

The Journal of Threatened Taxa (JoTT) is dedicated to building evidence for conservation globally by publishing peer-reviewed articles online every month at a reasonably rapid rate at [www.threatenedtaxa.org](http://www.threatenedtaxa.org). All articles published in JoTT are registered under [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/) unless otherwise mentioned. JoTT allows unrestricted use, reproduction, and distribution of articles in any medium by providing adequate credit to the author(s) and the source of publication.

## Journal of Threatened Taxa

Building evidence for conservation globally

[www.threatenedtaxa.org](http://www.threatenedtaxa.org)

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

### MONOGRAPH

## ILLUSTRATED FIELD KEYS TO THE BATS (MAMMALIA: CHIROPTERA) OF TAIWAN

Joe Chun-Chia Huang, Ying-Yi Ho & Hao-Chih Kuo

11 May 2020 | Vol. 12 | No. 6 | Pages: 15675–15710

DOI: [10.11609/jott.5485.12.6.15675-15710](https://doi.org/10.11609/jott.5485.12.6.15675-15710)



For Focus, Scope, Aims, Policies, and Guidelines visit <https://threatenedtaxa.org/index.php/JoTT/about/editorialPolicies#custom-0>

For Article Submission Guidelines, visit <https://threatenedtaxa.org/index.php/JoTT/about/submissions#onlineSubmissions>

For Policies against Scientific Misconduct, visit <https://threatenedtaxa.org/index.php/JoTT/about/editorialPolicies#custom-2>

For reprints, contact [ravi@threatenedtaxa.org](mailto:ravi@threatenedtaxa.org)

The opinions expressed by the authors do not reflect the views of the Journal of Threatened Taxa, Wildlife Information Liaison Development Society, Zoo Outreach Organization, or any of the partners. The journal, the publisher, the host, and the partners are not responsible for the accuracy of the political boundaries shown in the maps by the authors.

Member



Publisher & Host







## Illustrated field keys to the bats (Mammalia: Chiroptera) of Taiwan

Joe Chun-Chia Huang<sup>1</sup> , Ying-Yi Ho<sup>2</sup>  & Hao-Chih Kuo<sup>3</sup> 

<sup>1</sup> Formosan Golden Bat's Home, No. 1, Suqin Road, Shuilin Township, Yunlin County 65244, Taiwan.

<sup>1</sup> Division of Botanical Gardens, Taiwan Forestry Research Institute, No. 53, Nanhai Road, Zhongzheng District, Taipei 10066, Taiwan.

<sup>2,3</sup> Biodiversity Research Center, Academia Sinica, No. 128, Academia Road, Sec. 2, Nankang District, Taipei 11529, Taiwan.

<sup>1</sup> [ecojoe.huang@gmail.com](mailto:ecojoe.huang@gmail.com), <sup>2</sup> [yho19@gate.sinica.edu.tw](mailto:yho19@gate.sinica.edu.tw), <sup>3</sup> [haochih.kuo@gmail.com](mailto:haochih.kuo@gmail.com) (corresponding author)

**Abstract:** Bats of Taiwan, comprising 38 species in total, are biogeographically unique (11 endemic species and 16 endemic subspecies), taxonomically diverse (six families), and play crucial ecosystem roles as seed dispersers or insect suppressors. Many of these bat species were, nevertheless, scientifically described from or newly recorded in Taiwan during the last 20 years, rendering limited knowledge hitherto gained regarding their fundamental ecology and population statuses. To aid ecological research and thus benefit conservation of Taiwan's bat diversity, we constructed illustrated field keys to all 38 species.

**Keywords:** Bilingual, Chiroptera, external measurements, morphological traits, species identification.

臺灣的蝙蝠（合計38種）具有獨特性高（11個特有種與16個特有亞種）以及組成多元（分屬6個科）的特色，同時，藉由幫助植物傳播種子或是捕食害蟲，這些蝙蝠在生態系功能的維持上厥功甚偉。另一方面，許多臺灣的蝙蝠是在近20年才被釐清分類地位或是在臺灣被正式紀錄，因此關於這些物種的生態習性以及族群狀態都所知有限。在此，我們提供臺灣38種蝙蝠的圖檢索表，期望促進相關生態學研究，進而促進其保育。

**Editor:** Gabor Csorba, Hungarian Natural History Museum, Budapest, Hungary.

**Date of publication:** 11 May 2020 (online & print)

**Citation:** Huang, J.C.-C., Y-Y. Ho & H.-C. Kuo (2020). Illustrated field keys to the bats (Mammalia: Chiroptera) of Taiwan. *Journal of Threatened Taxa* 12(6): 15675–15710. <https://doi.org/10.11609/jott.5485.12.6.15675-15710>

**Copyright:** © Huang et al. 2020. Creative Commons Attribution 4.0 International License. JoTT allows unrestricted use, reproduction, and distribution of this article in any medium by providing adequate credit to the author(s) and the source of publication.

**Funding:** None.

**Competing interests:** The authors declare no competing interests.

**Author details:** JOE CHUN-CHIA HUANG is a conservation ecologist and community ecologist primarily based in Asia. His studies focus mostly on conservation of bat diversity in Taiwan and several SE Asian countries, including Malaysia, Indonesia and Vietnam. YING-YI HO is interested in conservation and behavioral ecology of bats, in particular under the effects of anthropogenic activities. HAO-CHIH KUO has expertise in taxonomy and systematics. He described several new bat species from Taiwan.

**Author contribution:** JCCH wrote the first draft; JCCH, YYH and HCK completed this article jointly.

**Acknowledgements:** We would like to thank Ching-Fong Lin, Han-Chun Lee and Yu-Cheng Chang for permission to use their pictures of bats, and Frank Bonaccorso for language support and various comments to the early manuscript. We also appreciate the National Museum of Natural Science, Taichung, for allowing us to assess their collections of bats.



## INTRODUCTION

Bat diversity in Taiwan is impressive since the island covers only around 36,000km<sup>2</sup>, but harbours 38 species (Wu 2007; Cheng et al. 2017b), which is more than twice the species richness in the United Kingdom. Taiwan's rich bat diversity is also characterized by high endemism, with 11 species found exclusively in this area and another six representing geographically unique races. Situated between the Palearctic and the Indomalayan realms, Taiwan has received fauna and flora that incurred following several routes from nearby mainland regions (He et al. 2018). Indeed, Taiwan bat fauna include genera with predominantly Palearctic distributions (e.g., *Plecotus*, *Barbastella*), and also shares genera with the Indochinese (e.g., *Kerivoula*, *Harpiole*) and the Sunda Shelf (e.g., *Pteropus*) bioregions of Indomalaya. While a few species such as the Ryukyu Flying Fox (*Pteropus dasymallus*) probably dispersed along the islands of the Philippine Arc and the Ryukyu Arc, the others presumably immigrated via the exposed continental shelf during the Pleistocene glacial drops in sea level (Li et al. 2006; Kuo et al. 2014). For the latter group, reformation of the Taiwan Strait during the interglacials blocked former genetic exchanges between Taiwan and the continent, and thus promoted endemism in Taiwan through allopatric divergence (Kuo et al. 2015).

Six of the Old World's 12 bat families (including the recently recognized family Rhinonycteridae) are recorded in Taiwan, namely Pteropodidae, Hipposideridae, Rhinolophidae, Molossidae, Miniopteridae, and Vespertilionidae. Taiwanese vespertilionids contribute three quarters (29 species) of the total richness, whereas only one to three species represent each of the other five families. Within Vespertilionidae, Vespertilioninae is the largest subfamily (13 species, nine genera), followed by Myotinae (nine species, two genera), Murinae (six species, three genera) and Kerivoulinae (one species, one genus). *Myotis* represents the most speciose genus of all, with eight species in total, followed by *Murina* (four species) and *Pipistrellus* (four species). The other genera are only recorded by one or two species each (Cheng et al. 2017b).

Bats are ecologically and economically significant for many natural and human-dominated habitats (Maas et al. 2015). The Formosan Flying Fox feeds mostly on small fruits of native tree species and plays a crucial role in forest regeneration on small islands of Taiwan (Chen et al. 2017). On the main island, except for few records of the flying fox, the bat fauna is exclusively composed of insectivorous species that provide services of insect pest

suppression in agricultural systems and help to maintain forest ecosystem stability through consumption of arthropods. Nevertheless, the diversity of bats and the associated ecosystem functions are threatened by increasing urbanization and agriculture as well as roost disturbance (Cheng et al. 2017b). Nine species are considered threatened or Near Threatened, and another 13 as Data Deficient by either the IUCN Red List (IUCN 2017) or the nation (Cheng et al. 2017a), or with statuses not yet assessed (Table 1).

Despite ongoing conservation assessments, our understanding of the natural history and distribution of most of the bat species in Taiwan as well as understanding the threats to their survival are still limited. Largely the knowledge about Taiwanese bats is restricted to some of the most common species and the protected species. The poor understanding of most bat species is partially due to the fact that many of them have come to be known only in the last 20 years. Lin et al. (1997) described 22 species in the first edition of "Bats of Taiwan". Since then, eight new species from genera *Thainycteris*, *Harpiole*, *Kerivoula*, *Murina*, and *Myotis* have been described (Csorba & Lee 1999; Kuo et al. 2006, 2009, 2017; Ruedi et al. 2015), and three *Pipistrellus* species were reported in Wu's (2007) thesis as putative new species to be formally described. In addition, new range extensions have been made for species of *Cynopterus*, *Hypsugo*, *Myotis*, and *Rousettus* on Taiwan's main island and/or in its nearby islets (see Cheng et al. 2017b for these new records; *Myotis pilosus* was recorded by the Bat Association of Taiwan in February 2018). The dramatic increase in the number of bat species of Taiwan warrants the need of an effective tool for species identification, especially for the multi-species vespertilionid genera *Murina*, *Myotis*, and *Pipistrellus*. Here, we present the first bilingual (English and Chinese) illustrated keys to the 38 Taiwanese bat species. Our goal is to provide a user-friendly tool for inexperienced researchers to identify species in the field without sacrificing animals. Such a tool is fundamental and vital for the further development of ecological research and conservation carrying capacity in Taiwan.

## METHODS

We followed Cheng et al. (2017b) for the nomenclature except that we assigned Taiwan's serotine bat to *Eptesicus pachyomus horikawai* instead of *E. serotinus horikawai* based on Juste et al.'s (2013) study and the generic name of *Thainycteris torquatus* (instead of *Arielulus*, following Wilson & Mittermeier 2019). For

**Table 1.** List of the 38 bat species in Taiwan with their endemism, IUCN Red List status (IUCN 2017) and local conservation status (Cheng et al. 2017a). Abbreviations: ES—endemic species | ESS—endemic subspecies | DD—Data Deficient | LC—Least Concern | NT—Near Threatened | VU—Vulnerable | NCR—Nationally Critical | NEN—Nationally Endangered | NVU—Nationally Vulnerable | n/a—not available.

Family	Species	Endemism	IUCN status	Status in Taiwan
Pteropodidae	<i>Cynopterus sphinx</i> <sup>1</sup>		LC	
	<i>Pteropus dasymallus formosus</i>	ESS	VU	NCR
	<i>Rousettus leschenaultii</i> <sup>2</sup>		LC	
Hipposideridae	<i>Coelops frithii formosanus</i>	ESS	LC	NVU
	<i>Hipposideros armiger terasensis</i>	ESS	LC	LC
Rhinolophidae	<i>Rhinolophus formosae</i>	ES	NT	
	<i>Rhinolophus monoceros</i>	ES	LC	
Miniopteridae	<i>Miniopterus fuliginosus</i>		LC	
Molossidae	<i>Tadarida insignis</i>		NT	
Vespertilionidae				
Kerivoulinae	<i>Kerivoula furva</i>		n/a	
Murinae	<i>Harpiocephalus harpia</i>		LC	DD
	<i>Harpiola isodon</i>		DD	
	<i>Murina bicolor</i>	ES	LC	
	<i>Murina gracilis</i>	ES	LC	
	<i>Murina puta</i>	ES	NT	
	<i>Murina recondita</i>	ES	LC	
Myotinae	<i>Myotis fimbriatus taiwanensis</i>	ESS	LC	
	<i>Myotis formosus flavus</i>	ESS	LC	NVU
	<i>Myotis frater</i>		DD	
	<i>Myotis laniger</i>		LC	
	<i>Myotis pilosus</i> <sup>1</sup>		NT	n/a
	<i>Myotis rufoniger</i>		n/a	
	<i>Myotis secundus</i>	ES	LC	
	<i>Myotis soror</i>	ES	n/a	DD
<i>Submyotodon latirostris</i>	ES	LC		
Vespertilioninae	<i>Thainycteris torquatus</i>	ES	LC	
	<i>Barbastella darjelingensis</i>		n/a	
	<i>Eptesicus pachyomus horikawai</i>	ESS	n/a	
	<i>Hypsugo pulveratus</i>		LC	DD
	<i>Nyctalus plancyi velutinus</i>		LC	
	<i>Pipistrellus abramus</i>		LC	
	<i>Pipistrellus</i> sp. 1		n/a	
	<i>Pipistrellus</i> sp. 2		n/a	
	<i>Pipistrellus</i> sp. 3		n/a	n/a
	<i>Plecotus taivanus</i>	ES	NT	
	<i>Scotophilus kuhlii</i>		LC	
	<i>Scotophilus cf. heathii</i> <sup>1</sup>		LC	
<i>Vespertilio sinensis</i>		LC	NEN	

<sup>1</sup> Only recorded from Kinmen Island | <sup>2</sup> Only recorded from Green Island

the three putative new species of *Pipistrellus* reported in Wu (2007), we referred to them as *Pipistrellus* sp. 1, *Pipistrellus* sp. 2 and *Pipistrellus* sp. 3.

Measurements and descriptions were taken from captured individuals in the field (from >60 localities across whole Taiwan), from specimens deposited at the Zoological Museum of the National Taiwan University (Taipei, Taiwan), the National Museum of Natural Science (Taichung, Taiwan), and from literature (Kuo et al. 2006, 2009, 2017; Huang et al. 2008; Ruedi et al. 2015). For species rarely recorded in Taiwan, data from additional conspecific samples from the continent (Francis 2008; Kruskop 2013; Smith & Xie 2013) were also used to avoid underestimation of intraspecific variation. Measurements were taken only from adults in order to control the age effect. Six external measurements were used: forearm length (FA), from the end of the elbow to the end of the wrist with the wing folded; hind foot length (HF), from the base of calcar to the tip of the toe, excluding the claw; penis length (PL), the whole length of the penis excluding the short proximal portion that is perpendicular to the rest; tibia length (TIB), from the knee joint to the ankle; weight (W), body mass of the live bat; (see Appendix 1 for measuring of FA, PL and TIB). Since our data are collected by different researchers and sources, all measurements in this paper are rounded to the first decimal place to minimize authors' biases.

## RESULTS

Herein we provided Illustrated keys to all 38 bat species in Taiwan, serving to aid researchers easily and accurately identifying these bats in the field. An English version of the identification keys is given below, whereas a Chinese version is provided as a supplementary material (Appendix 2).

### Picture credits

All pictures are credited to the authors (JCCH, YYH, and HCK, see details below), except the following items are used with permission from the original photographers. Image 2 of *Pteropus dasymallus formosus* courtesy of Han-Chun Lee. Image 44 of *Vespertilio sinensis* courtesy of Yu-Cheng Chang, and Image 45 of *Hypsugo pulveratus* courtesy of Ching-Fong Lin.

**JCCH**—Appendix 1 right-bottom panel, Image 1, Images 3–6, Image 9, Images 12–16, Image 19, Image 21, Images 24–26, Images 28–31, Images 33–40, Images 46–47, Image 49, Images 52–54, Image 56, Image 58, Image 59, Image 61, Images 66–67, Image 69, Image 71, Image

73, Image 75, Image 78, Images 88–94 | **HCK**—Appendix 1 top panel, Image 10, Image 22, Image 27, Image 32, Images 41–43, Image 55, Image 57, Image 60, Images 62–63, Image 65, Image 68, Image 72, Image 74, Images 76–77, Images 79–87, Image 95 | **YYH**—Appendix 1 left-bottom panel, Images 7–8, Image 11, Images 17–18, Image 20, Image 23, Image 48, Images 50–51, Image 64, Image 70.

## REFERENCES

- Cheng, H.-C., L.-W. Changchien, R.-S. Lin, C.-H. Yang & S.-W. Chang (2017a).** *The Red List of Terrestrial Mammals of Taiwan, 2017*. Endemic Species Research Institute and Forestry Bureau, Nantou, Taiwan, 35pp.
- Cheng, H.-C., Y.-P. Fang & C.-H. Chou (2017b).** *A Photographic Guide to the Bats of Taiwan, 3rd edition*. Endemic Species Research Institute, Nantou, Taiwan, 152pp (In Chinese).
- Chen, S.-F., T.-J. Shen, H.-C. Lee, H.-W. Wu, W.-T. Zeng, D.-J. Lu & H.-C. Lin (2017).** Preference of an insular flying fox for seed figs enhances seed dispersal of a dioecious species. *Biotropica* 49(4): 511–520. <https://doi.org/10.1111/btp.12449>
- Csorba, G. & L.-L. Lee (1999).** A new species of vespertilionid bat from Taiwan and a revision of the taxonomic status of *Arielulus* and *Thainycteris* (Chiroptera: Vespertilionidae). *Journal of Zoology* 248(3): 361–367. <https://doi.org/10.1111/j.1469-7998.1999.tb01035.x>
- Francis, C. (2008).** *A Guide to the Mammals of Southeast Asia*. Princeton University Press, Princeton, New Jersey, 392pp.
- He, J., Z. Gao, Y. Su, S. Lin & H. Jiang (2018).** Geographical and temporal origins of terrestrial vertebrates endemic to Taiwan. *Journal of Biogeography* 45(11): 2458–2470. <https://doi.org/10.1111/jbi.13438>
- Huang, C.-C., L.-L. Lee & H.-C. Kuo (2008).** An illustrated key to two medium-sized *Myotis* bats, *Myotis taiwanensis* and *Myotis* sp.1, in Taiwan. *Notes and Newsletter of Wildlifers* 12(2): 20–27 (In Chinese).
- IUCN (2017).** The IUCN Red List of Threatened Species 2017. <http://www.iucnredlist.org>. Assessed 13 September 2018.
- Juste, J., P. Benda, J.L. Garcia-Mudarra & C. Ibáñez (2013).** Phylogeny and systematics of Old World serotine bats (genus *Eptesicus*, Vespertilionidae, Chiroptera): an integrative approach. *Zoologica Scripta* 42(5): 441–457. <https://doi.org/10.1111/zsc.12020>
- Kuo, H.-C., S.-F. Chen, Y.-P. Fang, J. Flanders & S.J. Rossiter (2014).** Comparative rangewide phylogeography of four endemic Taiwanese bat species. *Molecular Ecology* 23(14): 3566–3586. <https://doi.org/10.1111/mec.12838>
- Kuo, H.-C., S.-F. Chen, Y.-P. Fang, J.A. Cotton, J.D. Parker, G. Csorba, B.K. Lim, J.L. Eger, C.-H. Chen, C.-H. Chou & S.J. Rossiter (2015).** Speciation processes in putative island endemic sister bat species: false impressions from mitochondrial DNA and microsatellite data. *Molecular Ecology* 24(23): 5910–5926. <https://doi.org/10.1111/mec.13425>
- Kuo, H.-C., Y.-P. Fang, G. Csorba & L.-L. Lee (2006).** The definition of *Harpiola* (Vespertilionidae: Muriniinae) and the description of a new species from Taiwan. *Acta Chiropterologica* 8(1): 11–19. <https://doi.org/10.3161/150811006777070758>
- 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. <https://doi.org/10.1644/08-MAMM-A-036.1>
- Kuo, H.-C., P. Soisook, Y.-Y. Ho, G. Csorba, C.-N. Wang & S.J. Rossiter (2017).** A taxonomic revision of the *Kerivoula hardwickii* complex (Chiroptera: Vespertilionidae) with the description of a new species. *Acta Chiropterologica* 19(1): 19–39. <https://doi.org/10.3161/15081>

### I. Keys to species other than Murinines and Myotines

- 1a Face fox-like (Images 1, 3, 5); ear simple, antitragus and tragus both absent (Image 5) ..... 2 (Pteropodidae)  
 1b Face not fox-like; ear with antitragus (Image 13: yellow arrow) and/or tragus (Image 22: yellow arrow) ..... 4
- 2a FA >130mm; ear only slightly larger than the eye in area (Image 1); fur dark brown, with light yellowish or cream collar in some adults (Image 2) ..... *Pteropus dasymallus formosus*  
 2b FA <100mm; ear at least 3 times larger than the eye in area (Images 4, 5) ..... 3
- 3a Adults ear edge and fingers whitish, hence contrast to the rest of the ear pinna and wing membrane (Image 3), but no such contrast in juveniles (Image 4); fur brown, reddish-brown or light brown in adults (Image 3), and light gray in juveniles (Image 4); FA 65–78 mm ..... *Cynopterus sphinx*  
 3b Ear and wing unicolor (Images 5, 6); fur brown, grayish-brown or light gray (Image 5); FA 75–100 mm .....  
 ..... *Rousettus leschenaultii*
- 4a Distal half of the tail protruding from the interfemoral membrane (Image 7); upper lip wrinkled (Image 8); ear with both tragus and antitragus, the tragus is on the inner side of the antitragus; FA 53–65 mm .....  
 ..... *Tadarida insignis* (Molossidae)  
 4b Tail fully or predominantly enclosed in the interfemoral membrane (Images 9, 10) ..... 5
- 5a Nose specialized with leaf-like and/or horn-like structure (noseleaf, Images 11, 12); ear with well-developed antitragus but no tragus (e.g., Image 13: yellow arrow) ..... 6  
 5b Nose without leaf-like and horn-like structure; ear with tragus (e.g., Image 22: yellow arrow), antitragus absent, inconspicuous or well-developed ..... 9
- 6a Noseleaf with a horn-like projection at its middle part (posterior to the nostrils) (Image 11: yellow arrow); the posterior part of noseleaf more-or-less triangle shaped (Image 14: yellow arrow) ..... 7 (Rhinolophidae)  
 6b Noseleaf without horn-like structure; the posterior part of noseleaf blunt (Image 12: yellow arrow) .....  
 ..... 8 (Hipposideridae)
- 7a FA 54–63 mm; fur dark grayish-brown or dark gray; noseleaf with two lateral lappets around nostrils (Image 13: cyan arrow) ..... *Rhinolophus formosae*  
 7b FA 35–41 mm; fur light grayish-brown, yellowish-brown or orange brown; no lappets on noseleaf (Image 14) .....  
 ..... *Rhinolophus monoceros*
- 8a FA 87–100 mm; ear pinna pointed at the tip (Image 15); 3–4 leaflets at each side of the anterior part of noseleaf (Image 12: cyan arrow); tail obvious (Image 16) ..... *Hipposideros armiger terasensis*  
 8b FA 36–43mm; ear pinna rounded at the tip (Image 17); no leaflets; tail greatly reduced, not visible (Image 18) .....  
 ..... *Coelops frithii formosanus*
- 9a The 3<sup>rd</sup> finger has a distal phalanx (right yellow bracket) about three times as long as the proximal phalanx (left yellow bracket) (Image 19); the tip of ear (when fully extended) is subequal to the top of head (Image 20) .....  
 ..... *Miniopterus fuliginosus* (Miniopteridae)  
 9b The 3<sup>rd</sup> finger has a distal phalanx (right yellow bracket) no more than 1.5 times longer than the proximal phalanx (left yellow bracket) (Image 21); the tip of ear (when fully extended) is obviously higher than the top of head (Image 22) ..... 10 (Vespertilionidae)
- 10a Ears particularly large and connected to each other by a flap of skin above the head (Images 23, 24) ... 11  
 10b Ears not particularly large, do not connect to each other (e.g., Image 22) ..... 12
- 11a Ear length at least 3 times longer than the width (Image 23) ..... *Plecotus taivanus*  
 11b Ear length at most 1.5 times longer than the width (Image 24) ..... *Barbastella darjelingensis*
- 12a Nostrils elongated like tubes (Image 25); the dorsal part of interfemoral membrane obviously hairy (Image 26) ..... Murininae (Keys II)  
 12b Nostrils normal, not tube-like (Image 27); interfemoral membrane inconspicuously hairy (Image 28) ... 13
- 13a Tragus bends at middle, its tip points towards snout (Image 29) ..... 14 (*Scotophilus*)  
 13b Tragus does not significantly bend, its tip points towards the top of head (Image 30) ..... 15
- 14a W 17–26 g, FA 44–55 mm; ventral part light brown or brown (Image 31) ..... *Scotophilus kuhlii*  
 14b W 37–46 g, FA 54–69 mm; ventral part yellowish brown (Image 32) ..... *Scotophilus cf. heathii*
- 15a Ear funnel-shaped, without any obvious transverse ridge on pinna (Image 33); ear pinna edge dark brown, strongly

contrasting to the pale-colored tragus (Image 34) ..... *Kerivoula furva*  
 15b Ear not funnel-shaped, with several transverse ridges on pinna (Image 35); no color contrast between ear pinna edge and tragus (Images 35–38) ..... 16

16a Antitragus present (Image 37: yellow arrow); tragus intermediate in length and blunt at tip (Image 35) or short and broad (Image 37) ..... 17 (partial Vespertilioninae)  
 16b Antitragus absent or inconspicuous (Image 38); tragus long, more or less pointed at tip (Images 36, 38) ..... Myotinae (Keys III)

17a FA >40mm ..... 18  
 17b FA <37mm ..... 21

18a Some dorsal hairs and those on the chest have white, gold or bronze tips; fur on the bases of ears and neck bright yellow (Images 39, 40) ..... *Thainycteris torquatus*  
 18b Hairs unicolor throughout the back or some dorsal hairs frosted/bronze-tipped depending on species; no yellow collar (Images 43, 44) ..... 19

19a Tragus length longer than the width, its tip blunt (Image 41) ..... *Eptesicus pachyomus horikawai*  
 19b Tragus length shorter than the width, its tip broadened (Image 42) ..... 20

20a Fur uniformly burgundy brown or dark reddish-brown (Image 43); 5<sup>th</sup> digit (metacarpal + phalanges) only slightly longer than the 3<sup>rd</sup> and 4<sup>th</sup> metacarpals ..... *Nyctalus plancyi velutinus*  
 20b Fur brown with bronze tips in dorsal hairs or dark brown with frosted tips in dorsal hairs (Image 44); 5<sup>th</sup> digit much longer than the 3<sup>rd</sup> and 4<sup>th</sup> metacarpals ..... *Vespertilio sinensis*

21a Face dark brown colored (Image 45); the calcar lobe weakly developed, with the transverse supported cartilage (the keel) also weakly developed or absent (Image 46); FA 32–37mm ..... *Hypsugo pulveratus*  
 21b Face dark flesh (Image 47) or flesh (Image 49) colored; the calcar lobe well-developed, with a marked keel (Image 48: black arrow) ..... 22 (*Pipistrellus*)

22a Fur gray, grayish or yellowish-brown, often varying through the body (Image 49); individual hairs on the chest tricolor, having a grayish dark base contributing 50–80 % of the total length, followed by gray and then grayish-brown or yellowish-brown at the tip (Image 51); penis more or less slender (Image 53), PL >9.5 mm ..... *Pipistrellus abramus*  
 22b Fur uniformly dark brown, brown or reddish-brown (Images 47, 50) individual hairs on the chest bicolored, having a dark base contributing approximately 85–90% of the total length and brown at the tip (Image 52); penis broaden at tip, hence club-shaped (Image 54, 55), PL <8.1 mm ..... 23

23a Male ..... 24  
 23b Female ..... *Pipistrellus* sp. (not distinguishable by external morphology)

24a The distal, broadened part of the penis about the same length as its stalk part (Image 54) ..... *Pipistrellus* sp. 2  
 24b The distal, broadened part of the penis about twice as long as its stalk part (Images 55) ..... 25

25a The penis broadened part and a short segment of the stalk connected to it have the margin covered with long and dense hairs (Image 55) ..... *Pipistrellus* sp. 3  
 25b The penis broadened part and a short segment of the stalk connected to it have the margin covered with short and sparse hairs (picture not available) ..... *Pipistrellus* sp. 1

**II. Keys to species of Murininae**

1a FA >44mm; fur grayish-red (Images 56, 57); claws dark, distinctively darker than thumbs and toes (Image 58) ..... *Harpiocephalus harpia*  
 1b FA <42mm; claws brown, light brown, yellowish-brown or pale, same colored as or slightly paler than thumbs and toes (Image 59) ..... 2

2a Male TIB 16.1–19.2 mm, female TIB 16.6–19.2 mm ..... 3  
 2b Male TIB 12.9–15.2 mm, female TIB 13.6–15.5 mm ..... 4

3a Male FA 37.2–40.5 mm, female FA 40.3–41.6 mm; dorsal fur brown, ventral fur yellow, cream, or white, hence strongly bicolored (Image 60); the 1<sup>st</sup> upper premolar is substantially lower than the 2<sup>nd</sup> upper premolar (Image 62) ..... *Murina bicolor*  
 3b Male FA 31.7–36.1 mm, female FA 33.8–38.6 mm; dorsal fur brown or grayish-brown, ventral fur light brown or light gray, hence only slight contrast in coloration (Image 61); the 1<sup>st</sup> upper premolar is only slightly lower than the 2<sup>nd</sup> upper premolar (Image 63) ..... *Murina puta*





- 4a Male FA 30.3–32.7 mm, female FA 32.2–36.5 mm; the upper incisors, canine, and premolars are similar in height (Image 64); ventral fur is only slightly lighter than dorsal fur (Image 66); dorsal fur dark brown, dressed with long, shiny golden hairs throughout the back (Image 68) ..... *Harpiala isodon*  
 4b Male FA <30.5mm, female FA <32.5mm; the upper canine is obviously higher than upper incisors and the 1<sup>st</sup> upper premolar (Image 65); ventral fur white or light gray tipped, and strongly contrasts with dorsal fur (Images 67, 70, 71); dorsal fur light brown or yellowish-brown, with shiny long hairs scattered throughout the back or restricted to the head and upper back (Images 69, 72, 73) ..... 5
- 5a Long dorsal hairs with shiny golden tips throughout the back (Images 70, 72); distributed at elevations of 1,000–3,000 m ..... *Murina gracilis*  
 5b Long dorsal hairs with inconspicuous golden or reddish bronze tips, only those on the head and upper back tipped with bright sheen (Images 69, 73); distributed at elevations up to 2200m ..... *Murina recondita*

### III. Keys to species of Myotinae

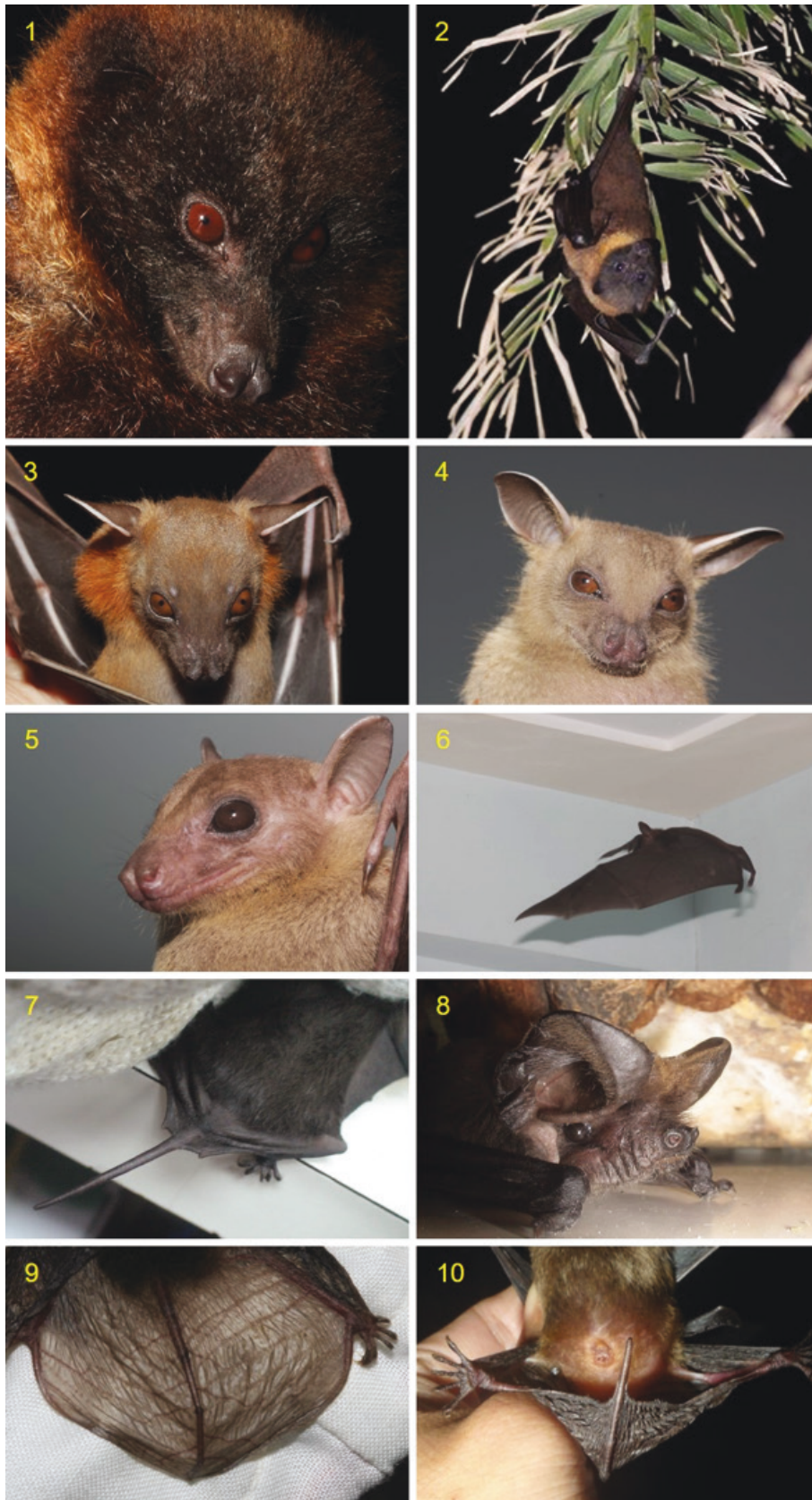
- 1a Fur yellow or orange; wing membrane bicolored, with areas surrounding arms, fingers, tail and body contrastingly yellow or orange, otherwise black (Image 74) ..... 2  
 1b Fur gray or brown; wing membrane unicolored (Image 75) ..... 3
- 2a Fur light yellow or light brownish-yellow (Image 74); ear and nostril unicolored (Image 76) ..... *Myotis formosus flavus*  
 2b Fur brownish-orange or reddish; ear and nostril openings edged with black (Image 77) ..... *Myotis rufoniger*
- 3a FA >50mm; HF 15–18 mm ..... *Myotis pilosus* (Image 78)  
 3b FA <45mm; HF <13mm ..... 4
- 4a Wing attached to side of foot, near the ankle (Image 79), or the base of toe, with the membrane largely narrowed near the foot (Image 81) ..... 5  
 4b Wing attached to the base of toe without narrowing (Image 80) ..... 6
- 5a Wing attached to side of foot (Image 79); the narrow part of hind foot claws is about half of the total length (Image 82); ear tip round (Image 84); penis broad at tip, mushroom-like (Image 86) ..... *Myotis fimbriatus taiwanensis*  
 5b Wing attached to the base of toe, with the membrane largely narrowed near the foot (Image 81); the narrow region of the hind foot claws is 70–75 % of the total length (Image 83); ear tip pointed (Image 85); penis slender at tip (Image 87) ..... *Myotis laniger*
- 6a FA 31.4–38.8 mm; TIB <19mm ..... 7  
 6b FA 38.0–42.6 mm; TIB >19mm ..... 8
- 7a TIB 14.6–19.0 mm; skin dark, dorsal fur dark, scattered with silver-tipped slightly shiny hairs (Image 88), or, in some cases, skin dark brown, dorsal fur brown (Image 90), with yellowish-bronze-tipped shiny hairs; dorsal hairs nearly uniform in length (Image 92) ..... *Myotis secundus*  
 7b TIB 12–14.6 mm; skin brown, dorsal fur dark brown, with long hairs yellowish-brown-tipped, but not shiny (Image 89) or, in some cases, skin dark gray, dorsal fur grayish-brown with long hairs light gray-tipped (Image 91); dorsal long hairs curled and those on the lower back obviously longer (Image 93) ..... *Submyotodon latirostris*
- 8a TIB 50–55 % of FA ..... *Myotis frater* (Image 94)  
 8b TIB 41–48 % of FA ..... *Myotis soror* (Image 95)

109ACC2017.19.1.002

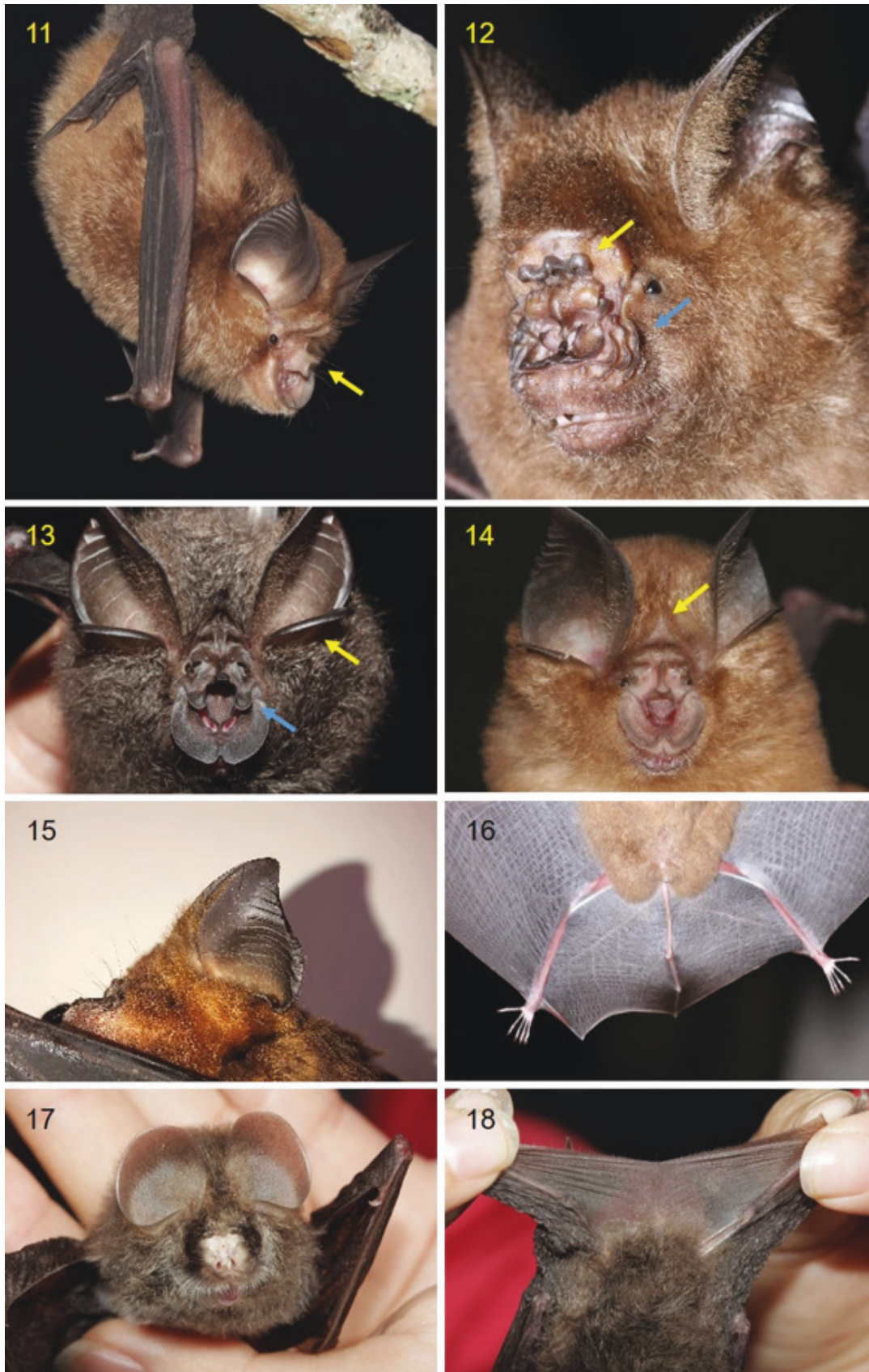
- Kruskop, S.V. (2013).** *Bats of Vietnam: Checklist and an Identification Manual*. Tovarishchestvo nauchnykh izdaniy KMK, Mosco, 299pp.
- Li, G., G. Jones, S.J. Rossiter, S.-F. Chen, S. Parsons & S. Zhang (2006).** Phylogenetics of small horseshoe bats from East Asia based on mitochondrial DNA sequence variation. *Journal of Mammalogy* 87(6): 1234–1240. <https://doi.org/10.1644/05-MAMM-A-395R2.1>
- Lin, L.-K., L.-L. Lee & H.-C. Cheng (1997).** *Bats of Taiwan, 1st edition*. National Museum of Natural Science, Taichung, Taiwan, 165pp (In Chinese).
- Maas, B., D.S. Karp, S. Bumrungsri, K. Darras, D. Gonthier, J.C.-C. Huang, C.A. Lindell, J.J. Maine, L. Mestre, N.L. Michel, E.B. Morrison, I. Perfecto, S.M. Philpott, Ç.H. Şekercioğlu, R.M. Silva, P.J. Taylor, T. Tschardtke, S.A. Van Bael, C.J. Whelan & K. Williams-Guillén (2016).** Bird and bat predation services in tropical forests

and agroforestry landscapes. *Biological Reviews* 91(4): 1081–1101. <https://doi.org/10.1111/brv.12211>

- Ruedi, M., G. Csorba, L.-K. Lin & C.-H. Chou (2015).** Molecular phylogeny and morphological revision of *Myotis* bats (Chiroptera: Vespertilionidae) from Taiwan and adjacent China. *Zootaxa* 3920(1): 301–342. <https://doi.org/10.11646/zootaxa.3920.2.6>
- Smith, A.T. & Y. Xie (Eds.) (2013).** *Mammals of China*. Princeton University Press, Princeton, New Jersey, 400pp.
- Wilson, D.E. & R.A. Mittermeier (eds.) (2019).** *Handbook of the Mammals of the World, Vol. 9: Bats*. Lynx Edicions, Barcelona, Spain, 1008pp.
- Wu, C.-T. (2007).** Taxonomic study of the genus *Pipistrellus* (Chiroptera: Vespertilionidae) in Taiwan. MS Thesis. Department of Biological Resources, National Chiayi University, Taiwan, ii+59pp (In Chinese).



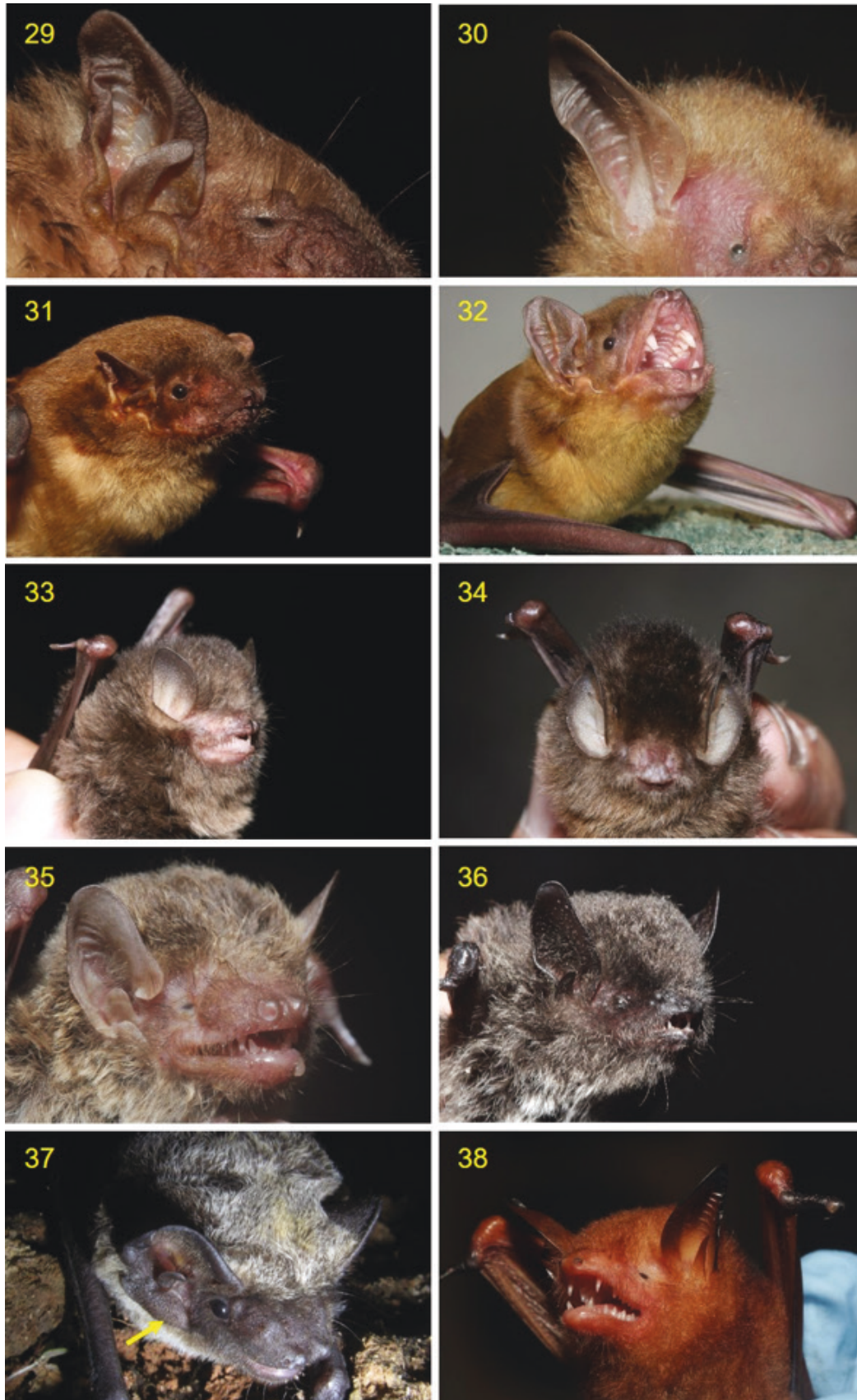
Images 1–10. 1–2—*Pteropus dasymallus formosus* | 3—*Cynopterus sphinx* (adult) | 4—*Cynopterus sphinx* (juvenile) | 5–6—*Rousettus leschenaultii* | 7–8—*Tadarida insignis* | 9—*Kerivoula furva* | 10—*Eptesicus pachyomus horikawai*. © Joe Chun-Chia Huang (1, 3–6, 9), Han-Chun Lee (2), Ying-Yi Ho (7–8) & Hao-Chih Kuo (10).



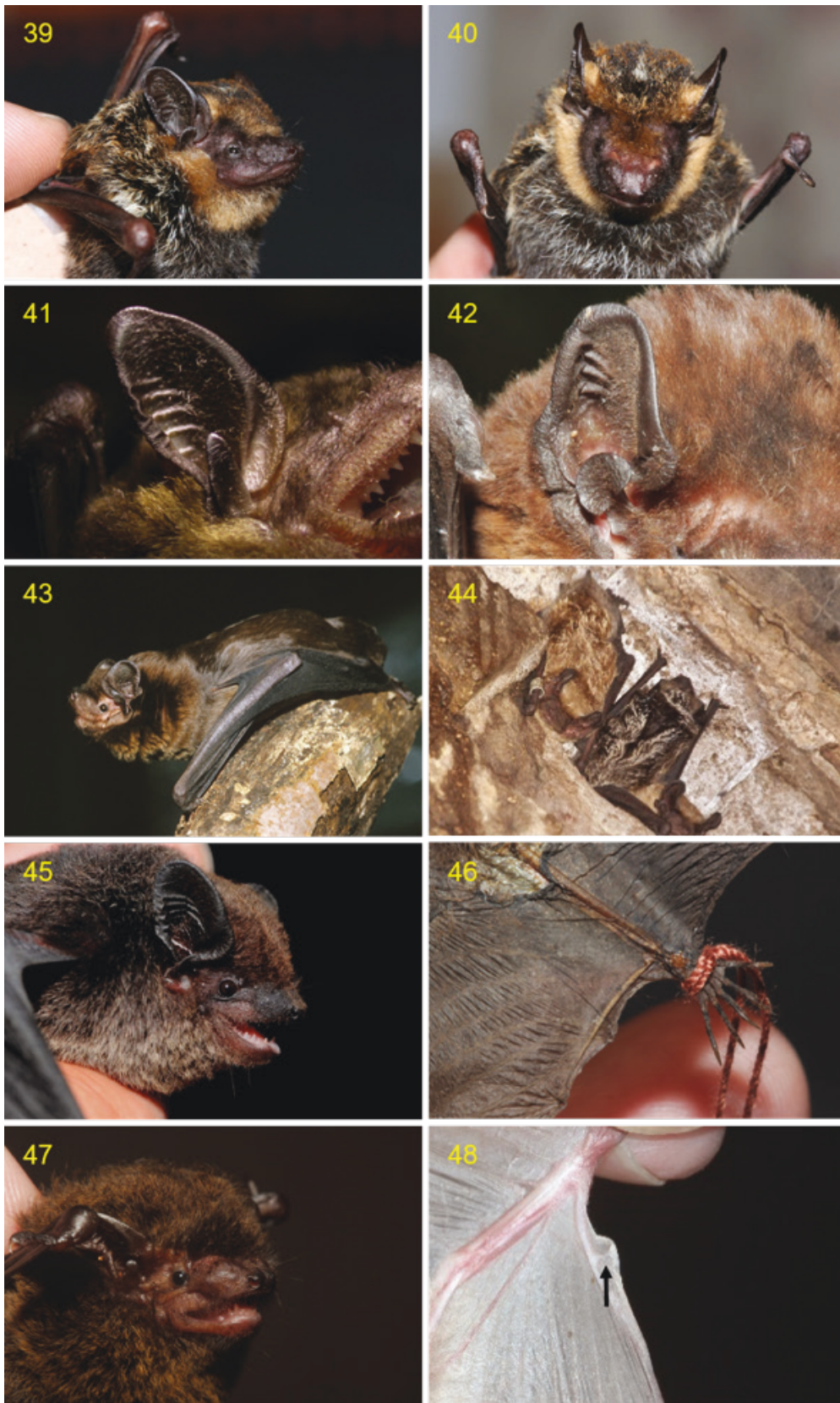
Images 11–18. 11, 14—*Rhinolophus monoceros* | 12, 15–16—*Hipposideros armiger terasensis* | 13—*Rhinolophus formosae* | 17–18—*Coelops frithii formosanus*. © Ying-Yi Ho (11, 17–18) & Joe Chun-Chia Huang (12–16).



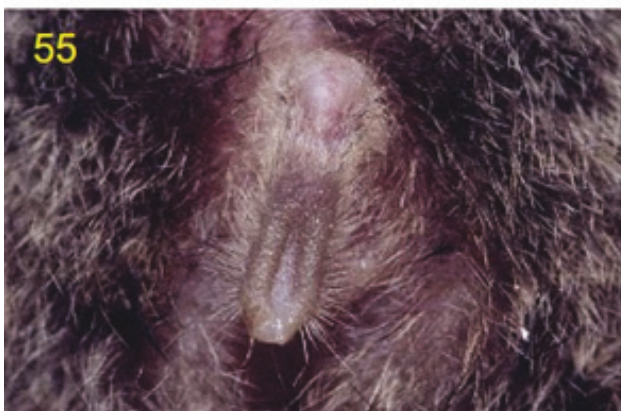
Images 19–28. 19–20—*Miniopterus fuliginosus* | 21—*Pipistrellus abramus* | 22—*Epitescus pachyomus horikawai* | 23—*Plecotus taiwanus* | 24—*Barbastella darjelingensis* | 25—*Murina recondita* | 26—*Murina puta* | 27—*Scotophilus kuhlii* | 28—*Myotis frater*. © Joe Chun-Chia Huang (19, 21, 24–26, 28), Ying-Yi Ho (20, 23) & Hao-Chih Kuo (22, 27).



Images 29–38. 29, 31—*Scotophilus kuhlii* | 30—*Murina puta* | 32—*Scotophilus* cf. *heathii* | 33–34—*Kerivoula furva* | 35—*Pipistrellus abramus* | 36—*Myotis secundus* | 37—*Vespertilio sinensis* | 38—*Myotis rufoniger*. © Joe Chun-Chia Huang (29–31, 33–38) & Hao-Chih Kuo (32).



Images 39–48. 39–40—*Thainycteris torquatus* | 41—*Eptesicus pachyomus horikawai* | 42–43—*Nyctalus plancyi velutinus* | 44—*Vespertilio sinensis* | 45–46—*Hypsugo pulveratus* | 47—*Pipistrellus* sp. 2 | 48—*Pipistrellus abramus*. © Joe Chun-Chia Huang (39–40, 46–47), Hao-Chih Kuo (41–43), Yu-Cheng Chang (44), Ching-Fong Lin (45) & Ying-Yi Ho (48).



Images 49–55. 49, 51, 53—*Pipistrellus abramus* | 50, 52, 54—*Pipistrellus* sp. 2 | 55—*Pipistrellus* sp. 3. © Joe Chun-Chia Huang (49–52–54), Ying-Yi Ho (50–51) & Hao-Chih Kuo (55).

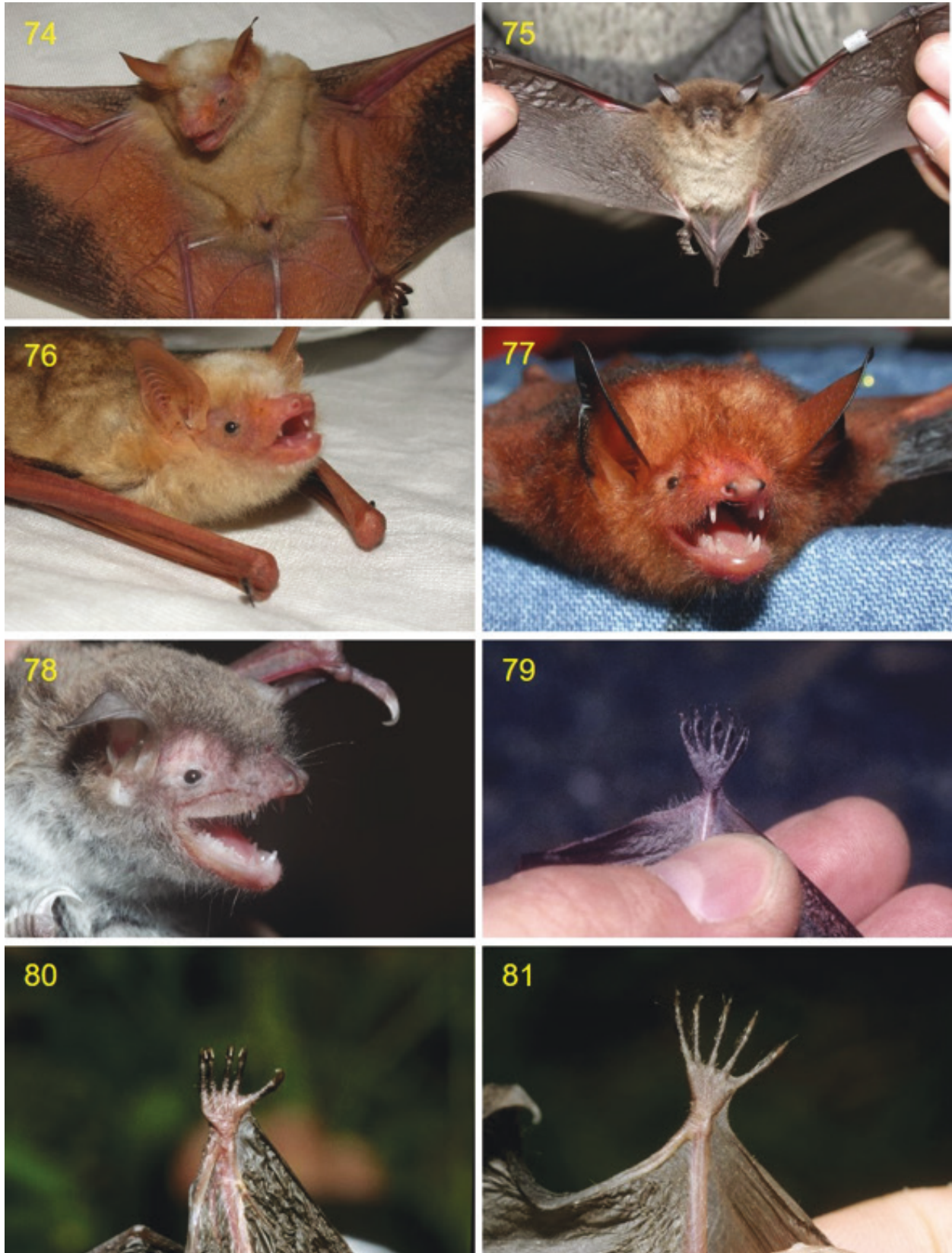


Images 56–65. 56–58—*Harpiocephalus harpia* | 59, 61, 63—*Murina puta* | 60, 62—*Murina bicolor* | 64—*Harpiola isodon* | 65—*Murina recondita*. © Joe Chun-Chia Huang (56, 58–59, 61), Hao-Chih Kuo (57, 60, 62–63, 65) & Ying-Yi Ho (64).





Images 66–73. 66, 68—*Harpiola isodon* | 67, 69, 71, 73—*Murina recondita* | 70, 72—*Murina gracilis*. © Joe Chun-Chia Huang (66–67, 69, 71, 73), Hao-Chih Kuo (68, 72) & Ying-Yi Ho (70).



Images 74–81. 74, 76—*Myotis formosus flavus* | 75, 81—*Myotis laniger* | 77—*Myotis rufoniger* | 78—*Myotis pilosus* | 79—*Myotis fimbriatus taiwanensis* | 80—*Myotis frater*. © Hao-Chih Kuo (74, 76–77, 79–81) & Joe Chun-Chia Huang (75, 78).



Images 82–87. 82, 84, 86—*Myotis fimbriatus taiwanensis* | 83, 85, 87—*Myotis laniger*. © Hao-Chih Kuo (82–87).



Images 88–95. 88, 90, 92—*Myotis secundus* | 89, 91, 93—*Submyotodon latirostris* | 94—*Myotis frater* | 95—*Myotis soror*. © Joe Chun-Chia Huang (88–94) & Hao-Chih Kuo (95).

Appendix 1. Measuring of forearm length (top), tibia length (bottom left), and penis length (bottom right). © Hao-Chih Kuo (top), Ying-Yi Ho (bottom left) & Joe Chun-Chia Huang (bottom right).



## Appendix 2. Keys to bats in Taiwan (Chinese version): 臺灣蝙蝠野外用圖檢索表

- 1a 臉部特徵似狐 (圖1、3、5)；耳殼簡單，不具迎珠和耳珠 (圖5) ..... 2 (狐蝠科)
- 1b 臉部不似狐；具迎珠 (圖13, 黃色箭頭)、耳珠 (圖22, 黃色箭頭) 或兩者皆具 ..... 4
- 2a 前臂長 >130mm；耳殼面積僅較眼球截面略大 (圖1)；體色黑褐色，部分個體頸肩部呈淡黃色或乳白色 (圖2) ..... 臺灣狐蝠 (*Pteropus dasymallus formosus*)
- 2b 前臂長 < 100mm；耳殼面積為眼球截面的三倍或以上 (圖4、5) ..... 3
- 3a 成體耳殼邊緣與掌指骨呈白或乳白色，與耳殼和翼膜顏色呈現明顯反差 (圖3)，幼體則無此反差 (圖4)；成體毛色為褐色、咖啡色或深紅褐色 (圖3)，幼體 (juvenile) 毛色淺灰 (圖4)；前臂長 65–78 mm ..... 印度犬果蝠 (*Cynopterus sphinx*)<sup>1</sup>
- 3b 耳殼單一顏色，掌指骨與翼膜顏色無明顯差異 (圖5、6)；毛色為褐色、灰褐色或灰色 (圖5)；前臂長75–100 mm ..... 棕果蝠 (*Rousettus leschenaultii*)<sup>2</sup>
- 4a 半截尾巴突出股間膜 (圖7)；上唇具明顯皺摺 (圖8)；耳兼具耳珠和迎珠 (耳珠位於迎珠後方)；前臂長 53–65 mm ..... 東亞游離尾蝠 (*Tadarida insignis*) (游離尾蝠科)
- 4b 尾巴末端不突出股間膜，或僅末端一節突出股間膜 (圖9、10) ..... 5
- 5a 鼻部結構複雜，具葉片狀和(或)突起構造 (鼻葉，圖11、12)；不具耳珠，迎珠發達 (如圖13, 黃色箭頭) ..... 6
- 5b 鼻部結構簡單，不具葉片狀和突起構造；有耳珠 (如圖22, 黃色箭頭)，迎珠缺、不發達或明顯 ..... 9
- 6a 中鼻葉 (鼻孔正上方) 具犀角狀突起 (圖11, 黃色箭頭)，上鼻葉大致呈三角形 (圖14, 黃色箭頭) ..... 7 (蹄鼻蝠科)
- 6b 中鼻葉不具明顯突起；上鼻葉大致呈橫條狀 (圖12, 黃色箭頭) ..... 8 (葉鼻蝠科)
- 7a 前臂長 54–63 mm；體色深褐色或暗灰色；鼻部中央突起兩側各有一個鼻垂 (圖13, 青色箭頭) ..... 臺灣大蹄鼻蝠 (*Rhinolophus formosae*)
- 7b 前臂長35–41 mm；體色淺灰褐、黃褐或紅褐色；不具鼻垂 (圖14) ..... 臺灣小蹄鼻蝠 (*Rhinolophus monaceros*)
- 8a 前臂長87–100 mm；耳殼頂端錐狀 (圖15)；下鼻葉兩側各有3–4片側鼻葉 (圖12, 青色箭頭)；尾部明顯 (圖16) ..... 臺灣葉鼻蝠 (*Hipposideros armiger terasensis*)
- 8b 前臂長36–43 mm；耳殼頂端圓弧狀 (圖17)；下鼻葉兩側無側鼻葉；尾部退化，極不明顯 (圖18) ..... 臺灣無尾葉鼻蝠 (*Coelops frithii formosanus*)
- 9a 第三指的第二指骨 (右側半括號) 至少為第一指骨 (左側半括號) 的3倍長 (圖19)；耳殼 (伸直時) 頂端大略與頭頂高度相仿或略低於頭頂 (圖20) ..... 東亞摺翅蝠 (*Miniopterus fuliginosus*) (摺翅蝠科)
- 9b 第三指的第二指骨 (右側半括號) 長度不長於第一指骨 (左側半括號) 的1.5倍 (圖21)；耳殼 (伸直時) 頂端明顯高於頭頂 (圖22) ..... 10 (蝙蝠科)
- 10a 耳殼特大，兩耳前緣基部於頭頂中央處相連 (圖23、24) ..... 11
- 10b 耳殼較小，兩耳前緣基部不相連 (如圖22) ..... 12

<sup>1</sup> 目前僅金門島有紀錄<sup>2</sup> 目前僅綠島有紀錄

- 11a 耳長至少為耳寬的3倍 (圖23) ..... 臺灣長耳蝠 (*Plecotus taivanus*)
- 11b 耳長不超過耳寬的1.5倍 (圖24) ..... 印度寬耳蝠 (*Barbastella darjelingensis*)<sup>3</sup>
- 12a 鼻孔延長為管狀 (圖25)；股間膜背面明顯被毛髮覆蓋 (圖26) ..... 管鼻蝠亞科 (獨立檢索表另附於後)
- 12b 鼻孔非管狀 (圖27)；股間膜背面無明顯毛髮覆蓋 (圖28) ..... 13
- 13a 耳珠明顯彎曲，頂端朝向鼻部 (圖29) ..... 14
- 13b 耳珠無明顯彎曲，頂端朝耳殼頂端 (圖30) ..... 15
- 14a 體重17 – 26 g，前臂長44 – 55 mm；腹部毛色淺褐色或褐色 (圖31) ..... 高頭蝠 (*Scotophilus kuhlii*)
- 14b 體重37 – 46 g，前臂長54 – 69 mm；腹部毛色黃褐色 (圖32) ..... 大黃蝠 (*Scotophilus cf. heathii*)<sup>4</sup>
- 15a 耳殼漏斗狀，無橫向皺褶構造 (圖33)；耳殼外緣深色，與淺色耳珠形成明顯對比 (圖34) ..... 玄彩蝠 (*Kerivoula furva*)
- 15b 耳殼不為漏斗狀，表面有數個橫向皺褶構造 (圖35)；耳珠與耳殼膚色相近 (圖35 – 38) ..... 16
- 16a 耳朵具迎珠 (圖37，黃色箭頭)；耳珠相對粗短，頂端鈍 (圖35) 或寬圓 (圖37) ..... 17 (蝙蝠亞科)(部分)
- 16b 耳朵無迎珠 (圖38)；耳珠相對細長，頂端錐狀 (圖36、38) ..... 鼠耳蝠亞科 (獨立檢索表另附於後)
- 17a 前臂長>40mm ..... 18
- 17b 前臂長<37mm ..... 21
- 18a 背部與胸部部分毛髮末端呈白、金黃或古銅色；頸部腹面至耳朵後方有帶狀卵黃色毛 (圖39、40) ..... 黃頸蝠 (*Thainycteris torquatus*)
- 18b 頸部腹面至耳後方毛色與背腹部相近，唯霜毛蝠背部與胸部部分毛髮末端呈霜白或古銅色；頸部無帶狀黃色毛 (圖43、44) ..... 19
- 19a 耳珠長大於寬、頂端圓弧而未膨大 (圖41) ..... 堀川氏棕蝠 (*Eptesicus pachyomus horikawai*)
- 19b 耳珠寬大於長，頂端膨大 (圖42) ..... 20
- 20a 頭、胸與背部毛髮暗褐色或紅褐色、毛髮末端無明顯之顏色變異 (圖43)；第五指 (包含掌骨與指骨)僅略長於第四或第三指的掌骨 ..... 絨山蝠 (*Nyctalus plancyi velutinus*)
- 20b 頭、胸與背部毛深褐色或淡褐色，頭部和軀幹部分毛髮末端白色或黃銅色 (圖44)；第五指明顯長於第四或第三指的掌骨 ..... 霜毛蝠 (*Vespertilio sinensis*)
- 21a 臉部皮膚暗色 (圖45)；腳距外側膜無明顯膨脹，膜上橫向支持軟骨消失或不明顯 (圖46)；前臂長 32 – 37 mm ..... 灰伏翼 (*Hypsugo pulveratus*)
- 21b 脸部皮膚暗肉色 (圖47) 或肉色 (圖49)；腳距外側膜明顯膨大成葉狀，膜上橫向支持軟骨明顯 (從腹面觀察) (圖48，黑色箭頭) ..... 22 (家蝠屬)

<sup>3</sup> 鄭等 (2017) 使用的東方寬耳蝠應為其舊名 *Barbastella leucomelas* 英文俗名 Eastern Barbastelle 之翻譯，本文認為應該依據目前認定的 *B. darjelingensis* 之英文俗名 Indian Barbastelle 進行翻譯較為適當

<sup>4</sup> 目前僅金門有紀錄

- 22a 體色灰色、灰褐色或黃褐色，毛色通常較混雜（圖49）；胸部毛髮呈三色，自基部約50–80%之區段灰黑色，中段暗灰色，末端顏色灰白或灰褐色（圖51）；陰莖大致呈柱狀（圖53），長度 >9.5mm ..... 東亞家蝠 (*Pipistrellus abramus*)
- 22b 體色黑褐色、褐色或紅褐色，毛色均一（圖47、50）；胸部毛髮雙色，自基部約90%之區段黑墨色，末端顏色褐色（圖52）；陰莖末段明顯膨大（圖54、55），長度 < 8.1mm ..... 23
- 23a 公蝠 ..... 24
- 23b 母蝠 ..... 家蝠屬物種（無法從外觀區別）
- 24b 陰莖末段膨大處與莖柄（狹窄處）的長度比例約為1:1（圖54） ..... 山家蝠 (*Pipistrellus* sp. 2)
- 24a 陰莖末段膨大處與莖柄的長度比例約為 2:1（圖55） ..... 25
- 25a 陰莖膨大處邊緣及與莖柄末端具濃密長毛（圖55） ..... 未命名家蝠物種 (*Pipistrellus* sp. 3)
- 25b 陰莖膨大處邊緣及與莖柄末端毛短而稀疏（圖缺） ..... 臺灣家蝠 (*Pipistrellus* sp. 1)

#### 管鼻蝠亞科檢索表

- 1a 前臂長 >44mm；體色淺灰，背部長毛上段紅色（圖56、57）；爪黑褐色，明顯比拇指和腳趾膚色深（圖58） ..... 毛翼管鼻蝠 (*Harpiocephalus harpia*)
- 1b 前臂長 <42mm；爪褐色、淺褐、黃褐或灰白色，與拇指和腳趾色相同或略淺（圖59） ..... 2
- 2a 公蝠腳脛長16.1–19.2 mm，母蝠腳脛長 16.6–19.2 mm ..... 3
- 2b 公蝠腳脛長12.9–15.2 mm，母蝠腳脛長 13.6–15.5 mm ..... 4
- 3a 公蝠前臂長37.2–40.5 mm，母蝠40.3–41.6 mm；腹部黃色、黃白色或白色，與背部顏色（棕色）差異明顯（圖60），上顎第1前臼齒明顯低於第2前臼齒（圖62） ..... 黃胸管鼻蝠 (*Murina bicolor*)
- 3b 公蝠前臂長31.7–36.1 mm，母蝠 33.8–38.6 mm，背腹顏色差異小，背部褐色或灰褐色，腹部為淺褐色或灰白色（圖61）；上顎第1前臼齒僅略低於第2前臼齒（圖63） ..... 臺灣管鼻蝠 (*Murina puta*)
- 4a 公蝠前臂長30.3–32.7 mm，母蝠 32.2–36.5 mm；上顎門齒、犬齒和前臼齒約略等高（圖64）；腹部毛色與背部相近而僅略淺（圖66）；背部深褐色，密布長毛，多數長毛具金色閃耀光澤（圖68） ..... 金芒管鼻蝠 (*Harpiola isodon*)
- 4b 公蝠前臂長 < 30.5 mm，母蝠 <32.5mm；上顎犬齒明顯高於門齒和第1前臼齒（圖65）；背腹顏色差異明顯（圖67、70、71）；背部淺褐色或深黃褐色，具閃耀光澤的長毛散布於全背或局限分布於頭及上背部（圖69、72、73） ..... 5
- 5a 閃耀金色的長毛散布於整個背部（圖70、72）；海拔分布1000–3000公尺 ..... 姬管鼻蝠 (*Murina gracilis*)
- 5b 長毛之金色或紅銅色閃耀光澤稍弱，且侷限分布於頭部及上背部（圖69、73）；海拔分布最高2200公尺 ..... 隱姬管鼻蝠 (*Murina recondita*)

#### 鼠耳蝠亞科檢索表

- 1a 毛黃或橙色；翼膜雙色，身體、四肢、手指四周翼膜為黃或橙色，其餘部分為黑色（圖74） ..... 2
- 1b 毛灰或褐色；翼膜單色（圖75） ..... 3



- 2b 毛色淡黃或淡黃褐 (圖74) ; 耳殼、鼻孔邊緣不呈黑色 (圖76) ..... 金黃鼠耳蝠 (*Myotis formosus flavus*)
- 2a 毛橙色; 耳殼和鼻孔邊緣呈黑色 (圖77) ..... 赤黑鼠耳蝠 (*Myotis rufoniger*)
- 3a 前臂長 > 50mm ; 後腳長 15 - 18 mm ..... 大足鼠耳蝠 (*Myotis pilosus*)<sup>5</sup> (圖78)
- 3b 前臂長 < 50mm ; 後腳長 <13mm ..... 4
- 4a 翼膜與後腳接於靠近腳踝處 (圖79), 或於靠近腳踝處急劇收窄, 而後接於近腳趾基部 (圖81) ..... 5
- 4b 翼膜與後腳接於腳趾基部, 且未特別收窄 (圖80) ..... 6
- 5a 翼膜接於腳掌側面近腳踝處 (圖79); 後腳爪細長部分約占全長的一半 (圖82) ; 耳殼頂端圓鈍 (圖84); 雄性陰莖末端膨大呈葷狀 (圖86) ..... 臺灣毛腿鼠耳蝠 (*Myotis fimbriatus taiwanensis*)
- 5b 翼膜於靠近腳踝處急劇收窄 (圖81), 後接於近腳趾基部位置; 後腳爪細長部分約占全長的 70 - 75% (圖83) ; 耳殼頂端尖 (圖85); 雄性陰莖末端無膨大, 呈圓柱狀 (圖87) ..... 華南水鼠耳蝠 (*Myotis laniger*)
- 6a 前臂長 31.4 - 38.8 mm ; 腳徑長 <19.0mm ..... 7
- 6b 前臂長 > 38.0 - 42.6 mm ; 腳徑長 >19.0mm ..... 8
- 7a 腳脛長14.6 - 19.0 mm ; 皮膚黑, 背毛黑, 夾雜尖端銀白色略帶光澤之毛髮 (圖88); 少數個體深褐色, 背毛褐色 (圖90), 夾雜尖端銅色略帶光澤之毛髮; 背部毛長度大致均齊 (圖92) ..... 長趾鼠耳蝠 (*Myotis secundus*)
- 7b 腳脛長12.0 - 14.6 mm ; 皮膚褐色, 背毛深褐色 (圖89), 長毛末端黃褐色且, 少數個體皮膚黑褐色, 背毛灰褐色, 長毛末端灰白色 (圖91); 背部長毛末端微捲, 下背部毛明顯較長 (圖93) ..... 寬吻鼠耳蝠 (*Submyotodon latirostris*)
- 8a 腳脛長為前臂長的50 - 55% ..... 長尾鼠耳蝠 (*Myotis frater*) (圖94)
- 8b 腳脛長為前臂長的41 - 48% ..... 紅棕鼠耳蝠 (*Myotis soror*) (圖95)

<sup>5</sup> 僅金門島有紀錄



圖 1. 臺灣狐蝠



圖 2. 臺灣狐蝠



圖 3. 印度犬果蝠 (成體)



圖 4. 印度犬果蝠 (幼體)



圖 5. 棕果蝠



圖 6. 棕果蝠



圖 7. 東亞游離尾蝠



圖 8. 東亞游離尾蝠

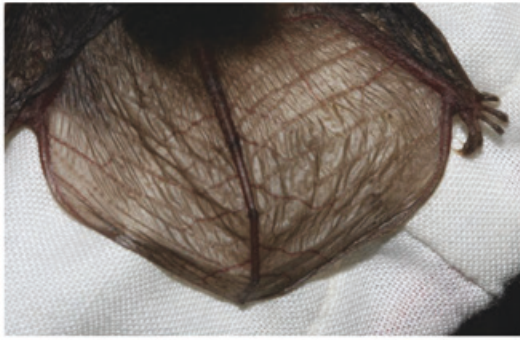


圖 9. 玄彩蝠

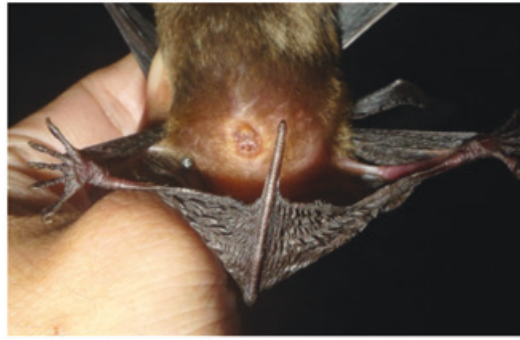


圖 10. 堀川氏棕蝠



圖 11. 臺灣小蹄鼻蝠



圖 12. 臺灣葉鼻蝠



圖 13. 臺灣大蹄鼻蝠



圖 14. 臺灣小蹄鼻蝠



圖 15. 臺灣葉鼻蝠



圖 16. 臺灣葉鼻蝠



圖 17. 臺灣無尾葉鼻蝠



圖 18. 臺灣無尾葉鼻蝠

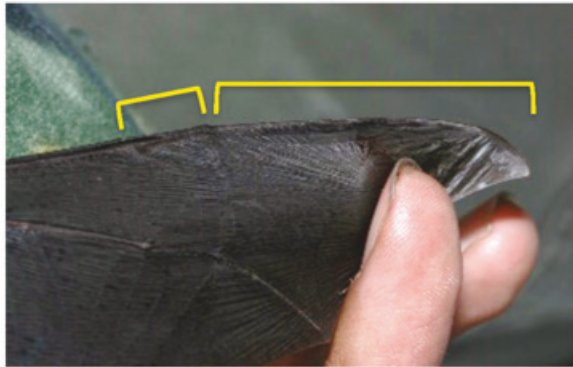


圖 19. 東亞摺翅蝠



圖 20. 東亞摺翅蝠

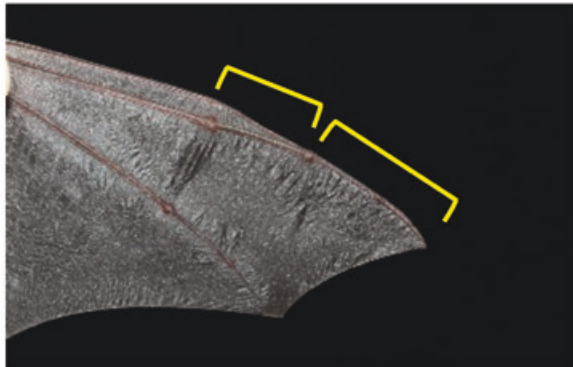


圖 21. 東亞家蝠



圖 22. 堀川氏棕蝠



圖 23. 臺灣長耳蝠



圖 24. 印度寬耳蝠



圖 25. 隱姬管鼻蝠



圖 26. 臺灣管鼻蝠

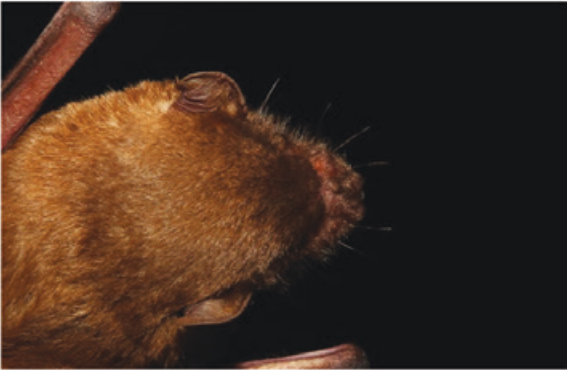


圖 27. 高頭蝠



圖 28. 長尾鼠耳蝠



圖 29. 高頭蝠



圖 30. 臺灣管鼻蝠



圖 31. 高頭蝠



圖 32. 大黃蝠



圖 33. 玄彩蝠



圖 34. 玄彩蝠



圖 35. 東亞家蝠



圖 36. 長趾鼠耳蝠



圖 37. 霜毛蝠



圖 38. *Myotis refoniger*



Fig 39. 黃頸蝠



Fig 40. 黃頸蝠



圖 41. 堀川氏棕蝠



圖 42. 絨山蝠



圖 43. 絨山蝠



圖 44. 霜毛蝠



圖 45. 灰伏翼



Fig 46. 灰伏翼



圖 47. 山家蝠



圖 48. 東亞家蝠



圖 49. 東亞家蝠



圖 50. 山家蝠



圖 51. 東亞家蝠



圖 52. 山家蝠



圖 53. 東亞家蝠



圖 54. 山家蝠

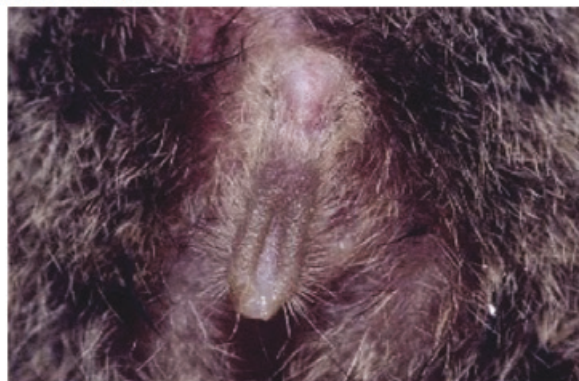


圖 55. 未命名家蝠物種 (*Pipistrellus* sp. 3)





圖 56. 毛翼管鼻蝠



圖 57. 毛翼管鼻蝠



圖 58. 毛翼管鼻蝠



圖 59. 臺灣管鼻蝠



圖 60. 黃胸管鼻蝠



圖 61. 臺灣管鼻蝠



圖 62. 黃胸管鼻蝠



圖 63. 臺灣管鼻蝠



圖 64. 金芒管鼻蝠



圖 65. 隱姬管鼻蝠

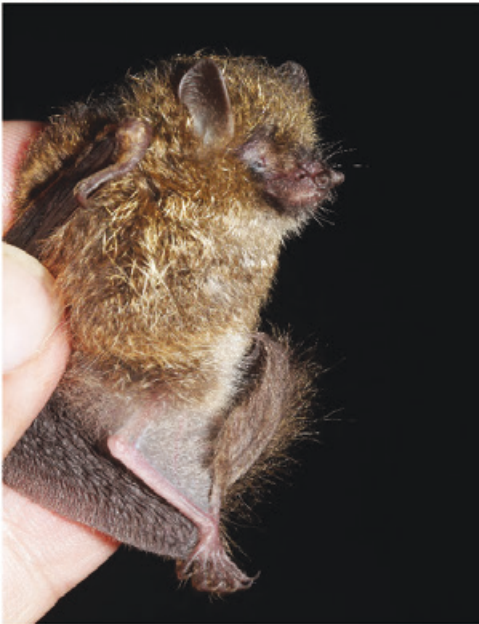


圖 66. 金芒管鼻蝠



圖 67. 隱姬管鼻蝠



圖 68. 金芒管鼻蝠



圖 69. 隱姬管鼻蝠



圖 70. 姬管鼻蝠



圖 71. 隱姬管鼻蝠



圖 72. 姬管鼻蝠



圖 73. 隱姬管鼻蝠



圖 74. 金黃鼠耳蝠



圖 75. 華南水鼠耳蝠



圖 76. 金黃鼠耳蝠



圖 77. 赤黑鼠耳蝠



圖 78. 大足鼠耳蝠



圖 79. 臺灣毛腿鼠耳蝠

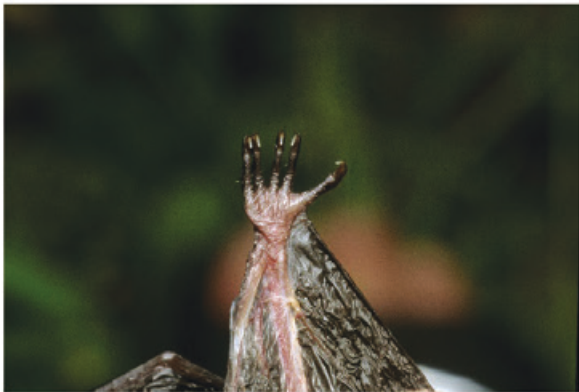


圖 80. 長尾鼠耳蝠



圖 81. 華南水鼠耳蝠



圖 82. 臺灣毛腿鼠耳蝠



圖 83. 華南水鼠耳蝠



圖 84. 臺灣毛腿鼠耳蝠



圖 85. 華南水鼠耳蝠



圖 86. 臺灣毛腿鼠耳蝠



圖 87. 華南水鼠耳蝠



圖 88. 長趾鼠耳蝠



圖 89. 寬吻鼠耳蝠



圖 90. 長趾鼠耳蝠



圖 91. 寬吻鼠耳蝠



圖 92. 長趾鼠耳蝠



圖 93. 寬吻鼠耳蝠



圖 94. 長尾鼠耳蝠



圖 95. 紅棕鼠耳蝠







www.threatenedtaxa.org

**PLATINUM  
OPEN ACCESS**



The Journal of Threatened Taxa (JoTT) is dedicated to building evidence for conservation globally by publishing peer-reviewed articles online every month at a reasonably rapid rate at [www.threatenedtaxa.org](http://www.threatenedtaxa.org). All articles published in JoTT are registered under [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/) unless otherwise mentioned. JoTT allows unrestricted use, reproduction, and distribution of articles in any medium by providing adequate credit to the author(s) and the source of publication.

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

May 2020 | Vol. 12 | No. 6 | Pages: 15675–15710

Date of Publication: 11 May 2020 (Online & Print)

DOI: 10.11609/jott.2020.12.6.15675-15710

## Monograph

### Illustrated field keys to the bats (Mammalia: Chiroptera) of Taiwan

– Joe Chun-Chia Huang, Ying-Yi Ho & Hao-Chih Kuo, Pp. 15675–15710

Member



Publisher & Host

