

Illustrated identification key
to the bats of Europe

By Christian Dietz
& Otto von Helversen

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and Otto von Helversen

and 14 drawings by Otto von Helversen.

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PREFACE

Since the identification key on the European bats published by VON HELVERSEN in 1989 a surprising number of new species has been discovered in Europe¹⁾ with the number of species rising from 31 to 39 in 2004. This rapid development in taxonomy and systematics has made it harder for field biologists to identify living bats, especially in the Mediterranean area. Most of the newly discovered cryptic species are closely related to one or more long known species. In some of these species groups identification has been problematic for many years and species assignment could only be solved by the aid of modern molecular methods. But the analysis of genetic characters is an inappropriate method for most field studies. Our new key on the European bats was written mainly for biologists aiming to identify captured living bats which would be released after identification.

The first part of the identification key is written mainly for students and beginners in the studies of bats, as most of the groups can be identified quite easily. The separated keys to the more difficult groups are addressed mainly to the more experienced field workers to help them when faced with an unknown species or with the most difficult groups of very similar bats.

However, not all characters of the newly described species are currently known in their full variability and furthermore some taxonomic questions are not finally clarified.

¹ We define Europe as the continental area west of a line from the Crimea peninsula to the north and the Mediterranean islands of Crete, Malta, Sicily, Sardinia, Corsica and the Balearic Islands.

Therefore we have chosen an electronic publication which is easier to update with new characters or newly described species. This will ensure that the identification key remains up to date. We would like to encourage all bat workers using our key to tell us about their experiences and to pass on their comments and thus help us keep the key up to date.

ACKNOWLEDGEMENTS

Many people helped us by sharing their experience in the field identification of bats. We are grateful to all our friends and colleagues for the many discussions on their newest findings in taxonomy and genetics or for checking characters in various parts of Europe.

We also benefited greatly from many people who helped us to capture the bat species so that we could take measurements and photographs. We are specifically grateful to Mauro Mucedda, Maja Zagamajster & Alenka Petrinjak for their help in catching *Plecotus sardus*, *Myotis punicus* and *Plecotus macrobullaris*. Isabel Schunger joined us during most of our excursions and gave valuable help in all respects. Further help to get permissions and to find and capture bats was provided by (in alphabetic order) Monika Braun, Kamen Christov, Philipp Dietz, Klaus Echle, Antoaneta Gueorguieva, Teodora Ivanova, Ingrid Kaipf, Vassiliki Kati, Spartak Merdschanov, Dessislava Merdschanova, Alfred Nagel, Rainer Nagel, Dietmar Nill, Eleni Papadatou, Boyan Petrov, Torsten Pröhl, Paul Schuhmacher and Nikolaj Simov. For many discussions on characters in identifying bats we are much obliged to Ursel Häussler, Ahmet Karataş and Katerina Tsytulina. For their permanent help in identifying bats by molecular genetic methods and for extensive discussions we are grateful to Frieder Mayer and Andreas Kiefer. We are also indebted to Doris Mörke for giving us access to the collections of the Staatliches Museum für Naturkunde Stuttgart (SMNS).

We are particularly indebted to Paul Bates for proof-reading the manuscript and for the many corrections of the language. We thank him for many useful suggestions how to improve the descriptions and how to make them easier to understand.

HOW TO PROCESS A CAPTURED BAT

As this key is written to determine living bats in the hand it is necessary to mention first that bats are protected in all European countries. Therefore a licence is required to catch and handle bats.

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 be best 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 or Daubenton's bats can be kept in small groups in bags, 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 measurements (see table 1) are the lengths of forearm (FA), fifth finger (D5) and third finger (D3). Additional valuable measurements are the lengths of thumb (D1), lower leg (Tib), hind foot (HF). For some species groups, length and width of the ear and of the tragus are used (ear length (earL), ear width (earW), tragus length (tragL) and tragus width (tragW)). In other species groups, the length of some of the phalanges: 1st and 2nd phalanx of the 4th finger (P4.1 and P4.2) and the 2nd and 3rd phalanx of the 3rd finger (P3.2 and P3.3) are needed. In some very difficult species groups also the upper tooth row length (CM³) can be of some help.

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 – 4).

Table 1: Measurements used in the identification key.

measurement	abbreviation	best taken by	measurement used in
Forearm-length	FA	Caliper or steel ruler	All bats
Length of fifth finger	D5	Caliper or steel ruler	All bats
Length of third finger	D3	Caliper or steel ruler	All bats
Length of thumb	D1	Caliper or steel ruler	Whiskered bats, <i>Plecotus</i>
Length of tibia	Tib	Caliper or steel ruler	Whiskered bats, <i>Plecotus</i>
Length of hind foot	HF	Caliper or steel ruler	Whiskered bats, <i>Plecotus</i>
Length of ear	earL	Steel ruler	Large <i>Myotis</i>
Width of ear	earW	Steel ruler	Large <i>Myotis</i>
Length of tragus	tragL	Steel ruler	<i>Plecotus</i>
Width of tragus	tragW	Steel ruler	<i>Plecotus</i>
Length of 2nd phalanx of 3rd finger	P3.2	Caliper	<i>Pipistrellus pipistrellus</i> / <i>pygmaeus</i>
Length of 3rd phalanx of 3rd finger	P3.3	Caliper	<i>Pipistrellus pipistrellus</i> / <i>pygmaeus</i>
Length of 1st phalanx of 4th finger	P4.1	Caliper	Medium sized horseshoe bats
Length of 2nd phalanx of 4th finger	P4.2	Caliper	Medium sized horseshoe bats
Length of upper tooth row	CM ³	Caliper	Large <i>Myotis</i> , <i>Eptesicus serotinus</i> / <i>bottae</i> , <i>Plecotus austriacus</i> / <i>kolombatovici</i>

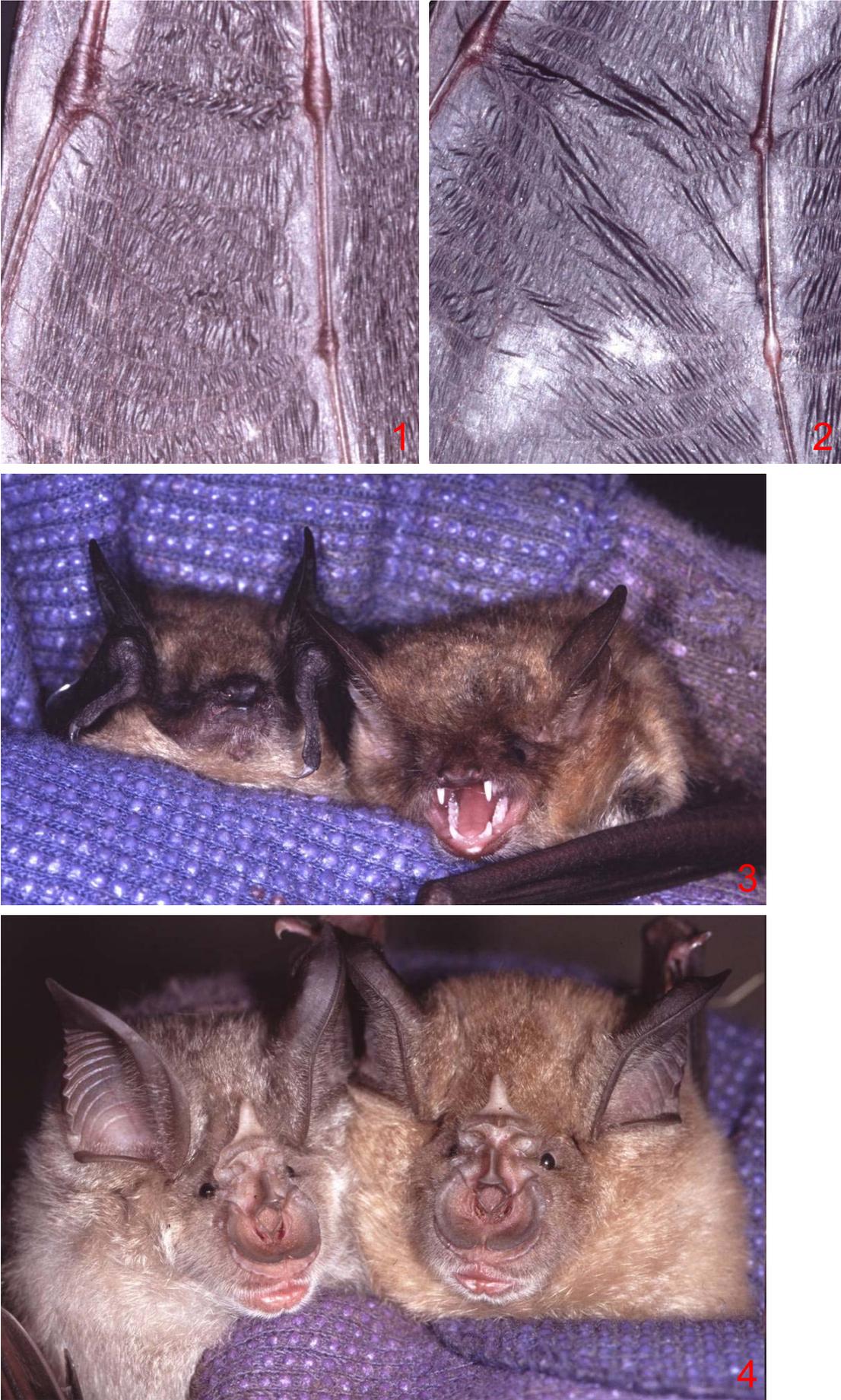


Plate 1: Age classification in bats. Juveniles are on the left, adults on the right.
M. aurascens (1 – 2), *M. emarginatus* (3), *R. ferrumequinum* (4).

HOW TO TAKE THE MEASUREMENTS USED FOR IDENTIFICATION

Measurements are of any value only when taken in the same standardised way. Calipers and in some measurements steel rulers will be needed to obtain reliable values.

To take the wing measurements (Fig. 8) 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. 5).

To take the **forearm length** (see Fig. 5) 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 maximum forearm length is taken between the elbow and the wrist [this is the maximum forearm length (FA+), in some publications the forearm length is given without the wrist (FA-) representing the true length of the forearm bone. Usually the values of FA- are about 0.5 to 1.2 mm less than FA+, depending on the species. As it is much harder to reproduce reliable FA- measurements, we recommend to use only FA+ in future or to give both values]. 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. 6 – 7). The outer end of the caliper is best attached to the inside of the wrist and the length to the tip of the finger is taken. In the fifth digit length the full length of the straight finger is taken, in the third finger length in living bats it is better to take the secant of the finger of the outstretched wing. The lengths of the phalanges are taken as shown in Fig. 11.

Thumb length is measured as the maximum distance of the straight thumb without claws (Fig. 9). **Hind foot length** is taken from the base of the spur to the toes without claws (Fig. 10). The **tibia length** is taken from the knee to the end of the tibia after having bent the foot (Fig. 10). **Ear width** in large *Myotis* is taken as shown in Fig. 12 and Fig. 13 as the combined value of a and b at the height of the tip of the tragus. **Tragus width** in *Plecotus* is taken at the point of the tragus with the maximum width (Fig. 14). The tragus is usually not flat, to obtain reliable values it is useful to attach the tragus to a steel ruler in order to make it level. **Tragus length** in *Plecotus* is measured from the notch at the outside of the tragus above its basal lobe to the tip of the tragus (Fig. 14). 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 in some species groups if the identification is not clear having used all other characters given in the key. It might be helpful to obtain these data in the species groups of *Myotis myotis* / *punicus* / *blythii* in some Mediterranean areas, *Plecotus austriacus* / *kolombatovici* along the Adriatic coast and Greece and in *Eptesicus serotinus* / *bottae* along the coastlines of Turkey and the Greek islands. This measurement is taken as the distance between the posterior margin of the last molar and the base of the canine (Fig. 15).

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

E. nilssonii (5 - 7).

Plate 3: How to take measurements of the wing, thumb and leg.

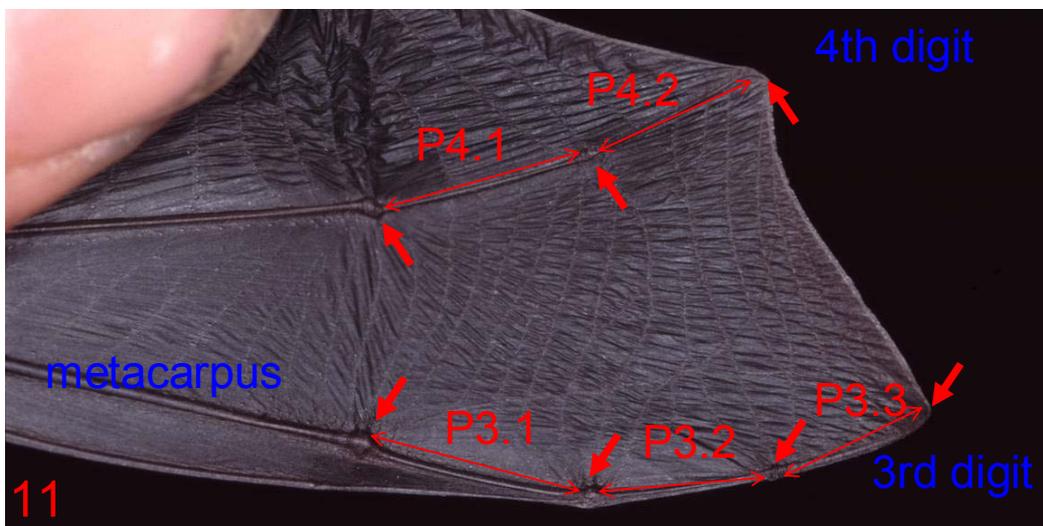
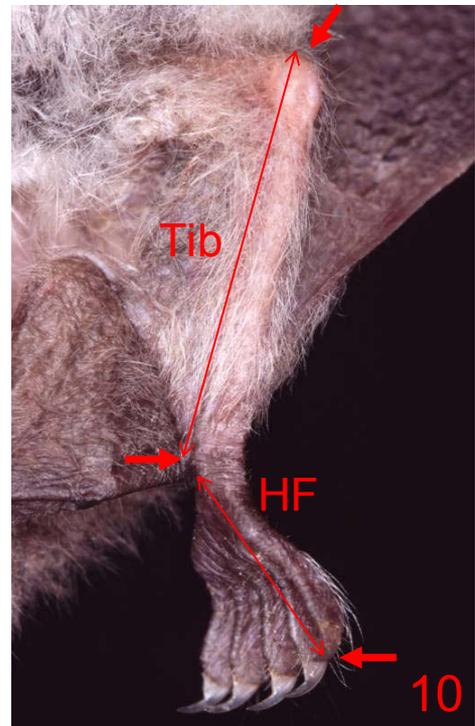
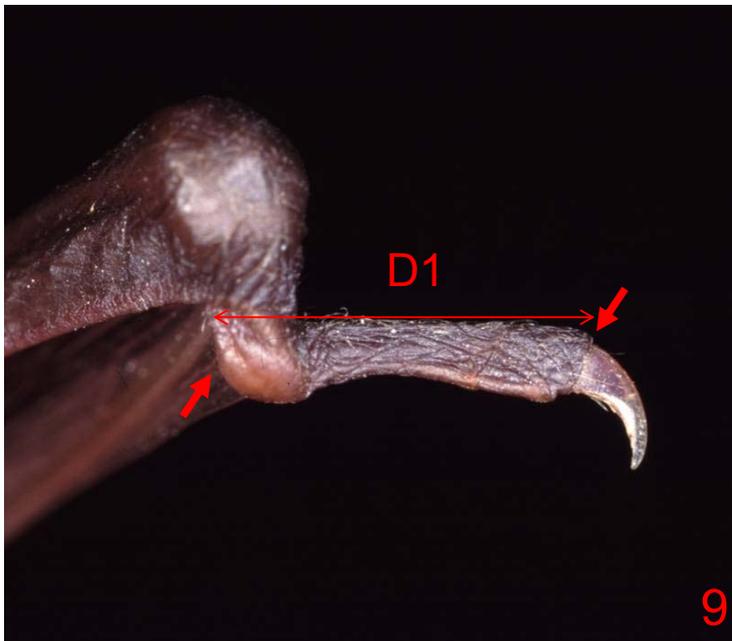
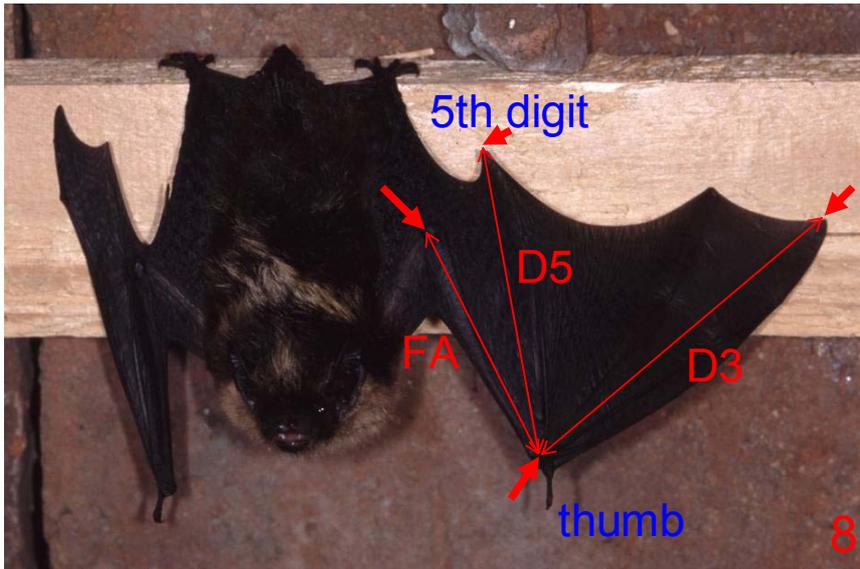
E. nilssonii (8), *P. auritus* (9), *M. capaccinii* (10), *P. pygmaeus* (11).

Plate 4: How to take measurements of the ear and the upper tooth row.

M. punicus (12), *M. blythii* (13), *P. kolombatovici* (14), *M. blythii* (15).



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



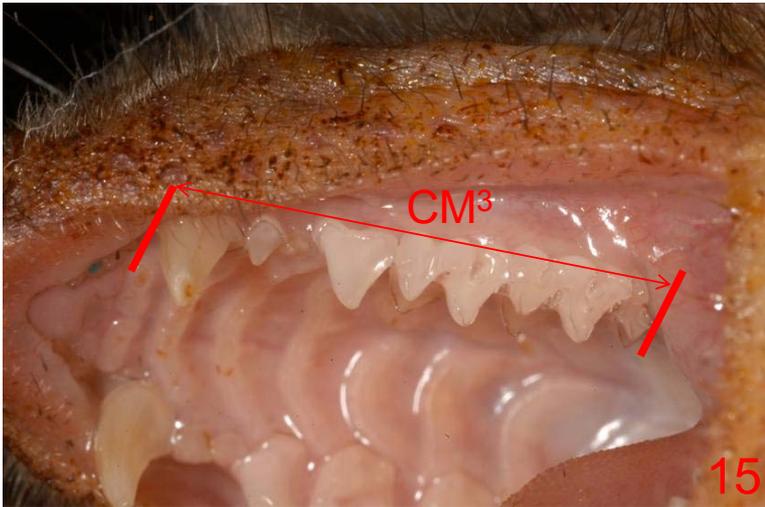
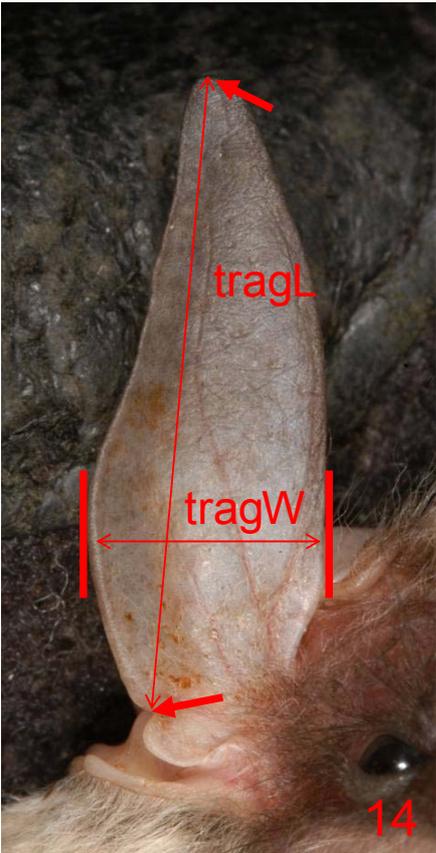
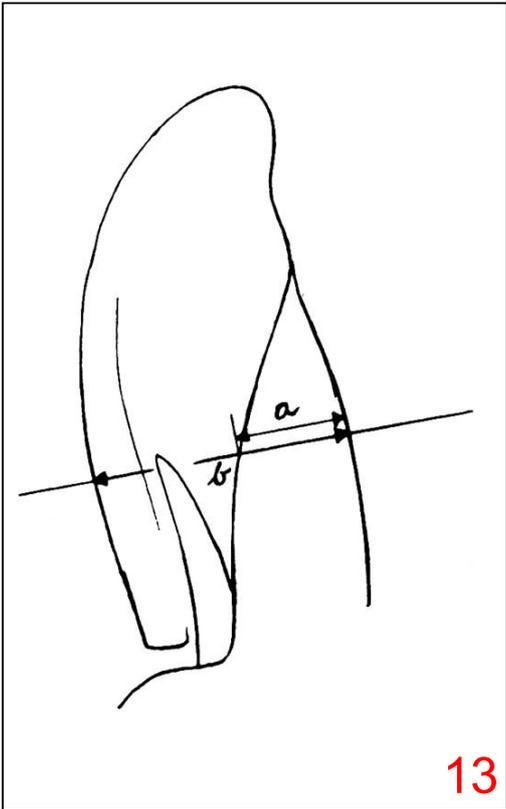
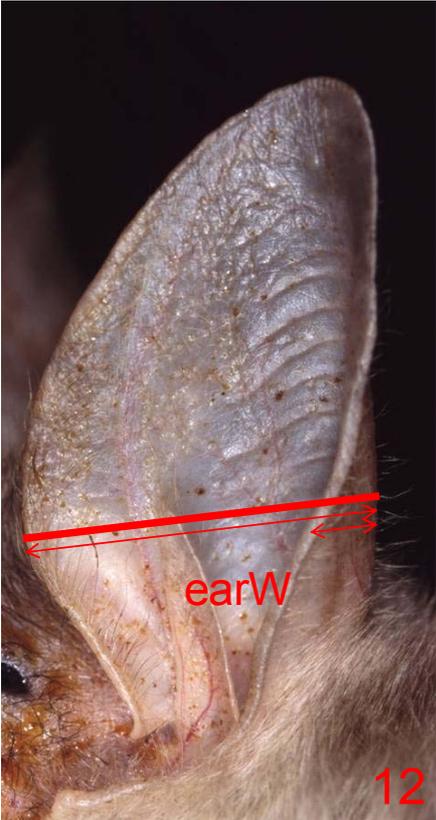


Plate 4: How to take measurements of the ear and the upper tooth row.

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. There is a high degree of intraspecific variability within some species (and perhaps this identification key is not reflecting the whole range of variability).

In some groups taxonomic questions have not been solved yet. Some cryptic species may still be awaiting discovery, and vagrants or accidentally transported individuals might further increase the list of European bat species.

IDENTIFICATION KEY TO THE FAMILIES

1) tail extending up to a half beyond the narrow tail membrane (Fig. 18). Lower part of the posterior margin of the ear with pronounced lobes (Fig. 17). No nasal process or nose leaf (Fig. 16). Only one species in Europe. – [Molossidae](#)

▶ Tail included completely in the broad tail membrane or except for the last one or two vertebrae (maximum about 5 mm) (Fig. 21 and 24). – **2**

2) Nose with a pronounced nose leaf (cutaneous process) (Fig. 19). Ears without a tragus (Fig. 20). Tail shorter or of same length as the hind legs (Fig. 21). Echolocation calls audible by a bat detector as long whistles. Five species in Europe. – [Rhinolophidae](#)

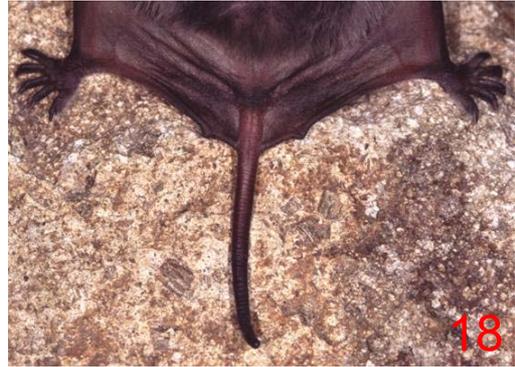
▶ No nose leaf (Fig. 22). Ears with a tragus (Fig. 23 and 26). Tail longer than the hind legs (Fig. 24). – **3**

3) Ears projecting beyond the top of the head (Fig. 23). Second phalanx of the third finger not specially elongated (up to about twice the length of the first phalanx, usually both are of more or less the same length). 32 Species in 9 genera in Europe. – [Vespertilionidae](#).

▶ Ears very short and triangular, not projecting beyond the top of the head (as if cut with scissors) (Fig. 25 and 26). Second phalanx of the third finger (P3.2) about three times as long as the first phalanx (P3.1) (Fig. 27). 3rd and 4th fingers at rest folded in the joint between 1st and 2nd phalanges. Only one species in Europe. – [Miniopteridae](#).

Plate 5: The four European families of bats.

T. teniotis (16, 17, 18), *R. mehelyi* (19), *R. ferrumequinum* (20, 21),
E. serotinus (22), *M. aurascens* (23), *M. daubentonii* (24),
M. schreibersii (25, 26, 27).



Family Molossidae



Family Rhinolophidae



Family Vespertilionidae



Family Miniopteridae

A) RHINOLOPHIDAE

1) connecting process (= upper saddle process, Crista) bluntly rounded in profile and shorter than the lower tip of the sella (= lower saddle process) (Fig. 29 and 33). – **2**

▶ connecting process in profile pointed and always longer than the tip of the sella (Fig. 36, 40 and 44). – **3**

2) Biggest of the five horseshoe bats, FA > 54 mm (54.0 – 62.4 mm, lowest extreme 51.0 mm), D5: 63 – 77 mm, D3: 78 – 94 mm, P4.1: 9.5 – 13.4 mm; P4.2: 17.5 – 22.5 mm. High and bluntly rounded connecting process, the small sella is usually constricted in the middle and the lancet is usually long and has a slender tip. (Fig. 30). – *Rhinolophus ferrumequinum*.

Additional characters: One or three mental grooves in the lower lip (Fig. 28) (very often the two lateral ones are reduced). Cf-frequency 79 - 84 kHz.

Distribution in Europe: Occurs in southern and central Europe, northwards to southern England and Wales, the Netherlands and Poland. Present on most Mediterranean Islands.

Photographs: Fig. 4, 20 - 21 and 28 – 31.

▶ smallest of the horseshoe bats, FA < 43 mm (usually 36 – 41 mm), D5: 46 – 53 mm, D3: 51 – 57 mm, P4.1: 5.7 – 7.5 mm; P4.2: 12.0 – 14.2 mm. The tip of the sella (= lower saddle process) is distinctly longer than the connecting process and in profile tapering to a point (Fig. 33 - 34). The fur is soft and sparse, grey on the back in younger individuals and brownish in older ones. – *Rhinolophus hipposideros*.

Additional characters: The lower lip has one mental groove (Fig. 32). Cf-frequency 108 - 115 kHz.

Distribution in Europe: It has the northernmost limit of distribution of all Rhinolophidae in Europe, reaching Ireland, the Netherlands, Thuringia in Germany and Poland. Common in the Mediterranean area and present on most islands.

Taxonomical note: The taxonomic position of some forms within this group is still not solved satisfyingly, especially in Asia. There are some morphological differences between the nominate form distributed over most of Europe and the populations from Northern

Africa (*R. h. escalerae*), Sicily, Crete (*R. h. minimus*), Cyprus and Western Anatolia.

Photographs: Fig. 32 – 34.

3) Second phalanx of the fourth finger (P4.2) less than twice as long as the first (P4.1) (P4.1: 7.6 – 9.2 mm; P4.2: 14.3 – 17.4 mm) (Fig. 38). Tip of the sella (= lower saddle process) narrow when viewed from the front and lower part not rounded (Fig. 37). The sella is wedge shaped when viewed from below. The horizontal furrow below the lancet is usually clearly indented in the middle when viewed from the front (Fig. 37). Connecting process (= upper saddle process) relatively long and straight, never curving downwards (Fig. 35 - 36). Bases of the hair whitish (tousled parts of the pelage have therefore a very light appearance), the tips of the hair are brown or greyish, often with a yellowish tinge (Fig. 35). FA 43.9 – 50.1 mm, D5: 54 – 62 mm, D3: 63 – 74 mm. – *Rhinolophus blasii*.

Additional characters: Cf-frequency 93 – 96 kHz.

Distribution in Europe: Restricted to south-eastern Europe from the northern Adriatic coast eastwards to Romania and all over the Balkans and Greece. Found also on some Greek islands including Crete.

Photographs: 35 – 38.

▶ Second phalanx of fourth finger (P4.2) more than twice as long as the first (P4.1) (Fig. 42). Tip of the sella (= lower saddle process) broad when viewed from the front and its lower margin rounded (Fig. 41 and 45). – 4

4) Lancet narrows more or less gradually to its tip, it has only a slight constriction above the middle and the tip is broadly rounded (Fig. 41). Connecting process (= upper saddle process) is slightly horn-shaped, being pointed in profile and forward curving (slightly downwards) (Fig. 40). FA usually < 50 mm (44.0 – 51.0 mm), D5: 52 – 63 mm, D3: 63 – 76 mm, P4.1: 5.7 – 8.2 mm; P4.2: 16.4 – 18.1 mm. Coloration of the belly more greyish (Fig. 39), not as whitish as in *R. mehelyi*. The boundary between the back and underside is indistinct. – *Rhinolophus euryale*.

Additional characters: The antitragus of the ear (horizontal lobe at the base of the ear) is about half as high as the conch, its width is about equal to its height and it is only weakly indented close to the connection to the ear. Cf-frequency 102 – 107 kHz. Body mass usually around 12 g (9 – 15 g) in summer.

Distribution in Europe: Widest distributed species of the three medium sized horseshoe bats in the whole Mediterranean area and the Balkans, extends north to central France, northern Italy, Slovakia and Romania. Present on Corsica, Sardinia and Sicily but absent from the Balearic Islands.

Photographs: 39 – 42.

► Lancet is abruptly narrowed above the middle to a distinctly linear tip (Fig. 43 and 45). Connecting process (= upper saddle process) relatively blunt in profile and only slightly longer than the lower process (Fig. 44). FA usually > 49 mm (48.2 – 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. – *Rhinolophus mehelyi*.

Additional characters: The antitragus of the ear (horizontal lobe at the base of the ear) is not half as high as the conch, its width is greater than the height and it is strongly indented close to the connection to the ear, forming a well visible dent. Cf-frequency 106 - 112 kHz. Body mass usually around 15 g (12 – 18 g) in summer.

Some individuals from Sardinia have a distinct reddish brown to orange red coloration of the fur, even the belly can be coloured red in such individuals.

Distribution in Europe: Distributed in the Mediterranean area from central and southern Iberia, southern France, Sardinia, Sicily to Greece, range extends in the Balkans northwards to Romania.

Photographs: 19 and 43 – 45.

Plate 6: The five European species of horseshoe bats (Rhinolophidae).

R. ferrumequinum (28 - 31), *R. hipposideros* (32 - 34), *R. blasii* (35 - 38),
R. euryale (39 - 42), *R. mehelyi* (43 - 45).

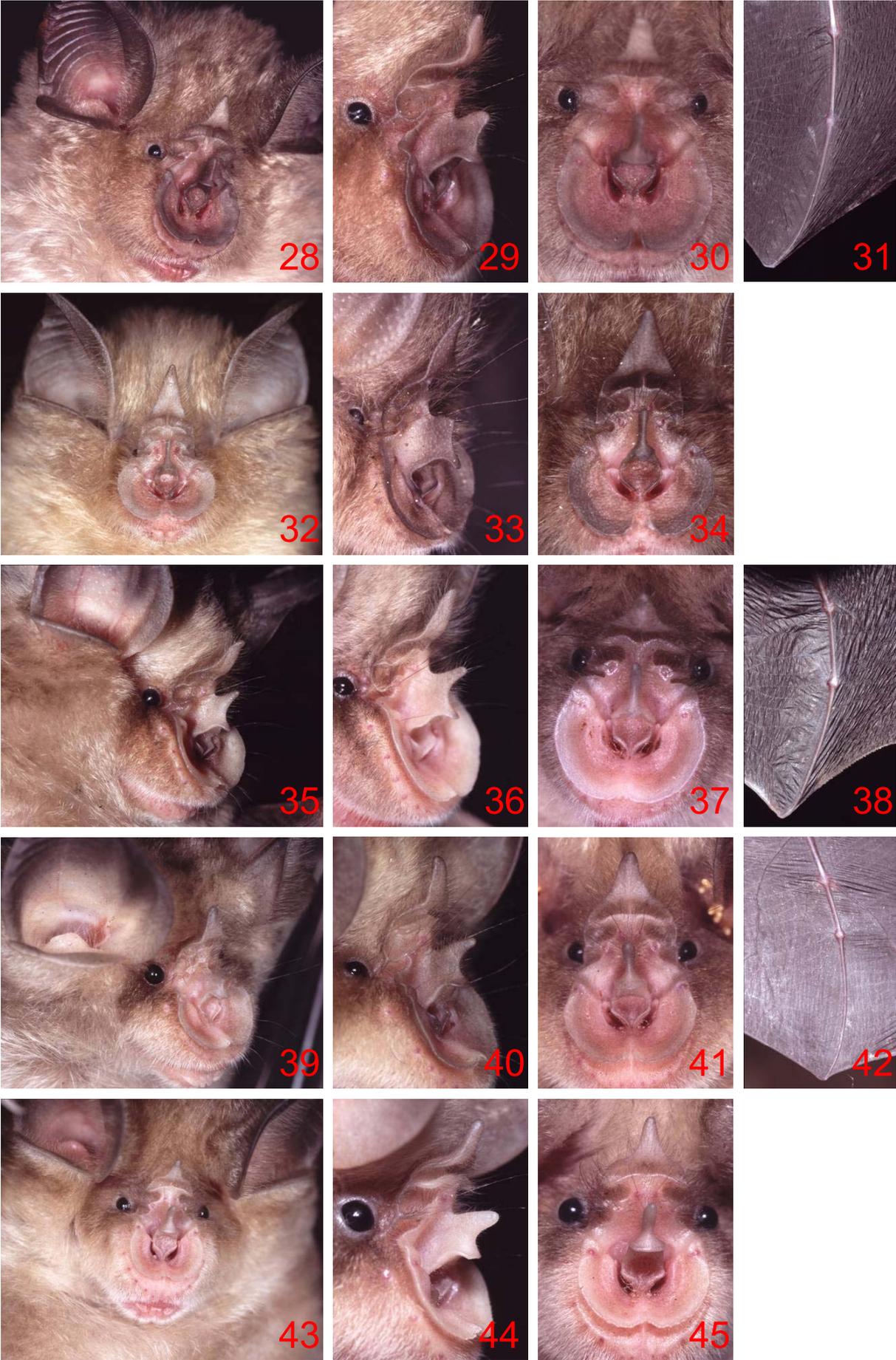


Plate 6: The five European species of horseshoe bats (Rhinolophidae).

B) MOLOSSIDAE

The only European species, *Tadarida teniotis*, is very large and has long and broad ears projecting forward over the face (Fig. 16). The ears touch in front at their base. The posterior margin of the ear is broadened and has a conspicuous antitragus (Fig. 17). The long muzzle has usually five creases in the upper lip (Fig. 16). The fur is short and silky and has the structure of a mole's pelage. The back is blackish-grey, some individuals have a brownish tinge. At least one third of the tail extends beyond the tail membrane and has stiff hairs at the end (used as tactile organs) (Fig. 18). The wings are long and narrow. FA: 57.2 – 64.1 mm, D5 > 55 mm, D3 > 100 mm. – *Tadarida teniotis*.

Additional characters: Thumb and especially the hind foot with white and curved bristles which are used like a comb to clean the fur. The high and fast flying bats emit well audible and loud sounds (8 - 11 kHz).

Distribution in Europe: Distributed in the Mediterranean region northwards to the southern Alps, Adriatic coast and Bulgaria. Present on most of the Mediterranean Islands.

Photographs: 16 – 18.

C) MINIOPTERIDAE

The single European species, *Miniopterus schreibersii*, has a very short muzzle and a humped forehead (Fig. 25). The ears are short and triangular and do not extend over the top of the head (Fig. 26) which has a dense, short and erected pelage reaching the back of the nose. The dorsal pelage is greyish-brown, sometimes brown or blackish. The underside is of a slightly lighter grey hue. The wings are very long and narrow and at rest the third and fourth fingers are bent to the inside in the joint between 1st and 2nd phalanges. FA: 42.4 – 48.0 mm, D5: 48 – 56 mm, D3: 78 – 89 mm. – *Miniopterus schreibersii*

Additional characters: In south-eastern Europe most individuals have a contrasting cinnamon coloured throat patch (Fig. 25) and forehead during moulting. Penis thin and long.

Distribution in Europe: The species occurs in southern and south-eastern Europe and is widely distributed in the Mediterranean and the Balkans and reaches as far north as Switzerland, southern Germany (currently extinct), Alsace in France and Slovakia.

Taxonomical note: Until recently, the Miniopteridae were treated as a subfamily of the Vespertilionidae but genetic studies have shown a degree of distinctiveness supporting a family level of its own. Morphological and physiological characters (like suspension of embryonic development) give further support to this classification.

Photographs: 25 – 27.

D) VESPERTILIONIDAE

1) only one pair of upper incisors, ears short and rounded, inside densely covered with hairs. Tail membrane heavily furred. Yellowish-brown pelage with frosted white tips, throat buffy-yellow. FA: 42 - 59 mm. – *Lasiurus cinereus*

Additional characters: Two pairs of teats.

Distribution in Europe: Very rare vagrant from North America, only a few records on Iceland and the Orkneys.

Photographs: none

▶ ears not covered with dense hairs, two pairs of upper incisors (but the second incisor might be hidden sometimes in the gum in *Hypsugo savii* or can be very small in *Pipistrellus kuhlii*). – **2**

2) ears connected in front at their base by a fold of skin (Fig. 46) and touching each other when erected (Fig. 48). Nostrils open above (Fig. 53 l.). – **3** (Subfamily *Plecotini*)

▶ ears widely separated in front, no fold of skin between the ears (ears separated by normal pelage instead) (Fig. 47 and 49). Nostril open to the front (Fig. 47). – **4**

3) ears over 30 mm long with numerous horizontal furrows (Fig. 48 and 50), folded at rest (Fig. 46). Spur without post calcareal lobe. – Genus *Plecotus* – see separate key to the species.

▶ ears shorter (up to 18 mm long) and wide with 5 - 6 furrows (Fig. 51 and 52). Ears never folded at rest. Dorsal fur blackish with light tips (Fig. 53), appearing frosted. FA: 36.5 – 43.5 mm, D5: 47 – 54 mm, D3: 63 – 71 mm. – *Barbastella barbastellus*

Additional characters: Ears often with a button-like process in the middle of the outside margin (Fig. 51 and 52). Spur with a post calcareal lobe divided by a keel.

Distribution in Europe: Southern and Central Europe, northwards to Britain, Scandinavia and Latvia, missing or rare in the southernmost parts of Europe, being there confined to the mountains. Present on the Balearic Islands, absent from Crete.

Photographs: 51 – 53 (right).



P. kolombatovici (46, 48),
E. nilssonii (47),
M. bechsteinii (49),
P. sardus (50),
B. barbastellus
 (51, 52, 53 r.),
P. auritus (53 l.)

4) Tragus long, pointed spear-shaped (Fig. 54). No post calcareal lobe at the spur (Fig. 57) (in whiskered bats and some Bechstein's bats a narrow edging of skin is present, but the tragus is tapering and reaches half of the ear length). Three premolars in the upper and lower jaw. – 5 (Genus *Myotis*)

▶ Tragus short, curved, with a rounded tip (Fig. 55), sometimes even with mushroom-shaped broadening (Fig. 56). Well developed post calcareal lobe at the spur (Fig. 58 - 61). Only one or two premolars. – 10

5) Big bats, FA > 50 mm. – [Large *Myotis*-species](#) – see separate key to the species.

▶ Smaller bats, FA < 50 mm. – 6

6) very big ears (Fig. 62), more than 20 mm long (21 - 26 mm), when folded forward projecting by nearly half their length beyond the tip of the snout (extending more than 8 mm) (Fig. 64 and 65). Wing membrane inserted at the base of the first toe (Fig. 66). FA 39.0 – 47.1 mm, D5: 50 – 57 mm, D3: 61 – 69 mm. – [Myotis bechsteinii](#)

Additional characters: Outside margin of the ear with 9 – 11 horizontal creases (Fig. 62 and 64). Spur straight (Fig. 67), sometimes with a narrow edging of skin.

Distribution in Europe: Distributed all over Europe but rare in the north (missing in most parts of Britain), in Scandinavia only in southern Sweden. Local in the southernmost parts of Europe. Absent from the Balearic Islands, Sardinia and Crete.

Photographs: 49 and 62, 64, 65, 67 and 72.

▶ ears less than 20 mm long (usually less than 18 mm), when folded forward extending the snout at most by 5 mm (Fig. 66). Maximum of 8 horizontal creases at the outside of the ear. – 7

Plate 8: Characters of the genus *Myotis* in comparison to other genera.

M. myotis (54), *E. serotinus* (55), *N. leisleri* (56, 60), *M. daubentonii* (57),
H. savii (58, 59), *N. noctula* (61).

Plate 9: The “long-eared” *Myotis*-species *Myotis bechsteinii* and *Myotis nattereri*.

M. bechsteinii (62, 64, 65, 67, 72), *M. nattereri* (63, 66, 68, 69, 71).
M. daubentonii (70)



Plate 8: Characters of the genus *Myotis* in comparison to other genera.



7) Spur very long (longer than half of the margin of the tail membrane) and curved into S-shape (Fig. 68). Free margin of the tail membrane covered thickly with short, curved bristles (Fig. 69). Ears long with a very long (longer than half of the ear) and spear-shaped (lanceolate) tragus, ears light in colour (Fig. 63). FA: 34.4 – 44.0 mm, D5: 48 – 58 mm, D3: 65 – 74 mm. – *Myotis nattereri*

Additional characters: Wing inserted at the base of the outer toe (Fig. 68). Ventral pelage white (Fig. 71).

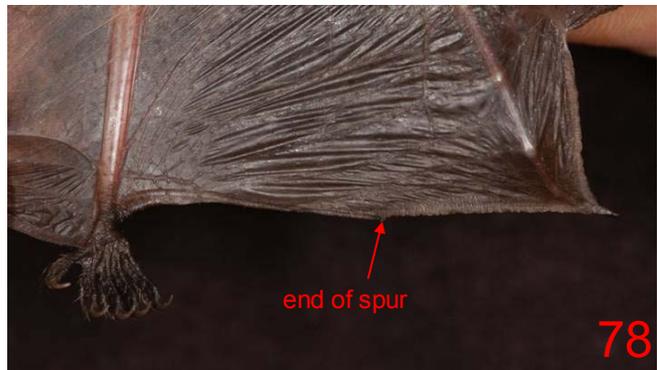
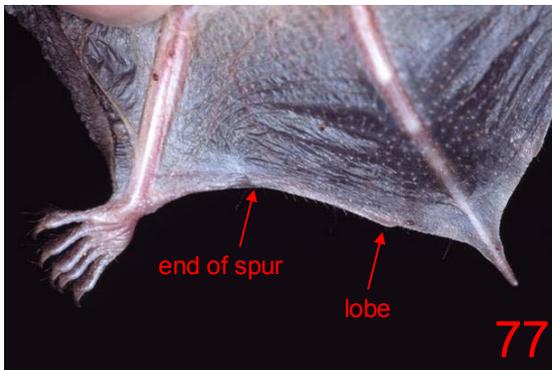
Distribution in Europe: Distributed all over Europe, in the north to Scotland and southern Scandinavia. Perhaps missing on Sardinia and Crete.

Photographs: 63, 66, 68, 69 and 71.

▶ spur straight or only slightly curved to one side (never S-shaped) and not longer than half of the margin of the tail membrane (Fig. 70), but there might be a small lobe at two third of the length of the margin of the tail membrane imitating the end of the spur (Fig. 70). Ears shorter. – **8**

8) very big hind foot with long bristles (Fig. 75), the hind foot length (HF) is larger than half of the tibia length (Tib) (Fig. 73). The wing membrane is inserted at the middle or base of the sole of the hind foot (Fig. 75) or at the tibia. The spur is about a third of the length of the tail membrane, but at two-thirds to three-quarters of length of the membrane is a distinct break, looking like the tip of the spur (therefore sometimes called the terminal lobe) (Fig. 77). Posterior margin of the ear without a distinct indentation (Fig. 79). – *Trawling Myotis* – see separate key to the species.

▶ hind foot smaller (Fig. 76), the hind foot length (HF) is only half, or less than half of the tibia length (Tib) (Fig. 74). Wing membrane inserted at the base of the outer toe (Fig. 76). Spur length is no more than half the length of the margin of the tail membrane and there is no terminal lobe or break present (Fig. 78). Posterior margin of the ear with a distinct indentation (Fig. 80). – **9**



M. capaccinii (73),
M. aurascens (74, 76, 78, 80),
M. daubentonii (75, 77, 79)

9) FA usually > 37 mm (36.1 – 44.7 mm), D5: 49 – 58 mm, D3: 59 – 71 mm. The distinct indentation (notch) on the outside of the ear is nearly a right-angle (Fig. 82). The indentation is not reached by the tip of the tragus (Fig. 81). Spur without post calcareal lobe or any edging of skin. Dorsal fur long, woolly and especially in adult individuals with a distinct reddish tinge (Fig. 88) (the bats of the population on Sardinia are much darker blackish-brown without any reddish tinge, Fig. 89). – *Myotis emarginatus*

Additional characters: The free margin of the tail membrane sometimes with evident fringe but usually with sparse, short soft hairs which sometimes are hardly visible and might even be absent. The skin of the testes and the epididymids are pigmented dark black, even in older (several years old) males (Fig. 86 and 87).

Distribution in Europe: All over southern and Central Europe, northernmost occurrence in the Netherlands and southern Poland.

Taxonomical note: The population on Sardinia might represent a distinct subspecies as it differs remarkably from mainland populations in fur colour (Fig. 87 and 89).

Photographs: 3 and 81 – 89.

▶ smaller species, FA mostly < 36 mm (only a few individuals reach nearly 38 mm). Tragus extends beyond the indentation on the posterior margin of the ear (Fig. 80) (if not reaching the upper margin of the indentation, individuals are very small with FA < 33 mm: *Myotis alcathoe*). Pelage long and frizzy. Hair with dark bases and lighter tips, frequently with golden gloss. Spur often with narrow edging of skin (post calcareal lobe). The skin at the testes is never dark pigmented and at the epididymids it is only dark in young males, later it is light coloured. – *Whiskered bats* – see separate key to the species.

Plate 11: Characters of *Myotis emarginatus*.

M. emarginatus (81 - 89), 87 and 89 show an adult male from Sardinia.



Plate 11: Characters of *Myotis emarginatus*.

10) 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 only. – **11**

▶ bigger species, FA > 38 mm. – **12**

11) Last 1 or 2 tail vertebrae extending beyond tail membrane by 4 – 5 mm (Fig. 95). Post calcareal lobe narrow and always without keel (Fig. 96), sometimes even absent. Ears, face and wing membranes dark black (Fig. 90 - 92), much darker than in any European *Pipistrellus* species. Dorsal pelage long and dark with contrasting light golden tips, dorsal pelage contrasting to white ventral pelage (Fig. 90) (in adult individuals; younger ones are more uniformly brownish or dark greyish without lighter tips of the pelage (Fig. 91)). Tragus short and slightly broadening above (Fig. 92). Length of the front margin of the tragus almost corresponding to its greatest width (Fig. 93). Tip of the ear broadly rounded. FA: 31.4 – 37.9 mm, D5: 38 – 47 mm, D3: 52 – 63 mm. – *Hypsugo savii*

Additional characters: Tragus sometimes with two superimposed serrations at the base of the outside margin (Fig. 92). Characteristic penis morphology differing from all pipistrelles: penis relatively small and distal part slightly broadened. Between proximal and distal part characteristic right-angled bend (Fig. 94). Upper side of the penis with a medial groove. Upper canine (C¹) and second upper premolar (P⁴) in contact (Fig. 178).

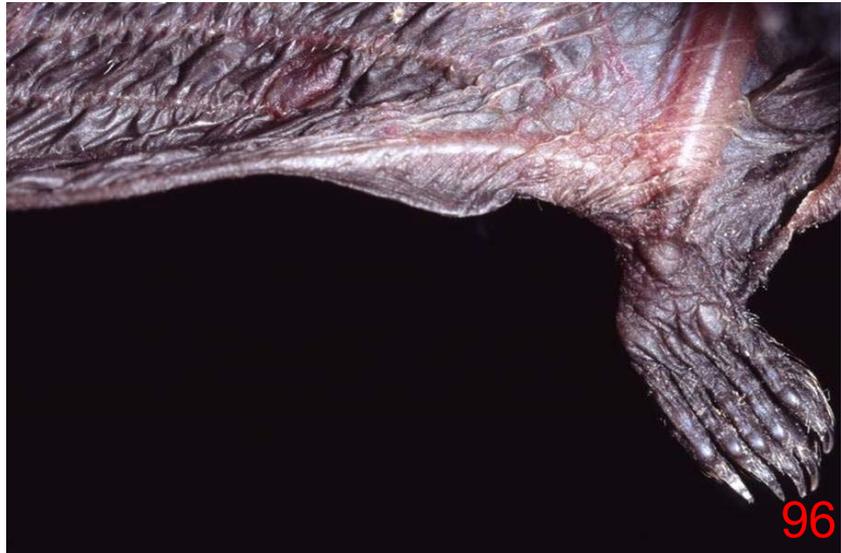
Distribution in Europe: Mainly distributed in the south, northwards to Switzerland, Slovakia and the Danube. Vagrants further northwards. Present on most Mediterranean islands.

Photographs: 22, 58 – 59, 90 – 96 and 152 - 155. Drawings: 178.

▶ Last tail vertebrae extending to a maximum of 1 - 2 mm beyond the tail membrane (Fig. 99). Post calcareal lobe broad with well developed keel (Fig. 98). Tip of the ears narrowly rounded (Fig. 97). Dorsal and ventral pelage not contrasting. Ears and face usually not dark black (Fig. 97). – Genus *Pipistrellus* – see separate key to the species.

Plate 12: Characters of the genus *Hypsugo* and genus *Pipistrellus*.

H. savii (90 - 96), *P. nathusii* (97), *P. pipistrellus* (98, 99).



12) posterior margin of the ear with a narrow furrow extending towards the corner of the mouth but ending before it (Fig. 100). Tragus clearly longer than wide (Fig. 101). Post calcareal lobe narrow and usually without visible keel (rarely visible in *E. nilssonii*) – Genus *Eptesicus* – see separate key to the species.

▶ posterior margin of the ear with a broad furrow extending down below the line of the corner of the mouth and ending by it (Fig. 103, 104 and 107). Post calcareal lobe broad with well visible keel. – **13**

13) Tragus broadens above into mushroom shape (Fig. 104). Underside of the wing membrane adjacent to the forearm covered with short brown hair, underside of the wing close to the body covered with fur as well (as far distal as the line connecting the knee to the elbow, in *N. lasiopterus* even further). Ventral pelage only slightly lighter than dorsal one. Wing membrane inserted at the heel. D5 only a little bit longer than the 3rd and 4th metacarpals. Females with two teats. – Genus *Nyctalus* – see separate key to the species.

▶ The tragus is short, widening above, but not broadened above into mushroom shape (Fig. 107). Fine grey hair is only present on the underside of the wing along the forearm (only visible when the wing is closed). Dorsal pelage dark brown or blackish at the base and appearing frosted because of white hair tips (Fig. 106). Underside whitish or white and sharply demarcated from the dorsal side, in younger individuals and some adults more grey. Wing membrane inserted at the base of the first toe. FA: 40.8 – 50.3 mm, D5: 48 – 53 mm; D3: 69 - 76 mm. – *Vespertilio murinus*

Additional characters: Females with four teats. Penis long and very narrow (Fig. 108).

Distribution in Europe: Distributed in Central and eastern Europe northwards to central Scandinavia, westwards to Belgium and eastern France, southwards to Bulgaria and Greece. Absent from western France, Iberia, most of Italy, Peloponnese and all the Mediterranean islands. Photographs: 106 – 108.

Plate 13: Characters of the genera *Eptesicus*, *Nyctalus* and *Vespertilio*.

E. serotinus (100 - 102), *N. leisleri* (103 - 105), *V. murinus* (106 -108).

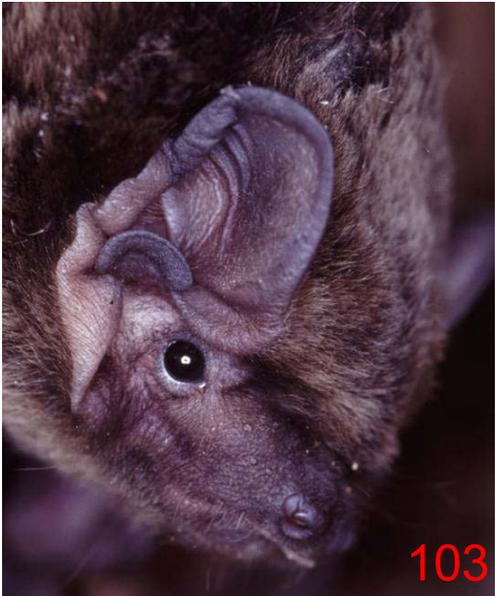


Plate 13: Characters of the genera *Eptesicus*, *Nyctalus* and *Vespertilio*.