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POPULATION ECOLOGY AND SPECIALIST ADVICE ON BATS

R E STEBBINGS

Monks Wood Experimental Station
Abbots Ripton
Huntingdon
Cambs PE17 2LS

December 1985

Which bat is it?

A guide to bat identification in Great Britain and Ireland

R E STEBBINGS

Institute of Terrestrial Ecology
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INTRODUCTION

Bats have always been difficult to identify, even by experienced naturalists. The main problem is that most people are unfamiliar with these fascinating flying mammals, and often take insufficient care to eliminate species systematically by detailed examination of characters. Recognizing this fact, I have presented a formal dichotomous key, which depends upon having a bat in the hand, together with tables and other information to aid identification.

It may be helpful to remember that there is an order of likelihood for finding bats in different situations and different geographic areas (Table 1 and distribution maps). Although it is most likely that the bat you have is an abundant species, there is always the possibility that it is rare or even a vagrant. In the British Isles, 15 species of bat are known to be resident (36% of the indigenous terrestrial mammal species, Corbet 1975), but there are twice as many in mainland Europe. Some species are known to migrate hundreds of kilometres. Exceptional weather conditions, eg extreme cold or strong winds, may cause bats to fly across to our islands.

If a bat appears to be either one of the very rare resident species or a vagrant, or if it is out of its normal range, then try to contact an expert to obtain confirmation (but see below concerning bat welfare and licensing). Alternatively, take close-up photographs or draw the face, particularly showing ear and tragus shape, and measure the forearm length.

TABLE 1 Relative likelihood of finding bats away from any roosts eg bats found dead. This table probably reflects relative abundance but there are regional variations. Also see distribution maps.

Most likely	Pipistrelle	Pipistrellus pipistrellus
	Brown long-eared bat	Plecotus auritus
	Natterer's bat	Myotis nattereri
	Daubenton's bat	Myotis daubentonii
	Whiskered bat	Myotis mystacinus
	Brandt's bat	Myotis brandtii
	Lesser horseshoe bat	Rhinolophus hipposideros
	Greater horseshoe bat	Rhinolophus ferrumequinum
	Noctule	Nyctalus noctula
	Serotine	Eptesicus serotinus
	Barbastelle	Barbastella barbastellus
	Leisler's bat	Nyctalus leisleri
	Bechstein's bat	Myotis bechsteinii
	Grey long-eared bat	Plecotus austriacus
Least likely	Mouse-eared bat	Myotis myotis

Pipistrellus pipistrellus does NOT occur in caves or mines. Small bats appearing like pipistrelles found underground are most likely to be Daubenton's, whiskered or Brandt's. Pipistrelles are known in rock fissures at the entrances of caves or cracks in cliff faces, but only in the light zone.

LEGISLATION

Dead bats No licence is required to collect dead bats. Remains may be found in various places, eg roofs, cave deposits or owl pellets, and many bats are brought into houses by cats. Even fragments of bones may be identified, so it is important to keep all material, carefully labelled with date, location, collector and circumstances of finding. The Wildlife and Countryside Act 1981 requires proof that the animals or material had not been taken illegally. You must not sell (NB the term includes exchange, hire or barter) or offer for sale any bat remains without a licence (obtainable from the Wildlife Licensing Branch, DoE, Tolgate House, Houlton Street, Bristol, BS9 2DJ). You may retain for your own use any material you find and you may give specimens legitimately obtained to others or to a museum. Material may be loaned but it is wise to provide an accompanying note giving details of origin and ownership.

Bat collection A national collection of bats is maintained at ITE Monks Wood Experimental Station, Abbots Ripton, Huntingdon, PE17 2LS. New specimens (skeletal or bodies in any condition) are always welcome. Please give details of location and date. Fresh or rotting material must be wrapped in leak-proof containers or preserved in 75% alcohol. Native and foreign bats are also maintained in the National Collections in the British Museum (Natural History).

Injured bats No licence is required to tend an injured bat. Keep a note of origin and circumstances of capture. If the bat recovers and can be released in good health in a reasonable time, eg within 15 days of capture, then release it as close to where found as practical; otherwise, it is probably more humane to keep the bat in captivity.

Live bats and their roosts It is illegal, without a licence, intentionally to catch, handle or disturb wild bats. This definition includes intentionally entering and searching known bat roosts. Licences are issued by the Nature Conservancy Council to people who have received adequate training.

Bat welfare Only appropriately trained and licensed people may disturb and handle wild bats. If they are handled, it should be for the minimum time necessary to obtain information or for identification. With experience, handling should not be necessary except for difficult species such as the whiskered and Brandt's. Bats which appear stressed, as may happen on very hot days, should be released immediately. This includes bats that shake or struggle violently. They should always be released at place of capture.

Bats which are thought to be very rare or vagrant should have their identity confirmed by an expert if possible. Healthy free-living bats need special care. If practical, telephone an expert to seek advice while keeping the bat in a soft cloth bag. The bat should be released within one hour. Also, take measurements and photograph or make drawings to show ear, tragus and wing shape.

Note that a separate licence is required for photography in situ in roosts as this is bound to cause some disturbance to the bats.

Dead or injured bats should be retained. Badly injured bats should be killed humanely, but other bats may respond to being given water and food (see Focus on bats booklet).

Fresh dead bodies should be frozen or preserved, but dried-out bats are often found in buildings.

Handling It is important that bats are handled as little as possible. When handled, bats are more co-operative and are less likely to bite if they are gently held in a relaxed natural position. The animal should be placed in cupped fingers, with the lower jaw projecting beyond the edge of the first finger (Figure 1). The thumb is then held lightly over its back and the wings are folded to the bat's side. In this position, head features may be seen and measured, as can the forearm. Tail and foot characters may be viewed by turning over the hand and moving fingers apart. Large bats may bite and for inexperienced people it is advisable to wear thin soft gloves (not woollen) or to partially wrap the bat in cloth.

Sometimes bats are held with their wings behind their backs. This method is dangerous as joints may easily be dislocated and bones broken. Never hold a bat by the wing tips.

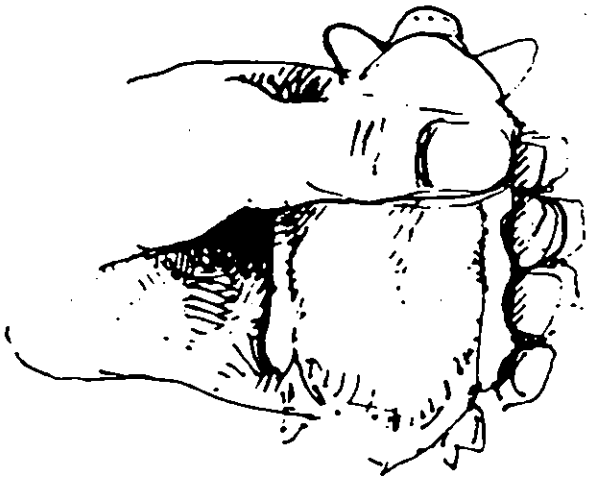


Figure 1. How to hold a live bat for examination

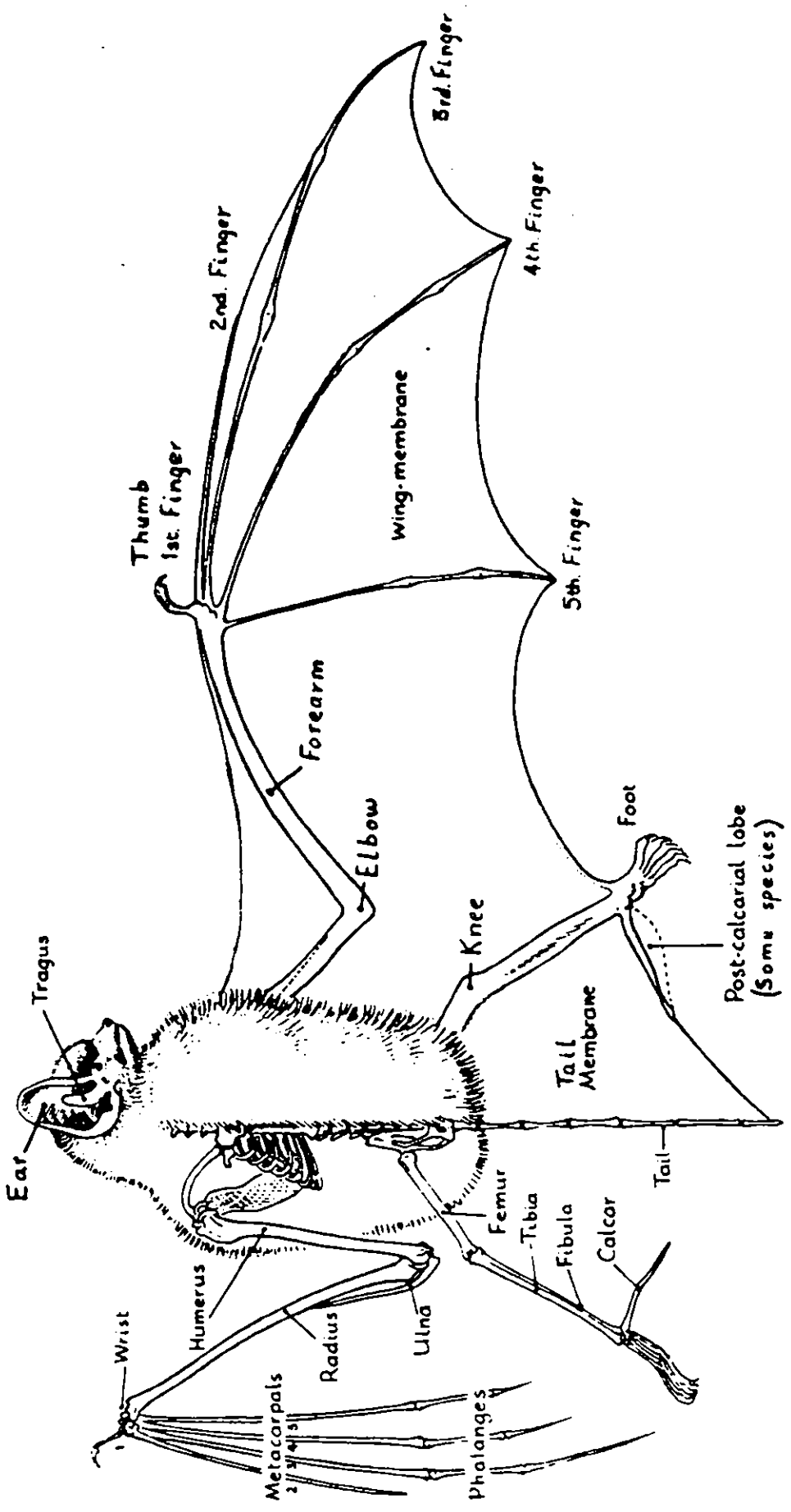


Figure 2. Parts of a bat

MEASUREMENTS

It is important to be familiar with the names of the various parts of bats used as identification characters and to know how to observe or measure these (see Figure 2).

The only essential equipment required for identifying all species is a short (10 cm) scale marked in millimetres. Vernier calipers may be needed for taking detailed measurements which can also help to separate some of the more difficult species.

Weights These are not helpful for identifying bats. Maximum weights may be double minimum ones and dead bats usually lose weight quickly.

Forearm length (Figures 3 & 4) This is the most useful measurement, which will, at once, eliminate at least half the species, and even immediately identify a large mouse-eared bat! Measure the overall length to the nearest millimetre with the wing folded beside the body. Female forearm lengths average 2-3% longer than males.

Ear length (Figure 5) Record the maximum height of the ear to the nearest millimetre.

Tragus length (Figure 6) A tragus is a lobe inside the ear, which is present in all species except the horseshoe bats. Tragus shape is often diagnostic of the species. Measure the anterior or front edge of the tragus.

Tragus width (Figure 7) This measurement is important for identifying the 2 long-eared bats. It should be taken across the widest part, preferably with the tragus partly folded back to eliminate errors due to curvature. Record to the nearest 0.1 mm if using calipers, but for long-eared bats there is need to establish only whether the width is greater or less than 5.5 mm.

Calcar (Figure 8) This is a spur of cartilage running from the ankle towards the tail. A membranous lobe called the post-calcarial lobe is found on the posterior free edge in some species. Extend the tail membrane to record whether the lobe is present and the length of the calcar proportional to the distance from the ankle to the tail.

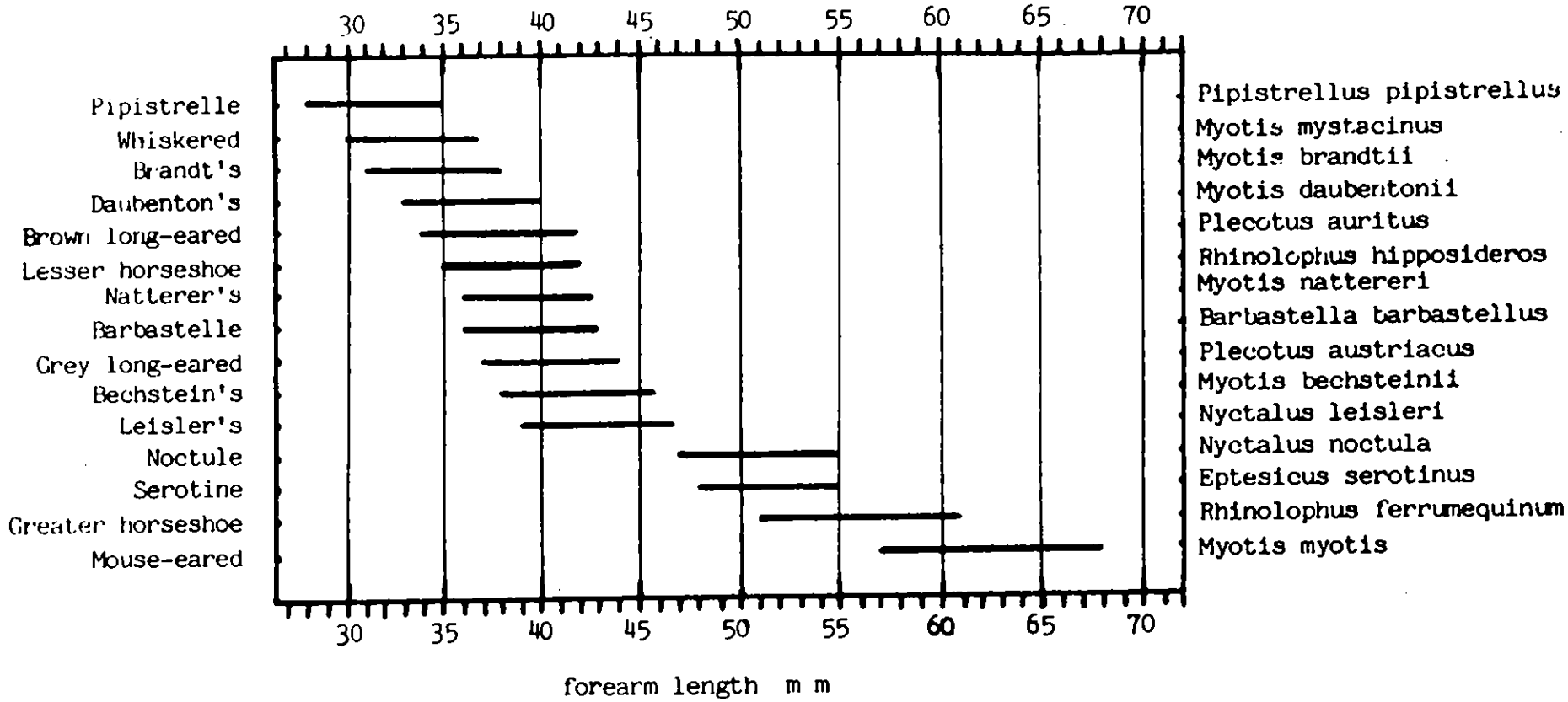


Figure 3 Forearm length: bars represent size range

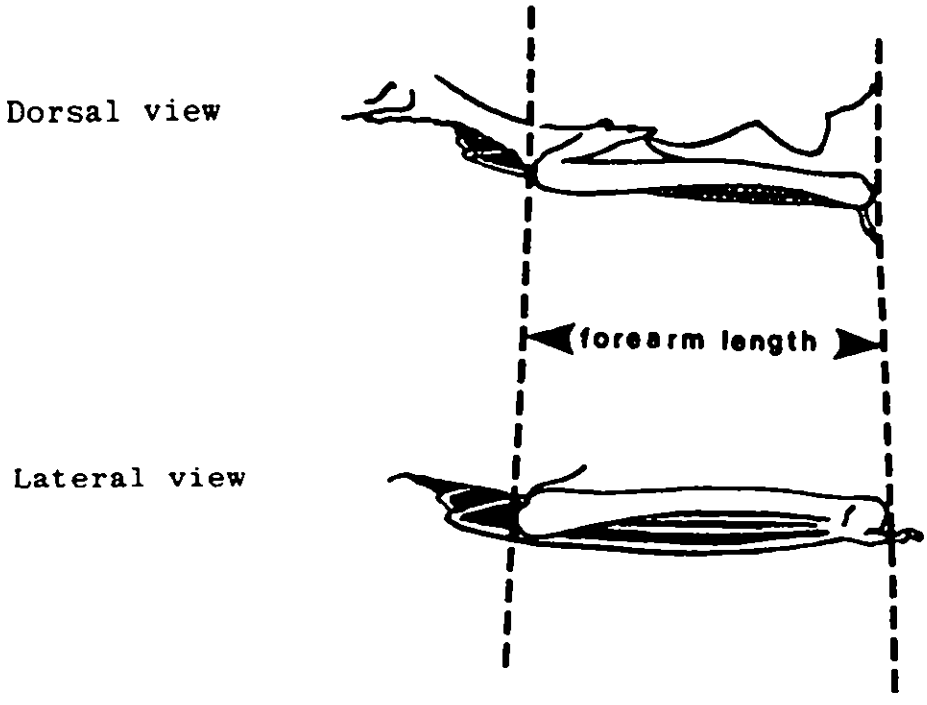


Figure 4. Measuring forearm length

Figure 5
Ear length

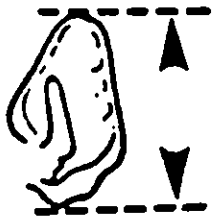
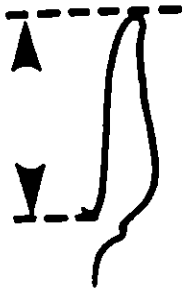


Figure 6
Tragus length



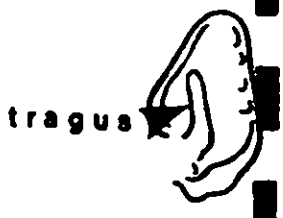


Figure 7
Tragus width

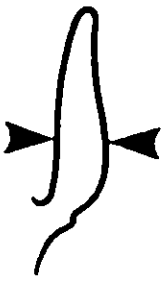


Figure 8
Calcar and post calcarial lobe

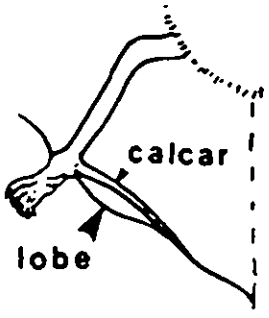


Figure 9
Shape of finger joints

a & b adult
c & d juvenile

b & d are joints held to light

Colour All European bats are essentially shades of brown or grey and there is much individual variation for each species. Colours are given as a general guide, but the inexperienced observer should be aware that atypical colours are found occasionally, with extremes such as albinos, being very rare.

Aging bats It is IMPORTANT to know whether a bat is young or full-grown before attempting to identify it. Bats grow very quickly and their bones are usually at full size by the end of September of the birth year. Therefore, bones of live or freshly dead bats from October to May are likely to have reached their maximum length. Dead bats, especially those found in buildings, and bats found in June-September could be babies or juveniles. Apart from a greyish colour, these bats may be distinguished by examining the joints of the wing bones. In young animals the bones consist of cartilage, which is translucent, and as growth proceeds bone gradually replaces the cartilage. In each bone, the centre of the shaft is first to ossify (become bone), followed by the ends (ie the joints). Gradually, the amount of cartilage becomes smaller and finally disappears around 60 days after birth (Figure 9). In live bats, if a wing is held to light, translucent patches near the ends of bones will be seen. In dead, dry bats the cartilage shrinks so that constrictions appear in the wing bones near the joints, and even in the forearm near the wrist. In young bats, measurements will not be very helpful, and other characters such as ear or tragus shape can change substantially as bats grow.

Bats of all species tend to be greyish for up to 12 months from birth. Also, their fur is usually dull rather than shiny or sleek and it appears woolly.

Dead bats may be sent to an expert for identification or confirmation.

IDENTIFICATION KEY

The following key is called a dichotomous key (ie divided into 2 parts), because, at each stage (couplet), decisions have to be made as to which of 2 descriptions applies to the bat being identified. It is important to consider each couplet carefully and to arrive at a correct decision before proceeding to the next. Thus, under the first choice, a decision has to be made as to whether the bat has a horseshoe-shaped flap of skin around the nose, or whether the nose looks more like that of a dog. Depending on your decision, look at the number in bold type on the right of the page and go to the section with that number lower down on the left side of the page, eg if the bat has a horseshoe-shaped skin growth, go to section number 2 below. Eventually, instead of a number on the right you will have a species name. The drawings and photographs should help considerably. When an identity is reached, check that the appearance, measurements, and other characters all conform (ensuring that the bat is not a juvenile). If any characters do not conform, go through the key again and the descriptions of similar species.

Arrows on drawings indicate points to compare.

Always keep careful notes of all positive identifications: species, date, place and name of recorder, and send these at least annually to the county mammal recorder or the Biological Records Centre, Monks Wood Experimental Station, Huntingdon, PE17 2LS. Record cards are available on request.

Distribution maps

These maps show the areas in which a species could be expected. Bats found outside these (black) areas would be exceptional. Known distribution maps showing historical and modern records are published by the Biological Records Centre (address above). Very little is known about the detailed distribution of bats and their relative abundance.

KEY

1 (a) Nose with horseshoe-shaped skin growth. Fig.10(a) 2

(b) Nose without horseshoe-shaped skin growth. Fig.10(b) 3

2 (a) Forearm more than 45 mm — Greater horseshoe bat (Rhinolophus ferrumequinum)

(b) Forearm less than 45 mm — Lesser horseshoe bat (Rhinolophus hipposideros)

3 (a) Base of ears joined over head Figs.11(a) & (b) 4

(b) Ears quite separate, positioned either side of the head. Fig.11(c) 6

4 (a) Ear more than 25 mm long when extended and nearly as long as body (the ear may be folded beneath the wing when at rest or curled like a ramshorn) 5

(b) Ear less than 20 mm long, almost as wide as high, tragus more or less triangular. Fig.11(b) — Barbastelle (Barbastella barbastellus)

Figure 10(a)
Horseshoe bat noseleaf,
eg Greater horseshoe bat

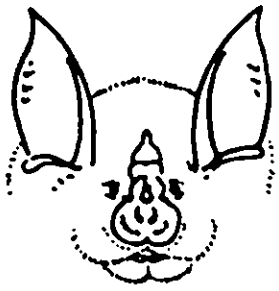


Figure 10(b)
Vesper bats,
eg Leisler's

Figure 11(a)
Long-eared bats,
ears joined

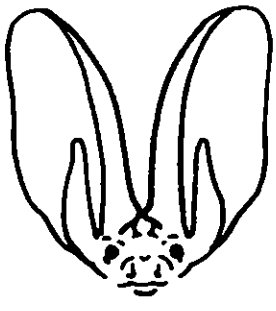


Figure 11(b)
Barbastelle,
ears joined

Figure 11(c)
ears separate

5	(a) Greatest tragus width less than 5.5 mm. Face usually brown or pink. Fig.12(a)	Brown long-eared bat (Plecotus auritus)	
	(b) Greatest tragus width more than 5.5 mm, face usually black. Fig.12(b)	Grey long-eared bat (Plecotus austriacus)	
6	(a) With a post-calcarial lobe. Fig.13(a)		7
	(b) Without a post-calcarial lobe. Fig.13(b)		10
7	(a) Forearm more than 37 mm.		8
	(b) Forearm less than 37 mm. Fig.14	Pipistrelle (Pipistrellus pipistrellus) (see also Nathusius' pipistrelle in vagrants section, p23)	
8	(a) Forearm more than 47 mm.		9
	(b) Forearm less than 47 mm. Fur is distinctly dark at base with pale tips. Long shaggy hair. Fig.15(b).	(Nyctalus leisleri)	

Figure 12(a)
Tragus of Brown long-eared bat

Figure 12(b)
Tragus of Grey long-eared bat

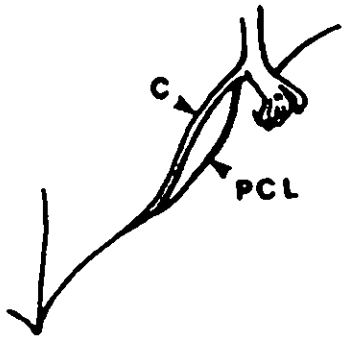


Figure 13(a)
Calcar with post-calcarial lobe

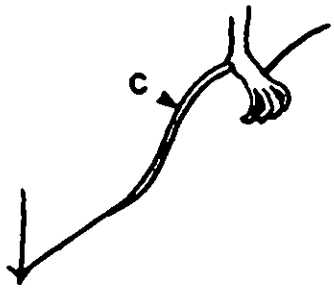


Figure 13(b)
Calcar

Figure 14
Pipistrelle

Figure 15
Leisler's

9	(a)	Tragus mushroom-shaped, fur colour a consistent golden brown all over the body and throughout each hair. Sleek fur. 2 mm of tail free of membrane. Figs.16(a) & (b)	Noctule (Nyctalus noctula)
	(b)	Tragus slightly curved and finger-like, bluntly rounded at tip, fur blackish or dark brown, usually with light tips and darkest at base, 5-7 mm of tail free of membrane. Figs.17(a) & (b)	Serotine (Eptesicus serotinus)
10	(a)	Forearm length less than 50 mm.	11
	(b)	Forearm length more than 50 mm. Fig. 18.	Mouse-eared bat (Myotis myotis)
11	(a)	Ear length less than 18 mm.	12
	(b)	Ear length more than 18 mm. Fig. 19.	Bechstein's bat (Myotis bechsteinii)

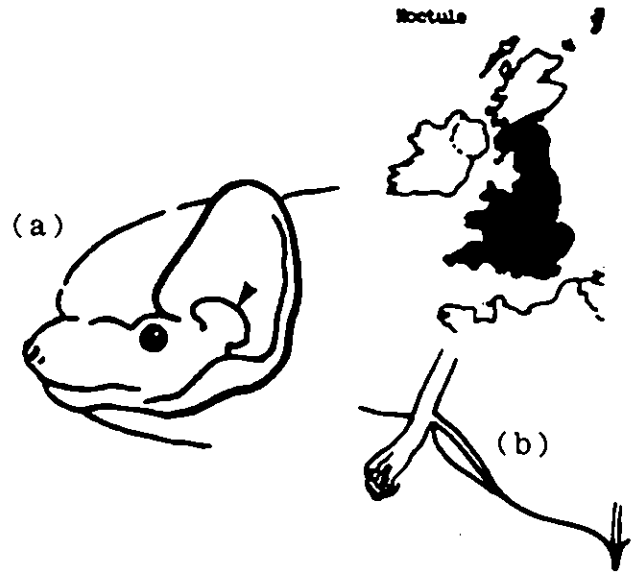


Figure 16
Noctule
(a) Head
(b) Tail showing post-calcarial lobe and short free tip to tail

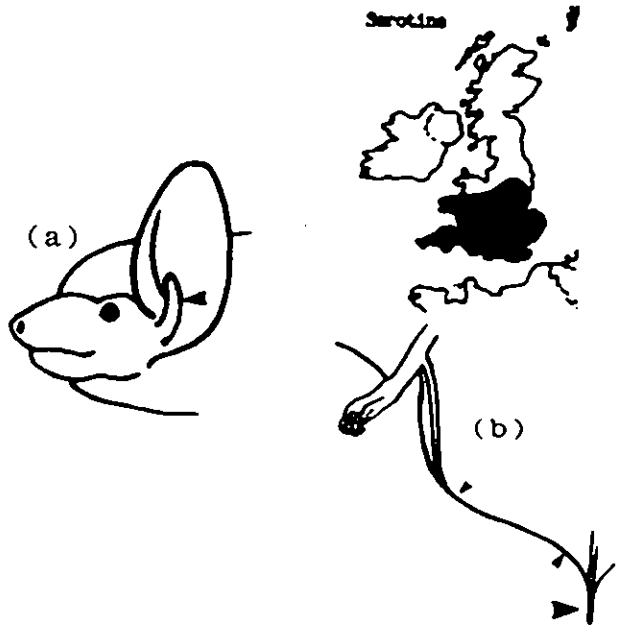


Figure 17
Serotine
(a) Head
(b) Tail showing post-calcarial lobe, S-shaped edge and long free tip to tail

Figure 18
Mouse-eared bat
Ears thick and fleshy

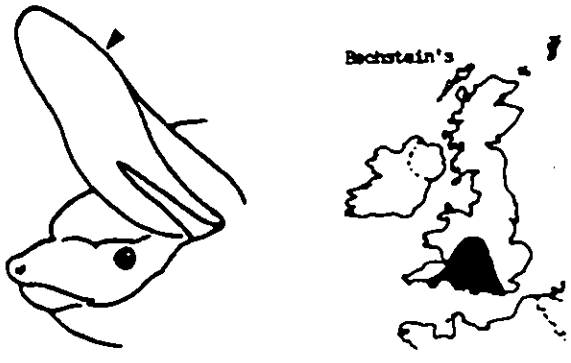


Figure 19
Bechstein's bat
Ears thin and translucent

12 (a) Tail membrane without 1 mm stiff bristles, but perhaps some fine hairs, including some on the calcar (see Fig. 22(b), (in which case ear length is less than 12 mm). 13

(b) Edge of tail membrane with a row of stiff bristles about 1 mm long from the end of calcar to tail (no bristles on calcar, but there may be some long, fine hairs). Ear length 14-17 mm, tragus length two-thirds the length of the ear, thin, pointed and straight-sided. Figs.20(a) & (b) Natterer's bat (Myotis nattereri)

13 (a) Foot about one-third the length of the shin. Calcar half length from foot to tail. Fur shaggy, black or dark brown, with light tips. Fig.21 14

(b) Foot more than half the length of the shin. Calcar three-quarters of the length from foot to tail. Fur dense, even length. Hair on back uniform colour from base to tip. Line of fine hairs

Figure 20(a)
Natterer's bat

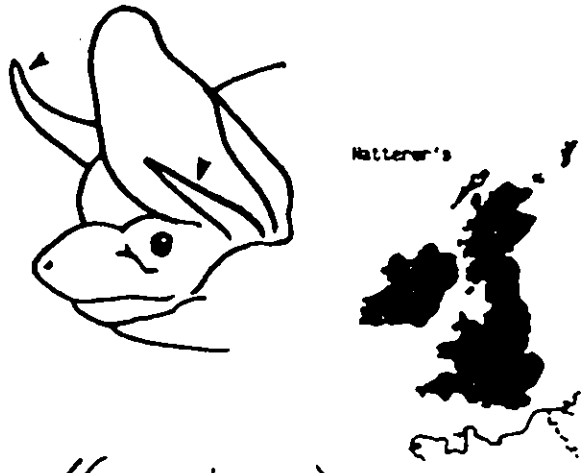


Figure 20(b)
Natterer's bat
showing large tail membrane
with stiff bristles from end
of calcar to tail

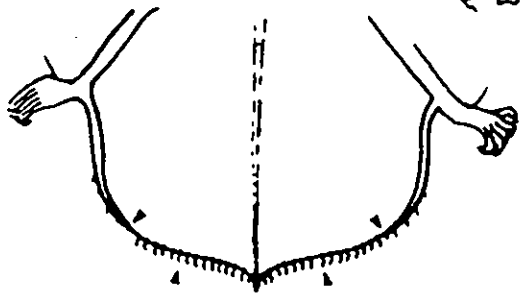
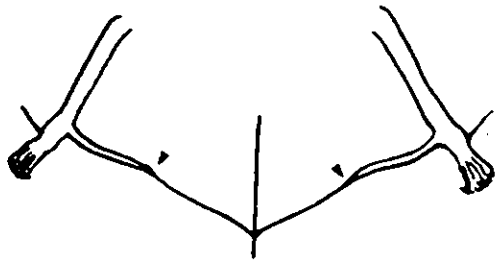


Figure 21
Whiskered and Brandt's bats
Calcar half length of
tail membrane edge



(1 mm long) on edge of tail membrane and calcar. Tragus convex on outer (posterior) edge. Figs.22(a) & (b) — Daubenton's bat (Myotis daubentonii)

14 (a) Tragus pointed with outer (posterior) edge straight or concave. Ear and nose usually black. Males have thin parallel-sided penis. Figs.23(a), (b) & (c) — Whiskered bat (Myotis mystacinus)

(b) Tragus bluntly pointed with outer edge usually convex. Ear and nose dark brown. Males have thick club-shaped penis. Figs.24(a) & (b) — Brandt's bat (Myotis brandtii)

Note: There is much variation in shape and size of many characters within whiskered and Brandt's bats and positive identification may be possible only when using skull characters (see Yalden 1985).

Figure 22(a)
Daubenton's bat

Figure 22(b)
Daubenton's bat
Note long calcar

Figure 23(a)
Whiskered bat

Figure 23(b)
Whiskered bat - ear and tragus

Figure 23(c)
Whiskered bat - penis

Figure 24(a)
Brandt's bat - ear and tragus

Figure 24(b)
Brandt's bat - penis

VAGRANTS AND POSSIBLE VAGRANTS

1. Nathusius' pipistrelle - Pipistrellus nathusii

Three specimens have been found in Britain, 2 in East Anglia and one in Dorset. A further bat was found on a North Sea oil platform. The species is now occurring more frequently in western Europe and more specimens may be expected in Britain. They are most likely to occur during migration in autumn and winter.
IDENTIFICATION: essentially similar to the pipistrelle but larger and may be distinguished by long shaggy fur, with light tips on the back giving a frosted appearance. Ventral fur is distinctly lighter than dorsal fur. On the ventral surface of wing hair extends to the elbow, then a 5 mm band of fine hair extends to the wrist just posterior to the forearm. Incisor teeth are distinctly long and slender (Yalden 1985), and can readily puncture the skin. Forearm length is 32-37 mm. The wings are relatively broad. Measure the length of the fifth digit from wrist to tip and divide by the forearm length. Pipistrellus nathusii is indicated if the result is over 1.25; otherwise it is likely to be P. pipistrellus (Stebbings 1970).

2. Parti-coloured bat - Vespertilio murinus.

There have been about 10 records of this species, either on the mainland of Britain or on oil and gas platforms in the North Sea. It is a highly migratory species normally spending the summer in northern central and eastern Europe and flying SSW to southern Europe to hibernate (Strelkov 1969).
IDENTIFICATION: a medium to large-sized bat with a forearm length of 39-49 mm, squarish ears and short, curved tragus with blunt round end, and fur which has dark brown bases and light silver or cream tips. The underside is white or grey and the skin very dark brown. Ears and membranes are thick and opaque. Tip of tail extends 4-5 mm beyond the membrane.

3. Notch-eared bat - Myotis emarginatus (also named Geoffroy's bat)

No authenticated record in Britain. Now very rare in north-west Europe, but occurs in Belgium, Holland and France.

IDENTIFICATION: distinct angular emargination (notch) above the halfway point on the posterior (outer) edge of the ear. Forearm length is 38-42 mm. Fur is long, dense and shaggy, woolly below and reddish, especially on the underside of tail near its base. Ears are similar size to Natterer's (about 16 mm long) but held parallel as viewed from front. Natterer's ears are splayed.

4. Pond bat - Myotis dasycneme

No definite record in the British Isles and the species is now endangered in the Netherlands, where the nearest nursery roosts occur.

IDENTIFICATION: a large greyish brown bat (forearm length 43-50 mm) with whitish fur extending on the undersurface of the tail membrane near the leg as far as the large feet.

5. Northern serotine - Eptesicus nilssonii

Not yet recorded in Britain but this is a highly migratory species which has recently been found more frequently in western Europe. Like other vagrants, this species is most likely to occur in autumn or winter.

IDENTIFICATION: forearm length 37-44 mm, similar in general appearance to the larger serotine, with a post-calcarial lobe, long shaggy, dark chestnut fur with gold tips on back, and 2-3 mm of tail free from membrane.

NORTH AMERICAN VAGRANTS

Three North American species have been recorded in Europe. One specimen of the hoary bat may have flown here but the others, the big brown bat and the little brown bat, have arrived in cargo holds of ships and have flown out or have been found dead at docks such as Southampton, Rotterdam and Hamburg.

1. Hoary bat - Lasiurus cinereus Has been recorded once in Orkney (September 1847) and 4 times in Iceland in autumn and early winter. It is a fast-flying highly migratory species. It is the only species to have colonized Hawaii.
   IDENTIFICATION: a large bat with a forearm length of 46-58 mm, dorsal hairs tipped white giving a frosted appearance, and the tail membrane is completely furred dorsally.

2. Little brown bat - Myotis lucifugus

   Recorded at least 3 times from Southampton in the 1980s (Stebbings unpublished).
   IDENTIFICATION: this bat is very similar to Daubenton's but ear length is 14-18 mm (Daubenton's, 8-12 mm) and fur is usually sleek and glossy, while Daubenton's has dull fur. The feet are covered with long fine hairs extending beyond the claws.

3. Big brown bat - Eptesicus fuscus

   One was caught alive leaving a boat at Rotterdam and the same boat later travelled to Southampton. Bats, which may have been this species, have been picked up in German ports.
   IDENTIFICATION: appearance is similar to the serotine, but it is usually smaller, forearm 42-51 mm. Posterior edge of curved tragus has distinct abrupt bend in the lower third. The serotine tragus is smoothly curved.

IDENTIFYING BATS AT REST, BUT WITHOUT CAPTURE

Bats, especially females, are usually active throughout the summer, especially when pregnant or lactating, and will often fly when approached closely, or when light is shone on them. Males are often semi-torpid and may be too cold to fly off immediately.

A LICENCE FROM THE NCC IS REQUIRED BEFORE KNOWN BAT ROOSTS ARE ENTERED BECAUSE SOME DISTURBANCE IS INEVITABLE.

Most bats prefer to roost in crevices, whether in buildings, trees or caves, so that often you may get only glimpses of parts of bats, eg a thumb, an ear, some fur or a foot, but, with experience, identification of most species should be possible.

Knowledge of the roost type and behaviour of the animals helps identify species, so that the following notes will help in addition to the photographs.

Bats in hibernation may be easier to identify because they do not fly off, but DO NOT shine a bright light on them for more than a few seconds, or stay close to any bats, as heat from your body and light will cause arousal. Roost type, as well as the bat's position in it, will help indicate the species' identity.

Table 2 Identifying bats without capture

Species	Roosts	Active bats	Torpid bats
Greater horseshoe bat *Rhinolophus ferrumequinum*	Found in buildings and caves	Large pear-sized bat, hangs free, wings at side or wrapped around body, especially if cold. Ears very mobile, appear like dark cones with white centres. Bodies twist and turn constantly when agitated. Bats fly off when disturbed.	Hangs free. Wings wrapped around body. Adults have brownish purple to pink membranes (juveniles greyish), membranes matt, face and ears usually exposed. May form tight clusters, usually high on walls or roof of roost.
Lesser horseshoe bat *Rhinolophus hipposideros*	Found in buildings and caves	Small plum-sized bat, hangs free, wings at side or wrapped around body. Ears very mobile, appear like dark cones with white centres. Bodies often twist and turn before flying off. Bats fly off when disturbed.	Hangs free. Wings wrapped around body. Membranes shiny black, face and ears usually covered by wings. Bats usually spaced or solitary at all heights, even under boulders.
Pipistrelle *Pipistrellus pipistrellus*	Found in buildings, trees and bat boxes (*never* in caves)	Small bat usually found in tight crevices, sometimes inside roof spaces but then often low down near eaves. Fur orange brown, face dark brown or blackish, bulbous nose, often noisy and chattering in clusters. Generally scurry away from light. This bat does not often take flight within roof spaces.	Found in stone or brick walls, in cracks between and in beams, also behind wall hangings in churches where small dark brown or blackish face and ears may be seen. Membranes thick, dull and dark brown. Short thumb.
Leisler's bat *Nyctalus leisleri*	Found in trees, bat boxes and in buildings	Medium-sized bat mostly roosting in crevices. Squarish ears, dark bulbous face and dark brown shaggy fur. Colonies are noisy only on hot days. Bats scurry away when disturbed in roofs.	Forms dense clusters in tree holes. Dark fur colour and squarish ears are diagnostic. Fur has light tips and dark bases.

Species	Roosts	Active bats	Torpid bats
Noctule *Nyctalus noctula*	Found in trees and bat boxes but rarely in buildings	A large bat with short sleek golden or ginger fur, which is the same colour at the base (against skin) as at tips. This is best seen around the shoulders. Colonies can be noisy and on hot days may be heard 200-300 m away.	Sleek golden fur of this large bat is diagnostic. Clusters may be found in hollow trees. Colonies have often been found when branches or trees were cut down.
Serotine *Eptesicus serotinus*	Found in buildings (one record in stone mine), rarely trees	A large crevice-dwelling bat occurring in hollow walls and around chimneys but colonies are also found inside roof spaces at the apex, especially on hot days. It has longish black ears, black fur often with goldish tips to the long dorsal fur. Scurries away from the light. Generally quiet until disturbed or at emergence.	Rarely found in winter but sometimes hangs from roof spaces at the apex. Known to hibernate in hollow walls.
Barbastelle *Barbastella barbastellus*	Found in buildings, trees and caves	A rare very distinctive black bat with squarish head due to large ears joined at the top of the forehead. Often seen and caught over water, but also around woodland and over meadows.	Found near entrances in caves in very cold weather.
Brown long-eared bat *Plecotus auritus*	Roosts in buildings, trees, caves and bat boxes	Colonies usually hidden in crevices in ridge tiles, or behind roof felt. Sometimes roost individually or are found clustered in roof space with ears partly curled (like a ram's horn). Adult colour dorsally is buff or mid-brown, juveniles dull grey, membranes are brown and translucent. Thumbs appear long. Sides of ears appear parallel when erect. Generally remain immobile when viewed but some fly away in roofs when disturbed, especially on hot days. This is the species most frequently found within roof spaces.	Often hangs free, from roof or wall as well as in crevices, with tail and wings partly folded around the body which is held at a 70° angle from the roof. (Horseshoe bats hang perpendicularly.) Ears are usually folded beneath the wings but each tragus remains erect and looks like a small ear. Fig.25

Species	Roosts	Active bats	Torpid bats
Grey long-eared bat *Plecotus austriacus*	Roosts in buildings and caves	Roosts in corners and crevices. Appears as a medium large bat with a black face and long grey fur which has black bases which may be seen around the shoulders especially. Thumbs are short. Ears appear large and oval when erect. Usually hides in crevices when disturbed.	Found hanging against walls of tunnels with wings held at the side. Black face, long grey fur and short thumbs are distinctive.

Note: Juvenile *Plecotus* tend to have sooty grey fur which is more or less the same colour at tips and bases. Adult Grey long-eared bats generally have long fur with light grey tips and black bases which is clearly visible without disturbing the bats.

Mouse-eared bat *Myotis myotis*	Found in buildings, caves and trees	A very large bat with long ears. Thick opaque membranes, and short yellowish fur. Hangs from roof apex between rafters. Very rare.	Usually hangs free, almost perpendicularly, as well as in open crevices, but is sometimes found hanging against cave walls. Large size, combined with thick large ears, white underside and bare face are diagnostic.
Bechstein's bat *Myotis bechsteinii*	Found in trees, caves and rarely buildings	A medium-sized bat with very long, thin shiny ears. Ears curl back like small ram's horns when bat is disturbed. Translucent brown membranes, shaggy yellowish buff fur.	Usually hangs free from cave roofs, or free within crevices. Brown membranes (Natterer's membranes are reddish). Long shiny ears and very long thumbs are diagnostic.
Natterer's bat *Myotis nattereri*	Found in buildings and caves, trees and bat boxes	Longish ears are usually slightly curled back while at rest. Distinctly white or light-coloured underside. Often hangs from apex within the roof space. Colony sometimes mixed with brown long-eared bats and specimens often fly when disturbed by light, especially on hot days.	Usually found in crevices, occasionally lying on back. Face is pink and membranes reddish. Medium long ears are curved back slightly at the tips, grey, but shading to pale pink at base. Thin pointed tragus more than half the length of the ear. Ears splayed when viewed from the front. Occurs in caves mostly from December to February. Fur on underside often appears very white.

Species	Roosts	Active bats	Torpid bats
Daubenton's bat *Myotis daubentonii*	Found in trees, buildings and caves, crevices in bridges or tunnels	Distinguished by short, even-lengthed dull brown fur. Short dark brown ears with tips often curled back and down to fur level, especially when disturbed. Eyes sometimes appear to have a pink circle of surrounding skin. Colonies hang from the roof apex and may be mixed with brown long-eared and Natterer's bats. They are also known to roost in tree holes with Noctules.	Often found hibernating in caves in very tight crevices. Short ears and mole-like fur distinguishes this from the other small bats, eg whiskered and Brandt's, which are also found in caves. Hairs on large feet extend beyond claw.
Whiskered bat *Myotis mystacinus*	Found in buildings, caves and bat boxes	Small bat with shaggy fur, black or very dark brown nose, ears and membranes. Adults sometimes have golden tips to dorsal fur. Roosts in roofs hanging from apex or hidden above ridge board. On hot days bats often take flight when disturbed. In cool weather they usually crawl into crevices.	Black or very dark brown skin with longish pointed ears, pointed tragus with straight or concave outer edge. Translucent shiny membranes and shaggy fur distinguish this from Daubenton's. Usually roosts on walls of caves and sometimes hangs free but is rarely found in crevices.
Brandt's bat *Myotis brandtii*	Found in buildings, caves and bat boxes	Similar to whiskered bat but ears and membranes brown. Fur a dark golden brown but juveniles are greyish like Whiskered bats.	Hangs in the open or against walls with brown rounded ears and a tragus usually with convex outer margin. Face and membranes very dark brown.

Note: Whiskered and Brandt's bats have many characters that are common to both or overlap, and in most cases the 2 species cannot be separated without handling and detailed examination.

Notes:
1. The term "caves" includes any site with a moist cool environment, eg mines, cellars, railway and canal tunnels, ice houses, etc.
2. Bats hibernating in caves often have condensation droplets covering the fur obscuring the colour. However, fur texture still shows, allowing the difficult whiskered types and Daubenton's to be identified.
3. Most bats, whether active or torpid, are found close to the entrances of caves or tunnels with few occurring more than 200 m inside, unless a tunnel is open at both ends. Bats roost at all levels with some, especially Daubenton's, roosting in loose rock or holes in the floor or ground.
4. Bats may be found in all parts of buildings or trees, sometimes in places where they may be seen by day without the aid of a torch. The presence of droppings often reveals roosts.

TABLE 3 Comparative characters for the Myotis bats

	Whiskered	Brandt's	Daubenton's	Natterer's	Bechstein's	Mouse-eared
Forearm length	30-37	31-38	33-40	36-43	38-46	57-68
Ear (a) held	upright	upright	upright	splayed	splayed	splayed
(b) relative size	medium length	medium length	short	long	very long	long
Tragus	long, concave or straight outer edge, sharply pointed	medium-long, convex on outer edge, rounded point	medium, convex on outer edge, rounded point	long, narrow, straight-sided, sharply pointed	long, straight-sided, rounded point	medium, convex outer edge, bluntly pointed
Face	hairy	hairy	hairy- often bare around eye	sparsely haired	bare	bare
	black	dark brown	brown or pink	pink	pink	pink
Nostrils	black	dark brown	brown	pink	pink	pink
Lips	black	dark brown	brownish pink	pink	pink	pink
Membranes	blackish, translucent, shiny	dark brown, translucent, shiny	brown, thin, opaque, matt	reddish, opaque, matt	reddish, opaque, matt	reddish, thick, opaque, matt
Calcar (length - foot to tail	half	half	three-quarters	half	half	three-fifths
Tail membrane edge	bare or a few fine hairs	bare or a few fine hairs	1 mm fine hairs along whole length	1 mm bristles from end of calcar to tail. Some long hairs on calcar	bare	bare

Note: In all species the ears may be curled outwards when the bats are disturbed.

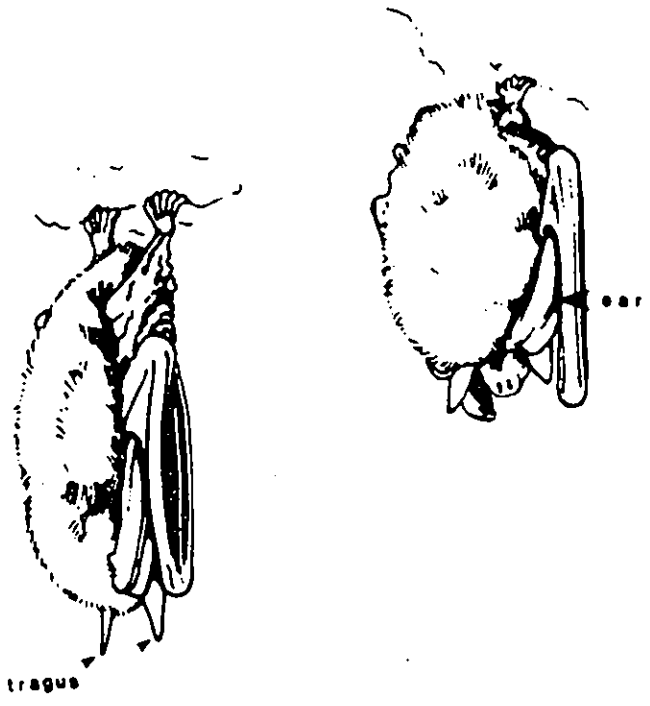


Figure 25
Brown long-eared bats, torpid in cave

IDENTIFICATION FROM DROPPINGS

Shape, size, texture and smell of bat droppings vary considerably, but with experience, a good indication of species identity may be obtained (Figure 26). As there is wide variation in shape, texture and colour within each species, it is only possible to give a rough guide. However, if a reference collection is made of large samples of droppings from known species, this will provide a most practical aid to identifying species from droppings.

Size of droppings varies according to the prey items and age of bat. Baby bats, whilst feeding on milk, produce greenish slimy droppings, and whilst weaning the droppings tend to be thin and pointed.

Length is usually greatest when prey items are beetles or flies and shortest after eating moths, almost certainly due to the powdery nature of moth scales which makes the droppings more fragile. The diameter recorded in Table 4 is the normal range for adults (measured fresh but air dry).

Droppings are hygroscopic and swell up in humid air. Length will not increase significantly but moisture helps break down the droppings into shorter pieces. Recorded lengths are those found in dry places. In most accumulations of droppings a large proportion will be fragmented.

Colour and, to a lesser extent, fragment size vary according to prey. Moths and some caddis usually result in brown faeces with finely broken remains (caddis can also be black), but black ones often come from beetles or flies and are generally coarse. As bats eat different food seasonally and through the night, the colour of droppings varies accordingly and therefore colour is not diagnostic.

Fresh droppings are generally shiny but later become dull and greyish, often with fine crystals of salts from urine. Guano piles can give an indication of the number of bats using a roost by their size and appearance. Record area and depth of piles and estimate proportion of fresh to old guano.

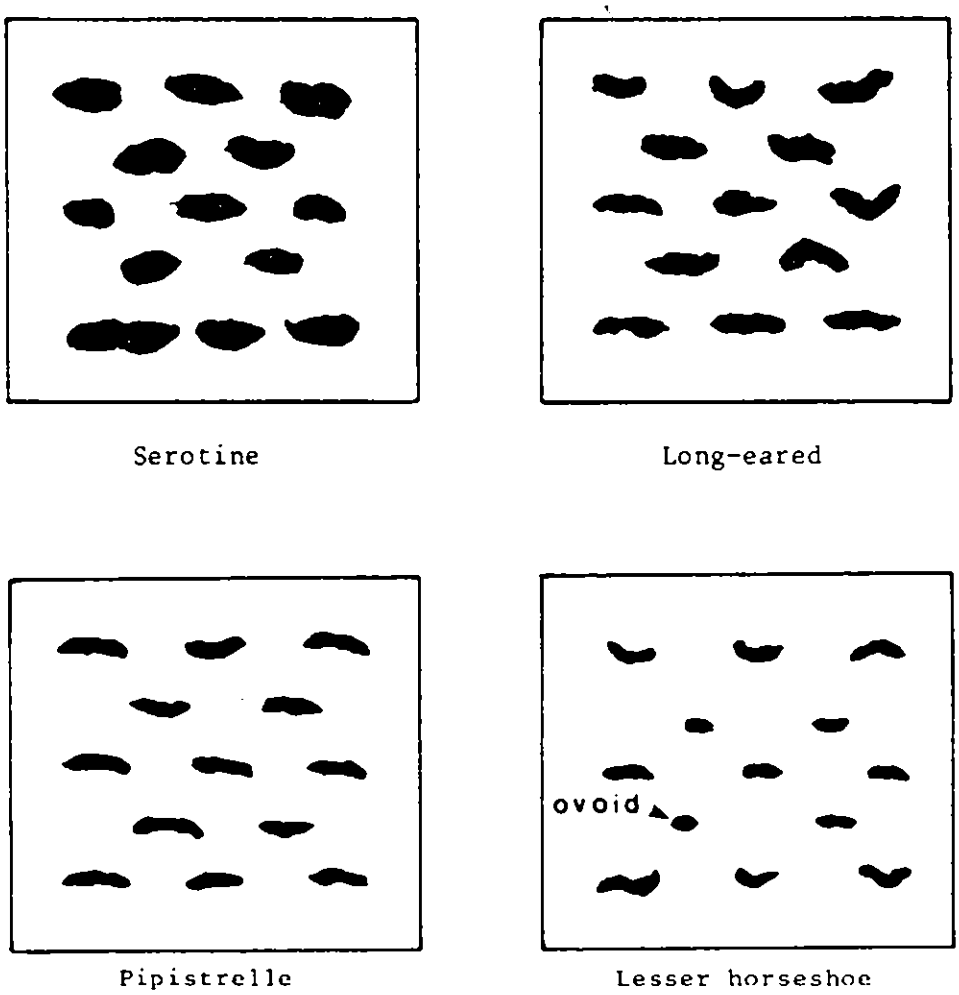


Figure 26 Bat droppings: life-size silhouettes of 4 species showing the range of size and shape. Droppings gradually fragment so that in roosts few remain as long as those shown here. Typically, Lesser horseshoe droppings at first break into small ovoids, then like other species disintegrate

Accumulation of moth wings in sheltered sites such as porches or in open barns indicates that a brown long-eared bat or barbastelle has used the site as a feeding perch. Often no bat droppings are present.

Sometimes moth wings and beetle elytra are found (both in bat roosts or outside), punctured with round or triangular holes. These indicate that bats have eaten the insect. Some idea of the identity of the species of bat responsible for making the holes may be possible if 2 holes are present which were clearly made by both upper canine teeth simultaneously. With calipers, the overall distance between the outer parts of the 2 holes should be measured. If this measures 4.0 mm or less, Long-eared bats are indicated, but holes around 6 mm apart, could mean serotine, greater horseshoe or Leisler's bats. A measurement of about 6.8 mm, would show that a Noctule ate the prey. In each case, there are other species which could have been responsible, but they are less likely.

Information of this kind can be useful for a field naturalist to know what species may be living in an area, but, results cannot be used for distribution or other records.

Table 4. Bat droppings - structure and size of intact fresh droppings from adult bats (diameters were measured with calipers)

Species	Particle size	Diameter mm	Length mm	Comments
Pipistrelle	Fine	1.5 - 2.0	7 - 9	Smooth outline.
Lesser horseshoe	Fine - medium	1.5 - 2.0	6 - 8	Frequently broken into ovoids 3-4 mm long
Daubenton's	Fine	1.8 - 2.3	8 - 9	Smooth outline. Smells of river plants or mud when fresh
Whiskered	Medium	2.0 - 2.3	6 - 9	
Brandt's	Medium	2.0 - 2.3	6 - 9	
Barbastelle	Medium - coarse	2.1 - 2.7	8 - 11	Smooth or knobbly outline often in 3 parts
Greater horseshoe	Coarse	2.2 - 2.7	9 - 13	
Natterer's	Medium	2.3 - 3.3	8 - 11	
Brown long-eared	Medium - coarse	2.5 - 3.0	8 - 10	Knobbly outline
Grey long-eared	Medium - coarse	2.5 - 3.0	9 - 11	Knobbly outline
Leisler's	Medium	2.5 - 3.0	6 - 9	
Bechstein's	Medium - coarse	2.5 - 3.5	9 - 12	
Noctule	Medium	3.0 - 3.5	11 - 15	
Serotine	Coarse	3.5 - 4.0	8 - 11	
Mouse-eared	Coarse	3.5 - 4.5	12 - 17	

Notes: Piles of lesser horseshoe bat droppings usually contain whole legs and wings of crane flies.

Greater horseshoes frequently have feeding perches in the entrances to caves and mines and these may contain dor beetle wing cases. Their presence indicates the roost is used in the autumn. In spring, similar temporary roosts tend to be associated with buildings and piles of droppings typically contain cockchafer beetle wing cases.

Piles of natterer's bat droppings often contain intact wings of insects, particularly moths. Heaps of long-eared bat droppings in roofs do not normally have insect wings.

Serotine droppings are often oval in longitudinal section rather than tubular as in other large bats.

If sending droppings to an expert for identification, send as large a sample as possible in a crush-proof container.

FLIGHT

Identification of bats in flight is very difficult. Flight characteristics vary according to circumstances, particularly the wind speed. Careful observation of wing shape, colour distribution, size of bat and behaviour can give an indication of species to experienced observers.

Although each species has preferred prey which typically are sought in differing habitats, using different hunting strategies, bats quickly adapt to the concentrations of insects. Thus, especially in hot weather, most species fly low over water to feed and drink. Similarly, on windy nights most species can be found feeding in small pasture fields with surrounding trees.

Equipment The most useful aid for bat watching is a bright searchlight, such as a car headlight, so that large areas can be scanned. Binoculars with large objectives and wide field of view, eg 7 x 50, are valuable at dusk and after dark in conjunction with lights. Infra-red viewers (£1000+) are of limited use for viewing flying bats because of their lack of definition and slow response time, but the more useful image intensifiers are very costly (£3000+).

Observation Some bats occasionally emerge before sunset, especially in spring, so observation ought to begin about 15 minutes before sunset. Face west to take advantage of the light 'afterglow' and later, when dark, stand facing away from a house or street light so that bats may be seen coming in to catch insects attracted to light. Light traps set to catch insects are often visited by bats.

Learning to recognize the flight characteristics of known species is an essential first step. Find colonies, either in buildings or trees, and, having identified the species, carefully observe the silhouette shape, speed of wing beat, whether the wings describe a full or partial arc, speed of flight and general height, and whether ears or colour are visible. Experienced observers will be able to get a good idea of what species are seen but flight records are not normally accepted for county or national species mapping schemes.

Flight characteristics

The following descriptions are given as a guide to help observers categorize what they see. They will not enable a complete novice to go into the field and correctly identify species of bat in flight.

Large bats : (wingspan about 330-450 mm). (The wingspan of a bat in flight is often difficult to estimate.)

(1) Wings relatively narrow, with pointed tips. Two distinct flight patterns - the first just before or at sunset, bats flying very high and fast up to at least 200 m - straight with occasional rapid manoeuvres - presumably while catching food en route to favourite feeding area. Other flight from ground to 30 m, purposeful fast flight with repeated deep dives and occasional glides. Wings describe a full arc when bat is accelerating. In good light, ears not visible and bat generally appears light brown.....Noctule

(2) Wings relatively broad and tips rounded. Flight often about 15 m but beneath tree tops, straight and level to feeding area, and then flight along the edge of trees with occasional dives almost to the ground. Gleans food off foliage or around treetops. Wings often describe a full arc. Bat appears very dark to black in colour and ears, in good light, are just visible silhouetted against bright sky at close quarters.....Serotine

(3) Wings very broad with rounded tips. Flight usually heavy butterfly-like with glides, often along streams or river banks, over pastures or in woodland. Usually low but up to 12 m. Ears not visible. Pale colour makes this bat very difficult to see when it flies over pasture. Usually flies in dark secluded places when first emerging.....Greater horseshoe bat

(4) Wings broad and very large. Flight slow, heavy and deliberate, straight, up to 25 m often along woodland edge or near large hedges. Ears visible in good light. Pale ventral fur clearly visible in light.....Mouse-eared bat

Medium-sized bats : (wingspan usually between 250-330 mm)

(5) Wings narrow, pointed, flight up to tree top level, 30 m, with shallow dives and gradual rises. Ears not visible.....Leisler's bat

(6) Wings broad, ears usually prominent. Flight from ground to 30m with frequent hovering amongst tree branches and with long glides .....Long-eared bats

(There is no obvious difference between the brown and grey long-eared bats).

(7) Wings broad, tips rounded, long ears usually visible in good light. Flight slow and generally low, 2-10 m, often in and around trees. Wings held rather stiffly - ie not appearing to flex or describe a large arc. Distinctly pale beneath.....Bechstein's bat

(8) Wings fairly broad but slightly pointed. Flight slow but with noticeably flexing wings, 2-10 m. Distinctly white ventral fur with small ears sometimes visible in good light. Frequently seen over roads with high hedges.....Natterer's bat

(9) Wings broad and pointed. Flight often low, 1-5 m, fluttering frequently over and beside rivers close to overhanging trees. Silhouette of square head and ears may be seen. Very dark to black bat. Sometimes circles low over water like Daubenton's - but with rapid rises to about 1 m.....Barbastelle

Small-sized bats : (wingspan 190-250 mm)

(10) Wings fairly broad. Flight up to 20 m but usually low along a "beat" (ie flying repeatedly along a hedgerow or close to trees), medium speed and fluttering, performs tight turns around vegetation.....Whiskered/Brandt's bats

(There is no obvious difference between whiskered and Brandt's bats)

(11) Wings fairly broad. Circling flight up to 15 m, often much lower - frequently over water, about 10 cm above, without rapid height changes except occasional dips to the water, presumably to pick up insects. Flight quite fast but wing beat speed deceptively slow and vibrating.....Daubenton's bat

(12) Wings narrow. Flight medium to high, 5-25 m, often along definite "beat" clear of vegetation. Rapid, jerky, twisting flight which frequently may be low over water but usually 15-25 cm above.....Pipistrelle

(13) Wings markedly broad. Flight up to 10 m, very rapid with sudden changes of height and direction with short glides. Colour noticeably dark.....Lesser horseshoe bat

Note: A bat flying over water is often assumed to be a Daubenton's. However, rivers and associated water meadows and woodlands are often a prolific source of flying insects and therefore a profitable habitat for most bats to forage over.

SOUND/ECHOLOCATION

In flight some bats produce characteristic sounds which are easily audible to young people (eg Noctules), but most species emit ultrasonic sounds that can be heard only when converted to a lower frequency with the aid of a "bat detector". These instruments have a microphone to collect the high frequency sounds, which are reduced in frequency electronically so they may be heard through headphones or a loudspeaker. With much practice and experience it is possible to identify a few species (Hooper 1969, 1977).

Remember that bats have ears too, and can hear the output from the bat detector loudspeaker. Whenever possible, use headphones as this will disturb the animals less. Bats can also be frightened away by noisy observers!

Ultrasonic sounds Each species of active bat produces a range of ever changing sounds in response to changing needs. An individual bat emits sounds with varying emphasis on particular frequencies to accommodate changing needs, such as whether it is flying in open areas or amongst vegetation or with other bats. Also, the nature of sounds arriving at a microphone will depend on various factors, including the bat's distance from the observer and whether the bat is flying towards or away from the detector. The type of microphone, electronic circuitry, loudspeaker or headphones all greatly influence what the observer hears. The listener's ability to discriminate the pattern of sound produced by a bat is an important factor in determining their potential in identifying bats.

Apparently identical instruments manufactured by the same company may produce quite different sounds, so it is important for a novice observer to become familiar with one instrument.

It is usually necessary to spend many hours listening to bats of known species flying close to roosts, before venturing out to attempt identification in other areas.

The greater and lesser horseshoe bats may be identified with relative ease by their characteristic frequencies but all other species are much more difficult (Table 5). Noctule and Leisler's produce loud characteristically metallic sounds which with a little practice separate them from other species, but not from each other. Barbastelle and the 2 long-eared bats (often called whispering bats) are not likely to be heard in the field, or at least not for long enough to allow identification, and all other species require a good ear, patience and a lot of practice.

Even if species recognition is not attempted, much can be learnt about the abundance and behaviour of bats by using detectors. Bats homing in on an insect increase their pulse repetition rate to about 200 per second at point of contact, and this is heard on the detector as a 'buzz' or 'burp'! Although it would not be known whether a chase was successful, the number of 'buzzes' in a set time could be recorded in different habitats and over a period to give an indication how feeding varied and was affected by changing weather. Detectors are also useful as activity recorders and may be connected to tape recorders or counters.

Instruments Bat detectors are essentially simple devices but in practice DIY electronics "wizards" have found them difficult to make. A circuit diagram for a simple detector was published by Fenton (1983).

The cheapest popular device is the 'QMC Mini' and is available from QMC Instruments, 229 Mile End Road, London, E1 4AA. The same company also make sophisticated 'research' instruments. Several other detectors are made abroad.

Audible sounds Colonies of bats often produce low frequency sounds which can be heard easily without special equipment and which can aid location and identification of species. Bats chatter and squeak and these social sounds may be heard at considerable distances. Some species vocalize more than others, with pipistrelles being the most vocal although their sounds are not normally heard further than 20 metres away, even for large colonies. All bats, including the large aggregations in nursery roosts, may be silent much of the day if the weather is wet and cold. Only occasional squeaks may reveal their presence.

Some large bats like noctules, Leisler's and serotines are very noisy on hot days, but the greater horseshoe makes only the occasional squeak. Most other species vocalize in roosts, the intensity increasing with size of colony and higher temperatures. Colonies are noisiest just before emergence. Long-eared bats rarely call but their presence is often revealed by other sounds, eg shuffling, grooming and wing flapping.

With experience, vocal and other sounds made by bats can aid roost location and species identification.

Table 5. Characteristics of sounds produced by bats in flight and heard on bat detectors

	Detected range of frequencies (kHz) lowest	highest	Optimum response setting on detector (kHz)	Pulse repetition rate in free flight (ie not chasing food) pulse/sec	Relative strength of signal	Sounds heard through loudspeaker/headphones
Pipistrelle	35 -	105	40 - 50	10 - 15	3	hard 'clicks'
Serotine	20 -	60	30 - 40	7 - 8	4	hard 'tock'
Noctule	15 -	75	20 - 25	5 - 10*	5	metallic 'chinks'
Leisler's	[15 -	80]	20 - 25	8 - 10	5	metallic 'chinks'
Whiskered/Brandt's	35 -	105	45 - 50	10 - 15	3	'clicks'
Daubenton's	30 -	100	45 - 50	12 - 15	3	'ticks'
Natterer's	30 -	100	45 - 50	20 - 35	3	'ticks'
Bechstein's	[20 -	100]	45 - 50	[20 - 30]	2	'ticks'
Mouse-eared	15 -	110	40 - 45	[20 - 30]	4	'clicks'
Brown long-eared	25 -	100	40	15 - 25	1	'ticks'
Grey long-eared	[25 -	100]	40	15 - 25	1	'ticks'
Barbastelle	25 -	100	40	15 - 25	1	'ticks'
Greater horseshoe	40 -	100	80 - 85	8 - 11	4	soft warbles
Lesser horseshoe	60 -	125	105 - 115	10 - 15	3	soft warbles

Note: Those in [] are estimated. There is a very wide variation in the sensitivity of different detectors so that the optimum response may be heard at widely different frequencies.

* Noctules flying very high often emit sounds at about one per second.

** Strength of signal gives an indication of distance over which bats may be heard

Under optimal conditions noctules may be detected at several hundred metres while long-eared bats and barbastelles need to be within 2 m.

1 = Very weak, 2 = Weak, 3 = Medium, 4 = Strong, 5 = Very strong

PHOTOGRAPHS

These can be a useful aid to identifying bats. However, it is important to realize that shape and relative size of features may appear distorted in one photograph so several views of each species should be compared. Apart from the photographs presented here, others appear in the NCC's booklet Focus on bats, and in the slide pack of the same name available from the Fauna and Flora Preservation Society and many books including Schober's The lives of bats.

Features to compare are the ear and tragus shape and their relative size, shape of nose and amount of hair on the face, whether fur is long, or short, shaggy or sleek, and the distribution and degree of pigmentation.

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Audiovisual Tape/Slide presentation

Stebbings, R.E. & Hutson, A.M. (1984). Focus on bats. ICCE/FFPS. (40 slides, 14 species of British bats depicted).

Useful addresses

The Mammal Society, Burlington House, Piccadilly, London, W1V 0LQ.

A charity founded in 1954 welcoming both amateurs and professionals, young and old. It organizes, oversees and provides advice on surveys and research into bats (and all mammals). It arranges meetings and publishes results. It publishes Mammal Review and a quarterly newsletter.

Nature Conservancy Council, Northminster House, Peterborough, PE1 1UA.

Government financed, responsible for the conservation of Britain's wildlife, and implementation of the Wildlife and Countryside Act 1981. Applications to disturb, handle or photograph bats should be directed to the licensing section. NCC has a responsibility to protect important bat roosts. Produces a biannual newsletter (Bat Chat) for licence holders.

Fauna and Flora Preservation Society, c/o Zoological Society of London, Regents Park, London, NW1 4RY.

World's oldest wildlife conservation society. It has full time staff undertaking bat conservation projects, and promotes conservation through booklets, lectures, broadcasting and a quarterly newsletter Bat news.