Illustrated identification key

to the bats of Egypt

by Christian Dietz

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PREFACE

For the last three decades bats have been in the focus of many research projects and the knowledge in the field of taxonomy, ecology and distribution of species has increased extraordinarily. In recent years more and more cryptic species have been found even in such densely examined areas as Central Europe. It has become obvious that especially areas connecting different biogeographic units might harbour many more species than expected until recently. Egypt is such an area connecting Africa with Asia and possibly being inhabited by species currently regarded as very rare or even by unknown species. But unfortunately the bat fauna of Egypt is still little known. The most comprehensive and excellent publication about the bats of Egypt by Qumsiyeh (1985) is now 20 years old and hardly any bat records have been published since (e.g. Osborn 1988).

The aim of the illustrated identification key presented here is to encourage young Egyptian scientists to take up the study of bats and to contribute to the knowledge about these fascinating animals. The hope for a new impulse in the study of bats is closely linked with the wish to a start in the protection of endangered species. Accordingly the new key to the bats of Egypt was written mainly for biologists aiming to identify captured life bats which will be released after identification.

As some characters of little known species are currently not known in their full variability and furthermore some taxonomic questions are not finally clarified, changes in taxonomy and characters might be necessary in future. Therefore the ID-key has to be regarded as preliminary, and I would like to encourage comments or corrections to improve this key.

ACKNOWLEDGEMENTS

Many people helped me by sharing their experience in the identification of bats. The ID-key on the bats of Egypt is similar to the key to the bats of Europe (Dietz & von Helversen 2004) and all people being involved in the European ID-key also helped to some degree with the key presented here. I am especially grateful to Brock Fenton, Eckhard Grimmberger and Erwin Kulzer for their kindly provided photographs of rare bats, to Asaf Tsoar for sharing his deep knowledge of the bats of the Middle East and to Annette Denzinger and Hans-Ulrich Schnitzler for providing echolocation data.

New data on the bats of Egypt were collected and most of the photographs were taken during a research project organised and financed by the British Operation Wallacea and the Egyptian BioMAP Project in 2005. I would like to express my gratitude to Operation Wallacea, especially to Tim Coles and his staff for giving me the possibility to work in Egypt. Samy Zalat and Francis Gilbert and all of the BioMAP Egypt staff contributed by establishing contacts, organising the excursions and by many fruitful scientific discussions. I am much indebted to all members and scientists of the Operation Wallacea team for their help in all respects, especially to Kathy Meakin, Rebecca Guenther and Steve Oliver. I am also grateful to the staff of the National Parks of Egypt for giving permissions to capture bats, for their help in logistics and in finding roosts. Also many thanks to all the Bedouin guides for their enthusiasm and perfect help in all respects.

For their help in identifying bats by molecular genetic methods, for various support, extensive discussions and for sharing their experience I am especially grateful to (in alphabetic order): Paul Bates, Isabel Dietz, Otto von Helversen, Andreas Kiefer, Dieter Kock, Eran Levin, Frieder Mayer, Hans-Ulrich Schnitzler and Björn Siemers. I am also indebted to Doris Mörike for giving me access to the collections of the Staatliches Museum für Naturkunde Stuttgart (SMNS).

HOW TO PROCESS A CAPTURED BAT

This key is written to determine living bats in the hand. Bats are seriously endangered and many species need protection. It is therefore one aim of the ID-key to raise awareness for the necessity of conservation efforts and I would like to ask everybody working with bats to do their very best to minimise disturbances and to release captured bats as soon as possible.

Bats might be caught by a variety of techniques both at roost sites and in free flight. General advice in bat work and how to catch bats is given for example in the “Bat Workers' Manual” published by the Joint Nature Conservation Committee, also available for free in electronic format (www.jncc.gov.uk/Publications/bat_workers). Once bats are captured great care is needed to ensure that they are determined and measured quickly and without causing any harm. Pregnant or lactating females with attached young should be released immediately without further disturbance.

After being caught, bats can best be kept in soft cloth bags. Bags should be always hung up and never laid on the ground. Horseshoe bats and sexually active males of the large vespertilionid bats should always be kept as singles. For horseshoe bats the bags should be fixed in a way that allows the bats to hang head down and they should be kept captive as briefly as possible. Small vespertilionid bat species like pipistrelles can be kept in bags in small groups, but species should never be mixed.

To obtain the bat’s measurements and to examine the characters it is best to wrap them in a cloth or to hold them with soft gloves. Make sure you do not handle them too long, avoid holding a bat tight in your palm (if they are very active, they might suffer from heat stress). Never hold the bats by their forearms, elbows or wing tips only, since their flight muscles might be strained or, even worse, their skeletal system damaged.

WHICH ARE THE MEASUREMENTS USED IN THIS IDENTIFICATION KEY?

The main measurement is the length of forearm (FA). For some species groups, additional measurements (like the length of some fingers) may be useful and are given partially in the text, but the only other value beside forearm length necessary to use this key is the upper tooth row length (CM^3) to distinguish between *Pipistrellus kuhlii* and *P. deserti*.

Although measurements like wingspan, head-body-length and tail length are often mentioned in books, they are not really useful and there is too much variation through different measuring techniques, so they should be avoided to reduce unnecessary stress for the bats. Body mass is a good indicator for the identification of some species when taken at the same time of the day. However, it is omitted here since there are considerable changes in the course of a day and a year.

All measurements given in this key are only valid for fully grown (adult) individuals. At the time of their first flight, the bones of juveniles are not fully ossified. In not fully grown bats, the epiphyses are best visible in the joints of the digits against a light background. Small juveniles have long stretched joints and the fingers are still cartilaginous. With the onset of flight, most parts of the fingers are fully ossified, but the growth plates near the joints are apparent as a light (translucent) cartilaginous gap. In autumn the cartilage is replaced by bone and the joint becomes more and more rounded, knuckle-like (see Fig. 1 – 2, Fig. 1 shows an eight week old juvenile, Fig. 2 the same bat at the age of one year). In addition juveniles of most species are more greyish in coloration and often have a sparser fur (Fig. 3).

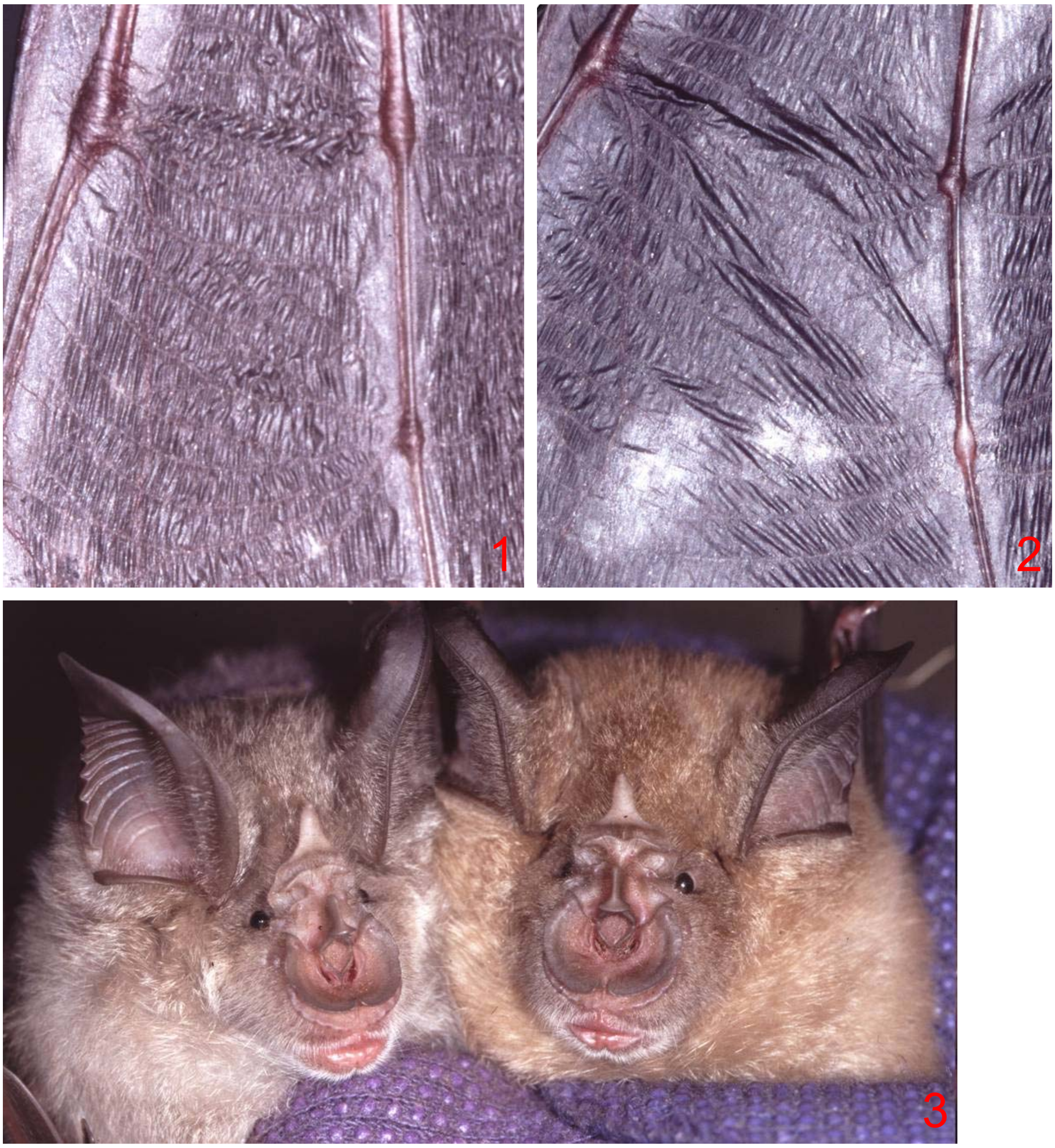


Plate 1: Age classification in bats. Juveniles are on the left, adults on the right.
Myotis aurascens (1 – 2), *Rhinolophus ferrumequinum* (3).

HOW TO TAKE THE MEASUREMENTS USED FOR IDENTIFICATION

Measurements are of any value only when taken in the same standardised way. A caliper will be needed to obtain reliable values. To take the wing measurements (Fig. 4, 6) it is best to hold the bat (for right-handed people) in your left palm curling your fingers around the bat's body (as shown in Fig. 4). To take the **forearm length** (see Fig. 4) it might be easiest to keep the bat in your palm and to fix the folded right forearm of the bat with your thumb and the tip of your index finger. The inner end of the caliper can be fixed by a finger at the bat's elbow. The forearm length is taken between the elbow and the wrist. It is important to ensure that the moveable jaws of the caliper are well attached to elbow and wrist and that the elbow is held parallel to the caliper. To take the **lengths of the third and the fifth digit** it is easiest to keep the bat (for right-handed people) with your left hand and attach it, the bat's ventral side up, to a flat surface (table or one's thigh) and open the wing (Fig. 5). The outer end of the caliper is best attached to the inside of the wrist and the length to the tip of the fingers is taken. The lengths of the phalanges are taken as shown in Fig. 7.

The **upper tooth row length** can also be measured in living bats, but experience and concentration are necessary not to hurt the bat. This measurement is only necessary to distinguish between two of the pipistrelle species. This measurement is taken as the distance between the posterior margin of the last molar and the base of the canine (Fig. 8).

ECHOLOCATION CALL PARAMETERS

Echolocation call parameters are also given briefly in the identification key. Most bat species vary their echolocation call repertoire significantly, the main parameter given here is the end-frequency of open-space calls. Abbreviations used are: cf = constant frequency, qcf = quasi constant frequency, fm = frequency modulated.

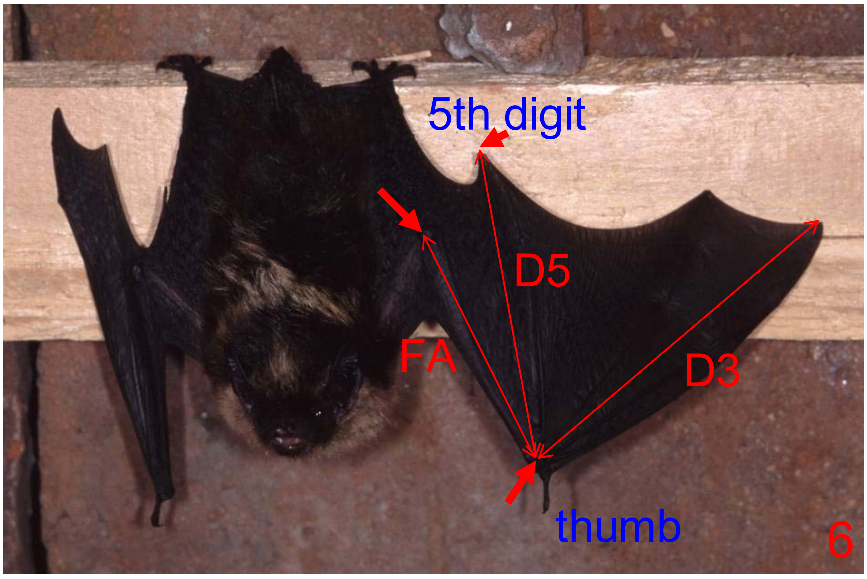
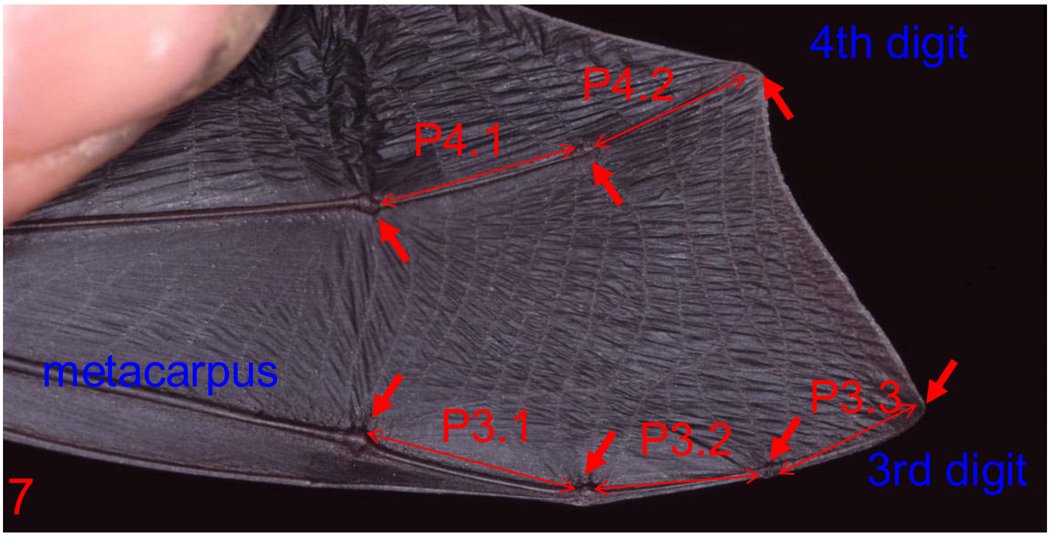


Plate 2:
How to hold a bat to take measurements of forearm and fingers.



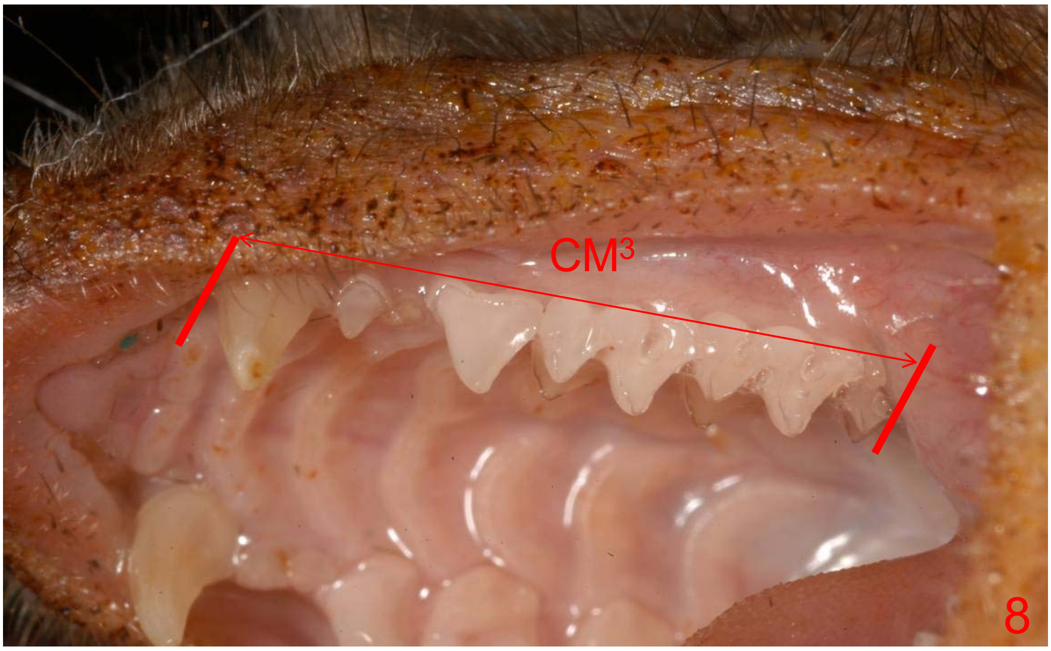


Plate 3: How to take measurements of the phalanges and of the upper tooth row.

LIMITS OF SPECIES IDENTIFICATION

Unfortunately it is not always possible to determine all bats by external characters. Even when considering all characters given in this key some species are difficult to distinguish and even more, some individuals differ so much from the usual appearance that they do not match the given descriptions. In some groups taxonomic questions have not been solved yet. Some cryptic species may still be awaiting discovery, and some species known from neighbouring countries might be discovered in Egypt as well.

IDENTIFICATION KEY TO THE FAMILIES

1) Ear simple without tragus and antitragus (Fig. 10), first and second finger clawed (Fig. 11). Tail very short (sometimes even missing), not contained in a tail membrane. Very large bats FA > 80 mm. – Pteropodidae.

► Ear more complicated with tragus or antitragus (Fig. 13, 16, 19, 22, 26, 30, 33), second finger not clawed, smaller bats FA < 80 mm. – 2.

2) Nose with a pronounced nose leaf (cutaneous process) (Fig. 12, 15). Ears without a tragus (Fig. 13, 16) but with a well developed antitragus. Tail within the tail membrane and shorter or of same length as the hind legs (Fig. 14) – 3.

► No nose leaf (Fig. 18, 25, 29, 32). Tail included in the tail membrane and longer than the hind legs (Fig. 20) or tail extending beyond a narrow tail membrane (Fig. 28, 31, 34). – 4.

3) Nose leaf with a single vertical process above a horseshoe (Fig. 12). – Rhinolophidae.

► Nose leaf with three vertical processes above a horseshoe (Fig 15, 17), (or without vertical processes, species not found in Egypt). – Hipposideridae.

4) Tail included completely in the broad tail membrane or enclosed in the membrane except for the last one or two vertebrae (maximum about 5 mm) (Fig. 20). – 5.

► Tail emerges from the tail membrane, either at the end of the membrane or at it's dorsal surface (Fig. 28, 31, 34). – 6.

5) Muzzle simple without a median furrow (Fig. 18). End of the last vertebrae of the tail not T-shaped (Fig. 20). – Vespertilionidae.

► Muzzle with a vertical median furrow (Fig. 21, 23). End of the last vertebra of the tail T-shaped (Fig. 24). – Nycteridae.

6) Tail protrudes form the dorsal surface of the tail membrane near the mid-point (Fig. 28). Pocket-like skin pouch between the base of the fifth finger and the forearm (Fig. 27) – Emballonuridae.

► Tail emerges from the edge of the tail membrane (Fig. 31, 34). No pocket-like skin pouch between the base of the fifth finger and the forearm. – 7.

7) Tail membrane narrow. Less than a third of the very long mouse-like tail is enclosed in the tail membrane (Fig. 34). Ear with a well developed tragus (Fig. 33) – Rhinopomatidae.

► Tail membrane narrow but enclosing about the half of the short tail (Fig. 31). Ear without tragus but with a well developed antitragus (Fig. 30) – Molossidae.

Plate 4: Four of the eight Egyptian families of bats.

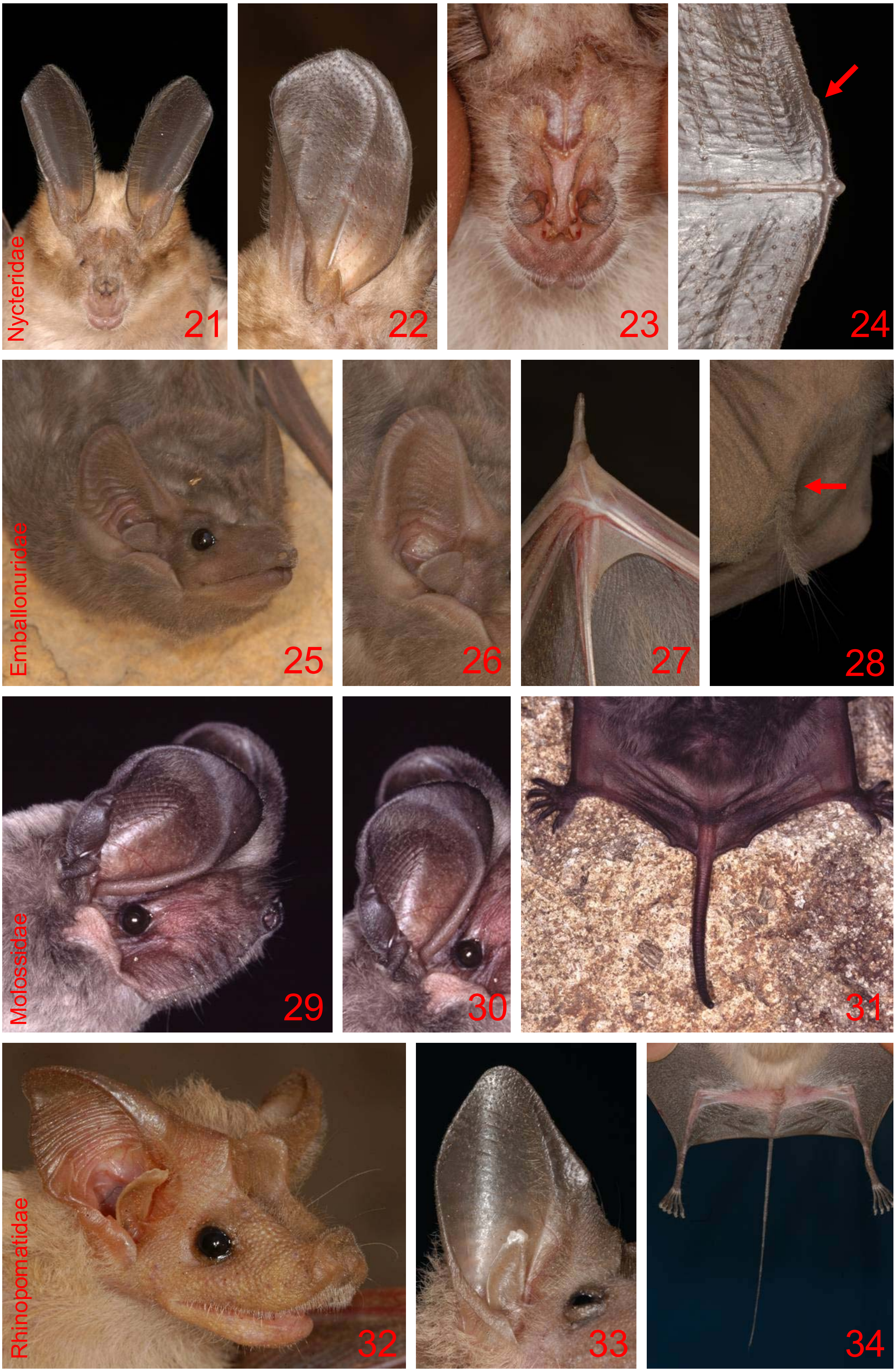


Plate 5: Four of the eight Egyptian families of bats.

A) PTEROPODIDAE

Only one species in Egypt, this is the largest Egyptian bat. The ear is simple without tragus or antitragus. The second finger is clawed. – *Rousettus aegyptiacus*.

Additional characters: FA: 83.0 – 99.0 mm, D5: 100 – 112 mm, D3: 135 – 154 mm. The tail membrane is greatly reduced and the tail is short (16 – 20 mm long) or even missing.

Echolocation: paired fm-echolocation clicks between 7-60 kHz (recordings from Sinai).

Distribution in Egypt: The Egyptian fruit bat is widely distributed in the Nile valley, Nile Delta and at least in some of the oasis of the Sinai peninsula.

Photographs: Fig. 9 - 11 (photographs from Sinai, Egypt).

B) RHINOLOPHIDAE

The horseshoe bats can be identified quite easily by the morphology of the nose leaf. The different parts of the nose leaf are explained in Fig. 35 - 36.

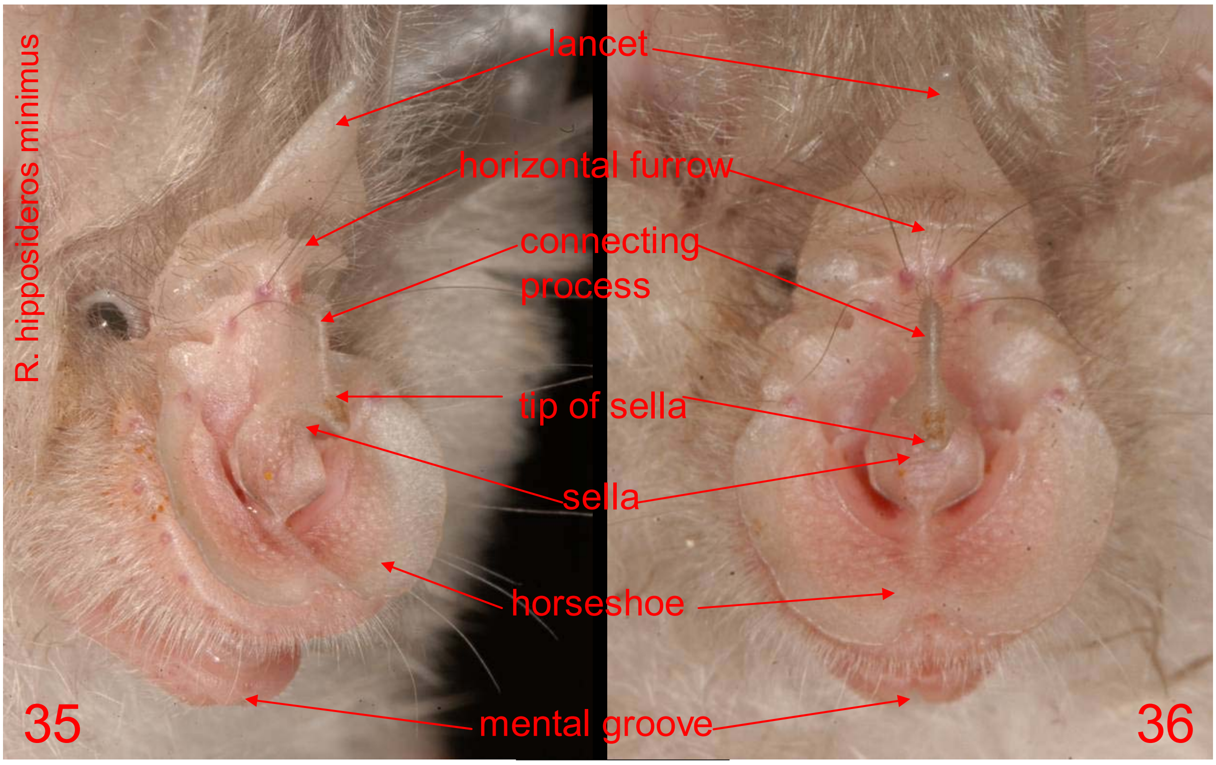


Plate 6: The different parts of the nose leaf of the family Rhinolophidae.

B) RHINOLOPHIDAE (continued)

1) Connecting process (= upper saddle process, Crista) bluntly rounded in profile and shorter than the tip of the sella (= lower saddle process) (Fig. 41, 44). Second phalanx of the fourth finger (P4.2) less than twice as long as the first (P4.1). One mental grove (Fig. 42, 45). – 2.

► Connecting process in profile pointed and always longer than the tip of the sella (Fig. 38). Second phalanx of the fourth finger (P4.2) more than twice as long as the first (P4.1). Three mental groves (Fig. 37). – *Rhinolophus mehelyi*.

Additional characters: FA: 46.5 – 54.8 mm, D5: 57 – 67 mm, D3: 71 – 83 mm, P4.1: 6.5 – 9.3 mm, P4.2: 17.4 – 21.5 mm. Whitish belly coloration and clear boundary between the back and underside coloration in adult individuals.

Echolocation: Cf-calls with a frequency of 106 - 112 kHz (Europe).

Distribution in Egypt: In the Mediterranean part of Egypt (Northern Egypt) and in the Nile Valley as far south as Sakkara.

Photographs: Fig. 37-39 (photographs from Bulgaria).

2) Smallest of the horseshoe bats, FA < 43 mm (34 – 41 mm). The tip of the sella (= lower saddle process) is distinctly longer than the connecting process and in profile tapering to a point (Fig. 41). – *Rhinolophus hipposideros*.

Additional characters: D5: 43 – 53 mm, D3: 51 – 57 mm, P4.1: 5.7 – 7.5 mm, P4.2: 11.5 – 14.2 mm.

Echolocation: Cf-calls with a frequency of 105 - 115 kHz (sound recordings from Sinai).

Distribution in Egypt: The species is only known in Egypt from three sites in the Sinai peninsula.

Taxonomical note: The taxonomic position of the Egyptian population within this species is not solved satisfyingly. There are some morphological differences between the nominate form distributed over most of Europe and the populations from Northern Africa.

Photographs: Fig. 35 – 36, 40 – 42 (photographs from Sinai, Egypt).

► see next page!

► Medium sized horseshoe bat, FA > 43 mm (43.5 – 53.0 mm). The tip of the sella (= lower saddle process) is broadly rounded (Fig. 44). – *Rhinolophus clivosus*.

Additional characters: D5: ~ 61 mm, D3: ~ 73 mm.

Echolocation: Cf-calls with a frequency of 84 – 86 kHz (sound recordings from Sinai).

Distribution in Egypt: Nile Valley, Eastern Desert and Sinai.

Taxonomical note: The populations of the Eastern Desert and Sinai (*R. c. clivosus*) and the Nile Valley (*R. c. brachygnathus*) differ substantially in the colouration with *R. c. brachygnathus* being much darker.

Photographs: Fig. 43 – 45 (photographs from Sinai, Egypt).

C) HIPPOSIDERIDAE

Only one species in Egypt. Nose leaf with three vertical processes above a horseshoe. – *Asellia tridens*.

Additional characters: FA: 46.0 – 54.1 mm, D5: 46 – 52 mm, D3: 59 – 66 mm.

Echolocation: Cf-calls with a frequency between 117-124 kHz and a prominent fm-part at the end of each call (sound recordings from Sinai and additional data from Israel).

Distribution in Egypt: Widely distributed in desert and subdesert regions.

Photographs: 15, 17 and 46 – 47 (photographs from Israel).

Plate 7: The Egyptian species of the families Rhinolophidae and Hipposideridae.

D) RHINOPOMATIDAE

1) Large bat, FA > 61 mm (61.1 - 73.4 mm). Only a small dermal ridge on the muzzle (Fig. 49). – *Rhinopoma microphyllum.*

Additional characters: Tail almost always shorter than the FA (Fig. 48). D5: 61 – 66 mm, D3: 73 – 82 mm.

Echolocation: long qcf calls with one prominent harmonic, end-frequency between 27-30 kHz, best-frequency 28 kHz (data form Israel & Morocco).

Distribution in Egypt: Nile Valley and Nile Delta.

Photographs: Fig. 48 – 50 (photographs from Morocco).

► Medium sized bat, FA < 62 mm, usually < 59 mm (54.0 – 62.2 mm). Pronounced dermal ridge on the muzzle (Fig. 52). – *Rhinopoma hardwickii.*

Additional characters: Tail usually longer than FA. D5: 51 – 60 mm, D3: 59 – 67 mm.

Echolocation: long qcf calls with one prominent harmonic, end-frequency between 30-34 kHz, best-frequency 32 kHz (sound recordings from the Nile Valley and from Israel).

Distribution in Egypt: Nile Valley and Nile Delta.

Photographs: Fig. 51 – 53 (photographs from Morocco and Egypt).

E) EMBALLONURIDAE

1) Large bat, FA > 66 mm (66.2 – 76.8 mm). Parts of the belly are naked (fur on the belly (and on the back as well) does not extend to the origin of the tail membrane) (Fig. 56). – *Taphozous nudiventris*.

Additional characters: D5: 59 – 72 mm, D3: 106 – 116 mm, Tail: 35.0 – 40.0 mm.

Echolocation: qcf-calls with two prominent harmonics, lower harmonic with an end-frequency between 21 – 25 kHz (data from Israel).

Distribution in Egypt: Nile Valley.

Photographs: Fig. 54 – 56 (photographs from Egypt).

► Medium sized bat, FA < 66 mm (59.2 – 66.0 mm). The belly is covered with fur. – *Taphozous perforatus*.

Additional characters: D5: 51 – 56 mm, D3: 85 – 94 mm, Tail: 24.0 – 32.0 mm.

Distribution in Egypt: Nile Valley, Nile Delta and Sinai.

Echolocation: qcf-calls with two prominent harmonics, lower harmonic with an end-frequency between 27 – 29 kHz (sound recordings from the Nile Valley and Israel).

Photographs: Fig. 57 – 59 (photographs from Egypt).

Plate 8: The Egyptian species of the families Rhinopomatidae and Emballonuridae.

F) MOLOSSIDAE

1) Large bat, FA usually > 58 mm (54.7 – 69.9 mm). – *Tadarida teniotis*.

Additional characters: Three pairs of lower incisors. D5: 55 - 59 mm, D3: 102 - 115 mm.

Echolocation: qcf-calls with an end-frequency between 9-14 kHz (sound recordings from Sinai, Israel and Europe).

Distribution in Egypt: Nile Valley and Sinai. Most probably widely distributed.

Photographs: Fig. 60 – 62 (photographs from Morocco).

► Medium sized bat, FA < 55 mm (48.9 – 55.1 mm) – *Tadarida aegyptiacus*.

Additional characters: Two pairs of lower incisors. D5: 44 – 54 mm, D3: 81 – 91 mm.

Echolocation: qcf-calls with an end-frequency around 20 (?) kHz (no data from Egypt available!).

Distribution in Egypt: Nile Valley and Red Sea Mountains, most probably widely distributed in the South.

Photographs: Fig. 63 – 65 (photographs from Egypt).

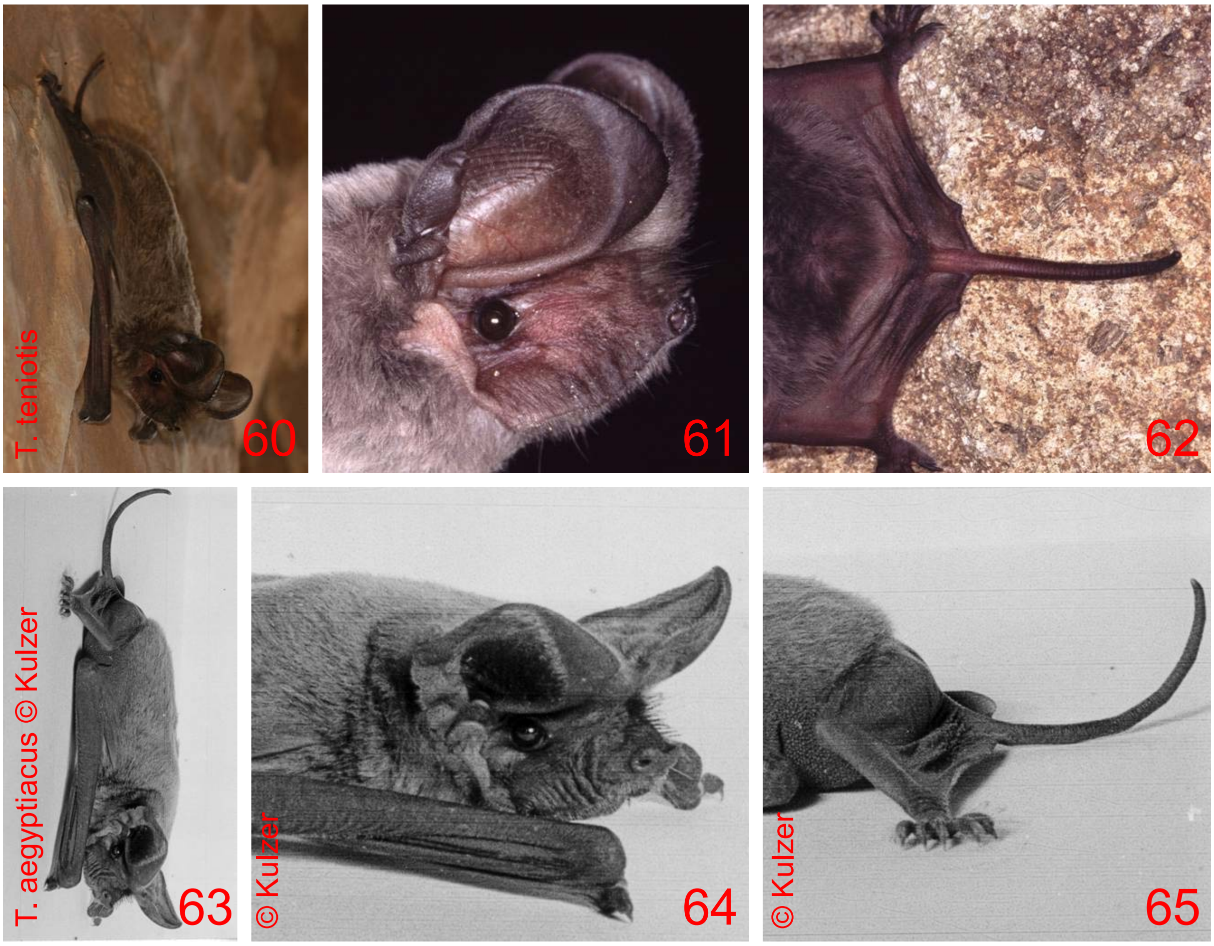


Plate 9: The Egyptian species of the family Molossidae.

G) NYCTERIDAE

Only one species in Egypt. Muzzle with a vertical median furrow (Fig. 23, 68 - 70). End of the last vertebra of the tail T-shaped (Fig. 24). – *Nycteris thebaica*.

Additional characters: Very long ears (Fig. 66). FA 41.0 – 49.0 mm, D5: 58 – 62 mm, D3: 76 - 81 mm.

Echolocation: bi- to multiharmonic fm-calls between 90-65 kHz (sound recordings from Israel & Morocco).

Distribution in Egypt: Nile Valley and Sinai.

Photographs: Fig. 21 – 24, 66 – 70 (photographs from Morocco).

Plate 10: *Nycteris thebaica*.

H) VESPERTILIONIDAE

1) Ears connected in front at their base by a fold of skin and touching each other when erected (Fig. 76). Nostrils open above (Fig. 72, 77). – 2.

► Ears widely separated in front, no fold of skin between the ears (ears separated by normal pelage instead) (Fig. 79). Nostrils open to the front (Fig. 79). – 3.

2) Ears over 30 mm long with numerous horizontal furrows (Fig. 71, 74), folded at rest. – *Plecotus christii*.

Additional characters:. FA: 37.7 – 41.3 mm, D5: 47 – 54 mm, D3: 61 – 69 mm.

Echolocation: fm-calls with two harmonics. 1stharmonic: 44 → 22 kHz, 2ndharmonic: 75 → 47 kHz (sound recordings from Sinai).

Distribution in Egypt: Western Desert, Nile Valley and Sinai.

Taxonomical Note: There might be a second species of long-eared bats occuring in the Western Desert: *Plecotus teneriffae gaisleri*. This species can be separated from *Plecotus christii* by its usually darker ventral colouration of the fur and by its shorter tibia (< 18.2 mm, in *P. christii* > 18.4 mm).

Photographs: Fig. 71 - 74 (photographs from Sinai, Egypt).

► Ears shorter (up to 18 mm long) and wide with 5 - 6 furrows (Fig. 77). Ears never folded at rest. Dorsal fur blackish grey or greyish brown with light silver-grey tips (Fig. 75 - 76). – *Barbastella leucomelas.*

Additional characters: FA: 37.3 – 39.2 mm, D5: 50 – 52 mm, D3: 70 - 71 mm.

Echolocation: two calls emitted alternating: type 1: 40 → 28 kHz and 3-4 ms long; type 2: 44 → 27 kHz, 8-12 ms long and much weaker than type 1 (sound recordings from Sinai).

Distribution in Egypt: Only known from the Sinai Peninsula around the central Ring Dyke.

Photographs: Fig. 75 – 77 (photographs from Sinai, Egypt).

Plate 11: The Egyptian species of the subfamily Plecotini of the Vespertilionidae.

3) Two incisors in each upper jaw (the small second upper incisor might be hardly visible in some individuals of the species *Pipistrellus kuhlii* and *P. deserti*). – 5.

► One incisor in each upper jaw. – 4.

4) Large bat, FA > 55 mm (55.1 – 66.4 mm). Ears long (> 35 mm) (Fig. 78). – *Otonycteris hemprichii*.

Additional characters: The colouration of the belly is of pure white (Fig. 79). Two pairs of teats. Penis built in a very complicated way (Fig. 81). D5: 64 – 79 mm, D3: 83 – 109 mm.

Echolocation: fm-calls with an end-frequency around 18 kHz (data from Israel).

Distribution in Egypt: Distributed throughout Egypt.

Photographs: Fig. 78 – 81 (photographs from Morocco).

► Small bat, FA < 35 mm (30.0 – 34.2 mm). Ears short (< 20 mm). – *Nycticeinops schlieffeni*.

Additional characters: No small upper premolar (Fig. 111 - 113). D5: 41 – 45 mm, D3: 58 – 61 mm.

Echolocation: no data available from Egypt.

Distribution in Egypt: Only known from the surroundings of Cairo and from Suez.

Photographs: Fig. 82 – 85, 111 - 113 (photographs from Zimbabwe and Sudan).

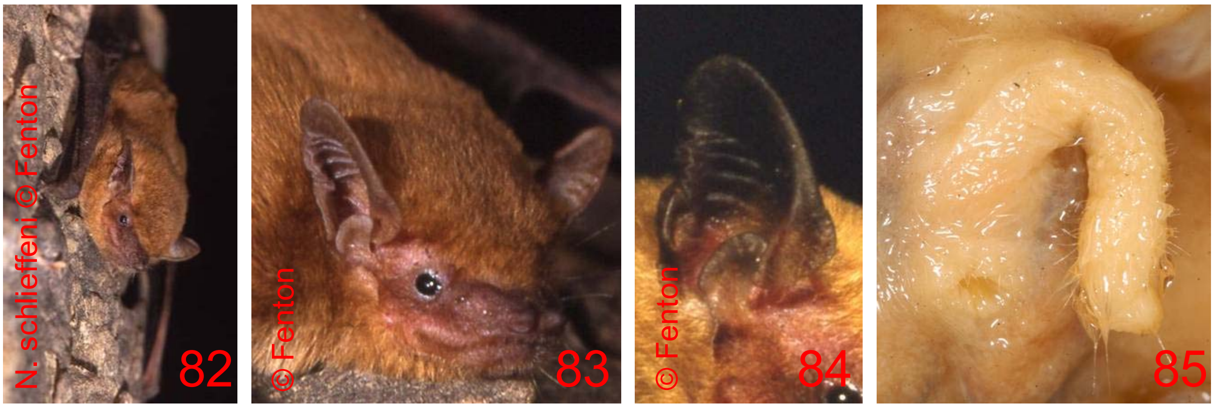


Plate 12: *Nycticeinops schlieffeni*.

5) Smaller species, FA < 38 mm. Tragus rounded, club shaped. Posterior margin of the ear connected with the corner of the mouth by a narrow furrow. – 6.

► Bigger species, FA > 38 mm (40.3 – 42.3 mm). Tragus clearly longer than wide (Fig. 87). Posterior margin of the ear with a narrow furrow extending towards the corner of the mouth but ending before it (Fig. 86). Post calcareal lobe narrow and usually without visible keel. – *Eptesicus bottae*.

Additional characters: D5: around 50 mm, D3: around 65 mm.

Echolocation: fm-cf or qcf-calls with an end-frequency of 27 – 32 kHz (sound recordings from Sinai).

Systematical note: While the form *innesi* distributed in Egypt has been described as a species on its own by LATASTE (1887) and has been regarded so by HARRISON (1963) also, it is now mostly considered to be a subspecies of *Eptesicus bottae* originally described from Yemen (PETERS 1869) (e.g. Harrison & Bates 1991). The systematic affinities to other *Eptesicus*-forms are not well resolved.

Distribution in Egypt: Cairo, Giza. The species was found to be quite common in the Sinai Peninsula, it might be therefore much further distributed than currently known.

Photographs: Fig. 86 – 88 (photographs from Sinai, Egypt).

Plate 13: *Eptesicus bottae innesi*.

6) Last 1 or 2 tail vertebrae extending beyond tail membrane by 4 – 5 mm (Fig. 89). Post calcareal lobe narrow and always without keel (Fig. 91). – 7 (genus *Hypsugo*).

► Last tail vertebrae extending to a maximum of 1 - 2 mm beyond the tail membrane (Fig. 90). Post calcareal lobe broad with well developed keel (in *P. kuhlii* and P. *deserti*, Fig. 92) or absent (*P. rueppellii*). – 8 (genus *Pipistrellus*).

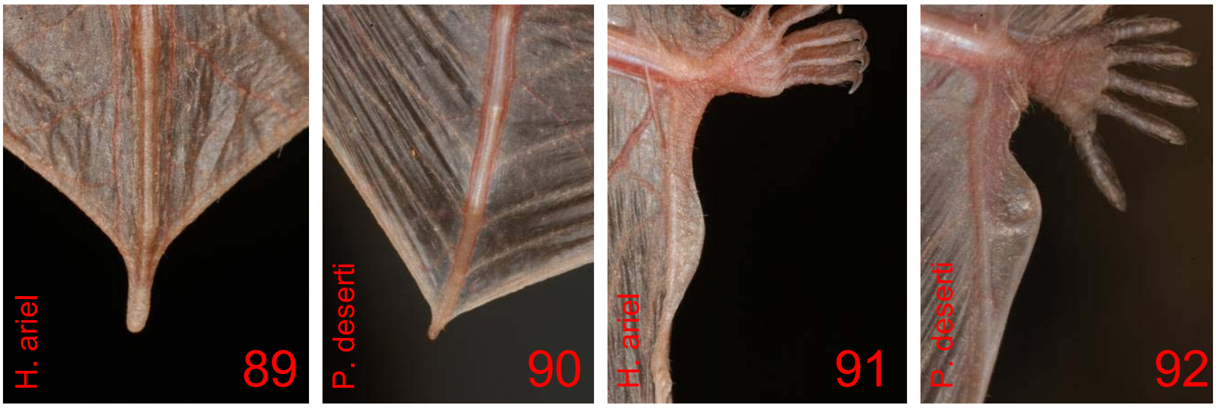


Plate 14: Characters of the genus *Hypsugo* and the genus *Pipistrellus*.

7) First upper incisor bicuspid, short and broad (Fig. 115, 116). Ears rounded and lower (Fig. 94). – *Hypsugo bodenheimeri*.

Additional characters: FA: 28.8 – 32.4 mm, D5: 37 – 39 mm, D3: 50 – 53 mm.

Echolocation: fm-cf or qcf-calls with an end-frequency of 43 – 47 kHz (Sinai).

Systematical note: Neither echolocation calls nor DNA-sequences of the ND1-gene differ between specimen of *H. bodenheimeri* and of *H. ariel* from Sinai (Dietz & Mayer, unpublished), they might be conspecific (Horacek et al. 2000, Benda et al. 2002).

Distribution in Egypt: Only known from the Sinai Peninsula.

Photographs: Fig. 93 – 94, 114 – 116 (photographs from Sinai, Egypt).

► First upper incisor unicuspid, tall and narrow (Fig. 118, 119). Ears tall and narrow (Fig. 97). – *Hypsugo ariel*.

Additional characters: FA: 28.5 – 30.7 mm, D5: around 38 mm, D3: around 54 mm.

Echolocation: fm-cf or qcf-calls with an end-frequency around 45 kHz (Sinai).

Distribution in Egypt: Southern Egypt and Sinai Peninsula.

Taxonomical note: most probably *Hypsugo bodenheimeri* is conspecific with *H. ariel*.

Photographs: Fig. 89, 91, 95 – 98, 117 – 119 (photographs from Sinai, Egypt).

8) First upper incisor bicuspid (Fig. 121, 122). Ventral fur clear white, strongly contrasting to dorsal colouration (clear line of demarcation between dorsal and ventral pelage) (Fig. 99). No post calcareal lobe present. – *Pipistrellus rueppellii*.

Additional characters: FA: 30.7 – 34.4 mm, D5: 42 – 45 mm, D3: 57 – 62 mm.

Echolocation: fm-cf / qcf-calls, end-frequency: 49–53 kHz (Israel), 54–57 kHz (Morocco).

Distribution in Egypt: Known only from a few localities in the Nile Valley.

Photographs: Fig. 99 – 102, 120 – 122 (photographs from Morocco).

► First upper incisor unicuspid (Fig. 124, 127). Ventral fur light but not white and no clear line of demarcation between upper and ventral colouration. Post calcareal lobe well developed and with a well visible keel (Fig. 92). – 9.

9) Upper tooth row length (CM^3) < 4.5 mm. Penis and vagina yellowish orange coloured (Fig. 106). Usually very light fur colouration. Naked parts of the skin light brown, in the face often of orange colour. The white stripe along the wing membrane is very wide, usually more than 5 mm wide. In some individuals the skin is also white along the fingers and the veins in the flight membrane. – *Pipistrellus deserti*.

Additional characters: FA: 32.2 – 35.2 mm, D5: 40 – 45 mm, D3: 50 – 60 mm.

Echolocation: fm-cf or qcf-calls with an end-frequency of 44 – 47 kHz (Morocco).

Distribution in Egypt: Southern Egypt in the Nile Valley north to Aswan.

Photographs: Fig. 90, 92, 103 – 106, 123 – 125 (photographs from Morocco).

► Upper tooth row length (CM^3) > 4.5 mm. Penis and vagina not yellowish orange coloured (Fig. 110). Fur colouration very variable but usually darker than in *P. deserti*. Naked parts of the skin dark brown to blackish. The well defined white stripe along the margin of the arm wing membrane, especially between fifth finger and hind foot, is up to 5 mm wide. – *Pipistrellus kuhlii*.

Additional characters: FA: 30.7 – 37.4 mm, D5: 40 – 45 mm, D3: 54 – 61 mm.

Echolocation: fm-cf / qcf-calls, end-frequency: 40–42 kHz (Israel) or 36–40 kHz (Europe).

Distribution in Egypt: Common in Northern Egypt in the Nile Valley and the Nile Delta.

Photographs: Fig. 107 – 110, 126 – 128 (photographs from Croatia and Greece).

Plate 15: The Egyptian bats of the genus *Hypsugo* and the genus *Pipistrellus*.

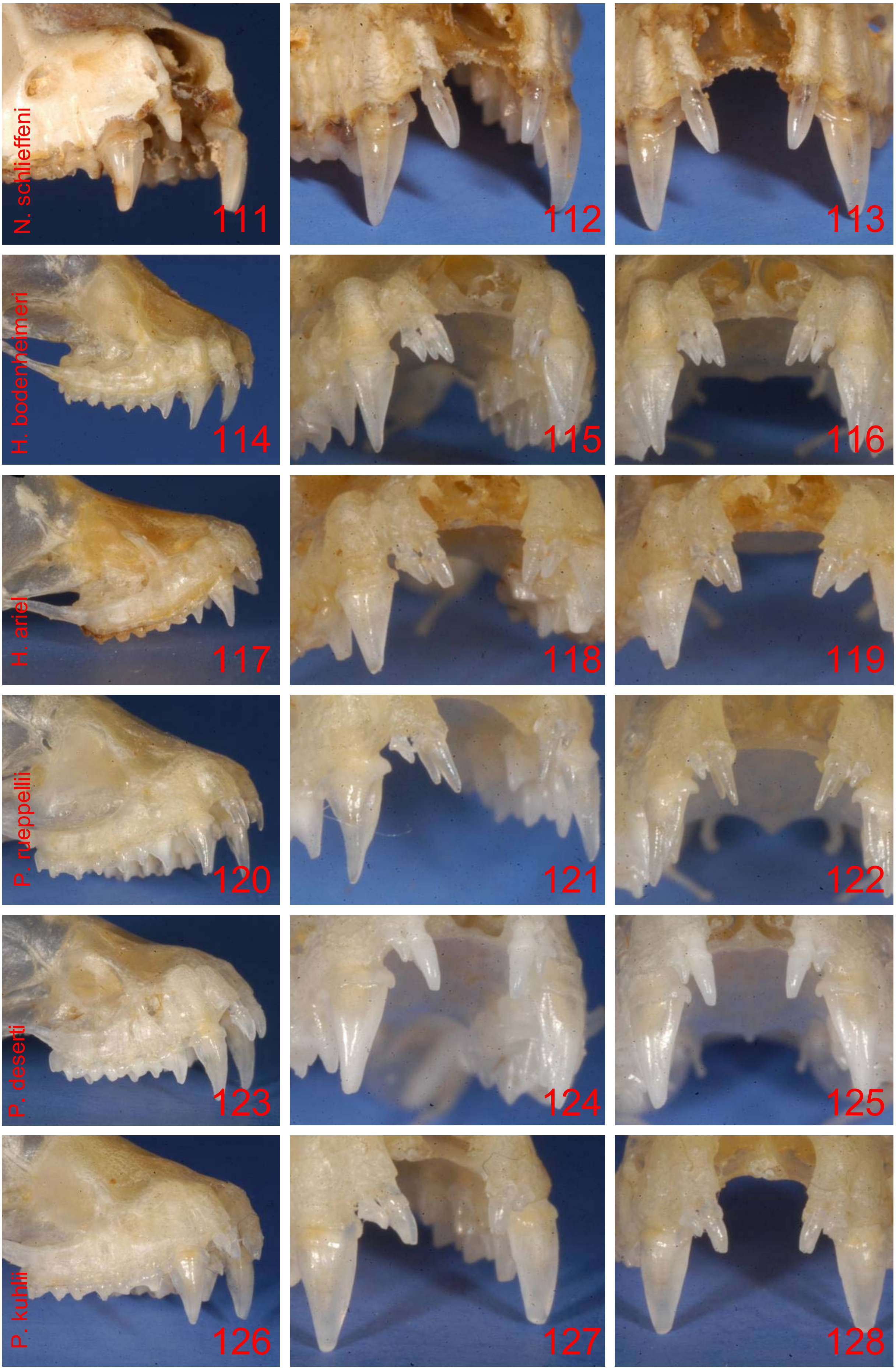


Plate 16: Skulls of the Egyptian “pipistrelle-like” bats.

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APPENDIX 1: LIST OF SCIENTIFIC AND ENGLISH NAMES OF THE EGYPTIAN BAT SPECIES

Only the synonyms that have been debated in the last few years (especially of the newly described species) are listed.

Rousettus aegyptiacus (E. Geoffroy, 1810) – Egyptian fruit bat
Pteropus egyptiacus Geoffroy, Annales Mus. Nat. Hist. Paris 15: 96. (misprint) corrected to *aegyptiacus* in 1818, Description de l'Egypte 2: 134, pl. 3, Fig. 2. Type locality: Great Pyramid, Giza, Egypt.

Rhinopoma microphyllum (Brünnich, 1782) – greater mouse-tailed bat
Vespertilio microphyllus Brünnich, Dyrenes Historie 1: 50, pl. 6, figs. 1-4. Type locality: Giza, Egypt (fixed by Koopman 1975).

Rhinopoma hardwickii Gray, 1831 – lesser mouse-tailed bat
Rhinopoma hardwickii Gray, Zoological Misc. 1: 37. Type locality: India.

Nycteris thebaica E. Geoffroy, 1818 – Egyptian slit-faced bat
Nycteris thebaicus E. Geoffroy, Description de l'Egypte 2: 119, pl. 1, No. 2. Type locality: Egypt.

Asellia tridens (E. Geoffroy, 1813) – Trident leaf-nosed bat
Rhinolophus tridens E. Geoffroy, Annales Mus. Hist. Nat. Paris 20: 265. Type locality: Egypt.

Rhinolophus clivosus Cretzschmar, 1828 – Cretzschmar's horseshoe bat, Arabian horseshoe bat
Rhinolophus clivosus Cretzschmar, in Rüppell, Atlas Reise Nördl. Africa, Säugethiere: 47. Type locality: Muwaylih (Mohila) Saudi Arabia.

Rhinolophus hipposideros (Bechstein, 1800) – lesser horseshoe bat
Vespertilio hipposideros Bechstein, in Pennant, Allgemeine Uebersicht der Vierfüssigen Thiere 2: 629. Type locality: France.

Rhinolophus mehelyi Matschie, 1901 – Mehely's horseshoe bat
Rhinolophus mehelyi Matschie, Sitzber. Ges. Naturf. Fr. Berlin 225. Type locality: Bucharest, Romania.

Taphozous perforatus E. Geoffroy, 1818 – tomb bat
Taphozous perforatus E. Geoffroy, Description de l'Egypte 2: 126. Type locality: Kom Ombo, Egypt.

Taphozous nudiventris Cretzschmar, 1830 – naked bellied tomb bat
Taphozous nudiventris Cretzschmar, in Rüppell, Atlas Reise Nördl. Africa, Säugethiere: 70, fig. 27b. Type locality: Giza, Egypt.

Nycticeinops schlieffeni (Peters, 1859) – Schlieffen's bat
Nycticeius schlieffenii Peters, Monatsberichte K. Preuss. Acad. Wiss. Berlin: 223. Type locality: Cairo, Egypt.

Eptesicus bottae (Peters, 1869) – Botta's serotine
Vesperus bottae Peters, Monatsber. K. Preuss. Acad. Wiss. Berlin: 406. Type locality: Yemen, Arabia.

Hypsugo ariel (Thomas, 1904) – Egyptian desert pipistrelle
Pipistrellus ariel Thomas, Ann. Mag. Nat. Hist., ser. 7, 14: 157. Type locality: Wadi Alagi, Kassala Province, Sudan.

Hypsugo bodenheimeri (Harrison, 1960) – Bodenheimer's pipistrelle
Pipistrellus bodenheimeri Harrison, Durban Mus. Nov. 5: 261. Type locality: 40 km N of Eilat, Wadi Araba, Yotwata, Israel.

Pipistrellus kuhlii (Kuhl, 1817) – Kuhl's pipistrelle
Vespertilio kuhlii Kuhl, Die Deutschen Fledermäuse, Hanau: 14. Type locality: Friuli-Venezia Giulia and Trieste, Italy.

Pipistrellus deserti Thomas, 1902 – desert pipistrelle
Pipistrellus deserti Thomas, Proc. Zool. Soc. 2: 4. Type locality: Murzuk, Fezzan, Libya.

Pipistrellus rueppellii (Fischer, 1829) – Rueppell's pipistrelle
Vespertilio rueppellii Fischer, Synopsis Mamm.: 109. Type locality: Dongola, Sudan.

Otonycteris hemprichii Peters, 1859 – Hemprich's long-eared bat
Otonycteris hemprichii Peters, Monatsberichte K. Preuss.Acad. Wiss. Berlin: 223. Type locality: no locality.

Barbastella leucomelas (Cretzschmar, 1826) – Arabian barbastelle
Vespertilio leucomelas Cretzschmar, in Rüppell, Atlas Reise Nördl. Africa, Säugethiere: 73. Type locality: Sinai, Egypt.

Plecotus christii Gray, 1838 – desert long-eared bat
Plecotus christii Gray, Mag. Zool. Bot. 2: 495. Type locality: Nile Valley between Qena and Aswan, southern Egypt (restricted by Qumsiyeh 1985).

Tadarida teniotis (Rafinesque, 1814) – European free-tailed bat
Cephalotes teniotis Rafinesque, Précis. Som. 12. Type locality: Sicily, Italy.

Tadarida aegyptiaca (E. Geoffroy, 1818) – Egyptian free-tailed bat
Nyctinomus aegyptiacus E. Geoffroy, Description de l'Egypte 2: 128, pl. 2, No. 2. Type locality: Giza, Egypt.

APPENDIX 2: EXTERNAL MEASUREMENTS OF THE BATS OF EGYPT.

Species	FA (mm)	D5 (mm)	D3 (mm)	Source
Rousettus aegyptiacus	83.0-99.0	100-112	135-154	Qumsiyeh 1985, own data
Rhinopoma microphyllum	61.1-73.4	61-66	73-82	Own data
Rhinopoma hardwickii	54.0-62.2	51-60	59-67	Own data
Nycteris thebaica	41.0-49.0	58-62	76-81	Qumsiyeh 1985, own data
Asellia tridens	46.0-54,1	46-52	59-66	Own data, A. Tsoar (pers. com.)
Rhinolophus clivosus	43.5-53.0	~ 61	~ 73	Qumsiyeh 1985, own data
Rhinolophus hipposideros	34.0-41.0	43-53	51-57	Own data
Rhinolophus mehelyi	46.5-54.8	57-67	71-83	Own data
Taphozous perforatus	59.2-66.0	51-56	85-94	Own data
Taphozous nudiventris	66.2-76.8	59-72	106-116	Qumsiyeh 1985, own data, A. Tsoar (pers. com.)
Nycticeinops schlieffeni	30.0-34.2	41-45	58-61	Qumsiyeh 1985, own data
Eptesicus bottae	40.3-42.3	~ 50	~ 65	Own data
Hypsugo ariel	28.5-30.7	~ 38	~ 54	Qumsiyeh 1985, own data
Hypsugo bodenheimeri	28.8-32.4	37-39	50-53	Qumsiyeh 1985, own data
Pipistrellus kuhlii	30.7-37.4	40-45	54-61	Qumsiyeh 1985, own data, A. Tsoar (pers. com.)
Pipistrellus deserti	32.2-35.2	40-45	50-60	Own data
Pipistrellus rueppellii	30.7-34.4	42-45	57-62	Qumsiyeh 1985, own data
Otonycteris hemprichii	55.1-66.4	64-79	83-109	Qumsiyeh 1985, own data, A. Tsoar (pers. com.)
Barbastella leucomelas	37.3-39.2	50-52	70-71	Qumsiyeh 1985, own data
Plecotus christii	37.7-41.3	47-54	61-69	Qumsiyeh 1985, own data
Tadarida teniotis	54.7-69.9	55-59	102-115	Own data, A. Tsoar (pers. com.)
Tadarida aegyptiaca	48.9-55.1	44-54	81-91	Own data