SEPARATE KEYS TO SPECIES GROUPS

I) Large *Myotis* species (*Myotis myotis – Myotis blythii – Myotis punicus*)

The two widely distributed species *Myotis myotis* and *Myotis blythii* usually can be distinguished quite well. The third species, *Myotis punicus*, is much harder to identify, but it seems to occur in Europe only in strict allopatry on the islands of Corsica, Sardinia, Malta and Gozo. It shows a mixture of characters found in the other two species and its systematic position has long been unclear. As it is clearly separated from the other two species by its genetics (cytochrome b and microsatellites) its species status may be accepted.

►►► big bat, FA 55.0 – 66.9 mm, D5: 67 – 84 mm, D3: 89 – 107 mm. Muzzle heavily built (Fig. 109). Ears broad: > 16 mm and long: > 24.5 mm (24.4 – 27.8 mm) (Fig. 112). The anterior margin of the ear clearly curves backward and the posterior margin usually has 7 – 8 horizontal creases (Fig. 112). The tragus is broad at its base and usually has a small dark spot at its tip (Fig. 115). – *Myotis myotis*

Additional characters: CM^3 > 9.4 mm (9.2 – 10.6 mm).

Distribution in Europe: Throughout Europe to the North Sea and Baltic Sea, being extinct on the British Isles. Vagrants to southern Sweden and Latvia. On the Azores, the Balearic Islands and Sicily. Contrary to older publications missing on Corsica, Sardinia and Malta.

Photographs: 54, 109, 112 and 115.

►► slightly smaller bat, FA: 50.5 – 62.1 mm, D5: 63 – 81 mm, D3: 85 – 103 mm. Ears narrow: earW < 16 mm and shorter: earL < 24.5 mm (21.0 – 24.3 mm) (Fig. 113). The front margin of the ear curves backward less strongly and the ear tapers to more of a point, the outside margin usually has 5 – 6 horizontal creases (Fig. 113). Tragus is narrow at its base, spear-shaped (lanceolate) (Fig. 116) and reaches half of the ear length. Usually underside brighter white than in *M. myotis*. – *Myotis blythii*

Additional characters: Having a much more graceful appearance than the heavily built *M. myotis* and a more 'open' appearance of the face due to shorter muzzle and clearer skin (Fig. 110). Individuals from Switzerland usually have a whitish tuft of hairs between the ears. This white spot is present quite irregular in most other populations (for example in south-eastern Bulgaria and Turkey only 5 - 45 % of the individuals have the white tuft.). *M. myotis* never has this white spot. CM^3 < 9.4 mm (8.1 – 9.4 mm).

Distribution in Europe: Common in the Mediterranean part of Europe from Portugal to Turkey, in the north to northern Switzerland, Slovakia and the Czech Republic. On Sicily and Crete and many Greek islands. Contrary to older publications missing on Corsica, Sardinia and Malta.

Taxonomical note: The subspecies *M. b. omari* is paler and slightly bigger than the European subspecies *M. b. oxygnathus*: FA: 54.0 - 62.4 mm, CM^3: 8.6 – 9.5 mm and occurs on Crete, other Greek islands and Cyprus. Recent genetic analyses placed *omari* closer to *M. myotis* than to *M. blythii*, but the systematic resolution within the large *Myotis* is quite low up to now. Further research is necessary.

Photographs: 54, 110, 113 and 116.

► Big bat, in size nearly as large as *M. myotis*: FA: 56.0 – 62.4 mm, D5: 73 – 74 mm, D3: 92 – 94 mm. The ears appear to be the largest and widest in relation to head size of all large *Myotis* bats (Fig. 111): EarL: 26.1 - 29.0 mm, earW: 14.7 - 17.9 mm. The ears are very wide in the medium part and as a consequence oval shaped (Fig. 114). Inside the long ears are 7 - 10 horizontal creases (Fig. 114). The tragus shape is quite variable, sometimes wide at its base and comparable to the one of *M. myotis* but lacks a black spot at the tip and its inward curve is slightly more developed, sometimes more like that of *M. blythii* (Fig. 117). – *Myotis punicus*

Additional characters: The muzzle and size of the eye are comparable to *M. blythii* (Fig. 111). Like in *M. blythii* clear line of demarcation between dorsal and ventral pelage coloration, ventral pelage white. Length of the upper tooth row between the two other species: CM^3: 8.9 – 10.0 mm.

Distribution in Europe: In Europe only on Sardinia, Corsica, Malta and Gozo, there like in Northern Africa, the only large *Myotis* species. No zone of overlap in distribution with *M. myotis* or *M. blythii* known.

Taxonomical note: The populations on the Mediterranean islands might belong to a subspecies different from the African form.

Photographs: 12, 111, 114, 117.

Plate 14: Characters of the large *Myotis*: *M. myotis*, *M. blythii* and *M. punicus*.
M. myotis (109, 112, 115), *M. blythii* (110, 113, 116),
M. punicus (111, 114, 117).

Plate 14: Characters of the large *Myotis*: *M. myotis*, *M. blythii* and *M. punicus*.

II) Whiskered bats (*Myotis alcathoe - Myotis mystacinus – Myotis aurascens & Myotis brandtii*)

The identification of living whiskered bats, especially of young individuals and females, is difficult. A correct identification is sometimes possible only by using characters of the skull and teeth - if at all. It is still unclear, if the relatively big and lighter coloured whiskered bats of south-eastern Europe really deserve species rank (*Myotis aurascens*) or if they are just a subspecies of *M. mystacinus*. In addition it is not clear if they really belong to the taxon *aurascens*, initially described from the Caucasus.

With this key it is not possible to assign all individuals unambiguously to one species described at present, as the variability within *M. alcathoe* is little known and *M. mystacinus* and *M. aurascens* are very similar. Characters of *M. mystacinus* as given in this key refer to Central European populations. The subspecies *M. m. occidentalis* from Iberia is bigger and lighter in dorsal coloration. It is not possible to distinguish with this key alone between *M. aurascens*, *M. m. occidentalis* and *M. mystacinus* from regions other than Central Europe. We recommend therefore to treat *M. mystacinus* and *M. aurascens* in any species lists as one group and to specify it with its geographical origin. Determination is possible with molecular methods in *M. brandtii* and *M. alcathoe*, but the markers tested up to now do not resolve within *Myotis mystacinus / aurascens / occidentalis*.

Plate 15: Characters of Brandt's bat and whiskered bats (genus *Myotis*).
M. brandtii (118 - 121), *M. alcathoe* (122 – 125), *M. mystacinus* (126 - 129), *M. aurascens* (130 - 133).

Plate 15: Characters of Brandt's bat and whiskered bats (genus *Myotis*). 41

1) small whiskered bat, FA usually < 32.8 mm, (30.8 – 33.3 mm, rarely > 33.0 mm), D5: 37 – 44 mm, D3: 50 – 56 mm. Ears short, the upper margin of the distinct indentation (notch) on the posterior margin of the ear is not reached by the tragus (Fig. 123) or hardly exceeded. Short thumb, D1 < 4.7 mm (3.8 – 4.7 mm, usually < 4.5 mm), Tib < 14.8 mm (13.5 – 14.8 mm, usually < 14.5 mm) and HF < 5.6 mm (5.1 – 5.6 mm). – *Myotis alcathoe*

Additional characters: Penis small with no marked thickening at the end (Fig. 124 and 125). The species resembles on the first view in general appearance, coloration and proportions *M. daubentonii* or *M. brandtii*, but is much smaller (Fig. 122). Hair of the back is reddish, only rarely with golden gloss. Young bats up to an age of one year and some older bats are more greyish. It has the shortest muzzle of all whiskered bats and the face of adults is pink to rufous, like *M. daubentonii*. The nostrils have a variable shape but the lateral part of the nostril is very well developed, the nostrils have therefore the shape of a heart (Fig. 122). The skin around the calcar is usually very light.

Distribution in Europe: Only sketchy information is available at present, records from Greece, Bulgaria, Hungary, Slovakia, Switzerland, France and Spain.

Photographs: 122 – 125.

► medium sized to big whiskered bat (usually FA > 33 mm), ears relatively long with a distinct indentation (notch) on the posterior margin of the ear. The long tragus projects above the indentation (Fig. 119, 127 and 131). Relatively long thumb (D1 > 4.3 mm, usually > 4.7 mm), Tib > 14.6 mm (usually > 15.3 mm) and HF > 5.8 mm (usually > 6.0 mm). – 2

2) penis distinctly thickened at the end (club shaped) even in subadult males, but most obvious in adult ones (Fig. 120 and 121). Upper second premolar (P^3) is located within the tooth row and is rather large (about 2/3 of the size of the first upper premolar (P^2)) (Fig. 136), cingular cusp of the third upper premolar (P^4) is higher than the second premolar (P^3) (Fig. 136). Paraconuli usually present. FA: 33.0 – 38.2 mm, D5: 40 – 49 mm, D3: 48 – 61 mm. – *Myotis brandtii*

Additional characters: Nostrils usually heart-shaped (Fig. 118). The dorsal pelage in adults with a golden gloss. All bare parts of skin are medium to light brown (Fig. 118), not blackish-brown. The base of the ear and the tragus are clearly lighter (Fig. 119) (all colour characters of adults are quite similar in *M. aurascens*; in young individuals coloration resembles *M. mystacinus*!). A narrow post calcareal lobe is usually present.

Distribution in Europe: Distributed mostly in central and northern Europe, getting more rare to the south. It is absent from Ireland, Iberia, western France, Greece and all Mediterranean islands. In the Balkan countries confined to the mountains.

Photographs: 118 – 121.

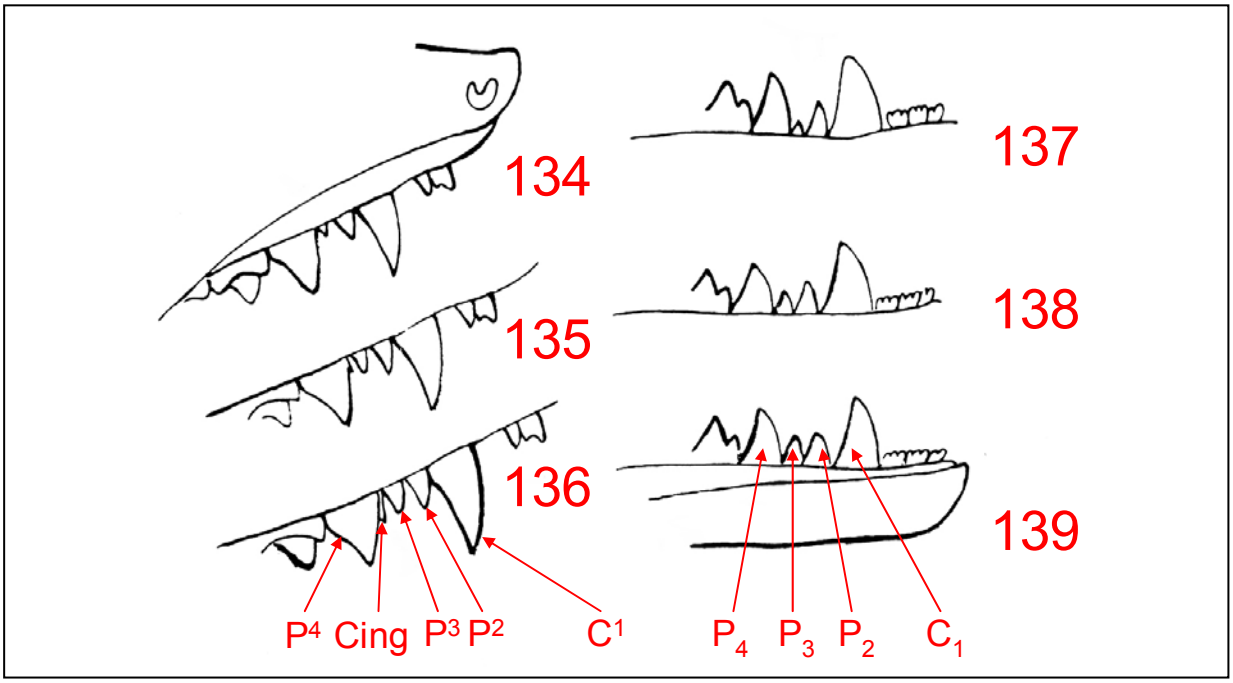


Plate 16: Teeth characters of Brandt's bat and whiskered bats.
M. aurascens (134, 137), *M. mystacinus* (135, 138) *M. brandtii* (136, 139).

► the penis is thin, of equal width, not or only slightly thickened at its end (Fig. 128 – 129 and 132 – 133). Upper second premolar rather small (maximum 1/2 of the size of the first upper premolar) (Fig. 135) and sometimes displaced palatally of the tooth-row (Fig. 134). Cingular cusp of third upper premolar is small or absent, always lower than the second upper premolar (Fig. 134 and 135). Paraconuli usually absent. – 3 (see note above!).

3) slightly smaller, penis slightly thinner and shorter (Fig. 128 and 129). Ears usually dark blackish-brown without lighter colour inside (Fig. 127). The muzzle is dark black-brown (Fig. 126). Nostril not heart-shaped, lateral part often very narrow (Fig. 126). Dorsal fur coloration brown but without golden tips or golden gloss. Adult individuals in most cases with pronounced yellowish-brown hair at and around the sides of the neck, forming a well visible sort of ruff (Fig. 126). Dimensions of thumb (D1: 4.3 – 5.9 mm, usually < 5.3 mm), lower leg (Tib: 14.6 – 16.8 mm, usually < 16.2 mm) and hind foot smaller (HF: 5.8 – 7.4 mm, usually < 6.8 mm). FA: 32.0 – 36.5 mm, D5: 38 – 46 mm, D3: 48 – 58 mm. – *Myotis mystacinus*

> Additional characters: The margin of the wing between the fifth finger and the leg of the same colour as the wing, not lighter. Upper second premolar small but usually within the tooth-row and about 1/3 to ½ of the size of the first upper premolar (Fig. 135).
>
> Distribution in Europe: Distributed from central Scandinavia to Iberia. Range in Italy and the Balkans largely unknown due to possible confusion with *M. alcathoe* and *M. aurascens*.
>
> Taxonomical note: Characters given here refer to the central European populations; the subspecies *M. m. occidentalis* (Iberia) resembles in some of its external characters *M. aurascens*, but differs clearly in skull and dental morphology.
>
> Photographs: 126 – 129. Drawings: 135 and 138.

► slightly bigger, penis relatively broader (Fig. 132 and 133). Ears brown, the inside of the ear and the base of the tragus lighter brown, sometimes even pinkish (Fig. 131). Nostril often heart-shaped, lateral part usually well developed (Fig. 130). In older individuals fur of the back with light golden tips. Adult individuals always without yellowish-brown hair on the sides of the neck, therefore ventral and dorsal colours of the fur sharply divided (Fig. 130). Large dimensions of thumb (D1: 5.2 – 7.0 mm, usually > 5.4 mm), lower leg (Tib: 15.7 – 18.1 mm, usually > 16.1 mm) and hind foot (HF: 6.8 – 8.7 mm, usually > 7.0 mm). FA: 32.0 – 37.4 mm, D5: 43 – 50 mm, D3: 52 – 61 mm. – *Myotis aurascens*

Additional characters: The margin of the wing membrane between the fifth finger and the leg usually has a very thin white or at least light border. Second upper and lower premolar very small, the upper one often dislocated palatally (1/4 to 1/3 of the size of the first upper premolar) (Fig. 134 and 137).

Distribution in Europe: Due to problems in species determination, the range is not well known in Europe. Common in Greece and Bulgaria, northwards to Romania and Serbia. Along the Adriatic coast to Northern Italy. Perhaps most of the populations in Italy and at least in parts of Hungary belong to this form as well.

Taxonomical note: see note at the beginning of the whiskered bat key. Up to now it has not been possible to distinguish *M. aurascens* and *M. mystacinus* by their genetics. So *M. aurascens* might only be a subspecies of *M. mystacinus* and is perhaps different from the true *aurascens* from the Caucasus. Another possible name for these bats is *Myotis mystacinus bulgaricus*.

Photographs: 130 – 133 (and 1 – 2). Drawings: 134 and 137.

III) Trawling Myotis (*Myotis daubentonii* – *Myotis capaccinii* – *Myotis dasycneme*)

1) fairly large species, FA > 42 mm (usually 43.0 – 49.0 mm), D5: 51 – 61 mm, D3: 72 – 77 mm. Tragus relatively short (shorter than half of the ear length) and for a *Myotis* species unusually short and broadly rounded at its tip (Fig. 149). Wing membrane inserted at the ankle of the foot (Fig. 151). Tail membrane with very fine whitish hairs on underside along lower leg up to the spur (Fig. 151). The pelage is dense and greyish-brown on the back and greyish-white on the underside (Fig. 148). – *Myotis dasycneme*

Additional characters: Penis is widest at its base and tapers towards the tip (Fig. 150).

Distribution in Europe: It is found from north-eastern France along the coast of the North Sea through northern Germany to southern Scandinavia, along the Baltic Sea to the Russian Plain and in the south to Slovakia, Croatia, Hungary and Romania.

Photographs: 148 – 151.

► smaller, FA usually < 42 mm. - 2

2) wing membrane inserted before ankle on the lower leg (tibia) (Fig. 147). Hind foot very big. Tragus long, reaches at least half of the ear length and is curved into slight S-shape (Fig. 145). Dorsal pelage a striking grey (Fig. 144). Tibia and tail membrane covered on dorsal and ventral side with downy hairs reaching from the leg to about the middle of the tail membrane (Fig. 147). The pelage on the back is a light smoky grey, rarely with a brownish tinge. The underside is grey. FA: 38.4 – 44.0 mm (but rarely more than 43.0 mm), D5: 48.6 – 56.4 mm, D3: 64 – 71 mm. – *Myotis capaccinii*

Additional characters: The nostrils are somewhat protruding giving the species a characteristic profile (Fig. 144). Penis slightly broadened towards its tip (Fig. 146).

Distribution in Europe: Distributed in the Mediterranean area and the Balkans. From the west coast of Spain to southern France, Italy, southern Switzerland, all the Balkan countries to Romania in the north. Present on all large Mediterranean islands.

Photographs: 144 – 147.

► wing membrane inserted between the ankle and the middle of the sole of the hind foot (Fig. 143), sometimes closer to the base of the first toe. Tragus long, reaches half the ear length, straight or slightly curved but not into S-shape (Fig. 141). Dorsal fur brownish, shiny. Tibia and tail membrane not hairy (Fig. 143). FA: 33.1 – 42.0 mm, D5: 39 – 52 mm, D3: 53 – 65 mm. – *Myotis daubentonii*

Additional characters: Penis parallel sided or slightly broadened to its tip (Fig. 142).

Distribution in Europe: It occurs throughout almost all of Europe, being absent only from northern Scandinavia, northern Scotland, Sicily, southern Greece and Crete. (In contradiction to earlier references largely overlaps in its distribution in the south with *M. capaccinii*.).

Taxonomical note: In Spain smaller and different coloured bats occur in sympatry with the typical form and were described as species of its own: *M. nathalinae*. But as individuals resembling the *nathalinae*-type were found in several parts of Europe as well and no genetic differences between those and typical *M. daubentonii* were found, *nathalinae* is currently regarded as a synonym of *M. daubentonii*.

Photographs: 57, 70 and 140-143.

Plate 17: Characters of the trawling *Myotis* (genus *Myotis*, subgenus *Leuconoe*).
M. daubentonii (140 - 143), *M. capaccinii* (144 - 147),
M. dasycneme (148 - 151).

Plate 17: Characters of the trawling *Myotis* (genus *Myotis*, subgenus *Leuconoe*).

IV) Genus *Pipistrellus* (*Pipistrellus pipistrellus – Pipistrellus pygmaeus – Pipistrellus kuhlii – Pipistrellus nathusii*)

Pipistrelles can be quite difficult to identify. It is important to consider the teeth and a set of other characters. However, with some experience most of the "qualitative" characters can be evaluated on first sight.

1) First upper incisor with a single cusp, second upper incisor small (without magnifying lens it appears to be only one single cusped tooth) (Fig. 179 and 182). The last upper premolar (P^4) is in contact with the canine (Fig. 179) (no small premolar (P^2) visible from the outside, if present, displaced to the inside). Usually a well defined white stripe along the margin of the arm wing membrane between fifth finger and hind foot (Fig. 183), usually also present along tail membrane and between fifth and fourth finger. Ears lighter brown, usually not blackish (Fig. 160 and 162). Dorsal pelage with dark black bases and sandy yellowish-brown tips (Fig. 160). Some individuals are dark brown without light tips, they resemble in coloration *P. nathusii*. FA: 30.3 – 37.1 mm, D5: 40 – 45 mm, D3: 54 – 61 mm. – *Pipistrellus kuhlii*

Additional characters: Posterior margin of the ear with a sharp indentation (Fig. 162). Penis is spear-shaped and without a medial stripe (Fig. 163) (its colour and shape even in juveniles quite similar to *Nyctalus leisleri*). The white stripe along the wing membrane is about 1 - 2 mm wide but up to 5 mm wide in animals from the south of the range.

Distribution in Europe: Occurring mainly in southern Europe in the whole Mediterranean, extending range northwards, reaching recently the southernmost parts of Germany and Austria. Missing or rare in the northern Balkan countries, absent from Romania, confined to the south in Bulgaria.

Photographs: 160 – 163, 175 and 182 – 183. Drawings: 179 (and 174).

► First upper incisor with two cusps and second incisor also clearly visible (Fig. 180 and 181). Wing membrane without a well defined white margin but sometimes with slightly lighter whitish margin. – 2

2) bigger species, FA: 32.2 – 37.1 mm. D5 usually > 43 mm (41 – 48 mm), D3: 57 – 62 mm. Pelage extends considerably on the tail membrane up to its proximal half. First upper premolar (P^2) clearly visible from outside and within the tooth row (Fig. 181). Second upper incisor (I^3) longer than the lower cusp of the first upper incisor (I^2) (Fig. 181). Cell of the wing membrane between the first joint of the fifth finger and the elbow divided by a keel (sometimes absent in small individuals) (Fig. 172 and 173). Coloration of the dorsal pelage dark brown (Fig. 156). – *Pipistrellus nathusii*

Additional characters: Margin of the wing membrane usually with a diffuse yellowish-white margin between leg and fifth finger. Underside of the tail membrane hairy along the lower leg (tibia). Characteristic gap between the second and third lower incisors (between I_2 and I_3). Penis well differentiated from all the other European pipistrelles in being robust and ovoid with a medial groove and strong hairs (Fig. 159). (Contrasting to earlier references, the relation between thumbL and width of the wrist is not species specific.)

Distribution in Europe: Occurs in Eastern, Central and Southern Europe. Common along the Baltic Sea, southern Scandinavia and northern Germany. Also present in the Balkans and on Corsica. Migrating to Sardinia and Sicily and Iberia. In the southern range in summer predominantly males, during migration and winter time also females.

Photographs: 97, 156 – 159 and 173. Drawings: 172 and 181.

► smaller species, FA < 34.6 mm. D5 < 43 mm (usually < 41 mm). Cusp of the first upper premolar (P^2) visible between canine and second upper premolar (P^4) but displaced inside of the tooth row (Fig. 180) (sometimes barely or not visible from outside, but unlike *P. kuhlii* P^4 and C^1 not directly in contact). Second upper incisor (I^3) shorter than the lower cusp of the first upper incisor (I^2) (Fig. 180). The three cusps of the incisor are stepped and look therefore even without magnification like a three-toothed comb (Fig. 180). No hair on the underside of the tail membrane along

the tibia. Cell of the wing membrane between the first joint of the fifth finger and the elbow not divided by a keel (Fig. 174 - 177) (only some very big females of *P. pipistrellus* show sometimes a weak keel). – 3

3) slightly bigger species, FA: 29.2 – 33.5 mm (in extremes 28.0 – 34.5 mm), D5: 37 – 41 mm, D3: 50 – 56 mm. Without internarial ridge between the nostrils (Fig. 165, 184) (only very dehydrated individuals do sometimes show a weakly developed ridge). The muzzle is longer and gradually narrowing. The glandular bumps are white (Fig. 186) or sometimes whitish-grey. The length of the inner margin of the ear is longer (8 - 9 mm) (Fig. 166). The pelage is dense but not as smooth as in *P. pygmaeus* and dark brown on the back, often rusty, sometimes a paler medium brown. Ears and muzzle are mostly black (Fig. 164 and 166), but in the south of the range some adults have a pale area around the eyes. Face and ears differ strongly from the pelage by their dark coloration. The penis is dark grey to greyish-brown and the glans penis with a contrasting pale median stripe (Fig. 167, 189). The wing cell connecting the first joint of the fifth finger with the elbow is not divided by an additional keel (Fig. 174, 175 and 192), but the cell above this is quite short, it usually does not extend to the forearm (Fig. 174 and 175). – *Pipistrellus pipistrellus*

Additional characters: In most individuals the second phalanx of the 3rd finger (P3.2) is 1 - 3 mm longer than the 3rd phalanx (P3.3) (Fig. 194), but sometimes they are of similar length (P3.2: 7.9 – 8.9 mm, P3.3: 6.0 – 8.4 mm). There is usually no gap between the second and third lower incisors, they are in contact (I_2 and I_3). Terminal frequency around 45 kHz (43 – 49 kHz, in extremes 41 – 52 kHz).

Distribution in Europe: The species is distributed all over Europe to southern Scandinavia and the Baltic states. Its northern limit of distribution is further south than in *P. pygmaeus.* In some Mediterranean areas *P. pipistrellus* is rarer than *P. pygmaeus*, but in most central European countries *P. pipistrellus* is the most common and widespread bat.

Taxonomical note: Within this species or species group some taxonomic questions still require clarification: some populations in eastern Thrace, the Peloponnese and on some

Greek islands are quite delicately built and show intermediate characters to *P. pygmaeus* and emit echolocation calls with a terminal frequency around 50 kHz; but they never have a yellowish or orange penis and vagina. In contrast some individuals from Sardinia are of a more robust build and resemble much more *P. kuhlii*, but they always show the typical characters of the upper incisors.

Photographs: 98 – 99, 164 – 167, 184, 186, 188 – 189, 192 and 194.

Drawings: 174 and 180.

► slightly smaller, FA: 27.7 – 32.3 mm, D5: 33 – 40 mm, D3: 46 – 55 mm. Obvious internarial ridge between the nostrils (Fig. 169, 185). In dorsal view, the short muzzle is parallel sided for approximately two-thirds of its length, then converging. Glandular bumps during reproductive season obvious orange or yellow, throughout the year at least with an orange or yellow tinge (Fig. 187). The ears are shorter, the length of the inner margin is 7 – 8 mm (Fig. 170). Pale bald areas on the face, especially between the ears and the eyes and around the eyes (Fig. 168). Facial skin and ears are not darker in colour than the pelage coloration. Very dense silky pelage, dorsal reddish-brown, in winter more olive brown, underside yellowish-grey. In the south the summer pelage often sandy coloured. Ears lighter than in *P. pipistrellus*. Like in *P. pipistrellus* there is only one cell in the wing membrane between the first joint of the fifth finger and the elbow. In addition the next cell above (closer to the wrist) is also not divided in most individuals and connecting forearm and fifth finger (Fig. 176, 177 and 193). Penis in full adults with obvious yellow coloration, during reproduction time often orange (Fig. 190), glans penis always without paler medial stripe (Fig. 171). In subadults or juveniles the penis is whitish, often with a yellow tinge, never brownish and always without pale stripe. In females the skin around the vagina is also orange coloured (Fig. 191), at least when they are in oestrus. – *Pipistrellus pygmaeus*

Additional characters: The uropatagium is densely covered with hairs on its proximal third. The second (P3.2) and the third phalanges (P3.3) of the third finger are more or less of

the same length (P3.2: 6.6 – 8.7 mm, P3.3: 6.3 – 8.2 mm) (Fig. 195). Obvious musk like odour, especially during mating season. Like in *P. nathusii* there is usually a gap between the second and third lower incisors (I_2 and I_3). Terminal frequency around 55 kHz (52 – 57 kHz, in extremes 50 – 64 kHz).

Distribution in Europe: The species seems to range all over Europe from Scotland and southern Scandinavia to Iberia and European Turkey, but records are missing from some regions like the northern Balkans and southernmost Italy. *P. pygmaeus* is more common in northern and southern parts of Europe, in Central Europe mostly confined to the valleys of larger river systems. The distribution is patchier than in *P. pipistrellus*.

Photographs: 168 – 171, 177, 185, 187, 190 – 191, 193 and 195.

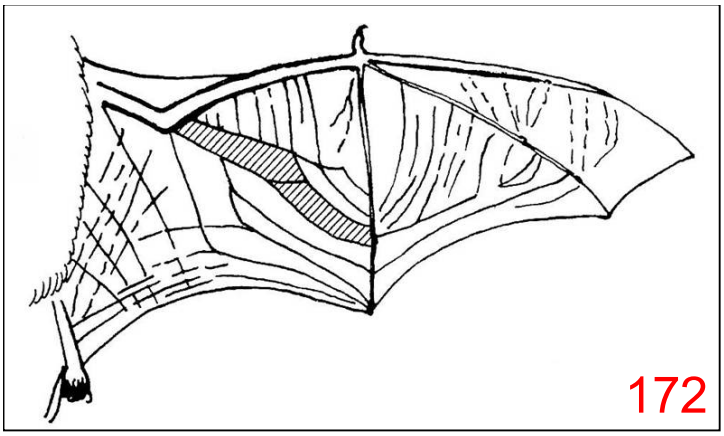
Drawings: 176 (and 180).

Plate 18: Characters of the species of the genera *Hypsugo* and *Pipistrellus*.
H. savii (152 - 155), *P. nathusii* (156 - 159), *P. kuhlii* (160 - 163),
P. pipistrellus (164 - 167), *P. pygmaeus* (168 - 171).

Plate 19: Characters of the species of the genera *Hypsugo* and *Pipistrellus*.
P. nathusii (172, 173, 181), *P. pipistrellus* (174, 173, 180),
P. pygmaeus (176, 177), *H. savii* (178), *P. kuhlii* (179, 182, 183).

Plate 20: Characters of the species *Pipistrellus pipistrellus* and *P. pygmaeus*.
P. pipistrellus (184, 186, 188, 189, 192, 194),
P. pygmaeus (185, 187, 190, 191, 193, 195).

Plate 18: Characters of the species of the genera *Hypsugo* and *Pipistrellus*. 54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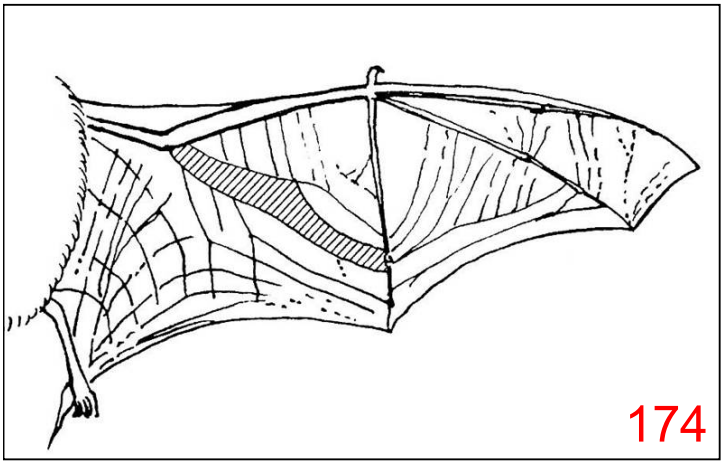
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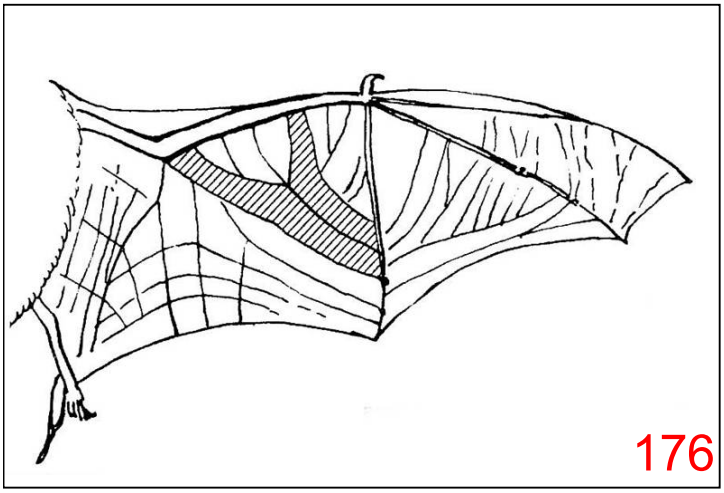
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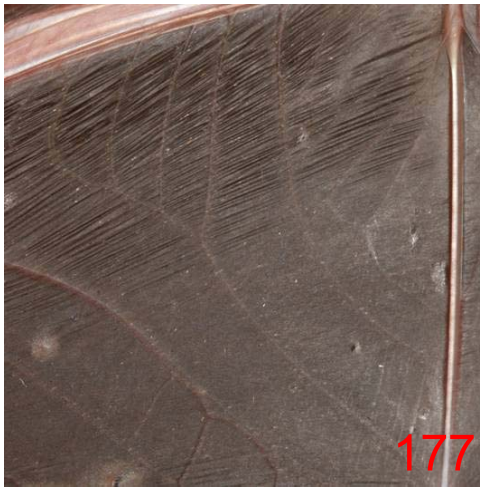
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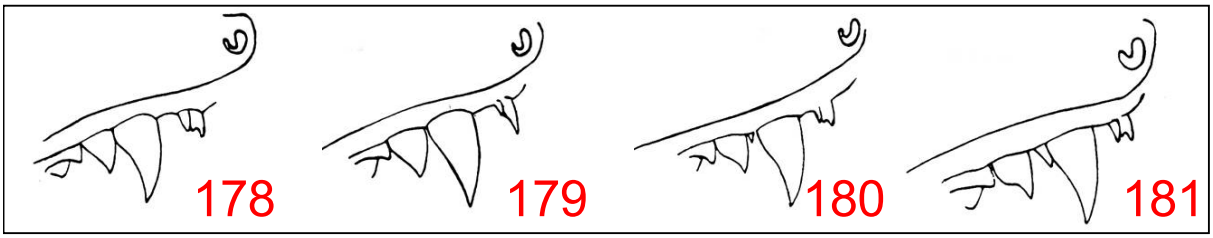
178
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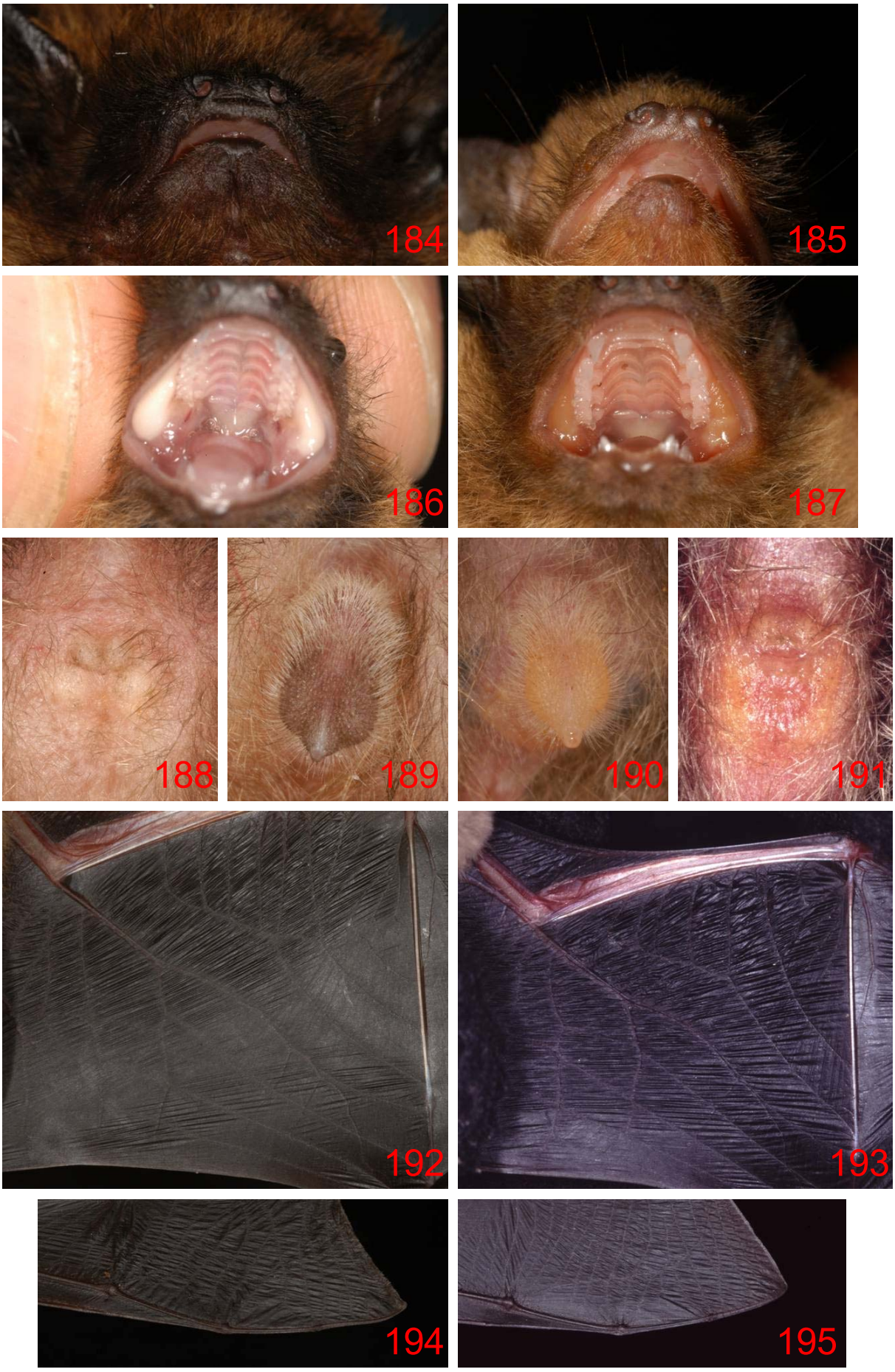

Plate 20: Characters of the species *Pipistrellus pipistrellus* and *P. pygmaeus*.

V) Genus *Eptesicus* (*Eptesicus serotinus – Eptesicus nilssonii – Eptesicus bottae*)

The two widely distributed species *E. serotinus* and *E. nilssonii* can be separated by external measurements only. In Europe *E. bottae* occurs only on some of the Greek islands off the Anatolian coast.

►►► large and robust species, FA: 48.0 – 58.0 mm, D5 > 60 mm (59 – 69 mm all over Europe, 61 – 67 mm in southern Greece and the Greek islands), D3: 84 – 92 mm. The muzzle is wide and robust (Fig. 199). The tragus is broad and the ears are long (Fig. 200). The penis is only slightly widened towards the end and its upper side has a weak medial ridge (Fig. 201). Pelage on the back ranging in colour from dark brown to sometimes yellowish or golden brown (Fig. 199). Dark black ears and muzzle. – *Eptesicus serotinus*

Additional characters: In south-eastern Europe, especially on the Greek islands, the dorsal pelage is a light yellowish brown. Hair on the back long (about 11 mm).

Distribution in Europe: Ranging all over Europe, in the north to central Britain, the southernmost Sweden and the Baltic states. Absent from Ireland and perhaps also from Sardinia.

Taxonomical note: A small serotine has been described as a species on its own from Romania: *Eptesicus sodalis* and has been subsequently found in various parts of Europe. The form *sodalis* is believed now to be a synonym of *Eptesicus serotinus*, as these bats seem to be just unusual small individuals.

Photographs: 55 and 100 – 102 and 199 – 201.

►► smaller species, FA: 37.0 – 44.0 mm, D5: 45 – 56 mm, D3: 62 - 68 mm. Dorsal pelage dark brown to black with light golden tips on the back and the forehead (Fig. 196). A well defined line of demarcation along the sides of the neck towards the light yellowish brown underparts. – *Eptesicus nilssonii*

Additional characters: Usually small tufts of golden or yellowish hair at the front margins of the ears (Fig. 196). Ears shorter than in the other *Eptesicus* species (Fig. 197).

In principle this is an unmistakeable species, but misidentifications do occur with *Hypsugo savii* (that is smaller, has a different ear and tragus and a characteristic penis with bend) or *Vespertilio murinus* (in *V. murinus* the silver hair tips do not reach the forehead, the pelage on the chin is white or at least light, it has well developed post calcareal lobe, its penis is long and very narrow. The flight membranes of *V. murinus* are greyish brown, but gleaming black in *Eptesicus*).

Distribution in Europe: Boreal species, with the most northerly range of all species (even reproduces north of the Arctic circle). Distribution gets more scattered to the south, being there mostly confined to the mountains. In the south-west to the Swiss Alps, in the south to the Dinaric Alps and Carpathians. One single record from Bulgaria.

Photographs: 47 and 196 – 197.

► medium sized species, FA: 43.3 – 50.0 mm (in extremes 37.6 – 52.1 mm). D5 < 60 mm (54 – 58 mm). Shorter muzzle and in relation bigger eyes (Fig. 202). Ears shorter and tragus more narrow (Fig. 203). Penis widely broadened towards the end and with a small triangular furrow at the tip (Fig. 204). Coloration similar to the light forms of *E. serotinus* yellowish-brown on the back. Ventral fur lighter than in *E. serotinus*, more whitish (Fig. 202). Dark black ears and face. CM^3 < 7.0 mm (in *E. serotinus* CM^3 > 7.2 mm). – *Eptesicus bottae*

Additional characters: Pelage on the back shorter, hair about 8 – 9 mm long.

Distribution in Europe: In Europe only on the Greek Islands off the Anatolian coast: Rhodes and possibly Samos and some more islands.

Taxonomical note: The characters outlined above are only valid for the Anatolian subspecies *E. b. anatolicus* distributed also on the Aegean Islands. The form *anatolicus* might be a distinct species as well.

Photographs: 202 – 203. Drawings: 204.

Plate 21: Characters of the species of the genus *Eptesicus*.
E. nilssonii (196, 197, (198)), *E. serotinus* (199 - 201),
E. bottae (202 - 204).

(198)

VI) Genus *Nyctalus* (*Nyctalus noctula – Nyctalus leisleri – Nyctalus lasiopterus*)

All three European species are well separated by their size and it is possible to determine them by using only the forearm length (FA).

►►► large species, FA: 48.0 – 55.4 mm (in extremes 47 - 59 mm), D5: 47 – 58 mm, D3: 85 – 98 mm. Pelage uniformly reddish-brown in late autumn and winter with a greyer tinge. – *Nyctalus noctula*

Distribution in Europe: Ranging throughout Europe except for Ireland, Scotland, northern Scandinavia and the southernmost parts of Greece and Italy. Mostly absent from the Mediterranean Islands.

Photographs: 61 and 208 – 210.

►► very large species, FA: 64 – 68 mm (extremes 61 – 70 mm), D5: 69 – 74 mm, D3: 108 – 116 mm. Pelage uniformly reddish-brown. Very broad ears (Fig. 212), heavy muzzle (Fig. 211). – *Nyctalus lasiopterus*

Additional characters: Especially males with long lion-like fur on the neck (Fig. 211).

Distribution in Europe: Scattered records all over southern Europe, single records also in central Europe. Most common in Spain and Greece.

Photographs: 211 - 213.

► medium sized species, FA: 39.2 – 45.6 mm (extremes 38.0 – 47.1 mm), D5: 43 – 51 mm, D3: 70 – 78 mm. Pelage uniformly brown to dark brown without reddish tinge. Dorsal pelage two-coloured with darker bases. Ears narrower (Fig. 206). – *Nyctalus leisleri*

Additional characters: basal inner part of the ear and the fold of skin connecting the ear with the mouth are very often lighter in colour than the rest of the ear (Fig. 206).

Distribution in Europe: Records from all over Europe, but mostly absent from Scandinavia and Estonia. Missing in southern Italy, Sicily and Crete.

Photographs: 56, 60, 103 – 105, 205 – 207.

Plate 22: Characters of the species of the genus *Nyctalus*.
N. leisleri (205 - 207), *N. noctula* (208 - 210), *N. lasiopterus* (211 - 213).

Plate 22: Characters of the species of the genus *Nyctalus*.

VII) Genus *Plecotus* (*Plecotus auritus* – *Plecotus austriacus* – *Plecotus macrobullaris* – *Plecotus kolombatovici* – *Plecotus sardus*)

1) thumb short (D1 < 6.5 mm) (Fig. 232 and 238). Thumb claw usually less than 2 mm long (Fig. 232). Hind foot short (HF without claws < 8 mm). Hairs on the toes short and plain (Fig. 233 and 239). Penis thickened and rounded towards the end (Fig. 234 and 240). Protuberance above the eye small (in diameter smaller than diameter of the eye) (Fig. 217 and 223). – 2

►► thumb long (D1 > 6.5 mm) (Fig. 229 and 235). Thumb claw long and curved (usually longer than 2 mm) (Fig. 235). Hind foot large (HF > 8 mm) with long hairs sticking up (Fig. 230 and 236). Tip of penis not thickened but penis parallel sided (Fig. 237 and 243) or tapered to the tip (Fig. 231). Protuberance above the eye medium-sized to big (Fig. 214 and 220). – 3

► thumb of medium length (D1: 6.0 – 6.5 mm) (Fig. 241). Thumb claw long and curved (2.0 – 3.1 mm) (Fig. 241). Tragus length > 18 mm (Fig. 228). Hind foot small to medium-sized (HF: 6.7 – 7.7 mm). Long sticking hairs only at the toes, not at the foot (Fig. 242). D5 usually > 55 mm (minimum 54 mm), D3 usually > 71 mm (minimum 66 mm). Dorsal fur brown to greyish-brown, underside lighter but not white, sharp boundary. Penis parallel sided, only tapered at the tip (Fig. 243). FA: 40.9 – 42.3 mm. – *Plecotus sardus*

Additional characters: Facial parts in older bats light. Chin with an obvious round gland.

Distribution in Europe: Endemic to the island of Sardinia.

Photographs: 50, 226 - 228 and 241 – 243.

2) Small species: FA in males < 38 mm, in females < 39 mm (36.1 – 39.3 mm, in extremes 41.0 mm). D3 < 65 mm (61 – 66 mm). D5 < 52 mm (46 – 51 mm). Tib < 18

mm (15.2 - 18.3 mm). TragL usually < 14 mm, TragW usually < 5.2 mm. Dorsal pelage brown-grey to brownish. – *Plecotus kolombatovici*

Additional characters: CM^3 < 5.7 mm (> 5.7 mm in *P. austriacus*).

Distribution in Europe: In Europe only along the Adriatic coast, many Adriatic islands and Greece.

Taxonomical notes: BENDA et al. (2004) described a new form of long-eared bats from Northern Africa ("*gaisleri*"). Due to a lack of a sympatric occurrence of the three closely related forms "*teneriffae*" (from the Canary islands), "*gaisleri*" (northern Africa) and "*kolombatovici*" (Adriatic coast, Greece and Turkey) they were claimed to be subspecies of one single species. As *teneriffae* was the species described first, they refer to them as *Plecotus teneriffae teneriffae*, *P. t. gaisleri* and *P. t. kolombatovoci*. Nevertheless, all three forms might represent independent species, as two of them (*P. t. gaisleri* and *P. t. kolombatovici*) were found in sympatry on the island of Pantelleria. Further research is needed to solve this taxonomical problem. Characters given in the identification key above are only valid for the form "*kolombatovici"* in Europe. *P. t. gaisleri* differs in having a darker coloration of pelage and naked parts and a larger thumb and forearm (FA: 37.2 - 40.9 mm). *P. t. teneriffae* is quite large (FA: 40.1 – 46.0 mm) and has a dark ash-grey ventral pelage coloration.

Photographs: 46, 48, 223 - 225 and 238 – 240.

► Larger species: FA in males usually > 38 mm, in females > 39 mm (36.5 – 43.5 mm). D3 > 64 mm (64 – 71 mm). D5 > 51 mm (48 – 55 mm). Tib > 18 mm. TragL: 14.0-16.0 mm and TragW > 5.4 mm. Dorsal pelage grey, but in east-mediterranean populations (Greece, Bulgaria, European part of Turkey sometimes brownish-grey). – *Plecotus austriacus*

Additional characters: CM^3 > 5.7 mm (< 5.7 mm in *P. kolombatovici*).

Distribution in Europe: Distributed all over central and southern Europe, in the north to southern Britain, missing in Denmark and Scandinavia. Everywhere in the south including most Mediterranean islands, but missing on the Adriatic islands.

Photographs: 217 – 219, 232 – 234.

3) long upright hairs on the whole hind foot and toes (Fig. 230). TragL < 15.5 mm. D5 < 55 mm (47 – 56 mm), D3 < 66 mm. Dorsal pelage light brown, brown or reddish-brown. Ventral fur lighter, usually yellowish-brown. Usually without a clear boundary between dorsal and ventral coloration. Facial parts of the skin, ears and tragus brownish coloured without grey or black (Fig. 214). Without smooth triangular pad on the lower lip (Fig. 215). Protuberance above the eye big (1.5 - 2.0 mm in diameter). Penis tapered continuously from the base towards the tip (Fig. 231) (triangular shaped). FA: 35.5 – 42.5 mm. – *Plecotus auritus*

Distribution in Europe: Distributed throughout almost all of Europe but getting rarer to the south and often being confined to mountainous areas, missing on most islands except Sardinia.

Taxonomical note: the subspecies *Plecotus auritus begognae* from southern Iberia is larger (FA: 38.3 - 43.5 mm, TL: 5.9 – 7.6 mm, HF: 6.7 – 9.6 mm, TragL: 12.6 – 17.1 mm, TragW: 4.4 – 5.8 mm).

Photographs: 53 (left), 214 – 216 and 229 – 231.

► the hind foot is sparsely haired with long sticking hairs only visible at the toes (Fig. 236). Thumb and thumb claw shorter (Fig. 235) and FA usually bigger (FA 39.6 – 45.0 mm.) than in *P. auritus*. TragL usually > 16 mm. D5 > 51 mm. D3 > 63 mm. Pelage long and silky, dorsal brownish-grey to grey, ventral fur conspicuously white: ventral hairs with white tips and greyish proximal parts. A hard triangular pad extends towards the chin at the lower lip (Fig. 221), this pad is darkly pigmented at least in younger individuals. Penis parallel sided, only tapered at the tip (Fig. 237). – *Plecotus macrobullaris*

Distribution in Europe: Distributed in the Alpine parts of the Pyrenees, Corsica, Alps, the Dinaric Alps, Pindus mountains and Crete. Perhaps also present in the Carpathians and Balkan mountains (as it is distributed eastwards to the Caucasus and the Taurus mountains).

Taxonomical note: Currently two recognised subspecies: *P. m. alpinus* ranging from the Alpine regions, northern Italy and Croatia westwards and *P. m. macrobullaris* from Greece eastwards to Turkey, Armenia and Ossetia. Details of distribution are not known yet.

Photographs: 220 – 222 and 235 – 237.

Plate 23: Characters of the species of the genus *Plecotus*.

P. auritus (214 - 216), *P. austriacus* (217 - 219), *P. macrobullaris* (220 - 222), *P. kolombatovici* (223 - 225), *P. sardus* (226 - 228).

Plate 24: Characters of the species of the genus *Plecotus*.

P. auritus (229 - 231), *P. austriacus* (232 - 234), *P. macrobullaris* (235 - 237), *P. kolombatovici* (238 - 240), *P. sardus* (241 - 243).

Plate 23: Characters of the species of the genus *Plecotus*.

Plate 24: Characters of the species of the genus *Plecotus*.

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

Only the synonyms that have been debated in the last few years (especially of the newly described species) are listed. Reference citations for the newly described species are given in the reference list.

Rhinolophus ferrumequinum (Schreber, 1774) – greater horseshoe bat

Rhinolophus hipposideros (Bechstein, 1800) – lesser horseshoe bat

Rhinolophus euryale Blasius, 1853 – Mediterranean horseshoe bat

Rhinolophus blasii Peters, 1866 – Blasius' horseshoe bat

Rhinolophus mehelyi Matschie, 1901 – Mehely's horseshoe bat

Myotis daubentonii (Kuhl, 1817) – Daubenton's bat
Synonym: *Myotis nathalinae* Tupinier, 1977

Myotis capaccinii (Bonaparte, 1837) – long-fingered bat

Myotis dasycneme (Boie, 1825) – pond bat

Myotis brandtii (Eversmann, 1845) – Brandt's bat

Myotis mystacinus (Kuhl, 1817) – whiskered bat

Myotis aurascens Kusjakin, 1935 – steppe whiskered bat, Eastern whiskered bat

Myotis alcathoe von Helversen & Heller, 2001 – Alcathoe's bat, nymph bat

Myotis emarginatus (Geoffroy, 1806) – Geoffroy's bat

Myotis nattereri (Kuhl, 1817) – Natterer's bat

Myotis bechsteinii (Kuhl, 1817) – Bechstein's bat

Myotis myotis (Borkhausen, 1797) – greater mouse-eared bat

Myotis blythii (Tomes, 1857) – lesser mouse-eared bat

Myotis punicus (Felten, 1977) – Maghrebian mouse-eared bat

Nyctalus noctula (Schreber, 1774) - noctule

Nyctalus leisleri (Kuhl, 1817) – Leisler's noctule

Nyctalus lasiopterus (Schreber, 1780) – greater noctule

Eptesicus serotinus (Schreber, 1774) – serotine

Eptesicus nilssonii (Keyserling & Blasius, 1839) – northern bat

Eptesicus bottae (Peters, 1869) – Botta's serotine

Vespertilio murinus Linnaeus, 1758 – parti-coloured bat

Pipistrellus pipistrellus (Schreber, 1774) – common pipistrelle, 45 kHz pipistrelle

Pipistrellus pygmaeus (Leach, 1825) – soprano pipistrelle, midge bat, 55 kHz pipistrelle
Synonym: *Pipistrellus mediterraneus* Cabrera, 1904

Pipistrellus nathusii (Keyserling & Blasius, 1839) – Nathusius' pipistrelle

Pipistrellus kuhlii (Kuhl, 1817) – Kuhl's pipistrelle

Hypsugo savii (Bonaparte, 1837) – Savi's pipistrelle

Plecotus auritus (Linnaeus, 1758) – common long-eared bat, brown long-eared bat

Plecotus austriacus (Fischer, 1829) – grey long-eared bat

Plecotus macrobullaris (Kusjakin, 1965) – Alpine long-eared bat
Synonyms: *Plecotus alpinus* Kiefer & Veith, 2002
Plecotus microdontus Spitzenberger, 2002

Plecotus kolombatovici (Dulic, 1980) – Kolombatovic's long-eared bat, Balkan long-eared bat

Plecotus sardus Mucedda & Kiefer, 2002 – Sardinian long-eared bat

Barbastella barbastellus (Schreber, 1774) - barbastelle

Miniopterus schreibersii (Kuhl, 1817) – Schreiber's bat, bent-winged bat

Tadarida teniotis (Rafinesque, 1814) – European free-tailed bat