane covered dorsally with thick hairs up to the end of the first or second tail vertebra and to the midst of femurs.

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. Recent studies (Appleton et al., 2004; Tian et al., 2004; Juste et al., 2007) have revealed distinctly higher taxonomic diversity within the genus than it was thought previously. More then twenty species are currently recognized, not divided neither into subgenera or even into species groups; status of many forms needs revision. Three, 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*[12] (p. 238)

– 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 fuliginosus* (p. 236)

– 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. 239)

Miniopterus fuliginosus (Hodgson, 1835)

Common names. Dơi cánh dài; Eastern bent-winged bat; Восточный длиннокрыл.

Material studied. Four specimens from Lao Cai province; also three specimens from Nepalese Himalayas and one male from South Korea.

[12] See comments under *M. pusillus* for its distinction from extralimital *M. australis*.

Identification. A medium-sized bent-winged bat (weight ca. 11.1–17.5 g; forearm ca. 45–59 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; App. II, Table 8), of typical appearance. Pelage soft and thick, 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. Frontal part of skull less abruptly elevated than in other Vietnamese species.

From other representatives of the genus this species differs in minor external and dental features, mainly by skull dimensions. Formerly this bat was treated as a subspecies (or group of subspecies) within common bent-winged bat, *M. schreibersii* (Koopman, 1994; Bates, Harrison, 1997; Borissenko, Kruskop, 2003) which thus thought to be an Old World cosmopolitan species. Recently paraphily of *M. schreibersii* s. lato was shown on molecular genetic grounds (Appleton et al., 2004; Tian et al., 2004; Kruskop et al., 2007; Francis et al., 2010) and *M. fuliginosus* was regarded to be a separate species, more closely related to *M. magnater* and other S.-E. Asian *Miniopterus* than to *M. schreibersii* (see also Kruskop et al., 2012).

Distribution and collecting sites. See Map 73. Asia from India to Japan, Korea, Russian Far East, E. China, Vietnam and Thailand (Corbet, Hill, 1992; Bates, Harrison, 1997; Francis, 2008). According to Corbet and Hill (1992), its distribution area covers the almost whole territory of India and S.-E. Asia. Dang Huy Huynh et al. (1994) reported it (as *M. schreibersii*) for Lao Cai, Ha Giang, Ninh Binh and Lam Dong provinces. According to Dang Ngoc Can et al. (2008) this species also occurs Tuyen Quang, Bak Kan, Lang Son, Son La, Phu Tho, Nghe An and Thua Thien-Hue provinces. *Miniopterus* record from Cat Ba Island (Vu Dinh Thong, Furey, 2008) most likely belongs to this species (Vu Dinh Thong, 2008). There is possibility that the southernmost record in Lam Dong was based on misidentified *M. magnater*.

Map 73. *Miniopterus fuliginosus.*

Comments on natural history. Strong and fast flyer foraging in the air at canopy level or above trees. Colonies usually occur in caves and rock caverns. Appears to favor hilly and forested areas from ca. 600 to more than 2100 m a.s.l. (Bates, Harrison, 1997). In Hoang Lien bats were netted and observed over the river in montane forest at ca.

1900–2000 m (Kruskop, Schinov, 2010). Females captured in middle May were pregnant.

Miniopterus pusillus Dobson, 1876

Common names. Dơi cánh dài nhỏ; Nikobar bent-winged bat; Никобарский длиннокрыл.

Material studied. Six specimens from Lam Dong and Dak Lak provinces.

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; App. II, Table 8), in general appearance similar to *M. fuliginosus*. 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. fuliginosus* this species could be distinguished by overall smaller size, several skull dimensions and slightly more haired interfemoral membrane.

A similar-sized species provisionally reported from Vietnam (Cuc Phuong; Ninh Binh Province; Dang Ngoc Can et al., 2008; B. Hayes, pers. comm.) is *M. australis*, which is distinguished by shorter tibia (ca. 11–13 mm) and also by on the average larger skull size (CBL ca. 12.7–14.0 mm; C–M^3 ca. 4.7–5.7 mm; M3–M3 ca. 5.1–6.0 mm [forearm ca. 34–40 mm]), however, its previously known distribution range (Philippines and the eastern Sunda Islands) indicates the possibility for erroneous identification of Vietnamese specimens.

Map 74. *Miniopterus pusillus* – black dots; *M. magnater* – black squares.

Distribution and collecting sites. See Map 74. 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 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 (Borissenko, Kruskop, 2003). Dang Ngoc Can et al. (2008) also reported this bat from Ninh Binh, Bin Dinh and Gia Lai Provinces. Recently we found this specie in Chu Yang Sin (Dak Lak province).

Comments on natural history. Not well known. In Cat Loc the colony this species (probably few hundred individuals) was found in a mixed cave col-

ony of bats (together with *M. magnater* and *Hipposideros grandis*). The bats were perching on exposed parts of the walls and ceiling, together with another species of bent-winged bat (*M. magnater*). In Chu Yang Sin single individual was hand netted while foraging over the trail in mixed broad-leafed and pine forest at ca. 700 m a.s.l.

***Miniopterus magnater* Sanborn, 1931**

Common names. Dơi cánh dài lớn; Western bent-winged bat; Большой длиннокрыл.

Material studied. Fourteen specimens from Lam Dong province.

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; App. II, Table 8). 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. fuliginosus*, from which it differs mainly by some larger skull dimensions.

Distribution and collecting sites. See Map 74. Sporadically from northern Myanmar and Hainan to Malacca, Great Sunda Islands, Timor, the Moluccas, New Guinea and Bismarck Islands (Corbet, Hill, 1992). In Vietnam it was found in Nam Cat Tien, Dong Nai province (Hayes, in Pham Nhat et al., 2001; Polet, Ling, 2004), in Cat Loc and in Bi Doup – Nui Ba, Lam Dong province (Borissenko, Kruskop, 2003; Abramov et al., 2010). It is also reported from Quang Tri and Thua Thien-Hue provinces (Dang Ngoc Can et al., 2008).

Comments on natural history. In Cat Loc representatives of this species composed the bulk of the mixed cave colony (together with *M. pusillus* and *Hipposideros grandis*), 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. On Dalat Plateau remains of this bat were found on the road; probably the animal was killed by vehicle while foraging over road cover.

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. *Tadarida* of the "*teniotis*" species group inhabit all the southern China close to the Vietnamese border (Corbet, Hill, 1992; Smith, Xie, 2008) and also known from Laos (Francis, 2008). Probably any of those species also inhabits the highlands of north Tonkin (Sokolov et al., 1986; Huynh et al., 1994; Kruskop,

Shchinov, 2010). Wroughton's free-tailed bat, *Otomops wroughtoni*, was recently found in Cambodia (Walston, Bates, 2001).

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. 242)

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 insignis, T. latochei*

– 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. 242)

– 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 insignis, T. latochei*

Genus *Chaerephon* Dobson, 1874

General characteristics. Medium-sized to large bats with general appearance typical to Molossidae.

Diagnosis. Skull on Fig. 70. 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.

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*. Eighteen species are currently recognized (Simmons, 2005); however since Chaerephon is thought now to be paraphyletic (Lamb et al., 2011), number of species could be greatly changed.

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 is 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 is 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 in Hanoi City (Dang Huy Huynh et al., 1994) and in Bac Kan (Ba Be) and Phu Tho (Xuan Son) provinces (Dang Ngoc Can et al., 2008), but very probably gas much more extand distribution.

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, A.V. Borisenko, pers. comms.). The echolocation signal is quite powerful with a shallow FM component around 30 kHz.

Appendix I

Skulls of selected Vietnamese Chiroptera

[lateral (left) and ventral view]

Fig. 39 Skull of *Pteropus vampyrus* ROM MAM-110948 (scale bar 5 mm).

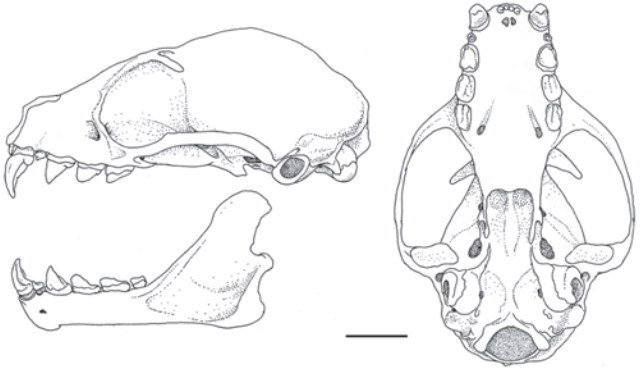


Fig. 40. Skull of *Cynopterus brachyotis* ZMMU S-173453 (scale bar 5 mm).

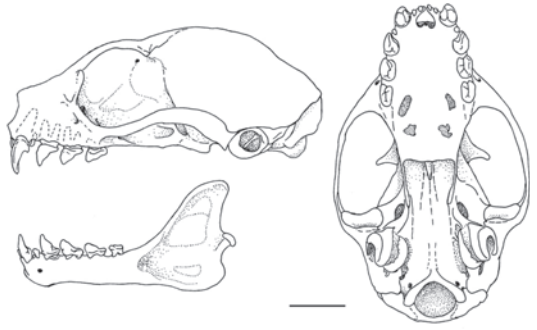


Fig. 41. Skull of *Megaerops niphanae* ZMMU S-168329 (scale bar 5 mm).

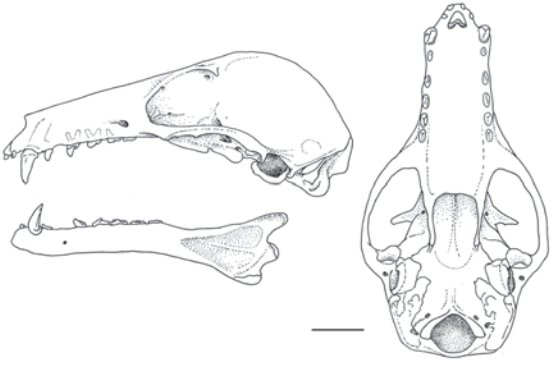


Fig. 42. Skull of *Macroglossus sobrinus* ZMMU S-167143 (scale bar 5 mm).

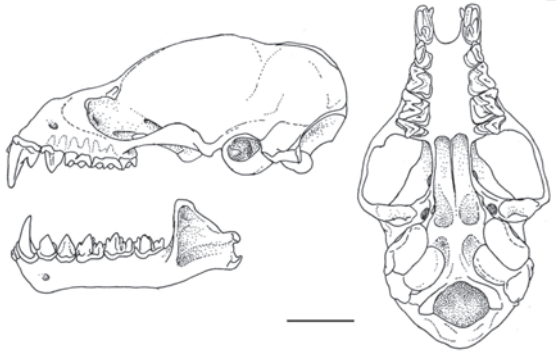


Fig. 43. Skull of *Megaderma spasma* ZMMU S-101654 (scale bar 5 mm).

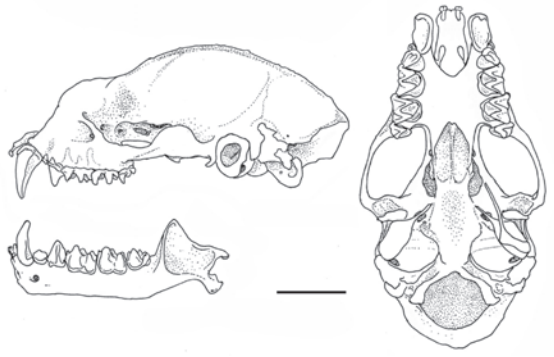


Fig. 44. Skull of *Hipposideros grandis* ZMMU S-189220 (scale bar 5 mm).

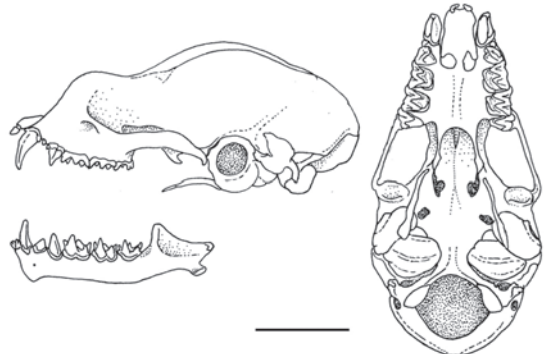


Fig. 45. Skull of *Hipposideros pomona* ZMMU S-167174 (scale bar 5 mm).

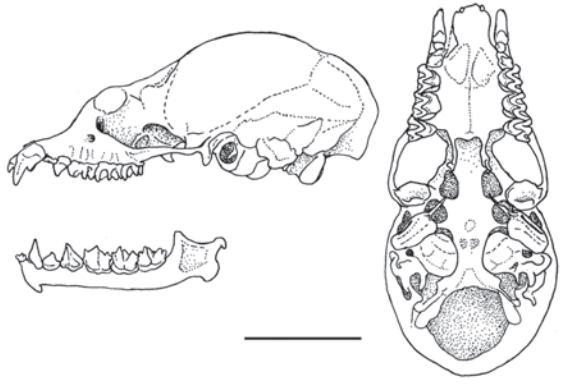


Fig. 46. Skull of *Coelops frithii* ZMMU S-164993 (scale bar 5 mm).

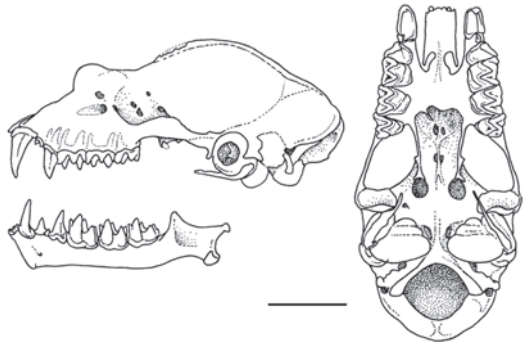


Fig. 47. Skull of *Rhinolophus affinis* ZMMU S-165098 (scale bar 5 mm).

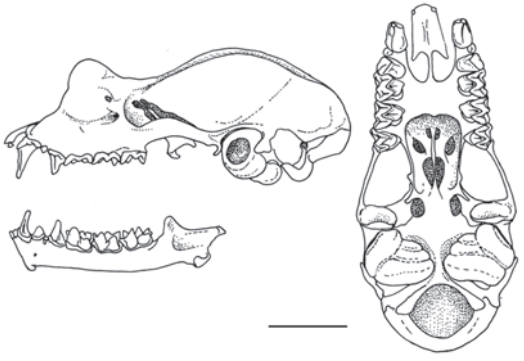


Fig. 48. Skull of *Rhinolophus shameli* ZMMU S-168305 (scale bar 5 mm).

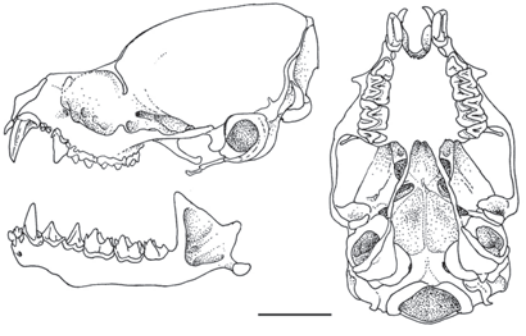


Fig. 49. Skull of *Taphozous melanopogon* ZMMU S-172666 (scale bar 5 mm).

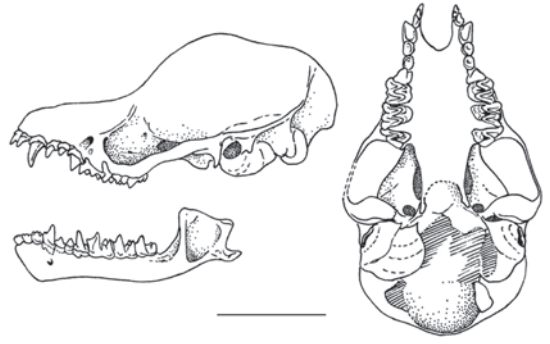


Fig. 50. Skull of *Kerivoula picta* ZISP-859 (scale bar 5 mm).

Fig. 51. Skull of *Kerivoula titania* ZMMU S-175149 (scale bar 5 mm).

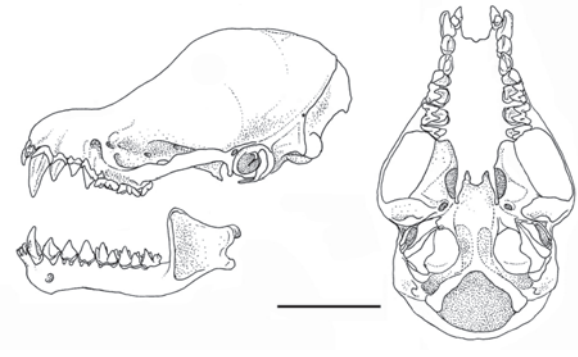


Fig. 52. Skull of *Phoniscus jagorii* ZMMU S-189237 (scale bar 5 mm).

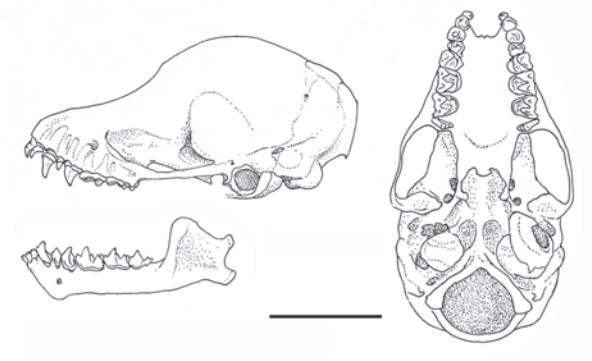


Fig. 53. Skull of *Murina harpioloides* ZMMU S-173401 (scale bar 5 mm).

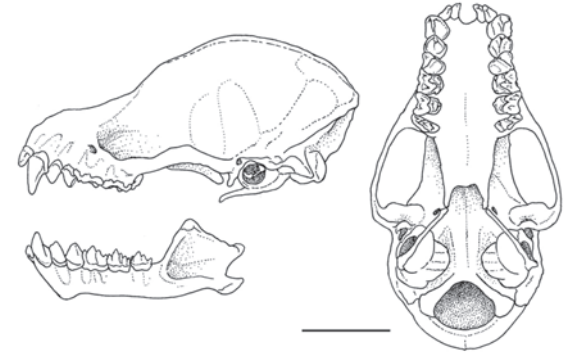


Fig. 54. Skull of *Murina fionae* ZMMU S-167185 (scale bar 5 mm).

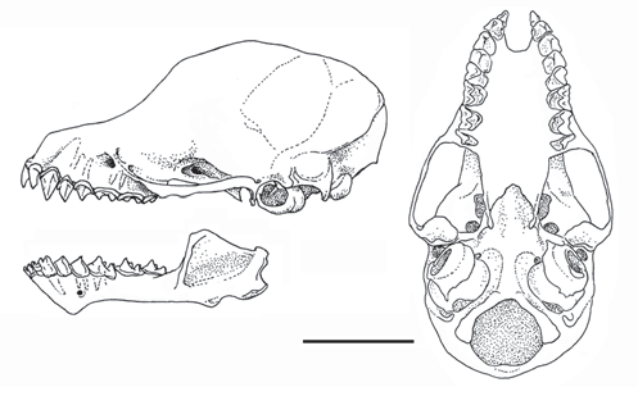


Fig. 55. Skull of *Harpiola isodon* ZMMU S-180001 (scale bar 5 mm).

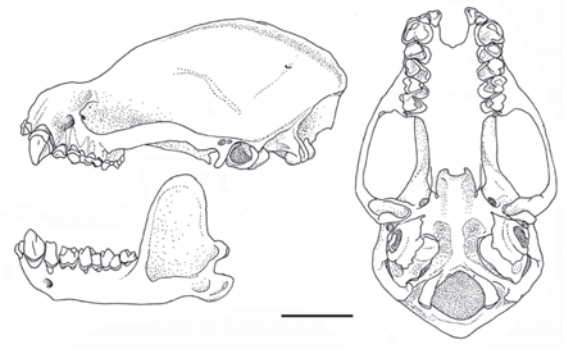


Fig. 56. Skull of *Harpiocephalus harpia* ZMMU S-182117 (scale bar 5 mm).

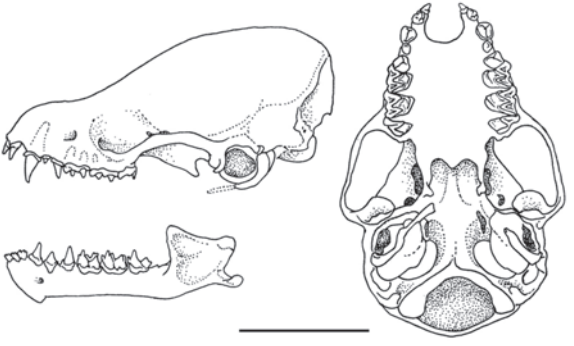


Fig. 57. Skull of *Myotis rosseti* ZMMU S-172636 (scale bar 5 mm).

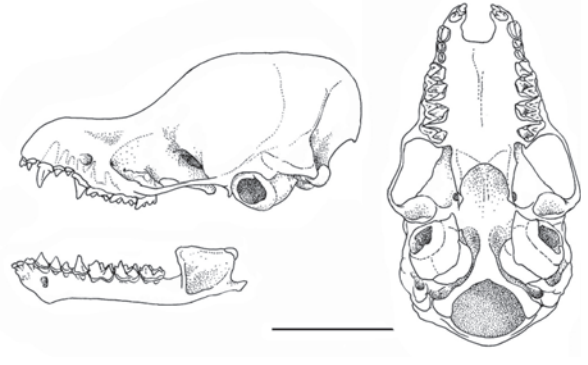


Fig. 58. Skull of *Myotis annamiticus* ZMMU S-167135 (scale bar 5 mm).

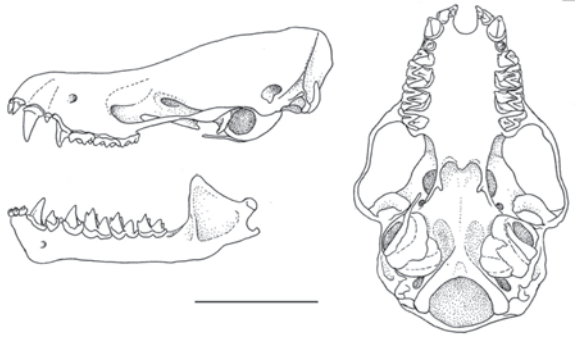


Fig. 59. Skull of *Eudiscopus denticulus* S-172558 (scale bar 5 mm).

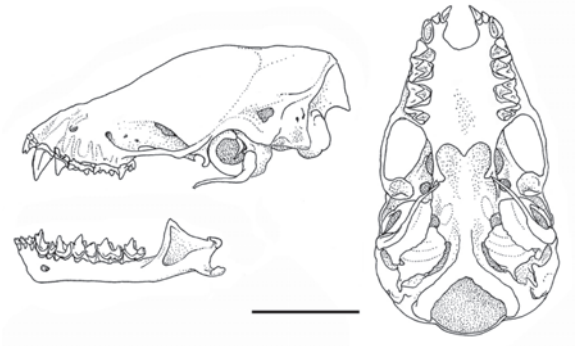


Fig. 60. Skull of *Barbastella darjelingensis* ZMMU S-186685 (scale bar 5 mm).

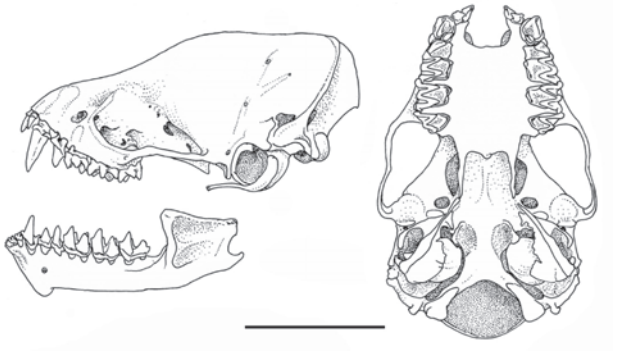


Fig. 61. Skull of *Pipistrellus paterculus* ROM MAM-107787 (scale bar 5 mm).

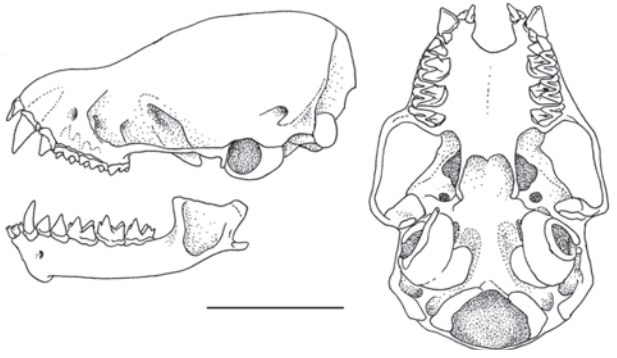


Fig. 62. Skull of *Glischropus bucephalus* ZMMU S-172561 (scale bar 5 mm)

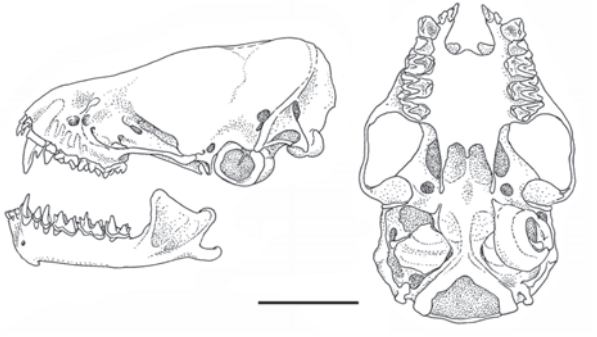


Fig. 63. Skull of *Hypsugo cf. joffrei* ZMMU S-186691 (scale bar 5 mm).

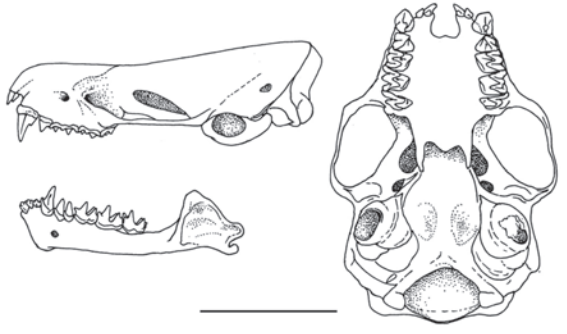


Fig. 64. Skull of *Tylonycteris pachypus* ZMMU S-172658 (scale bar 5 mm).

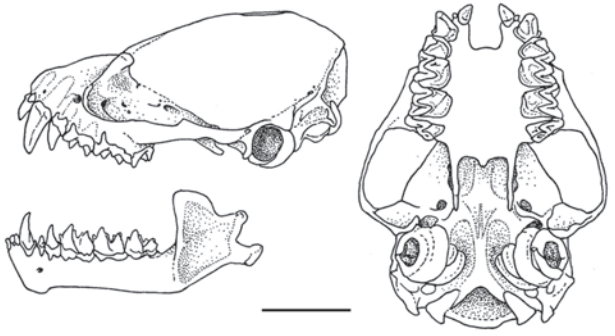


Fig. 65. Skull of *Thainycteris aureocollaris* ZMMU S-164990 (scale bar 5 mm).

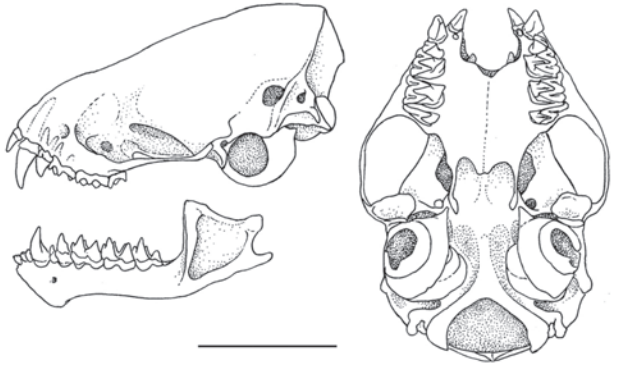


Fig. 66. Skull of *Hesperoptenus blanfordi* ZMMU S-168300 (scale bar 5 mm).

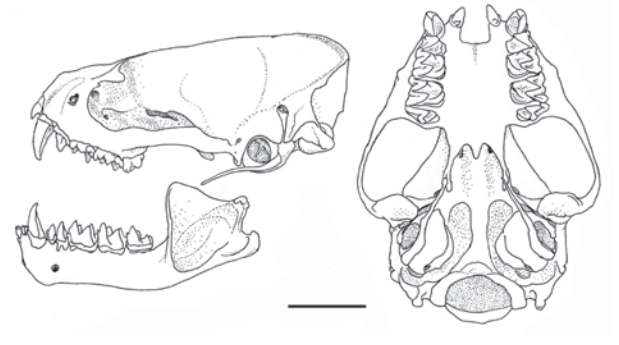


Fig. 67. Skull of *Scotomanes ornatus* ZMMU S-182152 (scale bar 5 mm).

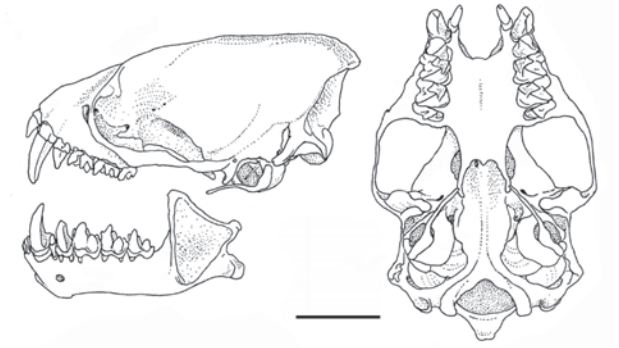


Fig. 68. Skull of *Scotophilus kuhlii* ZMMU S-188191 (scale bar 5 mm).

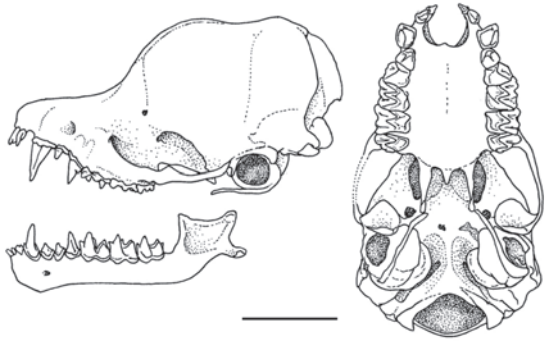


Fig. 69. Skull of *Miniopterus magnater* ZMMU S-172586 (scale bar 5 mm).

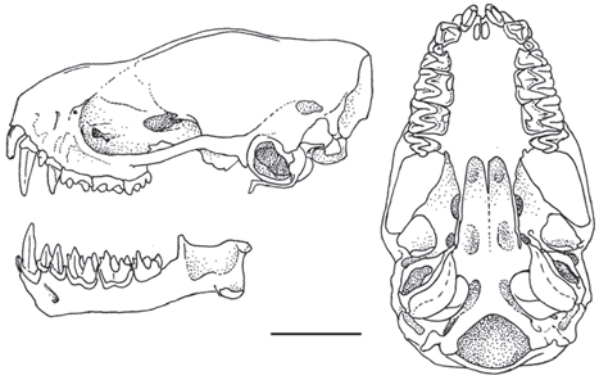


Fig. 70. Skull of *Chaerephon plicata* ZMMU S-166121 (scale bar 5 mm).

Appendix II

Weight and external measurements of selected Vietnamese bats

Note: The original measurements provided below were taken post-mortem or from live individuals. Therefore they may slightly exceed those which may be retrieved from collection specimens. These measurements also may not entirely correspond to those provided in the Identification sections of the respective species accounts, which were compiled from both original (when available) and literature data. Weights are given in grams; all measurements are in millimeters.

Table 2. Weight and external measurements of selected Vietbamese Pteropodidae.

	weight	**forearm**	**head and body**	**tail**	**planta**	**ear**	**tragus/antitragus**
Cynopterus sphinx (females)							
n	11	11	11	11	3	11	
avg	50.10	70.13	100.6	15.35	13.13	21.81	0
std	5.71	2.13	5.70	2.05		2.58	
min	39.5	66.4	85	13.03	11.9	18.1	
max	57.2	73.2	106	19	14.2	27.88	
Cynopterus sphinx (males)							
n	27	26	26	27	7	27	
avg	42.03	69.22	94.65	13.33	12.73	20.96	0
std	3.79	2.37	5.51	2.66	1.52	1.40	
min	33.4	65.31	85	7	11	17.9	
max	50	74.57	107	18	14.2	23.13	

	weight	forearm	head and body	tail	planta	ear	tragus/antitragus
Cynopterus brachyotis (females)							
n	7	6	7	7	1	7	
avg	31.24	63.37	84.36	13.21	13.70	16.70	0
std	6.96	2.57	5.45	3.65		4.31	
min	21.5	58.9	75.5	8		7.1	
max	44.6	66.7	93	18.5		19.5	
Cynopterus brachyotis (males)							
n	11	11	11	11	2	11	
avg	32.42	63.75	85.36	13.45	11.50	17.91	0
std	2.37	2.50	5.03	3.00		0.95	
min	26.5	60.6	76	7	11	16.6	
max	35.5	67.9	95	17	12	19.2	
Megaerops niphanae							
n	18	18	18	15	15	18	
avg	25.40	56.90	82.50	0.00	10.81	18.25	0
std	3.00	1.57	3.00	0.00	0.65	1.61	
min	21.8	53.52	78	0	10	15.5	
max	35.3	60.15	88	0	12	21	
Eonycteris spelaea							
n	5	5	5	5		5	
avg	52.36	68.90	101.40	18.18		20.41	0
std	2.15	1.32	4.56	3.76		1.31	
min	49.5	66.93	97	14.2		18.51	
max	54.6	70.5	108	24		21.9	
Macroglossus sobrinus							
n	22	22	22	21	2	22	
avg	23.49	47.82	78.73	1.04	10.25	17.01	0
std	2.13	0.95	3.71	1.91		1.18	
min	18	45.7	74	0	10.2	13.3	
max	27.7	49.2	86	7	10.3	18.7	

Table 3. Weight and external measurements of Vietbamese Megadermatidae.

	weight	**forearm**	**head and body**	**tail**	**planta**	**ear**	**tragus**
Megaderma spasma (females)							
N	7	7	7	6	6	7	5
Avg	17.54	52.51	70.00	0.00	13.53	36.09	20.60
Std	6.54	8.13	7.96	0.00	0.28	7.17	0.83
Min	7.7	34.6	53	0	13	20	19.9
Max	29.2	57.7	76	0	13.8	39.8	22
Megaderma spasma (males)							
N	9	9	9	5	9	9	9
Avg	16.28	54.83	71.39	0	13.58	36.90	20.46
Std	0.84	1.43	2.57		0.64	1.62	1.18
Min	15.2	53.6	67		12.4	33.8	18.8
Max	18	58	74		14.5	38.9	22.3
Megaderma lyra							
M	41.5	66.6	95	0	15.6	36.7	17.3
M	44.5	66.4	91	0	16.7	36.8	12.3

Table 4. Weight and external measurements of selected Vietbamese Hipposideridae.

	weight	forearm	head and body	tail	planta	ear	antitragus
Aselliscus stoliczkanus							
N	7	8	8	8	8	8	7
Avg	5.49	43.89	47.25	40.75	5.89	11.71	6.16
Std	0.32	0.91	1.39	2.25	0.43	0.69	1.02
Min	5	42.8	46	37	5.2	11.1	3.9
Max	5.9	45.6	49	43	6.6	13	6.9
Coelops frithii							
M	3.5	39.21	37	0.0		14.83	
M	6.6	41.6	48	0	6.9	13.1	8.4
Hipposideros alongensis							
N	4	4	4	4	4	4	4
Avg	27.43	68.78	81.25	37.88	11.85	29.93	11.15
Std	0.94	1.81	2.06	3.33	0.19	0.41	0.85
Min	26.7	66.3	79	35	11.7	29.4	9.9
Max	28.8	70.6	83	42.5	12.1	30.3	11.8
Hipposideros armiger (females)							
N	5	5	5	5	3	5	2
Avg	40.88	85.90	92.20	56.40	12.67	31.26	11.55
Std	5.09	2.71	1.64	2.51	1.01	1.04	1.06
Min	36	82.4	90	54	11.5	29.6	10.8
Max	48	89.2	94	60	13.3	32.3	12.3

	weight	**forearm**	**head and body**	**tail**	**planta**	**ear**	**antitragus**
Hipposideros armiger (males)							
N	9	11	11	11	2	11	9
Avg	44.96	89.75	93.59	56.98	14.60	32.80	12.66
Std	4.89	2.05	4.69	3.21		1.94	1.91
Min	37.2	86.7	87.5	51.5	13.7	29.8	9.4
Max	51.1	92.5	104	61	15.5	36.6	15
Hipposideros grandis (Vietnamese mainland)							
N	8	8	8	8	8	8	8
Avg	17.90	59.86	71.50	32.81	9.34	22.86	8.49
Std	3.14	1.63	2.00	3.29	0.24	0.99	0.84
Min	14.8	56.5	68	29	9	21.4	7.6
Max	22.6	61.4	75	38	9.7	24.5	9.7
Hipposideros cf. *grandis* (Con Dao islands)							
N	15	15	15	15	15	15	15
Avg	13.94	55.75	64.27	28.47	7.79	21.23	6.56
Std	2.11	1.06	1.33	1.73	0.58	1.00	0.46
Min	11.1	53.8	62	25	7	19.8	5.6
Max	18.7	57.6	67	31	8.6	22.7	7.5
Hipposideros larvatus poutensis							
N	3	3	3	3	3	3	3
Avg	13.33	53.17	64.33	35.83	8.17	22.87	9.23
Min	12	52.4	64	34	7.4	21.6	8.4
Max	14.2	53.9	65	38	9.6	24.6	9.8

	weight	forearm	head and body	tail	planta	ear	antitragus
Hipposideros cineraceus							
N	22	22	22	22	14	22	21
Avg	4.15	34.65	43.50	26.38	5.06	16.42	4.80
Std	0.45	0.72	1.65	1.76	0.37	0.88	0.54
Min	3.3	33.14	41	23	4.5	14.7	4
Max	4.9	36	46.6	31	5.7	18.4	5.9
Hipposideros diadema							
M	49.5	83	101	51	14.4	30.7	11.6
M	43	83.6	91	53	14.1	28.9	10.7
Hipposideros galeritus							
N	12	12	12	12	11	12	9
Avg	6.43	46.33	52.54	35.94	8.15	15.11	6.22
Std	0.33	0.90	1.27	9.49	8.94	1.44	0.94
Min	5.7	44.7	51	6.4	4.4	13.6	4.4
Max	6.9	47.4	55	41.5	35	17.8	7.4
Hipposideros pomona							
N	16	16	16	16	8	16	16
Avg	6.33	40.97	48.13	32.35	6.06	23.10	6.99
Std	0.93	1.46	3.52	2.26	0.42	1.76	0.86
Min	5.1	38.1	42	27	5.5	19	5.4
Max	7.8	42.8	54	36	6.6	25.8	8.1
Hipposideros scutinares							
N	10	10	10	10	10	10	10
Avg	40.26	78.95	89.85	54.65	17.49	31.53	12.64
Std	4.07	1.14	4.50	2.52	0.94	1.70	0.76
Min	31.9	76.8	84	51	16.2	28.5	11.4
Max	46.3	80.7	98	59	19.3	33.8	13.9

Table 5. Weight and external measurements of selected Vietbamese Rhinolophidae.

	weight	forearm	head and body	tail	planta	ear	antitragus
Rhinolophus affinis (females)							
N	27	35	35	35	19	35	16
Avg	13.11	50.88	60.53	26.59	10.31	20.14	8.00
Std	2.45	1.64	3.33	2.01	0.55	2.70	1.40
Min	9.9	48.13	53	23	9.5	8.31	6.21
Max	20.1	54	69	32	11.3	23	11.9
Rhinolophus affinis (males)							
N	30	32	32	32	21	32	16
Avg	13.50	50.84	62.61	25.93	9.79	21.06	9.77
Std	1.82	2.07	3.56	1.86	0.89	1.95	1.86
Min	9.9	44.9	53	22	8.1	16.37	7.01
Max	16.9	54	67	30	11.2	24.1	12.7
Rhinolophus chaseni (Vietnamese mainland - females)							
N	12	12	12	12	10	12	5
Avg	9.49	46.38	57.00	27.38	8.92	18.33	10.04
Std	0.74	1.39	1.54	1.88	0.67	5.53	1.11
Min	8.2	44.4	55	24.5	8.2	1	8.7
Max	10.8	49	60	32	10	21.4	11
Rhinolophus chaseni (Vietnamese mainland - males)							
N	14	14	14	14	13	14	10
Avg	9.11	44.97	57.61	26.14	8.42	19.71	9.49
Std	0.59	1.19	1.64	2.10	0.81	1.02	0.87
Min	8	43.2	55	22.5	7.1	18	8.4
Max	10.3	47	60	29	10	21.1	10.6

	weight	forearm	head and body	tail	planta	ear	antitragus
Rhinolophus chaseni (Con Dao islands)							
N	24	24	24	24	24	24	24
Avg	6.85	42.28	51.29	24.79	7.27	18.65	8.45
Std	0.64	1.01	1.78	2.04	0.43	1.21	0.58
Min	5.7	40.7	48	21	6.4	15.9	7
Max	8	44.4	54	28	8	21.2	9.4
Rhinolophus stheno							
F	12.4	45.6	59	19	9.3	20.1	10
F	14.3	45.4	56	18	80	18.6	10.3
Rhinolophus thomasi							
N	12	12	12	12		12	12
Avg	9.49	43.80	51.25	22.92		18.22	8.10
Std	2.29	1.19	3.77	1.41		1.47	0.54
Min	6.65	41.3	44	21		15.8	7.2
Max	14.1	45.4	58	25		20.1	8.8

Table 6. Weight and external measurements of selected Vietbamese Emballonuridae.

	weight	forearm	head and body	tail	planta	ear	tragus
Taphozous melanopogon							
F	30.7	65.9	81	28		19.8	7
F	23.6	64.3	77	27		20.0	7

	weight	forearm	head and body	tail	planta	ear	tragus
Saccolaimus saccolaimus							
N	5	4	4	4	1	4	1
avg	34.68	68.18	90.25	24.75	15.50	19.18	6.70
std	2.81	1.33	5.56	1.50		1.67	
min	31.2	66.7	84	23		17.8	
max	38	69.4	97	26		21.6	

Table 7. Weight and external measurements of selected Vietbamese Vespertilionidae.

	weight	forearm	head and body	tail	planta	ear	tragus
erivoula hardwickei							
n	9	9	9	9	9	9	8
avg	3.80	32.79	42.89	42.22	6.20	13.33	8.63
std	0.38	1.18	1.60	1.87	0.36	0.68	0.66
min	3.3	31.5	40	39	5.7	12.1	7.8
max	4.4	35	45	45	6.9	14.7	9.5
Harpiola isodon							
n	4	4	4	4	4	4	4
avg	5.20	32.23	47.00	28.50	7.18	12.88	5.88
std	1.97	2.35	4.32	4.64	0.97	0.41	0.28
min	3.4	30	43	24.5	5.8	12.5	5.6
max	8	35.4	53	35	8.1	13.4	6.2

	weight	forearm	head and body	tail	planta	ear	tragus
Murina cyclotis							
n	6	6	6	6	6	6	6
avg	5.73	32.15	49.00	36.17	6.48	16.10	9.12
std	0.76	1.11	1.41	1.17	0.58	0.61	0.56
min	4.8	31	47	35	5.5	15.3	8.4
max	6.5	33.8	51	38	7	17.2	9.8
Murina huttoni							
n	2	5	5	5	5	5	2
avg	6.55	33.76	48.40	39.10	7.34	16.56	9.30
std		0.99	4.04	1.75	1.01	0.43	1.70
min	5.9	32.7	43	37	6.1	16	8.1
max	7.2	35	54	41.5	8.6	17.1	10.5
Murina annamitica							
f	4.8	30	49	35	6.6	13.9	10
m	4.3	29.7	48	32.5	5.9	14.2	9.5
Myotis annectens							
m	8.7	44.5	63	50	9.6	16.7	8.6
m	8.1	43.1	58	41	8.7	15	7.6
Myotis ater							
n	35	35	35	35	26	35	18
avg	5.49	36.31	48.09	40.52	6.01	12.85	6.04
std	0.52	1.20	2.42	2.12	0.37	0.63	0.63
min	4.1	33.9	42	35	5.1	11.4	4.9
max	6.8	38.4	53	44	7.2	14.7	6.9
Myotis muricola							
n	75	77	77	77	51	76	37
avg	4.63	35.02	45.75	40.38	5.67	12.84	6.22
std	0.66	1.31	2.24	2.50	0.71	0.68	0.61
min	3.5	32.3	41	35	4.6	10.6	4.6
max	6.5	38.6	51	49	8	14.1	7.6

	weight	**forearm**	**head and body**	**tail**	**planta**	**ear**	**tragus**
Myotis «annatessae»							
n	18	18	18	18		18	18
avg	3.59	33.34	40.67	37.25		12.58	6.08
std	0.29	0.93	2.09	1.53		0.68	0.58
min	2.9	31.82	37	33.8		11.57	5
max	4.2	35.33	44	40.2		13.86	6.99
Myotis montivagus							
n	7	8	8	8	7	8	6
avg	9.56	39.88	54.75	44.59	6.74	14.72	7.02
std	2.08	2.32	2.38	2.08	0.30	0.85	0.50
min	6.2	37.8	51	42	6.3	13.9	6.5
max	11.9	45.24	59	47.7	7.1	16	7.6
Myotis rosseti							
n	14	14	14	14	6	9	5
avg	4.94	29.62	43.71	37.86	5.62	12.02	6.54
std	0.51	0.80	2.95	2.73	0.20	0.70	0.23
min	3.8	27.6	38	32.5	5.3	10.9	6.2
max	5.6	30.8	47	42	5.9	12.8	6.8
Myotis siligorensis							
n	14	14	14	14	11	14	14
avg	3.16	33.13	39.07	34.64	5.64	11.93	6.69
std	0.44	1.27	1.49	2.15	0.42	0.51	0.41
min	2.6	30.4	37	30	5	11.2	6.1
max	4	35	41	38	6.2	12.9	7.5
Myotis annamiticus							
n	13	13	13	13		13	13
avg	4.07	32.35	39.73	34.65		13.90	7.34
std	0.79	1.08	2.76	1.16		0.51	0.41
min	3	30.6	36	33		13.1	6.7
max	5.7	34.3	46	37		14.6	8

	weight	forearm	head and body	tail	planta	ear	tragus
Myotis horsfieldii							
n	6	6	6	6	2	6	6
avg	6.57	35.21	51.08	38.90	7.55	14.55	6.78
std	0.97	0.76	2.80	2.47		0.52	0.86
min	5.6	34.44	48.5	35.6	7.2	13.82	5.84
max	7.6	36.53	55	42.8	7.9	15.13	8.4
Eudiscopus denticulus							
n	16	16	16	16	15	16	15
avg	5.65	36.02	46.53	40.16	5.15	13.48	6.72
std	0.95	0.90	1.99	2.31	0.34	0.73	0.33
min	4.6	34.6	41.5	36.5	4.4	12	5.9
max	7.8	37.6	49	45	5.7	14.7	7.2
Barbastella cf. *darjelingensis*							
f	9.2	41.7	59	55	6.2	17.6	8.6
m	8.4	40	57	49.5	6.3	15.5	9.0
Glischropus bucephalus							
n	30	30	30	30	25	30	26
avg	5.06	33.64	46.62	38.92	5.96	10.88	5.51
std	0.76	0.82	2.02	1.96	0.35	0.72	0.61
min	4	31.7	40	35	5.3	9.6	4.4
max	6.8	35.7	49	43	6.7	12.2	6.4
Pipistrellus abramus							
n	30	30	30	30	14	30	16
avg	4.65	31.07	44.62	34.85	5.68	11.18	5.55
std	0.84	1.17	3.38	2.36	0.50	0.84	0.72
min	3.4	27.8	36.5	30	4.6	9.3	4.18
max	6.6	32.81	49	40	6.2	12.51	6.83

	weight	**forearm**	**head and body**	**tail**	**planta**	**ear**	**tragus**
Pipistrellus coromandra							
n	41	30	30	30	15	30	30
avg	4.85	33.33	47.50	35.62	5.69	12.11	6.23
std	0.54	1.21	1.76	2.64	0.71	0.85	0.58
min	3.6	31.1	44	30	4.7	9.6	5.4
max	6.6	37	50	41	6.7	13.3	7.7
Pipistrellus javanicus							
n	18	17	17	17	2	17	15
avg	5.81	31.96	48.58	35.32	5.90	11.40	6.08
std	0.84	1.20	3.01	2.64	0.00	0.98	0.40
min	4.5	30.34	40.3	31.8	5.9	9.96	5.4
max	7.55	34.5	53	42.5	5.9	13.5	6.7
Pipistrellus paterculus							
n	4	4	4	4	4	4	4
avg	5.15	30.35	48.75	32.25	5.15	11.18	5.18
std	0.65	0.77	0.96	2.22	0.58	0.46	0.53
min	4.3	29.6	48	30	4.7	10.6	4.4
max	5.7	31.2	50	35	6	11.6	5.5
Pipistrellus tenuis							
n	9	9	9	9	6	9	8
avg	3.40	28.72	41.89	32.11	4.57	10.91	6.34
std	0.56	1.77	2.80	2.56	0.42	0.54	0.52
min	2.8	26.9	38	30	4	9.88	5.5
max	4.3	31.2	46	36.5	5	11.9	6.8
Hypsugo cadornae							
f	7.0	36.4	55.0	42.0	8.3	14.5	6.70
m	5.5	34.4	50	35.5	5.4	15	5.90

	weight	forearm	head and body	tail	planta	ear	tragus
Hypsugo joffrei							
n	4	4	4	4	4	4	4
avg	11.45	37.13	60.50	41.25	7.08	12.65	4.83
std	0.53	1.21	2.65	2.50	0.29	0.95	0.74
min	10.9	35.7	58	38	6.9	11.3	4.1
max	12	38.6	64	44	7.5	13.5	5.6
Tylonycteris pachypus							
n	16	15	15	15	6	15	7
avg	3.62	26.39	41.10	29.97	4.98	8.81	4.19
std	0.92	0.81	2.63	2.49	0.35	1.15	0.51
min	2.6	24.4	37	23	4.7	6.2	3.4
max	6.4	27.4	46	34	5.6	11.7	4.8
Tylonycteris robustula							
n	8	9	9	9	9	9	9
avg	5.30	27.18	45.72	30.06	5.41	10.52	4.33
std	0.68	0.63	2.09	2.10	0.37	0.95	0.34
min	4.3	26.2	42.5	26	5	8.5	3.8
max	6.6	28.3	48	34	6.1	11.6	4.9
Hesperoptenus blanfordi							
n	15	15	15	15	14	15	15
avg	6.55	27.07	52.63	29.33	5.23	10.52	5.29
std	0.40	0.63	1.76	1.68	0.36	0.39	0.75
min	5.9	25.9	47	26	4.8	9.7	3.8
max	7.1	27.8	54	32	5.8	11.1	6.1
Hesperoptenus tickelli							
f	19.8	52.3	70	49	8.9	16.7	8.7
m	16.8	52.5	72	47	9	15.2	8.4

	weight	**forearm**	**head and body**	**tail**	**planta**	**ear**	**tragus**
Arielulus circumdatus							
n	7	7	7	7	5	7	4
avg	9.14	40.70	57.21	44.07	8.08	14.53	6.85
std	1.00	1.68	2.45	3.28	0.41	0.80	0.61
min	8	38.3	53	40	7.6	13	6.4
max	10.8	43	60	48.5	8.7	15.3	7.7
Thainycteris aureocollaris							
m	13.1	47	64	54	9.1	16.4	5.6
m	15.4	47.5	63	52.0		15.8	7.3
Scotomanes ornatus							
n	9	9	9	9	3	9	7
avg	27.22	57.64	74.44	58.64	12.67	21.40	9.67
std	6.95	1.55	5.05	3.74		0.97	0.73
min	20.2	55.8	65	53	12.1	19.9	8.9
max	39.1	60.1	82	63	13.6	22.5	10.7
Scotophilus heathii							
n	3	3	3	3	3	3	3
avg	40.8	61.9	87.8	64.5	11.0	17.3	10.6
min	37.5	61.7	86.0	62.5	10.2	16.7	10.3
max	47.5	62.0	91.0	66.0	11.6	18.1	10.9
n	3	3	3	3	3	3	3
Scotophilus kuhlii							
n	8	8	8	8	5	8	8
avg	21.80	49.86	74.25	50.19	9.00	13.70	8.03
std	3.92	1.55	4.10	2.87	0.61	0.93	0.99
min	16.8	47	67	44.5	8.1	11.9	7.0
max	29.3	52.1	79	53.5	9.8	14.8	9.8

Table 8. Weight and external measurements of Vietbamese Miniopteridae.

	weight	forearm	head and body	tail	Planta	ear	tragus
Miniopterus fuliginosus							
n	4	4	4	4	4	4	4
avg	13.90	47.88	63.25	58.50	9.33	11.55	6.18
std	2.66	0.56	2.22	1.00	0.25	0.71	0.39
min	11.6	47.5	61	58	9	10.5	5.8
max	17.5	48.7	66	60	9.6	12	6.6
Miniopterus magnater							
n	11	3	11	11		3	
avg	14.01	49.53	62.18	59.82		13.60	
std	0.93	1.06	2.99	2.52			
min	11.9	48.4	58	56		13	
max	15.4	50.5	69	64		14.4	
Miniopterus pusillus							
n	5	4	5	5		4	1
avg	7.64	41.68	52.40	49.80		9.90	6.40
std	0.71	0.36	2.79	1.10		0.41	
min	7	41.4	50	48		9.3	
max	8.8	42.2	57	51		10.2	

References

Abe, H. 2000. Illustrated skulls of Japanese mammals. Hokkaido University Press, Sapporo, 279 pp. [in Japanese]

Abramov, A.V., A.A. Kalinin, P.N. Morozov. 2007. Mammal survey on Phu Quoc Island, southern Vietnam. – Mammalia, 71(1–2): 40–46.

Abramov, A.V., S.V. Kruskop. 2012. The mammal fauna of Cat Ba Island, northern Vietnam. – Russian Journal of Theriology, 11(1):57–72.

Advani, R. 1981. Seasonal fluctuations in the feeding ecology of the Indian false vampire, *Megaderma lyra lyra* (Chiroptera: Megadermatidae) in Rajastan. – Zaitschrift fur Saugeitercunde, 46(2): 90–93.

Allen, G.M. 1938. The mammals of China and Mongolia. Natural history of Central Asia, Vol. XI, part 1. AMNH, New York, 620 pp.

Alvarez, I., J. Juste, B.E. Tabares, A. Garrido-Pertiera, C. Ibanez, J.M. Bautista. 1999. Molecular phylogeny and morphological homoplasy in fruitbats. – Molecular Biology and Evolution, 18(8):1061–1067.

Appleton, B.R., J.A. McKenzie, L. Christidis. 2004. Molecular systematics and biogeography of the bent-wing bat complex *Miniopterus schreibersii* (Kuhl, 1817) (Chiroptera: Vespertilionidae). – Molecular Phylogenetics and Evolution, 31(2): 431–439.

Artyushin, I.V., A.A. Bannikova, V.S. Lebedev, S.V. Kruskop. 2009. Mitochondrial DNA relationships among North Palaearctic *Eptesicus* (Vespertilionidae, Chiroptera) and past hybridization between Common Serotine and Northern Bat. – Zootaxa, 2262: 40–52.

Artyushin I., A. Bannikova, V. Lebedev, S. Kruskop. 2011. North palearctic serotines, molecular Study. – P.77 in: Proceedings of VI-th European Congress of Mammalogy, Paris, France, 19–23 July.

Bates, P. J. J., D. L. Harrison. 1997. Bats of the Indian Subcontinent. Sevenoaks: Harrison Zoological Museum, 258 pp.

Bates, P. J. J., D. L. Harrison, P. D. Jenkins, J. L. Walston. 1997. Three rare species of *Pipistrellus* (Chiroptera: Vespertilionidae), new to Vietnam. – Acta Zoologica Acad. Sci. Hungaricae, 43(4): 359–374.

Bates, P. J. J., D. K. Hendrichsen, J. L. Walston, B. Hayes. 1999. The review of mouse-eared bats (Chiroptera: Vespertilionidae: *Myotis*) from Vietnam with significant new records. – Acta Chiropterologica, 1(1): 47–74.

Bates, P. J. J., Tin Nwe, M. J. Pearch, Khin Maung Swe, Si Si Hla Bu, Thanda Tun. 2000. A review of bat research in Myanmar (Burma) and results of a recent survey. – Acta Chiropterologica, 2(1): 53–82.

Bates, P. J. J., Tin Nwe, Khin Maung Swe, Si Si Hla Bu. 2001. Further new records of bats from Myanmar (Burma) including *Craseonycteris thonglongyai* Hill 1974 (Chiroptera: Craseonycteridae). – Acta Chiropterologica, 3(1): 33–41

Benda, P. 2010. On small collection of bats (Chiroptera) from western Sabah (North Borneo, East Malaysia). – Vespertilio, 13–14: 45–76.

Benda, P., C. Dietz, M. Andreas, J. Hotovy, R. K. Lucan, A. Maltby, K. Meakin, J. Truscott, P. Vallo. 2008. Bats (Mammalia: Chiroptera) of the Eastern Mediterranean and Middle East. Part 6. Bats of Sinai (Egypt) with some taxonomic, ecological and echolocation data on that fauna. – Acta Societas Zoologicae Bohemicae, 72: 1–103.

Benda, P., V. Hanak, J. Cerveny. 2011. Bats (Mammalia: Chiroptera) of the Eastern Mediterranean and Middle East. Part 9. Bats from Transcaucasia and West Turkestan in collection of the National Museum, Prague. – Acta Societas Zoologicae Bohemicae, 75: 159–222.

Bates, P. J. J., M. K. Struebig, S. J. Rossiter, T. Kingston, S. S. L. Oo, K. M. Mya. 2004. A new species of *Kerivoula* (Chiroptera: Vespertilionidae) from Myanmar (Burma). – Acta Chiropterologica, 6(2): 219–226.

Benda, P., K. A. Tsytsulina. 2000. Taxonomic revision of *Myotis mystacinus* group (Mammalia: Chiroptera) in the western Palaearctic. – Acta Societas Zoologicae Bohemicae, 64: 331–398.

Bhat, H. R., T. H. Kunz. 1995. Altered flower/fruit clusters of the kitul palm used as roosts by the short-nosed fruit bat *Cynopterus sphinx* (Chiroptera: Pteropodidae). – J. Zool. London, 235: 597–604.

Bhattacharyya, T. P. 2002. Taxonomic status of the genus *Harpiola* Thomas, 1915 (Mammalia: Chiroptera: Vespertilionidae), with a report of the occurrence of *Harpiola grisea* (Peters, 1872) in Mizoram, India. – Proceedings of the Zoological Society, Calcutta, 55: 73–76.

Blood, B. R., and D. A. McFarlane. 1988. Notes on some bats from northern Thailand, with comments on the subgeneric status of *Myotis altarium*. – Z. Saugetierk., 53: 276–80.

Bogdanowicz, W., R. D. Owen. 1998. In the Minotaur's labyrinth: The phylogeny of the bat family Hipposideridae. – Pp. 27–42 in: T. H. Kunz and

P.A. Racey (eds.), Bat biology and conservation. Smithsonian Institution Press, Washington, DC.

Borissenko, A.V. 2000. Comparative morphology and evolution of the female reproductive system and reproductive biology of plain-nosed bats (Vespertilionidae, Chiroptera). – Zoologicheskie Issledovaniya, 6: 1–132. [in Russian]

Borissenko, A.V., S.V. Kruskop, E.V. Dorokhina. 2001. The Bats (Chiroptera, Mammalia) of the Vu Quang Nature Reserve: community structure and eco-morphological patterns. – Pp. 190–215 in: Materials of zoological and botanical studies in Vu Quang Nature Reserve (Ha Tinh Province, Vietnam), Moscow–Hanoi, 467 pp. [In Russian]

Borissenko, A.V., S.V. Kruskop. 2003. Bats of Vietnam and adjacent territories. An identification manual. Geos, Moscow, 203 pp.

Borisenko, A.V., S.V. Kruskop, P.N. Morozov. 2006. Preliminary inventory of the mammal fauna of the south-eastern extremity of the Truong Son mountain range. – Pp. 159–194 in: L.P. Korzoun, V.V. Rozhnov, and M.V. Kalyakin (eds.), Materials of zoological and botanical studies in Bi Doup and Hon Ba mountain, Dalat plateau, Southern Vietnam. KMK, Moscow-Hanoi. [in Russian]

Borisenko, A.V., S.V. Kruskop, N.V. Ivanova. 2008. A new mouse-eared bat (Mammalia: Chiroptera: Vespertilionidae) from Vietnam. – Russian Journal of Theriology, 7(2): 57–69.

Cao Van Shung. 1976. New data on morphology and biology of rare small mammals of Northern Vietnam. – Zoologicheskyi Zhurnal, 55(12): 1880–1885. [In Russian]

Constantine, D. G. 1990. Health precautions for bat researchers. – Pp. 491–528 in: Ecological and behavioral methods for the study of bats. T. H. Kunz (ed.) Smithsonian Institution Press, Washington, D. C.– London, 533 p.

Corbet G. B., J. E. Hill. 1992. Mammals of the Indomalayan region. A systematic review. Oxford Univ. Press, Oxford, 488 pp.

Csorba, G., P. Jenkins 1998. First records and a new subspecies of *Rhinolophus stheno* (Chiroptera, Rhinolophidae) from Vietnam. – Bulletin of the Natr. Hist. Mus., Zool. Ser., 64(1): 207–211

Csorba G., S. Kruskop, A. Borissenko. 1999. Recent records of bats (Chiroptera) from Nepal, with remarks on their natural history. – Mammalia, 63(1): 61–78.

Csorba, G., P. Ujhelyi, N. Thomas. 2003. Horseshoe bats of the World (Chiroptera: Rhinolophidae). Alana Books, Shropshire, 160 pp.

Csorba, G., Vu Dinh Thong, P. J. J. Bates, N. M. Furey. 2007. Description of a new species of *Murina* from Vietnam (Chiroptera: Vespertilionidae: Murininae). – Occasional papers, Museum of Texas Tech University, 268: 1–10.

Csorba, G., N. T. Son, I. Saveng, N. M. Furey. 2011. Revealing cryptic bat diversity: three new *Murina* and redescription of *M. tubinaris* from Southeast Asia. – Journal of Mammalogy, 92(4): 891–904.

Dang Huy Huynh, Dao Van Tien, Cao Van Sung, Pham Trong Anh, Hoang Minh Khien. 1994. Checklist of mammals in Vietnam. Science and Technics, Hanoi, 168 pp. [in Vietnamese]

Dang Ngoc Can, Endo H., Nguyen Truong Son, Oshida T., Le Xuan Canh, Dang Huy Phuong, D. P. Lunde, S.-I. Kawada, A. Hayashida, and M. Sasaki. 2008. Checklist of wild mammal species of Vietnam. IEBR, Hanoi, 356 p. [In Vietnamese]

Dobson, G. E. 1876. Monograph of the Asiatic Chiroptera, and catalogue of the species of bats in the collection of the Indian Museum, Calcutta. Trustees of the Indian Museum, London, 228 p.

Douangboubpha, B., S. Bumrungsri, P. Soisook, S. W. Murray, S. J. Puechmaille, C. Satasook, S. S. H. Bu, D. L. Harrison, P. J. J. Bates. 2010. A taxonomic review of *Hipposideros halophyllus*, with additional information on *H. ater* and *H. cineraceus* (Chiroptera: Hipposideridae) from Thailand and Myanmar. – Acta Chiropterologica, 12(1):29–50.

Douangboubpha, B., S. Bumrungsri, C. Satasook, P. Soisook, Si Si Hla Bu, B. Aul, D.L. Harrison, M. Pearch, N.M. Thomas, P.J.J. Bates. 2011. A new species of small *Hipposideros* (Chiroptera: Hipposideridae) from Myanmar and a revaluation of the taxon *H. nicobarulae* Miller, 1902 from the Nicobar Islands. – Acta Chiropterologica, 13(1): 61–78.

Duckworth, J. W., J. Pons. 2011. Reinstatement of Barbastella (Chiroptera, Vespertilionidae) and Eothenomys (Rodentia, Cricetidae) to the Lao fauna. – Mammalia, 75: 93–95.

Eger, J. L., M. M. Theberge. 1999. *Thainycteris aureocollaris* (Chiroptera, Vespertilionidae) in Vietnam. – Mammalia, 63:237–240.

Eger, J. L., B. K. Lim. 2011. Three new species of *Murina* from southern China (Chiroptera: Vespertilionidae). – Acta Chiropterologica, 13(2): 227–243.

Eick, G.N., D.S. Jacobs, C.A. Matthee. 2005. A nuclear DNA phylogenetic perspective on the evolution of echolocation and historical biogeography of extant bats (Chiroptera). – Molecular Biology and Evolution, 22(9): 1869–1886.

Ellerman, J. R., T. C. S. Morrison-Scott. 1966. Checklist of Palaearctic and Indian Mammals 1758 to 1946 (2nd ed.). Brit. Mus. (Natr. Hist.), 810 p.

Farafonova, G.V., A.V. Borissenko. 2001. Parasitic flies (Diptera: Nycteribiidae, Streblidae) of Vietnamese bats. – Pp. 383–391 in: Materials of zoological and botanical studies in Vu Quang Nature Reserve (Ha Tinh Province, Vietnam), Moscow–Hanoi, 467 pp. [In Russian]

Farafonova, G. V., S. V. Kruskop. 2001. Notes on the Nycteribiidae (Diptera) of Viet Nam. – International Journal of Dipterological Research, 12(1): 29–31.

Flannery, T. 1995. Mammals of New Guinea. Cornell Univ. Press, 568 p.

Francis C.M. 2008. A field guide to the mammals of South-East Asia. New Holland, London, 392 p.

Francis, C. M., D. Kock, J. Habersetzer. 1999. Sibling species of *Hipposideros ridleyi* (Mammalia, Chiroptera, Hipposideridae). – Senkenbergiana biol., 79 (2): 255–270.

Francis C. M., A.V. Borisenko, N.V. Ivanova, J.L. Eger, B.K. Lim, A. Guillén-Servent, S.V. Kruskop, I. Mackie, P.D.N. Hebert. 2010. The Role of DNA Barcodes in Understanding and Conservation of Mammal Diversity in Southeast Asia. – PLoS ONE, 5(9): e12575.

Francis, C.M., J.L. Eger. 2012. A review of tube-nosed bats (*Murina*) from Laos with a description of two new species. – Acta Chiropterologica, 14(1): 15–38.

Furey, N., Vu Dinh Thong, P.J.J. Bates, G. Csorba. 2009. Description of a new species belonging to the *Murina* '*suilla*-group' (Chiroptera: Vespertilionidae: Murininae) from north Vietnam. – Acta Chiropterologica, 11(2): 225–236.

Furey, N.M., I.J. Mackie, P.A. Racey. 2010. Bat diversity in Vietnamese limestone karst areas and the implications of forest degradation. – Bioiversity Conservation, DOI 10.1007/s10531-010-9806-0.

Giannini, N.P., N.B. Simmons. 2007. Element homology and the evolution of dental formulae in Megachiropteran bats (Mammalia: Chiroptera: Pteropodidae). – American Museum Novitates, 3559: 1–27.

Gromov, I.M., A.A. Gureyev, G.A. Novikov, I.I. Sokolov, P.P. Strelkov, K.K. Chapskiy. 1963. Mammals of the fauna of USSR. Part 1. Academy of Sciences of USSR, Moscow–Leningrad, 640 p. [in Russian]

Gu, X., S.-Y. He, L. Ao. 2008. Molecular phylogenetics among three families of bats (Chiroptera: Rhinolophidae, Hipposideridae, and Vespertilionidae) based on partial sequences of the mitochondrial 12S and 16S rRNA genes. – Zoological studies, 47(3): 368–378.

Hand, S.J. 1998. *Xenorhinos*, a new genus of Old World Leaf-nosed bats (Microchiroptera: Hipposideridae) from the Australian Miocene. – Journal of Vertebrate Paleontology, 18(2): 430–439.

Hand, S.J., J.A.W. Kirsch. 1998. A southern origin for the Hipposideridae (Microchiroptera). Evidence from the Australian fossil record. – Pp. 72–90 in: T.H. Kunz and P.A. Racey (eds.), Bat biology and conservation. Smithsonian Institution Press, Washington.

Handley, C.O. 1990. Specimen preparation. – Pp. 437–457 in: Ecological and behavioral methods for the study of bats. T. H. Kunz, ed. Smithsonian Institution Press, Washington, D.C.– London, 533 p.

Harrison, J. 1966. An introduction to mammals of Singapore and Malaya. Tien Wah Press, Singapore, 340 p.

Hayes, B., T. Howard. 1998. Technical report on the biodiversity survey of Pu Mat Nature Reserve. [Unpublished Report]

Heaney, L.R., D.S. Balete, L. Dolar, A.C. Alcala, A. Dans, P.C. Gonzales, N. Ingle, M. Lepiten, W. Oliver, E.A. Rickart, B.R. Tabaranza, Jr., R.C.B. Utzurrum. 1998. A synopsis of the mammalian fauna of the Philippine Islands. – Fieldiana Zoology n. s., 88: 1–61.

Hendrichsen, D.K., P.J. J.Bates, B.D. Hayes, J.L. Walston. 2001. Recent records of bats (Mammalia: Chiroptera) from Vietnam with six species new to the country. – Myotis, 39: 35–122.

Heller K.-G., M. Volleth. 1984. Taxonomic position of "*Pipistrellus societatis*" Hill, 1972 and the karyological characteristics of the genus *Eptesicus* (Chiroptera: Vespertilionidae). – Z. f. zool. Systematik Evolutionsforschung, 22 (1): 65–77.

Hill, J. E. 1986. A note on *Rhinolophus pearsoni* Horsfield, 1851 and *R. yunnanensis* Dobson, 1872. – Journal Bombay Nat. Hist. Soc., 83: 12–18.

Hill, J.E., C.M. Francis. 1984. New bats (Mammalia: Chiroptera) and new records of bats from Borneo and Malaya. – Bulletin of the British Museum (Natural History), Zoology Series, 47(5): 305–329.

Hill J. E., D. L. Harrison. 1987. The baculum in the Vespertilioninae (Chiroptera: Vespertilionidae) with a systematic review, a synopsis of *Pipistrellus* and *Eptesicus*, and the description of a new genus and subgenus. – Bull. Br. Mus. nat. Hist. (Zool.), 52 (7): 225–305.

Hill, J. E., J. D. Smith. 1981. *Craseonycteris thonglongyai*. – Mammalian species, 160: 1–4.

Hill, J. E., A. Zubaid, G. W. H. Davison. 1986. The taxonomy of leafnosed bats of the *Hipposideros bicolor* group (Chiroptera: Hipposideridae) from southeastern Asia. – Mammalia, 50(4): 535–540.

Hoofer, S. R., S. A. Reeder, E. W. Hansen, R. A. Van den Bussche. 2003. Phylogenetics and taxonomic review of Noctilionoid and Vespertilionoid bats (Chiroptera: Yangochiroptera). – Journal of Mammalogy, 84(3): 809–821.

Horacek I, V. Hanak. 1985–1986. Generic status of *Pipistrellus savii* and comments on classification of the genus *Pipistrellus* (Chiroptera, Vespertilionidae). – Myotis, 23–24: 9–16.

Hutcheon, J. M., J. A. W. Kirsch. 2006. A moveable face: deconstructing the Microchiroptera and a new classification of extant bats. – Acta Chiropterologica, 8(1): 1–10.

Jones, G., J. M. V. Rayner. 1988. Flight performance, foraging tactics and echolocation in free-living Daubenton's bats, *Myotis daubentonii* (Chiroptera: Vespertilionidae). – Journ. Zool., London, 215: 113–132.

Jones, C., W. J. McShea, M. J. Conroy, T. H. Kunz. 1996. Capturing mammals. – Pp. 115–155 in: Measuring and monitoring biological diversity. Standard methods for mammals. D. E. Wilson, F. R. Cole, J. D. Nichols, R. Rudran, M. S. Foster, eds. Smithsonian Institution Press, Washington, D. C.– London, 409 p.

Juste, J., C. Ibanez, J. Munoz, D. Trujillo, P. Benda, A. Karatas, M. Ruedi. 2004. Mitochondrial phylogeography of the long-eared bats (*Plecotus*) in the Mediterranean Palaearctic and Atlantic Islands. – Molecular Phylogenetics and Evolution, 31(3): 1114–1126.

Kalko, E., H. U. Schnitzler. 1989. The echolocation and hunting behavior of Daubenton's bat, *Myotis daubentoni*. – Behavioral Ecology and Sociobiology, 24: 225–238.

Kitchener, D. J., I. Maryanto. 1993. Taxonomic reappraisal of the Hipposideros larvatus species complex (Chiroptera: Hipposideridae) in the Greater

and Lesser Suns Islands, Indonesia. – Records of the Western Australian Museum, 16: 119–173.

Kock, D. 2000. On some bats (Chiroptera) from southern Cambodia with a preliminary checklist. – Zeitschr. f. Säugetierkde., 65(4): 199–208.

Kock, D. 1999. *Tadarida* (*Tadarida*) *latouchei*, a separate species recorded from Thailand with remarks on related Asian taxa (Mammalia: Chiroptera: Molossidae). – Senckenbergiana biol., 78($^{1}/_{2}$): 237–240.

Kock, D., G. Storch. 1996. *Thainycteris aureocollaris*, a remarkable new genus and species of vespertilioninae bats from SE-Asia. – Senckenberg. Biol., 76: 1–6.

Kock, D., D. Kovac. 2000. *Eudiscopus denticulus* (Osgood 1932) in Thailand with notes on its roost (Chiroptera: Vespertilionidae). – Zeitschr. f. Säugetierkde., 65(2): 121–123.

Koopman, K. F. 1972. *Eudiscopus denticulus*. – Mammalian Species, 19: 1–2.

Koopman, K. F. 1989. Distributional patterns of Indomalayan bats (Mammalia: Chiroptera). – American Museum Novitates, 2942: 1–19.

Koopman, K. F. 1993. Order Chiroptera. – Pp. 137–241 in: Mammal species of the world, a taxonomic and geographic reference, 2nd ed. D. E. Wilson, D. M. Reeder, eds. Smithsonian Institution Press, Washington, xviii+1206 p.

Koopman, K. F. 1994. Chiroptera: systematics. Handbook of zoology, vol. 8, Mammalia, Pt. 60. Walter de Gruyter, New York, 217 p.

Kruskop, S. V. 1999. Ecomorphological diversity of plain-nosed bats (Vespertilionidae, Chiroptera). – Folia Theriologica Estonica, 4: 1–33.

Kruskop, S. V. 2000a. Bats in caves of Ke Bang limestone area (Central Vietnam). – Plecotus et al., 3: 114–120. [In Russian]

Kruskop, S. V. 2000b. New records of bats from Central Vietnam. – Plecotus et al., 3: 121–128. [In Russian]

Kruskop, S. V. 2003. On the subspecies content of the leaf-nosed bat *Hipposideros larvatus* (Chiroptera: Rhinolophidae) in Central Vietnam. – Pp. 110–113 in: Systematics, phylogeny and palaeontology of small mammals. Materials of the international symposium. A. O. Averianov, N. I. Abramson (eds.) St-Petersburgh. [In Russian]

Kruskop, S.V. 2010a. Preliminary data on the bat fauna of Bu Gia Map National Park (Southern Vietnam). – Plecotus et al., 13: 69–74. [In Russian]

Kruskop, S.V. 2010b. Bat communities in forests of the Southern Vietnam. – Plecotus et al., 13: 75–79. [In Russian]

Kruskop, S. V. 2011a. New data on the bat fauna of Con Dao Islands. – Russian Journal of Theriology, 10(2): 37–46.

Kruskop, S.V. 2011b. First record of the groove-tothed bat (Phoniscus jagorii, Vespertilionidae) in the south of Vietnam. – Plecotus et al., 14: 3–8 [In Russian]

Kruskop, S.V. 2012. Order Chiroptera. – Pp. 73–126 in: I.Y. Pavlinov, A.A. Lissovsky (eds.), The Mammals of Russia: A Taxonomic and Geographic Reference. KMK scientific press, Moscow.

Kruskop, S.V., A.V. Borisenko, N.V. Ivanova, B.K. Lim, J.L. Eger. 2012. Genetic diversity of northeastern Palaearctic bats as revealed by DNA barcodes. – Acta Chiropterologica, 14(1): 1–14.

Kruskop S.V., J.L. Eger. 2008. A new species of tube-nosed bat *Murina* (Vespertilionidae, Chiroptera) from Vietnam. – Acta Chiropterologica, 10(2): 213–220.

Kruskop, S.V., M.V. Kalyakin, A.V. Abramov. 2006. First record of *Harpiola* (Chiroptera, Vespertilionidae) from Vietnam. – Russian Journal of Theriology, 5(1): 15–18.

Kruskop, S.V., A.V. Shchinov. 2010. New remarkable bat records in Hoang Lien Son mountain range, northern Vietnam. – Russian Journal of Theriology, 9(1): 1–8.

Kruskop, S.V.., E.A. Tsytsulina, R. Masuda. 2003. Position of the genus *Eudiscopus* (Mammalia, Chiroptera) in the taxomony of Vesper bats. – Pp 183–184 in: Teriofauna of Russia and adjacebt territories (VII congress of Theriological Society). Material of the international conference February 6–7, 2003. V.N. Orlov (ed.) Moscow. [In Russian]

Kulik, I.L., V.V. Kucheruk. 1989. Order Chiroptera. – Pp. 168–220 in: Medical Theriology: Rodents, Carnivores, Bats. V.V. Kucheruk, ed. Nauka, Moscow, 272 p. [In Russian]

Kunz, T. H., ed. 1988. Ecological and behavioral methods for the study of bats. Smithsonian Institution Press, Washington, D. C.– London, 533 p.

Kunz, T. H., A. Kurta. 1988. Capture methods and holding devices. – Pp. 1–29 in: Ecological and behavioral methods for the study of bats. T. H. Kunz, ed. Smithsonian Institution Press, Washington, D. C.– London, 533 p.

Kunz, T.H., R. Rudran, G. Gurri-Glass. 1996. Human health concern. – Pp.

255–264 in: Measuring and monitoring biological diversity. Standard methods for mammals. D. E. Wilson, F. R. Cole, J. D. Nichols, R. Rudran, M. S. Foster, eds. Smithsonian Institution Press, Washington, D. C.–London, 409 p.

Kuo, H.-C., Y.-P. Fang, G. Csorba, L.L. Lee. 2006. The definition of *Harpiola* (Vespertilionidae: Murininae) and the description of a new species from Taiwan. – Acta Chiropterologica, 8(1): 11–19.

Kuo, H.-C., Y.-P. Fang, G. Csorba, L.L. Lee. 2009. Three new species of Murina (Chiroptera: Vespertilionidae) from Taiwan. – Journal of Mammalogy, 90(4): 980–991.

Kuznetsov, G.V. 2000. Mammals of coastal islands of Vietnam: zoogeographical and ecological aspects. – Pp. 357–366 in: Isolated Vertebrate Communities io the Tropics. Rheinwald, G., ed. Proc. 4th Int. Symp., Bonn.

Kuznetsov, G.V. 2001. Studies of Vietnamese mammals: faunal structure, taxonomical and ecological diversity. – Pp. 35–46 in: Works on Ecological Studies of Tropical Forest in 1988–2001. Russian-Vietnamese Tropical Centre, 79 p. [In Russian]

Kuznetsov, G.V. 2006. Mammals of Vietnam. KMK Scientific Press Ltd., Moscow, 420 pp.

Kuznetsov, G.V., A.V. Borissenko, V.V. Rozhnov. 2001. A synopsis of the mammal fauna of the Vu Quang Nature Reserve. – Pp. 161–189 in: Materials of zoological and botanical studies in Vu Quang Nature Reserve (Ha Tinh Province, Vietnam), Moscow–Hanoi, 467 pp. [In Russian]

Kuznetsov, G.V., Pham Trong An'. 1992. Mammals of coastal islands of Vietnam (biogeographical and ecological aspects). – Pp. 182–197 in: Zoological studies in Vietnam, Nauka, Moscow, 280 pp. [in Russian]

Kuzyakin, A.P. 1980. Processing of bats for scientific collections. – Pp. 289–298 in: Bats (Chiroptera). Questions of Theriology Series. Nauka, Moscow, 316 p. [In Russian]

Lack, J.B., Z.P. Roehrs, C.E. Stanley, M. Ruedi, R.A. Van den Bussche. 2010. Molecular phylogenetics of *Myotis* indicate familial-level divergence for the genus *Cistugo* (Chiroptera). – Journal of Mammalogy, 91(4): 976–992.

Lamb, J.M., T.M. C. Ralph, T. Naidoo, P.J. Taylor, F. Ratrimomanarivo, W.T. Stanley, S.M. Goodman. 2011. Toward a molecular phylogeny for the Molossidae (Chiroptera) of the Afro-Malagasy region. – Acta Chiropterologica, 13(1): 1–16.

Lekagul, B., J. A. McNeely. 1977. Mammals of Thailand. Assoc. Conservation Wildlife, Bangkok, 758 pp.

Matveev, V.A. 2005. Checklist of Cambodian bats (Chiroptera), with new records and remarks on taxonomy. – Russian Journal of Theriology, 4(1): 43–62.

Medway, L. 1972. Reproductive cycles of the flat-headed bats *Tylonycteris pachypus* and *T. robustula* (Chiroptera: Vespertilioninae) in a humid equatorial environment. – Zoological Journal of the Linnean Society, 51: 33–61.

Medway L. 1978. The wild mammals of Malaya (Peninsular Malaysia) and Singapore. Oxford Univ. Press, Oxford, New York, Melburne, 128 pp.

Mein, P., Y. Tupinier. 1977. Formule dentaire et position systematique du Minioptere (Mammalia, Chiroptera). – Mammalia, 41(2): 207–211.

Menu, H. 1987. Morphotypes dentaires actuels et fossiles des Chiropteres Vespertilionines. 2eme Partie: implications systematiques et phylogenetiques. – Palaeovertebrata, 17(3): 77–150.

McBee K., D. A. Schlitter, L. R. Robbins. 1987. Systematics of African bats of the genus *Eptesicus* (Mammalia: Vespertilionidae). 2. Karyotypes of African species and their genetic relationships. – Annals of the Carnegie Museum, 56(11): 213–222.

McKenna, M. C., S. K. Bell. 1997. Classification of mammals above the species level. Columbia University Press, N. Y., 631 p.

Mickleburgh, S. P., A. M. Hutson, P. A. Racey. 1992. Old World fruit bats: an action plan for their conservation. IUCN, Gland, 252 p.

Miller-Butterworth, C. M., W.J. Murphey, S.J. O'Brien, D. S. Jacobs, M. S. Springer, E. C. Teeling. 2007. A Family Matter: Conclusive Resolution of the Taxonomic Position of the Long-Fingered Bats, Miniopterus. – Molecular Biology and Evolution, 24(7): 1553–1561.

Murray, S. W., P. Campbell, T. Kingston, A. Zubaid, C. M. Francis, T. H. Kunz. 2012. Molecular phylogeny of hipposiderid bats from Southeast Asia and evidence of cryptic diversity. Molecular Phylogenetics and Evolution, 62(2): 597–611.

Nguyen Trong Son, Dang Huy Phuong, Trinh Viet Cuong, Vu Dinh Thong, G. Csorba. 2009. Preliminary results about bats and rodent in Vinh Cuu Nature Reserve and Historical Monument, Dong Nai province. – Pp. 776–783 in: Proceedings of the 3rd National Scientific Conference on Ecology and Biological Resources Hanoi, 22–23 Oct. Agricultural Publish House, Hanoi. [in Vietnamese]

Nguyen Xuan Dang, Pham Nhat. 2000. Terrestrial mammals of Indochina and Thailand. Science and Technics, Hanoi, 256 pp. [in Vietnamese]

Nowak, R. M. 1994. Walker's Bats of the World. Johns Hopkins Univ. Press, Baltimore – London, 287 p.

Ognev, S. I. 1928. The mammals of the Eastern Europe and of the Northern Asia. Vol. 1. Glavnauka. Moscow – Leningrad, 631 p. [in Russian]

Ohdachi, S. D., Y. Ishibashi, M. A. Iwasa, T. Saitoh (eds.) 2009. The wild Mammals of Japan. Shoukadon Book Sellers, Kyoto, 544 pp.

Osgood, W. H. 1932. Mammals of the Kelley-Roosevelts and Delacour Asiatic Expeditions. – Publications of the Field Museum of Natural History, Zoology, 18: 193–339.

Panyutina, A. A. 2008. Skeleton proportions of flying apparatus in horseshoe bats (Chiroptera, Rhinolophoidea) with different foraging strategies. – Zoologicheskii Zhurnal, 87(11): 1361–1374.

Pavlinov, I. Ya., A. V. Borissenko, S. V. Kruskop, E. L. Yakhontov. 1995. Mammals of Eurasia. II. Non-Rodentia. (Faunal research series). Moscow State Univ. press, Moscow, 336 p.

Pettigrew, J. D. 1986. Flying primates? Megabats have the advanced pathway from eye to midbrain. – Science, 231: 1304–1306.

Phillips, W.W.A. 1980. Manual of the mammals of Sri Lanka. Part 1. Wildlife and Nature Protection Soc. of Sri Lanka, 116 p.

Racey, P. A. 1990. Reproductive assessment. – Pp. 31–45 in: Ecological and behavioral methods for the study of bats. T. H. Kunz, ed. Smithsonian Institution Press. Washington, D. C., London, 533 p.

Reudi, M., F. Mayer. 2001. Molecular systematics of bats of the genus *Myotis* (Vespertilionidae) suggests deterministic ecomorphological convergences. – Molecular Phylogenetics and Evolution, 21(3): 436–448.

Robbins C. B., F. De Vree, V. Van Cakenberghe. 1985. A systematic revision of the African bat genus *Scotophilus* (Vespertilionidae). – Zoologische Wetenschappen, 246: 53–84.

Robinson, M. F., A. L. Smith. 1997. Chiroptera from Loei Province, north-east Thailand. – Natr. Hist. Bull., Siam Soc., 45: 1–16.

Robinson, M. F., M. Webber. 2000. Survey of bats (Mammalia: Chiroptera) in the Khammouan Limestone National Biodiversity Conservation Area, Lao P.D.R. – Natural History Bulletin of the Siam Society, 48: 21–45.

Roehrs, Z. P., J. B. Lack, R. A. Van den Bussche. 2010. Tribal phylogenetic relationships within Vespertilioninae (Chiroptera: Vespertilionidae) based on mitochondrial and nuclear seqence data. – Journal of Mammalogy, 91(5): 1073–1092.

Rozhnov, V.V., A.V. Abramov, G.V. Kuznetsov, P.N. Morozov. 2008. Mammals of Hoang Lien Son. – Pp. 80–103 in: Biodiversity of Hoang Lien Son Mountains. Russian-Vietnamese Tropical Center & Hoang Lien National Park, Hanoi. [in Vietnamese]

Schliemann, H., D. Kock. 2000. Notes on the rare vespertilionid bat *Eudiscopus denticulus* (Osgood, 1932) (Chiroptera, Verspertilionidae). – Mitteilungen aus dem hamburgischen zoologischen Museum und Institut, 97: 131–134.

Simmons, N. B. 2005. Order Chiroptera. – Pp. 312–529 in: D.E. Wilson, D.M. Reeder (eds.). Mammal species of the World: a taxonomic and geographic reference, Third Edition.Volume 1. Baltimore: Johns Hopkins University Press.

Simmons, N. B., J. H. Gaisler. 1998. Phylogenetic relationships of *Icaronycteris*, *Archeonycteris*, *Hassianycteris*, and *Palaeochiropteryx* to extant bat lineages, with comments on the evolution of echolocation and foraging strategies in microchiroptera. – Bulletin of the American Museum of Natural History, 235: 1–182.

Shina, Y. P., S. Chakraborty. 1971. Taxonomic status of the vespertilionid bat, *Nycticejus emarginatus* Dobson. – Proc. zool. Soc., Calcutta, 24: 53–59.

Smith, A. T., Y. Xie (eds.). 2008. A guide to the Mammals of China. Princeton University Press, Princeton, 544 pp.

Snitko, V.P. 2001. Long-handled grips as a device for capturing bats at their roost places. – Plecotus et al., 4: 3–7.

Soisook, P., S. Bumrungsri, A. Dejtaradol, C. M. Francis, G. Csorba, A. Guillen-Servent, P. J. J. Bates. 2007. First records of *Kerivoula kachinensis* (Chiroptera: Vespertilionidae) from Cambodia, Lao PDR and Thailand. – Acta Chiropterologica, 9(2): 339–345.

Soisook, P., S. Bumrungsri, C. Satasook, Vu Dinh Thong, Si Si Hla Bu, D. L. Harrison, P. J. J. Bates. 2008. A taxonomic review of *Rhinolophus stheno* and *R. malayanus* (Chiroptera: Rhinolophidae) from continental Southeast Asia: an evaluation of echolocation call frequency in discriminating between cryptic species. – Acta Chiropterologica, 10(2): 221–242.

Soisook, P., P. Niyomwan, M. Srikrachang, T. Srithongchuay, P. Bates. 2010.

Discovery of *Rhinolophus beddomei* (Chiroptera: Rhinolophidae) from Thailand with a brief comparison to other related taxa. – Tropical Natural History, 10(1): 67–79.

Sokolov, V. E., G. V. Kuznetsov, Dang Huy Huynh, Cao Van Sung, Pham Trong An. 1986. Taxonomical list of mammalian species of Vietnamese fauna. – Pp. 5–14 in: Fauna and ecology of Vietnamese mammals and birds. Nauka, Moscow. [in Russian]

Stadelmann, B., D. S. Jacobs, C. Schoeman, M. Ruedi. 2004. Phylogeny of African *Myotis* bats (Chiroptera, Vespertilionidae) inferred from cytochrome b sequences. – Acta Chiropterologica, 6(2): 177–192.

Stadelmann, B., L.-K. Lin, T. H. Kunz, M. Ruedi. 2007. Molecular phylogeny of New World *Myotis* (Chiroptera, Vespertilionidae) inferred from mitochondrial and nuclear DNA genes. – Molecular Phylogenetics and Evolution, 43: 32–48.

Strelkov, P. P., R. T. Shaimardanov. 2001. Tongs for long-range seizure of bats and portable ladder designed by Butovsky. Some words about Butovsky. – Plecotus et al., 4: 8–12.

Tate, G. H. H. 1942. Results of the Archbold expeditions. No. 47. Review of vespertilionine bats, with special attention to genera and species of the Archbold collections. – Bull. Amer. Mus. Nat. Hist., 80: 211–297.

Teeling, E. C. 2009. Hear, hear: the convergent evolution of echolocation in bats? – Trends in Ecology and Evolution, 24(7):351–354.

Teeling, E. C., O. Madsen, R. A. Van den Bussche, W. W. De Jong, M. J. Stanhope, M. S. Springer. 2002. Microbat paraphyly and the convergent evolution of a key innovation in Old World rhinolophoid microbats. – PNAS, 99(3): 1431–1436.

Teeling, E. C., M. S. Springer, O. Madsen, P. J. J. Bates, S. J. O'Brien, W. J. Murphey. 2005. A molecular phylogeny for bats illuminates biogeography and the fossil record. – Science, 307: 580–584.

Tian, L., B. Liang, K. Maeda, W. Metzner, S. Zhang. 2004. Molecular studies on the classification of *Miniopterus schreibersii* (Chiroptera: Vespertilionidae) inferred from mitochondrial cytochrome *b* sequences. – Folia Zoologica, 53(3): 303–311.

Tideman, C. R., D. P. Woodside. 1978. A collapsible bat-trap and a comparison of results obtained with the trap and with mist-nets. Australian Wildlife Research, 5: 355–362.

Timmins, R. J., Do Tuoc, Trinh Viet Coung, D. K. Hendrichsen. 1999. A preliminary assessment of the conservation importance and conservation priorities of the Phong Nha-Ke Bang proposed National Park, Quang Binh Province, Vietnam. – Fauna & Flora International, Indochina Programme, Hanoi. [Unpublished report].

Tiunov, M. P. 1997. Bats of Russian Far East. Dalnauka, Vladivostok, 134 p. [in Russian]

Tiunov, M. P., S.V. Kruskop, J. Feng. 2011. A new mouse-eared bat (Mammalia: Chiroptera, Vespertilionidae) from South China. – Acta Chiropterologica, 13(2): 271–278.

Thabah, A., S. J. Rossiter, T. Kingston, S. Zhang, S. Parsons, K. M. Mya, Z. Akbar, G. Jones. 2006. Genetic divergence and echolocation call frequency in cryptic species of *Hipposideros larvatus* s.l. (Chiroptera: Hipposideridae) from the Indo-Malayan region. – Biological Journal of the Linnean Society, 88(1): 119–130.

Thabah, A., G. Li, Y. Wang, B. Liang, K. Hu, S. Zhang, G. Jones. 2007. Diet, echolocation calls and phylogenetic affinities of the great evening bat (*Ia io*; Vespertilionidae): another carnivorous bat. – Journal of Mammalogy, 88(3): 728–735.

Thomas, N. M. 2000. Morphological and mitochondrial-DNA variation in *Rhinolophus rouxii* Temminck, 1835 (Chiroptera). – Bonner Zoologische Beitrage, 49(1–4): 1–18.

Thonglongya K. 1973. First record of *Rhinolophus paradoxolophus* (Bourret, 1951) from Thailand, with the description of a new species of the *Rhinolophus philippinensis* group (Chiroptera, Rhinolophidae). – Mammalia, 37(4): 587–597.

Topal G., 1970. The first record of *Ia io* Thomas, 1902 in Vietnam and India and some remarks on the taxonomic position of *Parascotomanes beaulieui* Bourett, 1942, *Ia longimana* Pen, 1962 and the genus *Ia* Thomas, 1902 (Chiroptera, Vespertilionidae). – Opusc. Zool. Budapest, 10(2): 341–347.

Topal, G. 1993. Taxonomic status of the *Hipposideros larvatus alongensis* Bourret, 1942 and occurrence of *Hipposideros turpis* Bangs, 1904 in Vietnam (Mammalia, Chiroptera). – Acta Zoologica Hungarica, 39(1–4): 267–288.

Topal G. 1997 A new mouse-eared bat species, from Nepal, with statistical analyses of some other species of subgenus *Leuconoe* (Chiroptera, Vespertilionidae). – Acta Zool. Hung., 43(4): 375–402.

Tuttle, M. D. 1974. An improved trap for bats. – Journal of Mammalogy, 55: 475–477.

Vallo, P., P. Benda, A. Reiter. 2011. Yellow-bellied or white-bellied? Identity of Arabian house bats (Vespertilionidae: *Scotophilus*) revealed from mitochondrial DNA and morphology. – African Zoology, 46(2): 350–361.

Van Peenen, P. F. D., P. F. Ryan, R. H. Light. 1969. Preliminary identification manual for mammals of South Vietnam. Smithsonian Institution Press, Washington.

Van Peenen, P. F. D., M. L. Cunningham, J. F. Duncan. 1970. A collection of mammals from Con Son island, Vietnam. – Journal of Mammalogy, 51(2): 419–424.

Vu Dinh Thong, N. M. Furey. 2008. The bat fauna of Cat Ba Biosphere Reserve. – Journal of Biology, 30(3): 73–77. [in Vietnamese]

Vu Dinh Thong, S. Bumrungsri, D. L. Harrison, M. J. Pearch, K. M. Helgen, P. J. J. Bates. 2006. New records of Microchiroptera (Rhinolophindae and Kerivoulinae) from Vietnam and Thailand. – Acta Chiropterologica, 8(1): 83–93.

Vu Dinh Thong, C. Dietz, H.-U. Schnitzler, A. Denginger, N. M. Furey, A. V. Borisenko, P. J. J. Bates. 2008. First record of *Hipposideros khaokhouayensis* (Chiroptera: Hipposideridae) from Vietnam. – Journal of Science of HNUE, 53(5): 138–143.

Vu Dinh Thong, Nguyen Truong Son, Dao Nhan Loi, Pham Duc Tien. 2010. An overview of bat research in Bai Tu Long and Con Dao National Parks, with results from recent surveys. – Vietnamese Journal of Biotechnology, 8(3A): 999–1005. [In Vietnamese]

Vu Dinh Thong, S. J. Puechmaille, A. Denzinger, C. Dietz, G. Csorba, P. Bates, E. C. Teeling, H.-U. Schnitzler. 2012a. A new species of *Hipposideros* (Chiroptera: Hipposideridae) from Vietnam. – Journal of Mammalogy, 93(1): 1–11.

Vu Dinh Thong, S. J. Puechmaille, A. Denzinger, P. Bates, C. Dietz, G. Csorba, P. Soisook, E. C. Teeling, S. Matsumura, N. Furey, H.-U. Schnitzler. 2012b. Systematics of the *Hipposideros turpis* complex and a description of a new subspecies from Vietnam. – Mammal Review, 42(2): 166–192.

Volleth, M., K.-G. Heller. 1994. Phylogenetic relationships of vespertilionid genera (Mammalia: Chiroptera) as revealed by Karyological analysis. – Z. zool. Syst. Evolut.-forsch., 32: 11–34.

Walston, J. L. and P.J.J Bates. 2001. The discovery of Wroughton's free-tailed bat *Otomops wroughtoni* (Chiroptera: Molossidae) in Cambodia. – Acta Chiropterologica, 3(2): 249–252.

Wang, H., B. Liang, J. Feng, L. Sheng, S.-Y. Zhang. 2003. Molecular phylogenetic of Hipposiderids (Chiroptera: Hipposideridae) and Rhinolophids (Chiroptera: Rhinolophidae) in China based on mitochondrial cytochrome b sequences. – Folia Zoologica, 52(3): 259–268.

Wilson, D. E. 1989. Bats.– Pp. 365–382 in: H. Leith and M. J. A. Werger (eds.), Tropical rainforest ecosystems: Biogeographical and ecological studies. Elsevier Science Publishers B.V., Amsterdam.

Wilson, D. E., F. R. Cole, J. D. Nichols, R. Rudran, M. S. Foster, eds. 1996. Measuring and monitoring biological diversity. Standard methods for mammals. Smithsonian Institution Press, Washington, D. C. – London. 409 p.

Yanushewicz, A. I., B. M. Aizin, A. K. Kydyraliyev, G. S. Umrikhina, T. F. Fedyatina, E. D. Shukurov, R.V. Grebenyuk, M. M. Tokobayev. 1972. Mammals of Kirgisia. Ilim Publishing House, Frunze, 463 pp. [In Russian]

Zhang, J.-S., N.-J. Han, G. Jones, L.-K. Lin, J.-P. Zhang, Z. Guan-Jian, D.-W. Huang, S.-Y. Zhang. 2007. A new species of *Barbastella* (Chiroptera: Vespertilionidae) from North China. – Journal of Mammalogy, 88(6): 1393–1403.

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Scientific names

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Common names

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