

THE BATS

Order Chiroptera

ORDER CHIROPTERA

The ordinal name Chiroptera, literally meaning “hand-winged ones” refers to bats’ most distinctive characteristic. Bats are the only mammals that have their forelimbs modified as wings, and they are the only mammals capable of sustained flight.

Most bats are insectivorous. Many eat flying insects that they capture in the air. Others glean insects from foliage, from the ground, or from the surface of water. In tropical and semitropical areas, insectivorous bats exist together with species specialized for diets of fruit, nectar, pollen, fish, other small vertebrates, or blood. The three families of bats that range widely into temperate regions, Rhinolophidae, Vespertilionidae, and Molossidae, are insectivorous. Because their food supply is generally unavailable in winter, these temperate species either hibernate or migrate seasonally to warmer climates.

Most bats are nocturnal, and most navigate with the aid of echolocation. Ultrasonic sounds are emitted through the nose or mouth, and the reflected sounds are received by the ears. The detailed mechanism of this varies (Henson 1970; Novick 1977). Many groups have simple to elaborate fleshy flaps, ridges, or other projections associated with the nose, the ears, or both. These structures are believed to aid in echolocation.

Bats affect humans in many ways. Many nectar-feeding and pollen-feeding bats provide service in pollination of plants, and many fruit bats aid in seed dispersal. Deposits of bat guano (feces) in caves are, or have been, mined in many parts of the world for use as fertilizer. Insectivorous bats, particularly in temperate regions, may play an important role in insect control. Vampire bats are responsible for the deaths of many

domestic animals from disease (e.g., rabies). Some species are eaten by humans and may be endangered as a result.

DISTINGUISHING CHARACTERS

The forelimb is modified to form a wing. The metacarpals and phalanges of digits two through five are elongated and interconnected by a thin web of skin (Fig. 14.1). The **propatagium** extends from the shoulder to the wrist anterior to the upper arm (brachium) and forearm (antebrachium). The **dactylopatagia** fill the spaces between the digits, with the dactylopatagium minus between digits 2 and 3, the dactylopatagium longus between digits 3 and 4, and the dactylopatagium latus between digits 4 and 5. The **plagiopatagium** extends from digit five to the side of the body and the hindleg. The **uropatagium** extends between the hindlegs and usually incorporates the tail, if one is present (Fig. 14.2). A cartilaginous spur, termed the **calcar**, is sometimes present. It extends medially from the ankle region of each hindfoot and helps support the uropatagium (Fig. 14.2A–E). The first manual digit is clawed, the second bears a claw only in most Pteropodidae, and the remaining digits are always clawless. The pedal digits all bear claws. The clavicle is well-developed, and the sternum is frequently keeled.

The **tragus**, a fleshy lobe projecting from the lower medial corner of the inner margin of the pinna, is present in most microchiropterans (Fig. 14.3A–C), but is absent in the megachiropterans (Fig. 14.3E). A flap, termed the **antitragus**, on the lower edge of the outer margin of the

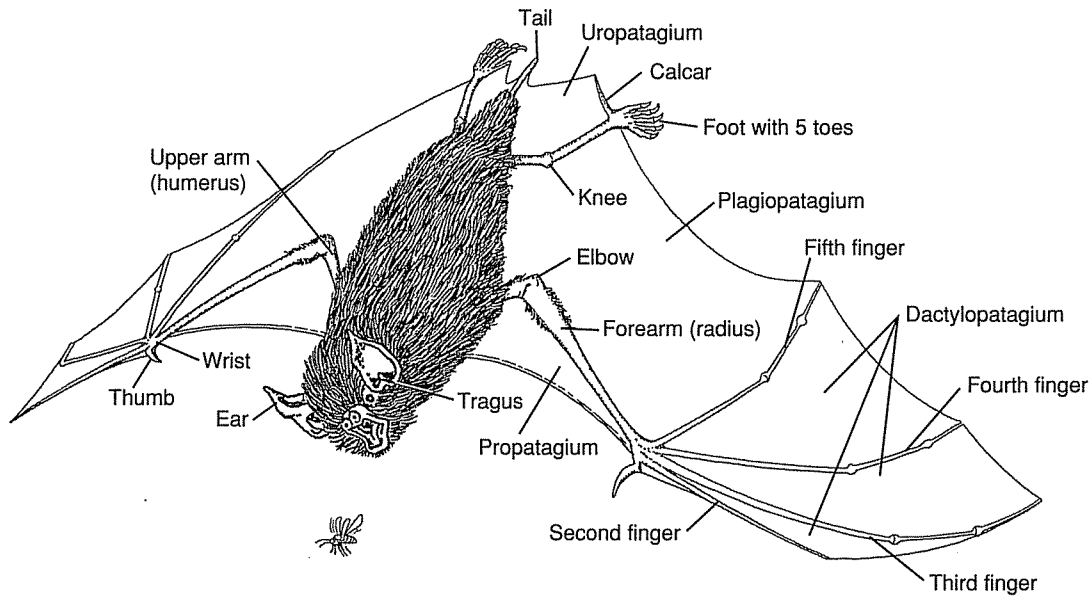


Figure 14.1 The major external features of bats.
(Feldhamer et al. 1999)

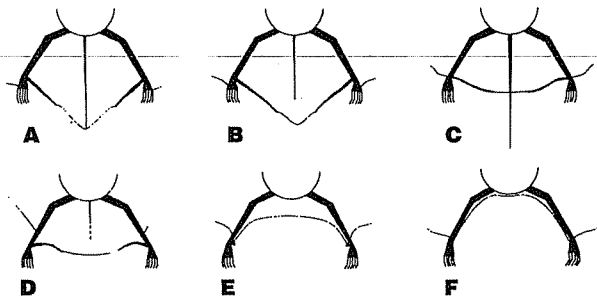


Figure 14.2 Diagrams of various tail and uropatagium arrangements found in bats. (A and B) Tail enclosed in uropatagium, (C) tail extending beyond posterior margin of uropatagium, (D) tail protruding from dorsal surface of uropatagium, (E) tail absent, uropatagium short, and (F) tail absent and uropatagium essentially absent.
(R. Roesener)

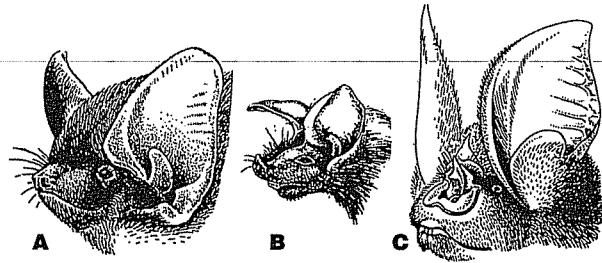


Figure 14.4 Bat heads showing varying degrees of development of flaps and projections on the nose. (A) Plain nose of a *Pipistrellus*, (B) simple leaf of a *Rhinopoma*, and (C) the complex noseleaf of *Rhinolophus*. Not all to same scale.
(A, Kuzyakin 1950; B, Harrison 1964, used with permission; C, Gromov et al. 1963)

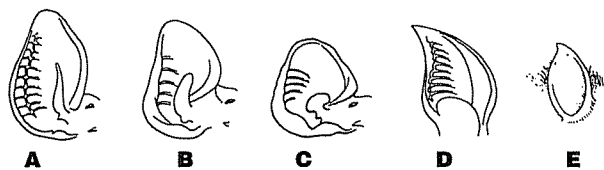


Figure 14.3 The ears of some representative bats. (A–D) are of Microchiroptera, (E) is of a Megachiropteran. (A–C), all vespertilionids, show differences in tragus size and shape. (D), a rhinolophid, lacks a tragus but has the antitragus enlarged. (E), a pteropodid, has a continuous inner ear margin and completely lacks both tragus and antitragus. Not all to same scale.
(A–D, Barrett-Hamilton, 1910; E, R. Roesener)

pinna is particularly well-developed in microchiropterans that lack a tragus (Fig. 14.3D). The noses of many microchiropteran bats are ornamented with noseleaves that vary from simple flaps of skin to highly complex structures (Fig. 14.4).

LIVING FAMILIES OF CHIROPTERA

Living families and their contents are listed in Table 14.1.

Bats occur over most of the earth's land surface except the permanently cold polar regions and a few small oceanic islands. Even such remote islands as New Zealand and the Hawaiian Islands have endemic bats.

4' Incisors 2/2, 2/1, or 2/0; noseleaf present or absent, if absent, incisors 2/2 5

5 (4') Noseleaf absent; chinleaf present, extending ventrally from lower lip (Fig. 14.8); tail protruding from dorsal surface of uropatagium; rostrum tilted up anteriorly giving a dorsal profile of skull that is strongly concave in lateral view (Fig. 14.9); dental formula $2/2 \ 1/1 \ 2/3 \ 3/3 = 34$ **Mormoopidae**
leaf-chinned bats

5' Noseleaf usually present (Fig. 14.10); chin leaf absent; tail, if present, various but never protruding from dorsal surface of uropatagium; dorsal profile of skull usually convex or flat, not strongly concave; dental formula various, including above **Phyllostomidae** (in part)
all New World leaf-nosed bats except *Desmodontinae*

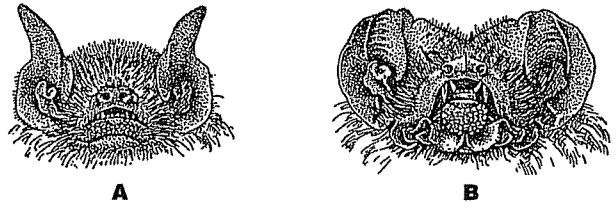


Figure 14.8 Faces of mormoopids. (A) *Pteronotus*, and (B) *Mormoops*. (Goodwin and Greenhall 1961)

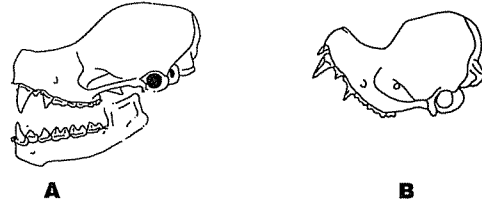


Figure 14.9 Lateral views of the skulls of mormoopids. (A) *Pteronotus*, and (B) *Mormoops*. (Smith 1972)

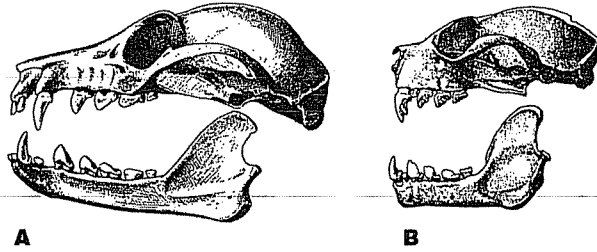


Figure 14.5 Skulls of representative Pteropodidae. (A) *Pteropus*, and (B) *Nyctimene*. (A, Miller 1907; B, Andersen 1912)

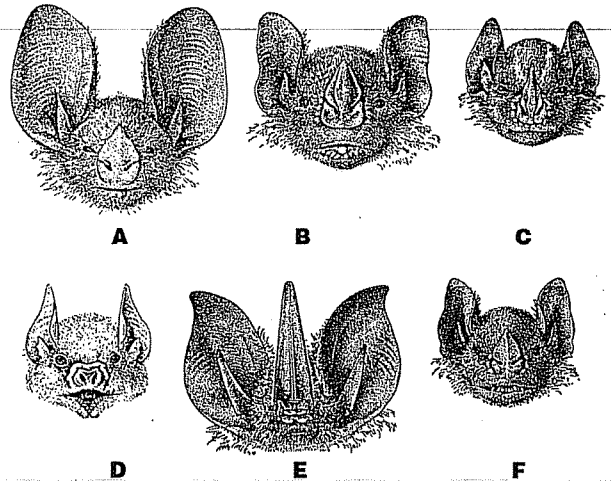


Figure 14.10 Faces of representative phyllostomids. (A) *Tonatia saurophila*, (B) *Artibeus jamaicensis*, (C) *Platyrrhinus helleri*, (D) *Brachyphylla sp.*, (E) *Lonchorhina aurita*, and (F) *Sturnira lilium*. (D, Dobson 1878; all others, Goodwin and Greenhall 1961)

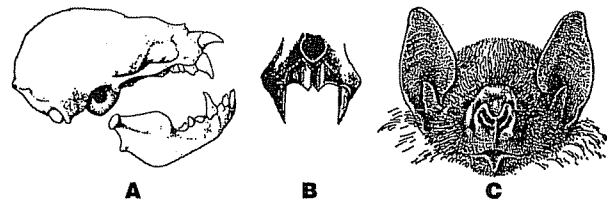


Figure 14.6 A vampire bat, *Desmodus rotundus*, Phyllostomidae. (A) Lateral view of the skull, (B) anterior view of upper jaw showing incisors, and (C) face. (A, Ruschi 1953; B, Dobson 1878, C, Goodwin and Greenhall 1961)

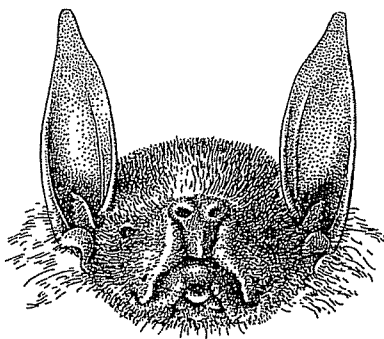


Figure 14.7 Face of *Noctilio leporinus*, Noctilionidae. (Goodwin and Greenhall 1961)

6 (3') Dental formula $1/1 \ 1/1 \ 2/2 \ 3/3 = 28$; basal talon present on claws on thumb (Fig. 14.11) and toes; short tail projects from midpoint of dorsal surface of uropatagium **Mystacinidae**
New Zealand short-tailed bats

6' Dental formula not as above, incisors not 1/1, or if 1/1, total number of teeth 26; claws without basal talon; tail, if any, various 7



Figure 14.11 Wrist and thumb of *Mystacina tuberculata*, *Mystacinidae*, showing the basal talon on the claw. (Dobson 1876)

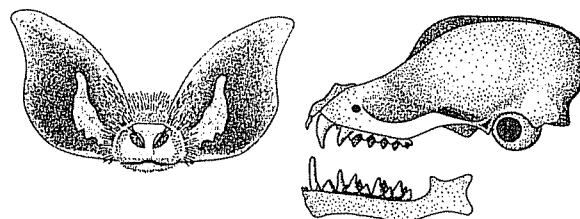


Figure 14.13 Face and skull of *Craseonycteris thonglongyai*, *Craseonycteridae*.

(Hill 1974) (A new family, genus and species of bat [Mammalia: Chiroptera]. Bull. British Museum [Nat. Hist.]. 32920:29-43, figs. 1-4. Copyright 1974 Trustees of the British Museum [Natural History]. Reprinted with permission.)

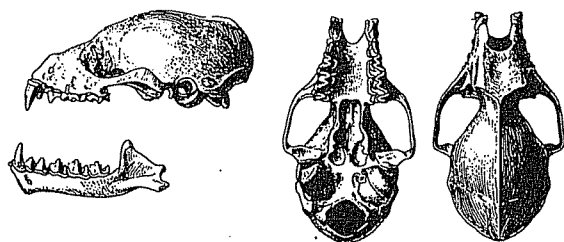
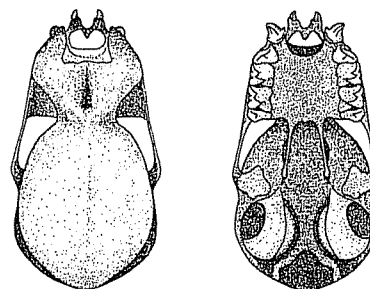
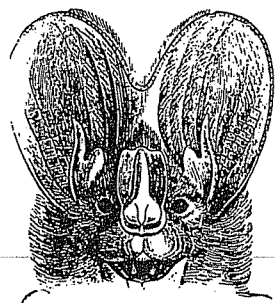


Figure 14.12 Representative megadermatids, face of *Megadermy lyra* and skull of *M. spasma*. (Face, Finn 1929; skull, Miller 1907)

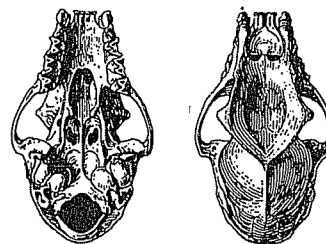
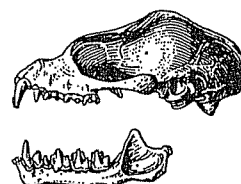


Figure 14.14 Skull of a hollow-faced bat, *Nycteris javanica*, *Nycteridae*. (Miller 1907)



- 7 (6) Premaxillae and upper incisors absent (Fig. 14.12); nose leaf present, tragus bifurcated (Fig. 14.12); tail absent **Megadermatidae**
Old World false vampire bats
- 7' Premaxillae and upper incisors present; nose leaf present or absent; tragus, if present, not bifurcated; tail present or absent **8**
- 8 (7') Premaxillae form a complete ring around the external nares (Fig. 14.13); dental formula $1/2 \ 1/1 \ 1/2 \ 3/3 = 28$; tail absent, uropatagium well-developed **Craseonycteridae**
bumblebee bat
- 8' Premaxillae not forming a complete ring around external nares; dental formula various; tail present, uropatagium various **9**

- 9 (8') Postorbital processes present, sometimes incorporated into a broad supraorbital shelf (Figs. 14.14, 14.16); tail completely enclosed in uropatagium or protruding from dorsal surface of uropatagium **10**
- 9' Postorbital processes and supraorbital shelves absent; tail various but never protruding from dorsal surface of uropatagium **11**

10 (9') Premaxillae with palatal branches only, nasal branches absent; skull with a deep concavity in the frontal area (Fig. 14.14); tip of terminal tail vertebra attached to T-shaped or Y-shaped cartilage in hind edge of uropatagium (Fig. 14.15) **Nycteridae**
hollow-faced bats

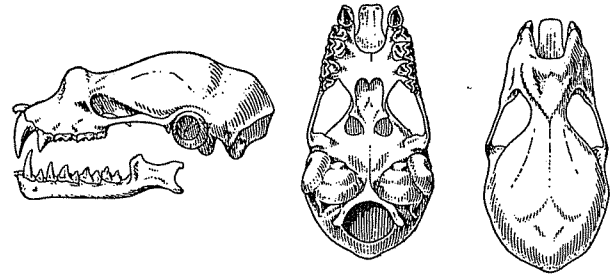
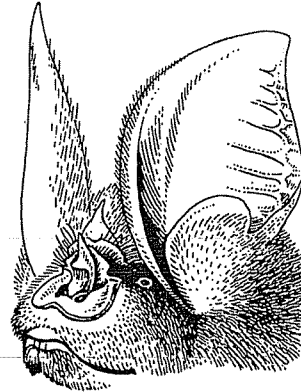


Figure 14.17 Skull of a rhinolophid, *Rhinolophus euryale*. (Kuz'yakin 1950)

10' Premaxillae with nasal branches only, palatal branches absent; usually no frontal concavity (Fig. 14.16); tail usually protrudes from dorsal surface of uropatagium **Emballonuridae**
sheath-tailed or sac-winged bats

11 (9') Nasal branches of premaxillae absent, palatal branches fused to each other medially, but widely separated from the maxillae laterally (Fig 14.17); complex noseleaf present, tragus absent, antitragus well-developed (Fig. 14.18) **Rhinolophidae**
horseshoe bats



A

11' Nasal branches of premaxillae present, palatal branches, if present, not as above; nose leaf absent, or is a simple flap or projection; tragus present **12**

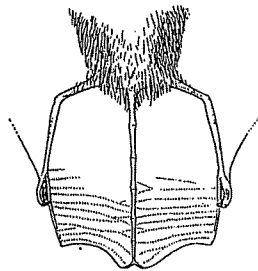
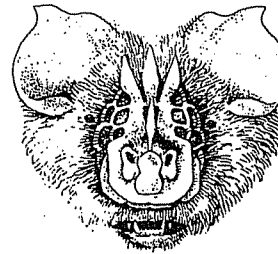
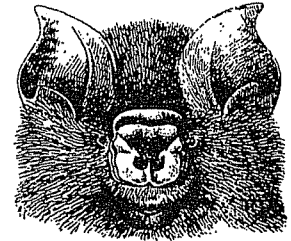


Figure 14.15 Tail and uropatagium of *Nycteris arge*, Nycteridae. (Lang and Chapin 1917)



B



C

Figure 14.18 Faces of representative Rhinolophidae. (A) *Rhinolophus mehelyi*, (B) *Trianops persicus*, and (C) *Hipposideros caffer*. (A, Gromov et al. 1963; B, Dobson 1878; C, Cabrera 1932)

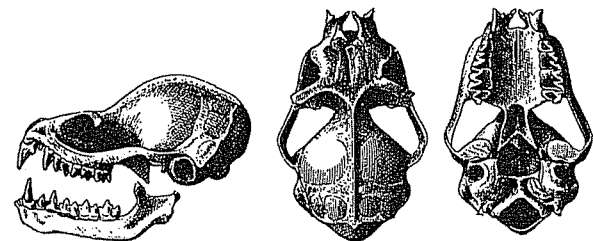


Figure 14.16 Skull of a sac-winged bat, *Saccopteryx bilineata*, Emballonuridae. (Miller 1907)

12 (11') Dental formula $1/2 \ 1/1 \ 1/2 \ 3/3 = 28$; nasal region of skull inflated (Fig. 14.19); tail long and slender, almost as long as head plus body; uropatagium short, less than $1/3$ the length of the tail (Fig. 14.20) **Rhinopomatidae**
mouse-tailed bats

12' Dental formula various, teeth usually number more than 28; nasal region of skull not inflated; tail usually less than $2/3$ the length of head plus body; uropatagium extends for more than $1/3$ of the length of the tail **13**

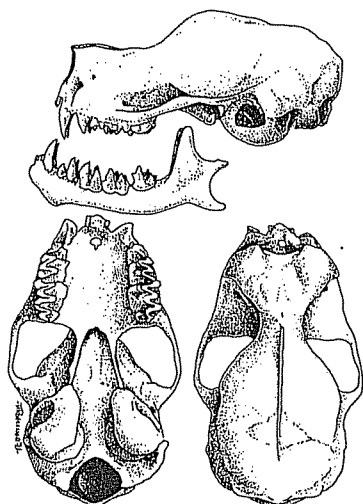


Figure 14.19 Skull of a mouse-tailed bat, *Rhinopoma hardwickei*, Rhinopomatidae. (R. Roesener)

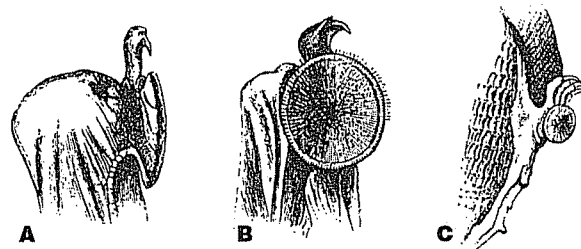


Figure 14.21 Sucking disks of a disk-winged bat, *Thyroptera tricolor*, Thyropteridae. (A and B) Wrist, and (C) foot. (Dobson 1876)

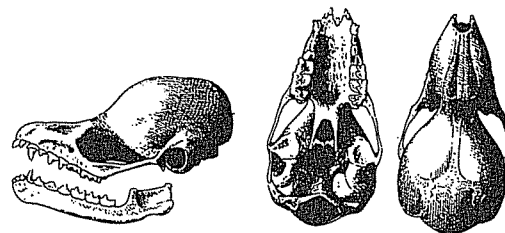


Figure 14.22 Skull of *Thyroptera discifera*, Thyropteridae. (Miller 1907)

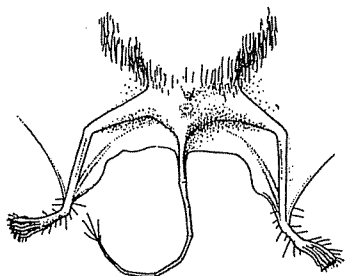


Figure 14.20 Posterior end of a mouse-tailed bat, Rhinopomatidae. (Lang and Chapin 1917)

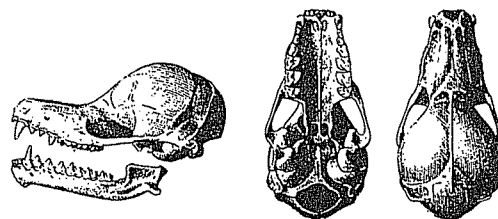


Figure 14.23 Skull of *Natalus stramineus*, Natalidae. (Miller 1907)

- 13 (12') Posterior bases of pterygoids connected by a distinct ridge on the basisphenoid; dental formula $2/3 \ 1/1 \ 3/3 \ 3/3 = 38$ **14**
- 13' Posterior bases of pterygoids not connected by a ridge; dental formula various **15**
- 14 (13) Full length of third and fourth toes and claws fused; sucking disks present on feet and thumbs (Fig. 14.21); anterior palatal emargination, if present, V-shaped, incisive foramina absent, rostrum tapered anteriorly (Fig 14.22) **Thyropteridae**
disk-winged bats
- 14' Third and fourth toes and claws not fused; no sucking disks present; anterior palate not deeply notched, and two small incisive foramina usually present, rostrum squared or rounded off anteriorly (Fig. 14.23).....**Natalidae** (in part)
funnel-eared bats

- 15 (13') Palate with anterior emargination and no incisive foramina (Figs. 14.25, 14.27) **16**
- 15' Palate entire, or with only very shallow anterior emargination, two small incisive foramina present (Fig. 14.23) or absent (Fig. 14.24) **17**
- 16 (15) Incisors 1-2/2-3, first upper incisors widely separated at bases and tips (Fig. 14.25), teeth number from 28 to 38; tail attached to uropatagium for all, or almost all, its length; ears usually more or less upright; tragus usually elongate (Fig. 14.26) **Vespertilionidae**
vespertilionid bats
- 16' Incisors 1/2-3 (Fig. 14.27), first upper incisors widely separated at base but closer together at tips, teeth number from 28 to 32; tail extending 1/3 to 2/3 of its length beyond the posterior edge of the uropatagium (Fig. 14.28); ears frequently directed nearly horizontally forward; tragus usually short and rounded (Fig. 14.28) **Molossidae** (in part)
free-tailed bats

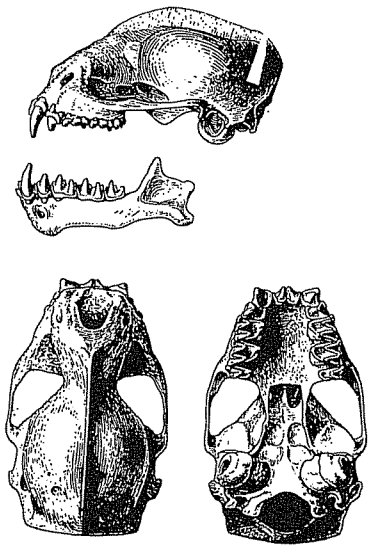


Figure 14.24 Skull of a molossid bat that has no palatal emargination, *Molossus ater*. (Miller 1907)

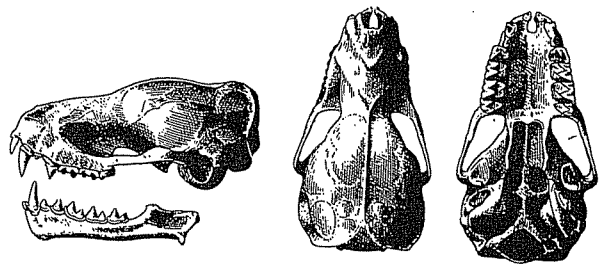


Figure 14.27 Skull of a molossid bat with an anterior palatal emargination, *Nyctinomops macrotis*. (Miller 1907)

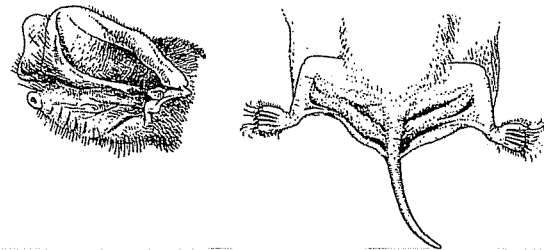


Figure 14.28 Head and posterior end of the free-tailed bat, *Tadarida teniotis*, Molossidae. (Head, Cabrera 1914; tail, Lang and Chapin 1917)



Figure 14.25 Skull of *Myotis myotis*, Vespertilionidae. (Popov 1956)

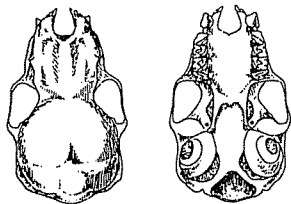


Figure 14.29 Wrist region of the smoky bat, *Furipterus horrens*, Furipteridae. (Goodwin and Greenhall 1961)

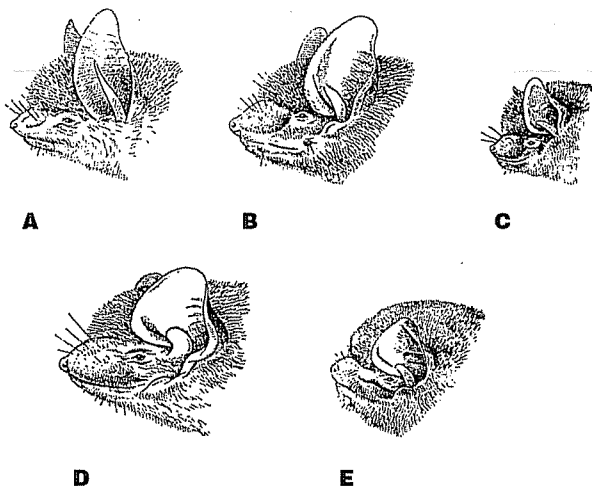


Figure 14.26 Heads of representative Vespertilionidae. (A) *Myotis natterveri*, (B) *Eptesicus serotinus*, (C) *Pipistrellus pipistrellus*, (D) *Nyctalus noctula*, and (E) *Miniopterus schreibersi*. (Cabrera 1914)

- 17 (15') Dental formula $1/1-3 \ 1/1 \ 1-2/2 \ 3/3 = 26$ to 32; tail extending $1/3$ to $2/3$ of its length beyond the posterior edge of the uropatagium (Fig. 14.28) **Molossidae** (in part)
free-tailed bats
- 17' Dental formula $2/3 \ 1/1 \ 2-3/3 \ 3/3 = 36$ or 38; tail attached to uropatagium for all, or almost all, of its length **18**
- 18 (17') Dental formula $2/3 \ 1/1 \ 2/3 \ 3/3 = 36$; thumb reduced, enclosed in patagium to base of minute claw (Fig. 14.29) **Furipteridae**
smoky bats
- 18' Dental formula $2/3 \ 1/1 \ 3/3 \ 3/3 = 38$; thumb free of patagium or, if enclosed, a large claw present **19**

- 19 (18') Posterior palatal emargination reaches anteriorly to last molar; canine in contact with adjacent incisor; rostrum broader than long; unique mushroom-shaped structure in ear partially blocking auditory canal (Fig. 14.30); thumb free; sucker pads on wrists and ankles

..... **Myzopodidae**
sucker-footed bat

- 19' Palate extending posteriorly well beyond last molar (Fig. 14.23); a distinct space present between canine and adjacent incisor; rostrum as long as or longer than broad; no mushroom-shaped structure in ear; thumb enclosed in patagium; sucker pads absent **Natalidae** (in part)
funnel-eared bats

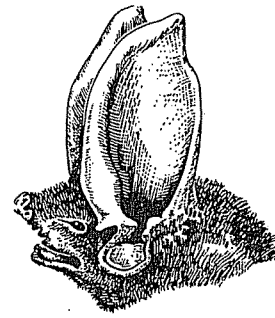


Figure 14.30 Head of *Myzopoda aurita*, Myzopodidae.
(Thomas 1904)

COMMENTS AND SUGGESTIONS ON IDENTIFICATION

Externally, bats are easily recognized by their wings. The two suborders are usually easily separated by size and shape of ears, eye size, and overall body size, but keep in mind that some megachiropteran species are smaller than some of the largest microchiropteran species.

The microchiropteran families Craseonycteridae, Mystacinidae, Rhinolophidae, Rhinopomatidae, Molossidae, Noctilionidae, Nycteridae, Megadermatidae, Emballonuridae, Furipteridae, Myzopodidae, Thyropteridae, and Natalidae are each recognized by one or two distinctive characteristics. The family Vespertilionidae is very large and relatively homogeneous but lacks any one good distinctive character. The family Phyllostomidae is large and very heterogeneous, probably more so cranially than any other family of mammals. Become familiar with the many different types.