

Keys to the Mammals and Mammal Skulls of the Northern Coastal Plain of Virginia

John F. Pagels¹, Department of Biology,
Virginia Commonwealth University, Richmond, VA 23284

A. Scott Bellows, Department of Biological Sciences,
Old Dominion University, Norfolk, VA 23529 and

Joseph C. Mitchell, Department of Biology,
University of Richmond, Richmond, VA 23173

ABSTRACT

This publication is designed to function as a tool for the identification of the mammal species that occur on the Coastal Plain of northern Virginia. We provide whole-body and skull keys to the 40 species that occur in this region. Baseline data for this work were collected during several studies conducted on Fort A. P. Hill, Caroline County. The intended audience includes interested naturalists, teachers, students, field biologists, and natural resource managers.

INTRODUCTION

These keys address all native land mammal species with geographic ranges that include Fort A. P. Hill (APH), Caroline County, Virginia, and nearby portions of the northern Coastal Plain. The species are representative of the mammal fauna of the northern Coastal Plain of Virginia. APH is centered approximately 77° 15' N and 38° 05' W and is about 15 km east of the Fall Line—the boundary between the Piedmont and Coastal Plain physiographic regions. The current landscape consists of a mosaic of managed habitats that range from old field to mature hardwood forest (Mitchell and Roble, 1998; Bellows et al., 2001c). Baseline data for this work were collected as part of several studies conducted on APH (e.g., Bellows et al., 1999; Bellows and Mitchell, 2000; Bellows et al., 2001a, 2001b). Bellows et al. (2001c) provide descriptions of the biologies, ecologies, and distributions of the 40 indigenous species we address herein, as well as descriptions of watershed drainages, climate, and habitats of the region. The presence of 38 mammal species on APH has been verified through direct observation or voucher specimens. One bat species, *Myotis austroriparius*, was identified by examination (ASB) and by photograph (David Webster, University of North Carolina at Wilmington). *Mustela frenata* has not been captured or observed; however, APH is well within its geographic range (Hall, 1981) and its presence on the post is likely. The range of another species included in the keys, *Blarina carolinensis*, does not include APH, but it is found nearby to the north and east in the Northern Neck (Tate et al., 1980; Pagels and French, 1987). Native species *Sigmodon hispidus* and *Ochrotomys nuttalli* with range limits nearby the project area, as well as the known introduced species *Rattus rattus*, *R. norvegicus*, and *Mus musculus*, are not included herein. These species are described in Bellows et al. (2001c).

1 Corresponding author: (Phone) 804-828-0076, jpagels@mail1.vcu.edu

MAMMALS DESCRIBED IN THE FOLLOWING KEYS

Notations on abundance are based on various studies at APH unless otherwise noted. Vernacular names follow Jones et al. (1997).

- Didelphis virginiana*, Virginia opossum (common)
Sorex hoyi, pygmy shrew (common)
Sorex longirostris, southeastern shrew (common)
Blarina brevicauda, northern short-tailed shrew (abundant)
Blarina carolinensis, southern short-tailed shrew (see text above)
Cryptotis parva, least shrew (common)
Scalopus aquaticus, eastern mole (probably common, but rarely captured)
Condylura cristata, star-nosed mole (uncommon, rarely captured)
Myotis austroriparius, southeastern myotis (rare)
Myotis septentrionalis, northern myotis (common)
Myotis lucifugus, little brown myotis (common)
Lasiurus borealis, eastern red bat (migratory [Shump and Shump, 1982], abundant)
Lasiurus cinereus, hoary bat (migratory [Zinn and Baker, 1979], uncommon, rarely captured)
Lasionycteris noctivagans, silver-haired bat (migratory [Handley and Patton, 1947], uncommon)
Pipistrellus subflavus, eastern pipistrelle (common)
Eptesicus fuscus, big brown bat (abundant)
Nycticeius humeralis, evening bat (uncommon)
Sylvilagus floridanus, eastern cottontail (abundant)
Tamias striatus, eastern chipmunk (uncommon)
Marmota monax, woodchuck (abundant)
Sciurus carolinensis, eastern gray squirrel (abundant)
Glaucomys volans, southern flying squirrel (common)
Castor canadensis, American beaver (abundant)
Oryzomys palustris, marsh rice rat (uncommon, rarely captured)
Reithrodontomys humulis, eastern harvest mouse (uncommon)
Peromyscus leucopus, white-footed mouse (abundant)
Microtus pennsylvanicus, meadow vole (common)
Microtus pinetorum, woodland (pine) vole (probably common, rarely captured)
Ondatra zibethicus, common muskrat (common)
Zapus hudsonius, meadow jumping mouse (common)
Canis latrans, coyote (uncommon)
Vulpes vulpes, red fox (uncommon)
Urocyon cinereoargenteus, common gray fox (common)
Procyon lotor, common raccoon (common)
Mustela frenata, long-tailed weasel (not observed but likely present [Hall, 1981])
Mustela nivalis, least weasel (rare)
Mustela vison, American mink (uncommon)
Lontra canadensis, northern river otter (uncommon)
Mephitis mephitis, striped skunk (common)
Lynx rufus, bobcat (rare)
Odocoileus virginianus, white-tailed deer (abundant)

ANNOTATED KEY TO THE MAMMALS

This key relies heavily on external features, particularly selected measurements (Fig. 1), coloration, and certain easily viewed features of the skull. All morphological

characteristics are evident or can be measured on whole or partial specimens. Magnification may be required in some instances (e.g., examination of shrew dentition). Unless the term "total" is used, numbers of teeth refer to the upper and lower teeth in one-half of the jaw. For example, when describing the number of incisors in the Virginia opossum, 5/4 means five upper incisors on one side and four lower incisors on one side (or a total of 10 upper incisors and eight lower incisors). Other useful characteristics are described in the key or on the figures when first used.

KEY TO THE ORDERS OF MAMMALS

- 1a. Hind foot with thumb-like first toe, opposable; marsupium present in females; incisors 5/4 (Marsupialia) Didelphimorphia
- 1b. Hind foot first toe not thumb-like or opposable; marsupium not present in females; incisors never more than 3/3 2

- 2a. Forelimbs modified as wings, for flight; skull small, greatest length about 20 mm or less; a large U-shaped opening in rostrum (snout) between one or two incisors Chiroptera
- 2b. Forelimbs not modified as wings; skull very small, < 10 mm to large, deer size; upper jaw complete without U-shaped opening in rostrum 3

- 3a. Feet with hooves; upper incisors absent Artiodactyla
- 3b. Feet with claws; upper incisors present 4

- 4a. Canines absent, tooththrows with a conspicuous diastema (Fig. 2A), specimens with and without a diastema; size from very small mice and voles to rabbits and the beaver 5
- 4b. Canines present, tooththrows with no conspicuous diastema (Fig. 2B); total length ranges from very small, approx. 70 mm (pygmy shrew) to nearly 1200 mm (coyote) 6

- 5a. Incisors 2/1, second upper incisor a small peg behind first; ears much longer than tail Lagomorpha
- 5b. Incisors 1/1; ears much shorter than tail Rodentia

- 6a. Canines nearly equal in size to adjacent teeth; incisors not 3/3; body size small (< 100 g) Insectivora
- 6b. Canines noticeably larger than adjacent teeth; incisors 3/3; range in size from <65 g (least weasel) to 40-200 kg (black bear) Carnivora

KEY TO THE GENERA AND SPECIES OF MAMMALS

I. Order Didelphimorphia (Marsupialia). Although marsupials traditionally were placed in the single Order Marsupialia, several orders are now recognized (Gardner, 1992). The Virginia opossum is the only native North American didelphid north of Mexico (Gardner, 1982).

. Virginia opossum, *Didelphis virginiana*

II. Order Insectivora. The Order Insectivora is a large, diverse order with representatives found throughout much of the world. Virginia representatives of this order

are moles and shrews. Moles are easily recognized by their extremely enlarged forefeet, an adaptation for their fossorial or burrowing mode of locomotion. Shrews are well known for their small size and long, pointed snouts. Shrew and mole skulls are rarely found but sometimes appear in owl pellets (Rageot, 1957; Jackson et al., 1976), and shrew skulls are often found in discarded glass bottles (Pagels and French, 1987).

- 1a. Forefeet greatly enlarged, > 6 mm across palm, adapted for digging; no ear pinna (flap) (moles) 2
- 1b. Forefeet not greatly enlarged, < 6 mm across palm; ear pinna present though greatly reduced in most species (shrews) 3
- 2a. Nose plain; tail length relatively short (< 45 mm) eastern mole, *Scalopus aquaticus*
- 2b. Each nostril surrounded by 11 slender, fleshy appendages; tail length > 45 mm, spindle shaped, diameter near middle greater than near base and tip star-nosed mole, *Condylura cristata*
- 3a. Tail short, < 25 % of total length; pinna greatly reduced 4
- 3b. Tail length > 30 % of total length; pinna visible above the hair 6
- 4a. Size small, total length ≤ 85 mm; coloration brownish; four unicuspid teeth, three visible in lateral view (Fig. 3A) least shrew, *Cryptotis parva*
- 4b. Relatively stocky body form, total length 84-125 mm; coloration slate gray to nearly black; five unicuspid teeth, four visible in lateral view (Fig. 3B) 5
- 5a. Size relatively small, total length about 84-107 mm, average total length 96 mm southern short-tailed shrew, *Blarina carolinensis*
- 5b. Size relatively large, total length about 100-125 mm, average total length 114 mm (Fig. 4B, *B. carolinensis* nearly identical except smaller) northern short-tailed shrew, *Blarina brevicauda*
- 6a. Size very small, total length < 80 mm; tail relatively short, about 27 mm; skull slender and flattened; only three of the five unicuspid teeth (1, 2, and 4) visible in lateral view (Fig. 3C) pygmy shrew, *Sorex hoyi*
- 6b. Small long-tailed shrew; total length generally 80-85 mm; tail about 33 mm; four of the five unicuspid teeth visible in lateral view (Fig. 3D) southeastern shrew, *Sorex longirostris*

III. Order Chiroptera. The Order Chiroptera (bats) is the second largest of all mammalian orders with more than 900 species. Bats are unique in that they are the only mammals capable of true flight. All bats are easily distinguished from other mammals by the presence of their "hand-wing." All species within the region are members of the Family Vespertilionidae.

- 1a. Interfemoral (tail) membrane thickly furred dorsally over entire surface or for basal half or more; hairs on back not of uniform coloration, often tipped white 2
- 1b. Interfemoral membrane nearly naked dorsally or, if furred, near base only; hairs on back with uniform shade of brown, never tipped with white 4
- 2a. Dorsal surface of interfemoral membrane not heavily furred to the tip; general coloration very dark brown to blackish with hairs on back tipped with white; calcar not keeled (Fig. 5) silver-haired bat, *Lasionycteris noctivagans*
- 2b. Dorsal surface of interfemoral membrane heavily furred from base to tip; general coloration not dark brown to blackish; whitish shoulder patches; calcar keeled (Fig. 5) 3
- 3a. General coloration reddish or reddish-yellow; males brighter red and less frosted than females; length of forearm, (Fig. 5) <44 mm. eastern red bat, *Lasiurus borealis*
- 3b. General coloration gray with hairs tipped with white, giving a frosty appearance; length of forearm 50 mm or greater hoary bat, *Lasiurus cinereus*
- 4a. General coloration dark brown dorsally, paler ventrally; forearm length > 40 mm; calcar keeled big brown bat, *Eptesicus fuscus*
- 4b. Forearm length < 40 mm 5
- 5a. Tragus long and moderately to sharply pointed (Fig. 6A) 6
- 5b. Tragus short and blunt (Fig. 6B) 8
- 6a. Pelage brown dorsally and paler ventrally and lacks a glossy appearance; ears reach > 2 mm beyond tip of snout when laid forward; calcar keeled northern myotis, *Myotis septentrionalis*
- 6b. Ears reach only to tip of snout when laid forward 7
- 7a. Face usually black; fur long, glossy, and dark brown above; calcar not keeled little brown myotis, *Myotis lucifugus*
- 7b. Face pinkish, fur dull, woolly, and grayish brown above (but highly variable, when in doubt likely a little brown myotis); calcar not prominently keeled southeastern myotis, *Myotis austroriparius*
- 8a. Sparse, dull brown fur; forearm > 34 mm; relatively short, leathery ears; calcar not keeled evening bat, *Nycticeius humeralis*
- 8b. Fur soft, brownish-yellow; forearm < 34 mm; ears (and flight membranes) reddish brown; forearm pinkish colored; calcar not prominently keeled eastern pipistrelle, *Pipistrellus subflavus*

IV. Order Lagomorpha. The Order Lagomorpha contains rabbits, hares, and pikas. The eastern cottontail is characterized by enlarged ears, a small fluffy tail that is white

on the underside, and enlarged hind limbs that are adapted for a jumping (saltatorial) locomotion

..... eastern cottontail, *Sylvilagus floridanus*

V. Order Rodentia. The Order Rodentia, the largest of all mammalian orders, includes among others, squirrels, rats, mice, and voles. Adapted for gnawing, a special feature of rodents is the presence of an upper and lower pair of ever-growing incisors behind which there is a large diastema, or space, that separates the incisors from the cheek teeth.

- 1a. Very large, up to 1,200 mm; tail naked, dorsoventrally flattened, and very wide; second toe on hind foot has a double claw
..... American beaver, *Castor canadensis*
- 1b. Rodents of various sizes; tails variously shaped, but never dorsoventrally flattened or noticeably wide 2
- 2a. Uppers incisors with a longitudinal groove; size small only; mouse-like forms 3
- 2b. Uppers incisors without a longitudinal groove; size from small mouse-like to large (woodchuck) 4
- 3a. Pelage dark brown with a darker mid-dorsal stripe; total length of adults about 120-140 mm; tail less than 1/2 total length; hind limbs not adapted for jumping locomotion eastern harvest mouse, *Reithrodontomys humulis*
- 3b. Longitudinal dorsal band on pelage of yellow and darker brown hairs; total length about 190-210 mm; tail much longer than 1/2 total length; hind limbs large, adapted for saltatorial locomotion
..... meadow jumping mouse, *Zapus hudsonius*
- 4a. Tail bushy, individual hairs of tail much greater in length than diameter of tail core (vertebrae, skin and associated structures) 5
- 4b. Tail not bushy, ranging from nearly hairless to covered with very short hairs 8
- 5a. Pelage gray dorsally and paler below; fold of skin (patagium) between hind and front legs that terminates at wrists and ankles; adapted for gliding southern flying squirrel, *Glaucomys volans*
- 5b. No fold of skin between hind and front legs; not adapted for gliding 6
- 6a. Pelage reddish-brown to yellowish with two lateral pairs of darker stripes on back; relatively small, < 270 mm total length
..... eastern chipmunk, *Tamias striatus*
- 6b. No stripes on back; relatively large, > 300 mm total length 7
- 7a. Pelage gray to reddish-brown dorsally, paler ventrally; very large and stocky, up to 675 mm; tail short, approximately 25% or less of total length
..... woodchuck, *Marmota monax*

- 7b. Pelage gray dorsally and white below; relatively slender body; tail very bushy, long, > 50% total length . . . eastern gray squirrel, *Sciurus carolinensis*

- 8a. Body rat-like, or very large mouse; long tail; hind foot ≥ 27 mm 9
- 8b. Body mouse-like; tail may be long or very short; hind foot < 27 mm 10

- 9a. Large, approximately 600 mm total length; tail laterally compressed; dense underhair covered by coarse guard hairs; general coloration somewhat variable, from chestnut brown to nearly black
 common muskrat, *Ondatra zibethicus*
- 9b. Pelage gray dorsally and buff to white ventrally; relatively small rat, to about 255 mm total length; tail round, scaly, and with few hairs
 marsh rice rat, *Oryzomys palustris*

- 10a. Mouse-like form with long tail, slightly < 50% total length; upper coloration of adults grayish-brown to orangish-brown (young are uniformly gray above); coloration of underparts and feet (young and adults) is white, and strongly contrasts with upper coloration
 white-footed mouse, *Peromyscus leucopus*
- 10b. Mouse-like forms with short tails, < 30 % total length; ventral coloration somewhat paler than dorsal pelage but contrast is not great and no sharp line of demarcation between the two 11

- 11a. Tail very short, approximately the length of the hind foot; pinnae and eyes small; chestnut-colored fur very soft
 woodland (pine) vole, *Microtus pinetorum*
- 11b. Medium size with tail approximately 2x the length of the hind foot; dorsal coloration dark brown to nearly black, underparts gray; hair relatively long and coarse meadow vole, *Microtus pennsylvanicus*

VI. Order Carnivora. The Order Carnivora contains a relatively diverse group of mammals including bears, the common raccoon, foxes, dogs, cats and their allies, weasels, and skunks. Although diverse in form and size, all carnivores possess a total of six upper and six lower incisors, and distinctly enlarged upper and lower canines.

- 1a. Face with distinct black mask; tail with alternate dark and light rings
 common raccoon, *Procyon lotor*
- 1b. Face without black mask; tail without rings 2

- 2a. Nearly all black, or black with two white stripes on back
 striped skunk, *Mephitis mephitis*
- 2b. Coloration not black, generally brown or some shade of brown above and pale brownish to whitish below 3

- 3a. Tail short, < 25% total length 4
- 3b. Tail > 25% total length 5

- 4a. Very small, total length approximately 200 mm; legs short; body slender
 least weasel, *Mustela nivalis*
- 4b. Relatively large, total length > 700 mm; legs long; cat form
 bobcat, *Lynx rufus*
- 5a. Body form fox- or wolf-like; legs relatively long; tail long and bushy from
 near base to tip 6
- 5b. Body form slender; legs relatively short; tail furred but hairs not conspicu-
 ously long and bushy 8
- 6a. Upper coloration reddish yellow, belly white, feet black, and yellowish
 tail tipped with white red fox, *Vulpes vulpes*
- 6b. Upper coloration grizzled grayish and without white tail tip 7
- 7a. Total length < 1000 mm; hind foot about 135 mm; upper coloration gray
 blending to reddish on the sides; tail blackish near tip
 common gray fox, *Urocyon cinereoargenteus*
- 7b. Total length > 1000 mm; hind foot about 180-200 mm; upper coloration
 grayish throughout including tail and tip of tail coyote, *Canis latrans*
- 8a. Total length of adults approximately 1000 mm; tail long and very thick at
 base; toes of front and hind feet webbed
 northern river otter, *Lontra canadensis*
- 8b. Total length of adults < 600 mm; tail not conspicuously thick at base; toes
 not webbed 9
- 9a. Upper and underparts uniform glossy brown except for white spots some-
 times on chin and throat; tail length > 175 mm American mink, *Mustela vison*
- 9a. Upper parts brown; tip of tail black, underparts white to yellowish white;
 tail length < 160 mm long-tailed weasel, *Mustela frenata*

VII. Order Artiodactyla. The Order Artiodactyla contains the even-toed ungulates, i.e., cattle, swine, antelope, deer, elk, moose, and others. The only artiodactylan known from APH is the white-tailed deer. This species is characterized by its rows of spots when very young and the branched antlers of adult males
 white-tailed deer, *Odocoileus virginianus*

ANNOTATED KEY TO THE SKULLS OF SELECTED MAMMALS

Our key to skulls of mammals of Virginia's northern Coastal Plain includes all native species known from the area. Some of the species are rarely found in the field. A few characteristics used in this key were also used in the general key, most notably, skull size and dentition. When unresolvable questions on identification arise, an expert should be consulted. Because the lower jaw is often missing from specimens found in natural situations, in most cases the key applies only to the upper portion of the skull. Select characteristics may apply to the nearly whole skull, but sometimes only to the dentition or the cranial (braincase) or rostral (snout) portions of the skull. Certain

measurements and several characteristics of the dentition are helpful with identification of mammal skulls. These include numbers of teeth, the presence or absence of certain teeth (e.g., canines, incisors), and the shape and pattern of the crown and surface of the teeth. Most special features are described when first used in this key. Except for species that lack certain teeth or groups of teeth, the anteriormost teeth are the incisors, followed by the canines, and then the premolars and molars (Fig. 2). Premolars and molars are referred to as the molariform or cheek teeth. Many species, but notably all rodents and lagomorphs, lack canines and instead there is a large diastema (gap) between the incisors and the molariform teeth (Fig. 2).

Age at death can often be a confounding factor when identifying a specimen. Young of many species leave the nest when they are much smaller than adults and a measurement may suggest that it is a species different from the one under examination. If that is suspected, it is often helpful to examine the dentition and sutures (joints between bones of the skull). In young individuals, teeth show little or no wear, some juvenile teeth may still be present, and the sutures are incomplete or "loose;" individual bones of the skull are highly evident or missing. In adults some tooth wear should be evident and sutures will be complete. In old individuals sutures may no longer be evident and consequently borders between individual bones of the skull are not obvious.

- 1a. Upper incisors absent; molariform teeth with crescent-shaped cutting edges; large fenestrae (openings) in rostrum evident (Fig. 7A and 7B) white-tailed deer, *Odocoileus virginianus*
- 1b. Incisors present on upper jaw 2
- 2a. Canines absent; large diastema separates incisors and molariform teeth 3
- 2b. No large diastema behind incisors; area occupied by small teeth or large canines 15
- 3a. Single pair of upper incisors (Fig. 8A) (rodents) 4
- 3b. Two small, peg-like incisors directly behind the two large incisors; rostral fenestrae (lattice-work openings) evident (Fig. 8B) (lagomorphs) eastern cottontail, *Sylvilagus floridanus*
- 4a. Postorbital process (projection of bone) prominent behind orbit (opening for eye) Fig. 9) (squirrels and allies) 5
- 4b. Postorbital process absent, or if present, much reduced in size and found only in a very large rodent skull 8
- 5a. Skull large; greatest length of skull > 70 mm; posterior border of postorbital process at distinct right angle to longitudinal axis to the skull; rounded to slightly pointed cusps evident on cheek teeth (Fig. 9A and 10B) woodchuck, *Marmota monax*
- 5b. Skull < 65 mm in length; posterior border of postorbital process curving backward, cusps on cheek teeth 6
- 6a. Skull moderately large, approximately 58-64 mm in length (Fig. 9B) eastern gray squirrel, *Sciurus carolinensis*
- 6b. Skull < 45 mm in length 7

- 7a. Greatest length of skull 32-36 mm; rostrum flat in region medial to postorbital processes to tip of nasals (Fig. 9C)
 southern flying squirrel, *Glaucomys volans*
- 7b. Greatest length of skull 37-41 mm; rostrum slightly convex in region medial to postorbital processes to tip of nasals (Fig. 9D)
 eastern chipmunk, *Tamias striatus*
- 8a. Skull very large, greatest length of skull > 75 mm; surface of cheek teeth flat with transverse loops of enamel ridges; bony structure of external auditory meatus (external ear opening) elongate (Fig. 10A)
 American beaver, *Castor canadensis*
- 8b. Skull < 70 mm; surface of cheek teeth not as above; external auditory meatus does not open at end of elongated bony structure 9
- 9a. Greatest length of skull > 50 mm (approximately 60-70 mm); surface of cheek teeth flat but with triangular prismatic ridges of enamel (Fig. 10C)
 common muskrat, *Ondatra zibethicus*
- 9b. Greatest length of skull < 35 mm 10
- 10a. Incisors with longitudinal groove 11
- 10b. Incisors without longitudinal groove 12
- 11a. Greatest length of skull about 19.5 mm; infraorbital foramen (opening below the orbit) small and somewhat v-shaped
 eastern harvest mouse, *Reithrodontomys humulis*
- 11b. Greatest length of skull about 21-23 mm; infraorbital foramen large, approximately 2 mm by 4mm, and oval shaped
 meadow jumping mouse, *Zapus hudsonius*
- 12a. Surfaces of cheek teeth flat with triangular prismatic ridges of enamel 13
- 12b. Cusps or tubercles present on cheek teeth; surfaces of cheek teeth not flat or with triangular enamel ridges 14
- 13a. Greatest length of skull of adult 27-30mm; last upper molar with three closed triangles meadow vole, *Microtus pennsylvanicus*
- 13b. Greatest length of skull of adult 23-26 mm; last upper molar with two closed triangles woodland (pine) vole, *Microtus pinetorum*
- 14a. Greatest length of skull about 30 mm; distinct temporal ridges that extend from the upper portion of the orbit to the back of the skull
 marsh rice rat, *Oryzomys palustris*
- 14b. Greatest length of skull about 26 mm; temporal ridges lacking
 white-footed mouse, *Peromyscus leucopus*
- 15a. Canines not enlarged, first pair of incisors elongated followed by numerous small tubercular teeth (insectivores) 16
- 15b. Canines noticeably larger and longer than incisors 22

- 16a. Zygomatic arch (cheekbone) absent; most teeth tipped with reddish coloration; greatest length of skull 23 mm 17
- 16b. Zygomatic arch present but very thin; greatest length of skull > 30 mm 21
- 17a. Four unicuspid teeth, three visible in lateral view (Fig. 3A) least shrew, *Cryptotis parva*
- 17b. Five unicuspid teeth 18

- 18a. Skull greater than 17 mm in total length; lateral edge of braincase angular, pointed 19
- 18b. Skull less than 17 mm in total length; lateral edge of braincase not angular, pointed 20

- 19a. Greatest length of skull approximately 22 mm, greater than 20 mm (Fig. 3B) northern short-tailed shrew, *Blarina brevicauda*
- 19b. Greatest length of skull approximately 19 mm, 20 mm or less (not pictured) southern short-tailed shrew, *Blarina carolinensis*

- 20a. Only three of five unicuspid teeth (1, 2, and 4) visible in lateral view (Fig. 3C) pygmy shrew, *Sorex hoyi*
- 20b. Four of five unicuspid teeth (1, 2, 3, and 4) visible in lateral view (Fig. 3D) southeastern shrew, *Sorex longirostris*

- 21a. Total of 20 teeth, 10 on each side in upper jaw (Fig. 4A) eastern mole, *Scalopus aquaticus*
- 21b. Total of 22 teeth, 11 on each side in upper jaw star-nosed mole, *Condylura cristata*

- 22a. Skull small, greatest length of skull about 20 mm or considerably less, with one or two incisors (no more) on each side of a large U-shaped opening at the front of the rostrum. Bats (Fig. 11). Crowns of the cheek teeth are characterized by W-shaped cutting edges. Bat skulls are rarely found (chiropterans) 23
- 22b. Greatest length of skull > 30 mm, usually much more; anterior rostral area complete, no U- shaped opening 30

- 23a. Incisors = 1/3, total number of teeth = 30 or 32 24
- 23b. Incisors = 2/3, total number of teeth = 32 to 38 26

- 24a. Rostrum noticeably shorter than braincase, upper incisor is in contact with canine; seven teeth in one side of upper jaw; total teeth = 32 25
- 24b. Rostrum length comparable to braincase length; upper incisor not in contact with canine; six teeth in one side of upper jaw; total teeth = 30 evening bat, *Nycticeius humeralis*
- 25a. Greatest skull length 15.5 mm eastern red bat, *Lasiurus borealis*
- 25b. Greatest skull length > 15.5 mm hoary bat, *Lasiurus cinereus*

LITERATURE CITED

- Bellows, A. S., and J. C. Mitchell. 2000. Small mammal communities in riparian and upland habitats on the upper Coastal Plain of Virginia. *Virginia Journal of Science* 51:171-186.
- Bellows, A. S., J. C. Mitchell, and J. F. Pagels. 1999. Small mammal assemblages on Fort A. P. Hill, Virginia: Habitat associations and patterns of capture success. *Banisteria* 14:3-15.
- Bellows, A. S., J. F. Pagels, and J. C. Mitchell. 2001a. Macrohabitat and microhabitat affinities of small mammals in a fragmented landscape on the upper Coastal Plain of Virginia. *American Midland Naturalist* 146:345-360.
- Bellows, A. S., J. F. Pagels, and J. C. Mitchell. 2001b. Plant community composition and small mammal communities in old fields on Virginia's Coastal Plain. *Journal of the Elisha Mitchell Scientific Society* 117:101-112.
- Bellows, A. S., J. C. Mitchell, and J. F. Pagels, H. N. Mansfield. 2001c. Mammals of Fort A. P. Hill, Caroline County, Virginia and vicinity. *Virginia Journal of Science* 52:163-226.
- Cothran, E. G., M. H. Smith, J. O. Wolff, and J. B. Gentry. 1991. Mammals of the Savannah River Site. Publication No. SRO-NERP-21, The Savannah River Site National Environmental Research Park Program. 191 pp.
- Gardner, A. L. 1982. Virginia opossum—*Didelphis virginiana*. Pp 3-36 in J. A. Chapman and G. A. Feldhammer (eds). *Wild Mammals of North America: Biology, Management, Economics*. The Johns Hopkins University Press, Baltimore, Maryland. 1147 pp.
- Gardner, A. L. 1992. Order Didelphimorpha. Pp 15-23 in D. E. Wilson and D. M. Reeder (eds), *Mammal species of the world*, 2nd ed. Smithsonian Institution Press. 1206 pp.
- Hall, E. R. 1981. *The mammals of North America*. John Wiley and Sons, New York 2:601-1181 + 90 pp.
- Handley, C.O., Jr., and C.P. Patton. 1947. *Wild Mammals of Virginia*. Virginia Commission of Game and Inland Fisheries, Richmond, VA. 220 pp.
- Jackson, R. S., J. F. Pagels, and D. N. Trumbo. 1976. The mammals of Presquile, Chesterfield County, Virginia. *Virginia Journal of Science* 27:20-23.
- Jones, C., R. S. Hoffman, D. W. Rice, M. D. Engstrom, R. D. Bradley, D. J. Schmidly, C. A. Jones, and R. J. Baker. 1997. Revised checklist of North American mammals north of Mexico, 1997. Occasional Papers, Museum of Texas Tech University. Number 173:1-19.
- Menzel, M. A., J. M. Menzel, S. B. Castleberry, J. Ozier, W. M. Ford, and J. W. Edwards. 2002. Illustrated key to the skins and skulls of bats in the southeastern and mid-Atlantic states. United States Department of Agriculture, Forest Service. Research Note NE-376:1-9.
- Mitchell, J. C., and S. M. Roble. 1998. Annotated checklist of the amphibians and reptiles of Fort A. P. Hill, Virginia, and vicinity. *Banisteria* 11:19-31.
- Pagels, J. F., and T. W. French. 1987. Discarded bottles as a source of small mammal distribution data. *American Midland Naturalist* 118:217-219.
- Rageot, R. H. 1957. Predation on small mammals in the Dismal Swamp, Virginia. *Journal of Mammalogy* 38:281.

Shump, K.A., Jr., and A.U. Shump. 1982. *Lasiurus borealis*—Mammalian Species No. 183. Special Publication of the American Society of Mammalogists. 6 pp.

Tate, C. M., J. F. Pagels and C. O. Handley, Jr. 1980. Distribution and systematic relationship of two kinds of short-tailed shrews (Soricidae: *Blarina*) in south-central Virginia. Proceedings of the Biological Society of Washington 93:50-60.

Zinn, T.L., and W.W. Baker. 1979. Seasonal migration of the hoary bat, *Lasiurus cinereus*, through Florida. Journal of Mammalogy 60:634-635.

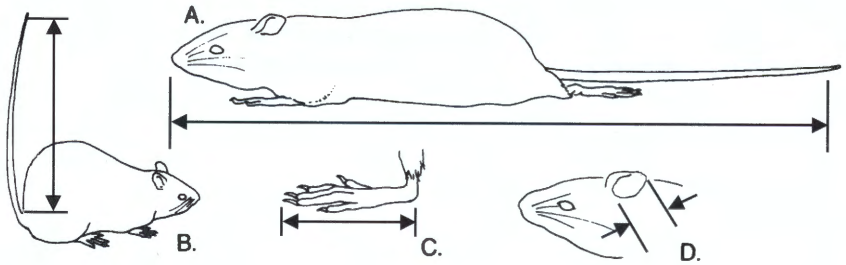


FIGURE 1. Standard mammal measurements. (A) total length, (B) length of tail vertebrae (tail length), (C) length of the hind foot, and (D) length of ear. Body length is determined by subtracting length of tail vertebrae from total length (from Cothran et al., 1991). Total length measurement includes body and tail vertebrae only; hairs at tip of tail are not included.



FIGURE 2. Lateral view of the skulls of the (A) American beaver, *Castor canadensis* (diastema indicated) and (B) gray fox, *Urocyon cinereoargenteus*. (Photo by J. C. Mitchell)

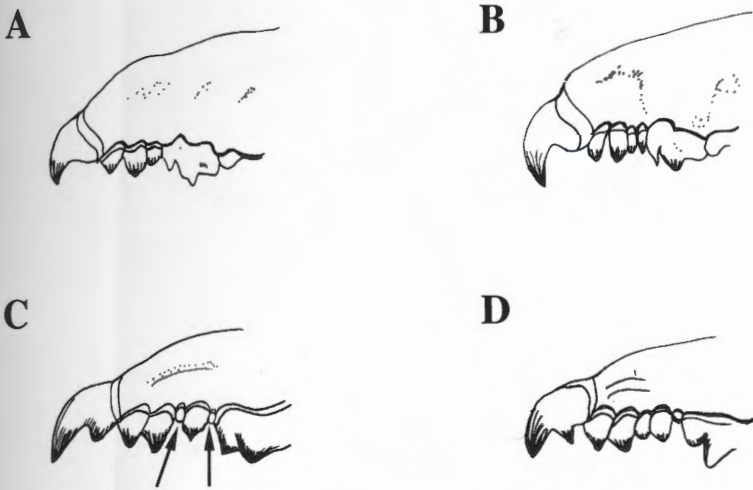


FIGURE 3. Lateral view of unicuspid dentition and nearby teeth found in *Cryptotis parva* (A), *Blarina brevicauda* (B), *Sorex hoyi* (C), and *Sorex longirostris* (D). Note that in *S. hoyi* arrows indicate the location of the minute unicuspid teeth three and five that are not evident in lateral view. In *S. longirostris* (D), the fifth unicuspid is greatly reduced but visible. (Illustrated by D. L. Jobe)

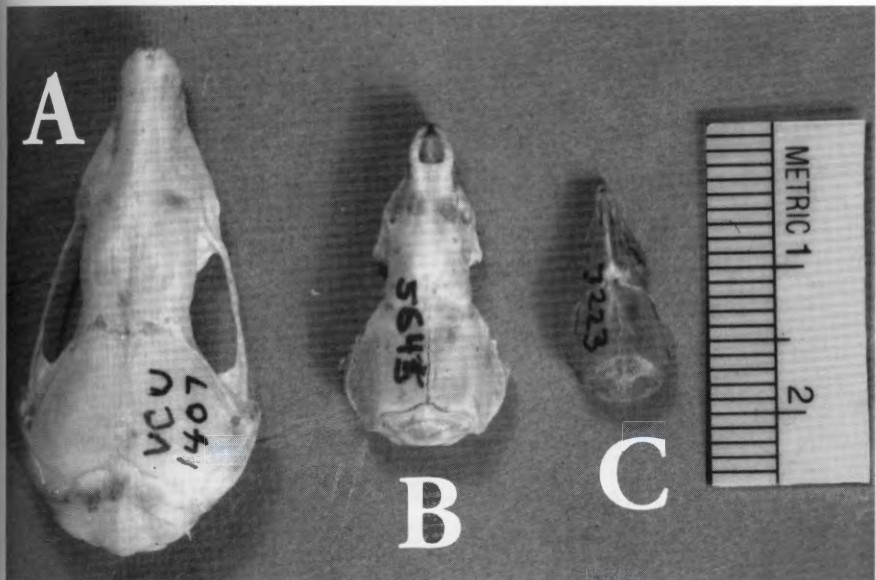


FIGURE 4. Insectivores. Dorsal view of the skulls of the (A) eastern mole, *Scalopus aquaticus*; (B) northern short-tailed shrew, *Blarina brevicauda*; (C) southeastern shrew, *Sorex longirostris*. Note absence of a zygomatic arch in the shrews. (Photo by A. S. Bellows)

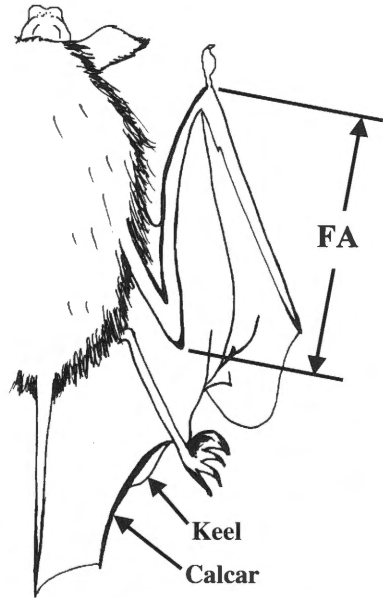


FIGURE 5. Standardized measurement of forearm length (FA) in bats. Calcar with a keel indicated. (Illustrated by D. L. Jobe)

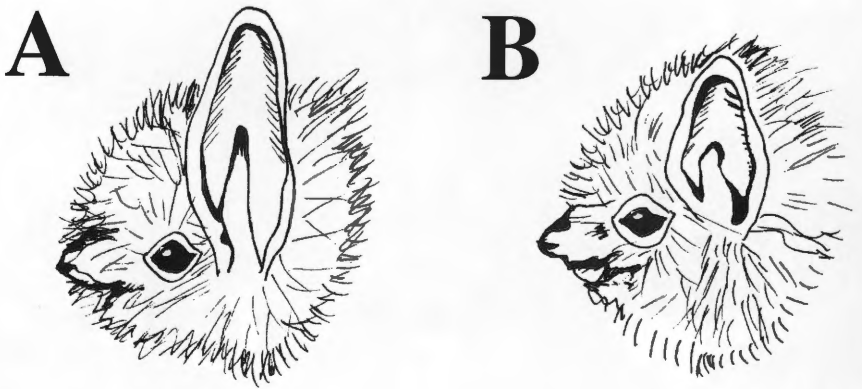


FIGURE 6. Tragus length and form in vespertilionid bats. (A) depicts the long and pointed tragus, characteristic of members of the genus *Myotis*, and (B) depicts the typically short and blunt tragus of other genera described. (Illustrated by D. L. Jobe)

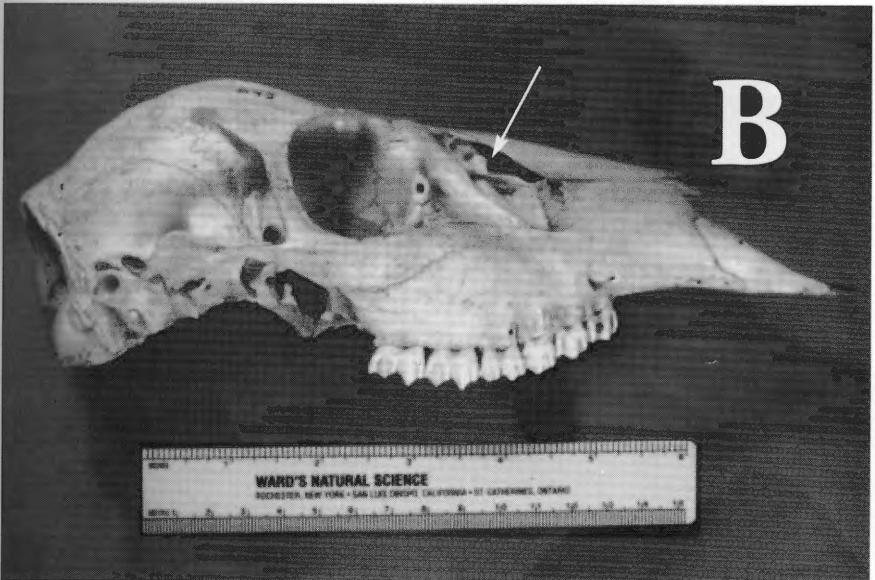
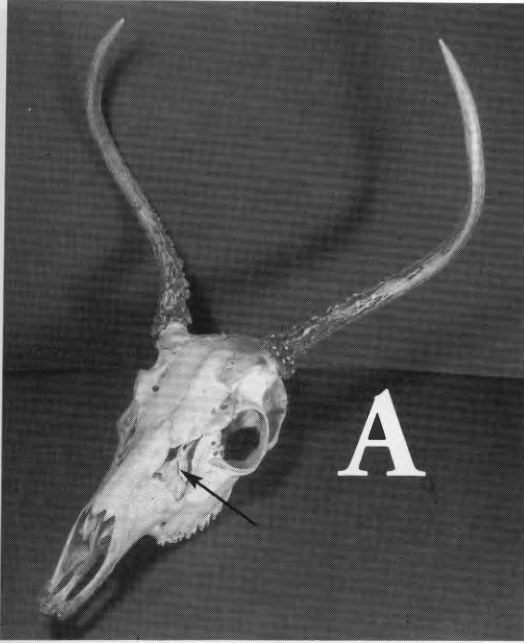


FIGURE 7. White-tailed deer, *Odocoileus virginianus*, (A) buck, (B) doe (fenestrae indicated). (Photos by A. S. Bellows)

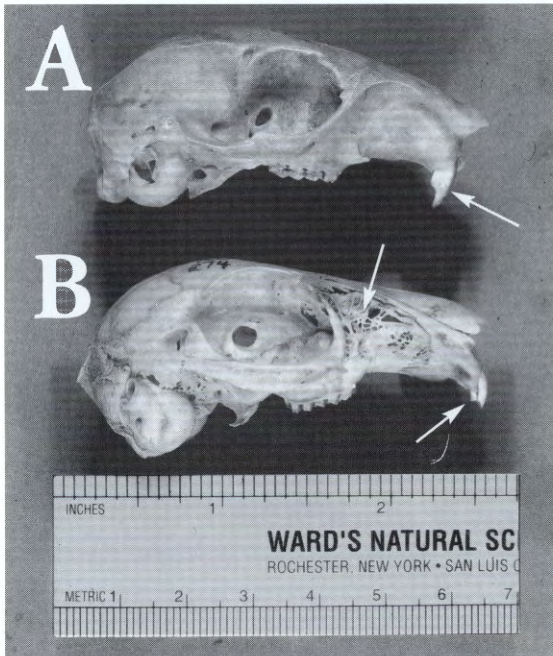


FIGURE 8. Lateral view of the skulls of the (A) eastern gray squirrel, *Sciurus carolinensis* (single pair of incisors is indicated) and (B) eastern cottontail, *Sylvilagus floridanus* (peg-like second incisors and rostral fenestrae are indicated). (Photo by J. C. Mitchell)

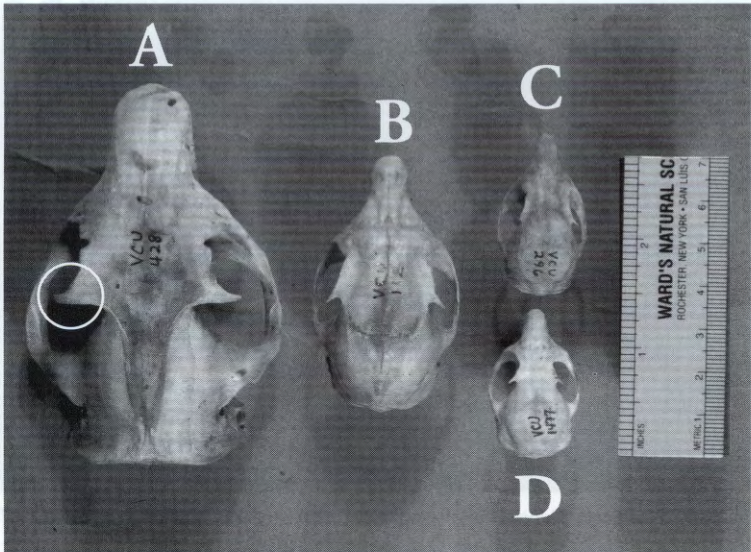


FIGURE 9. Dorsal view of the skulls of the (A) woodchuck, *Marmota monax*; (B) eastern gray squirrel, *Sciurus carolinensis* (C) southern flying squirrel, *Glaucomys volans*; (D) eastern chipmunk, *Tamias striatus*. Post-orbital process (indicated) on *M. monax* only. (Photo by J. C. Mitchell)

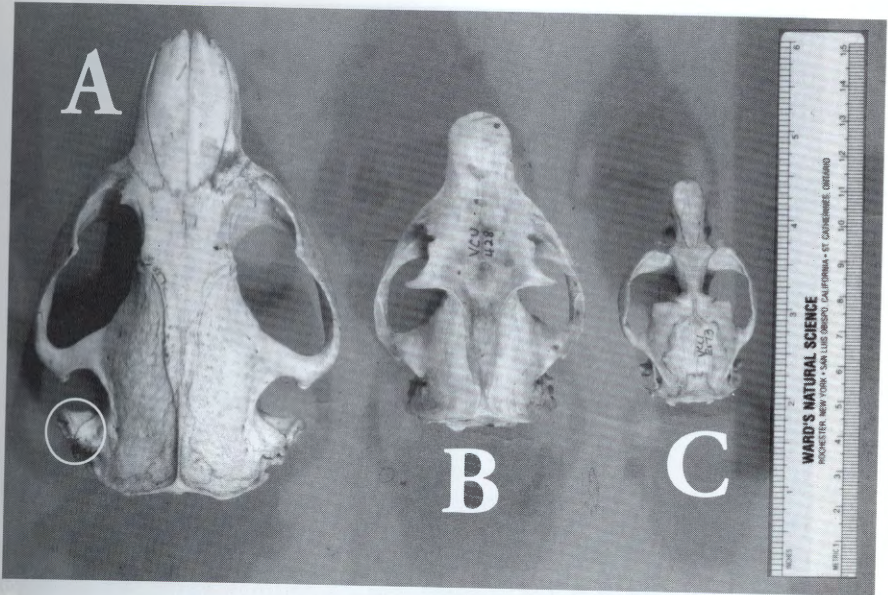


FIGURE 10. Large rodents. Dorsal view of the skulls of the (A) American beaver, *Castor canadensis* (bony structure of external auditory meatus indicated); (B) woodchuck, *Marmota monax*; (C) muskrat, *Ondatra zibethicus*. (Photo by A. S. Bellows)

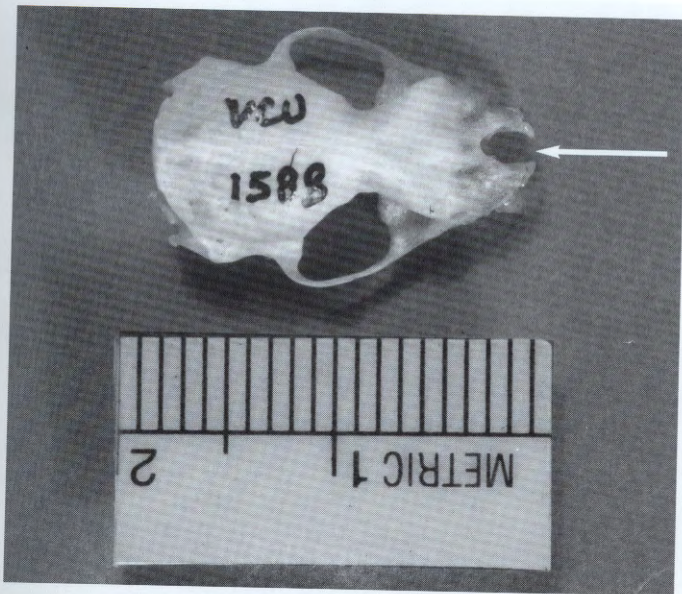


FIGURE 11. Generalized bat skull with U-shaped opening in rostrum (indicated). Dorsal view of the skull of the big brown bat, *Eptesicus fuscus*. (Photo by A. S. Bellows)

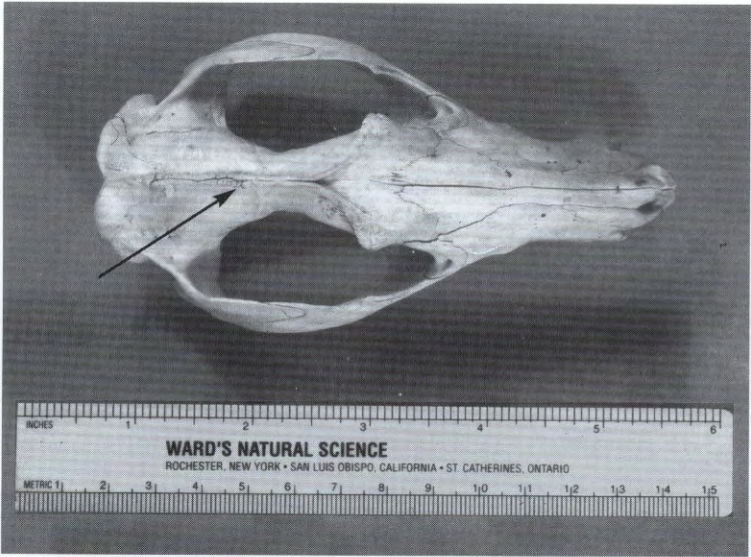


FIGURE 12. Dorsal view of the skull of the Virginia opossum, *Didelphis virginiana* (sagittal crest indicated). Note the small brain case compared to a skull of the same length, raccoon Fig. 15A. (Photo by A. S. Bellows)

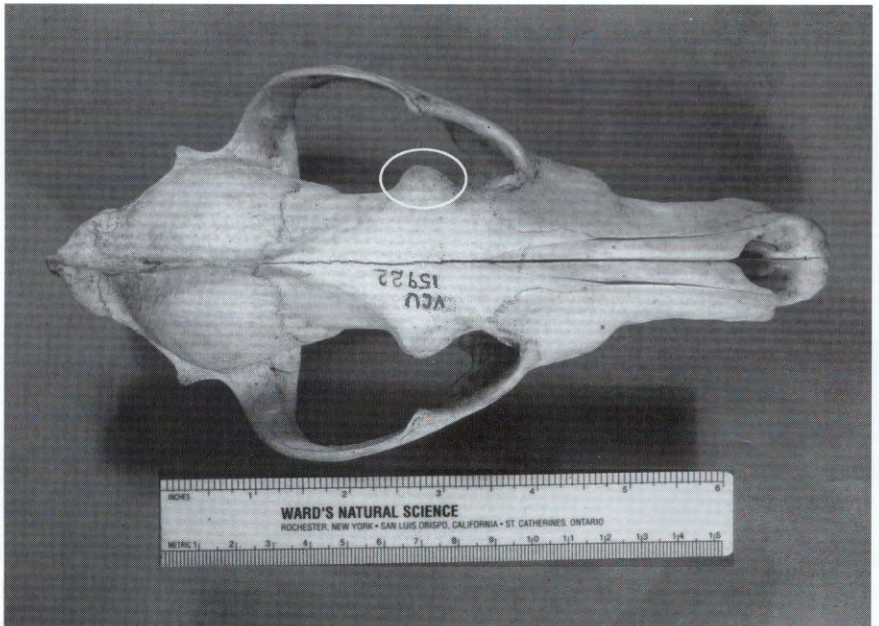


FIGURE 13. Dorsal view of the skull of the coyote, *Canis latrans* (postorbital processes indicated). (Photo by J. C. Mitchell)

Volume 34, Number 1
Spring 2002

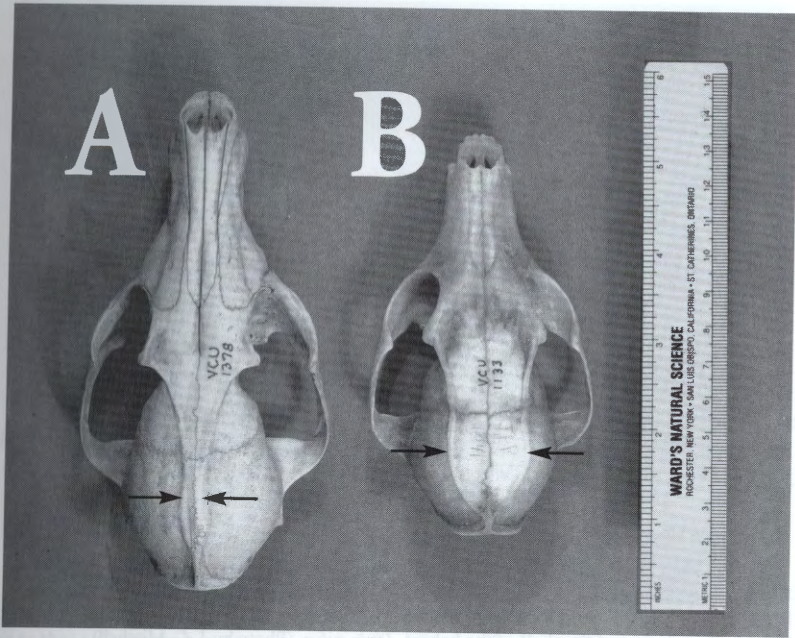


FIGURE 14. Dorsal view of the skulls of the (A) red fox, *Vulpes vulpes* and (B) gray fox, *Urocyon cinereoargenteus* (lyre-shaped temporal ridges indicated). (Photo by J. C. Mitchell)

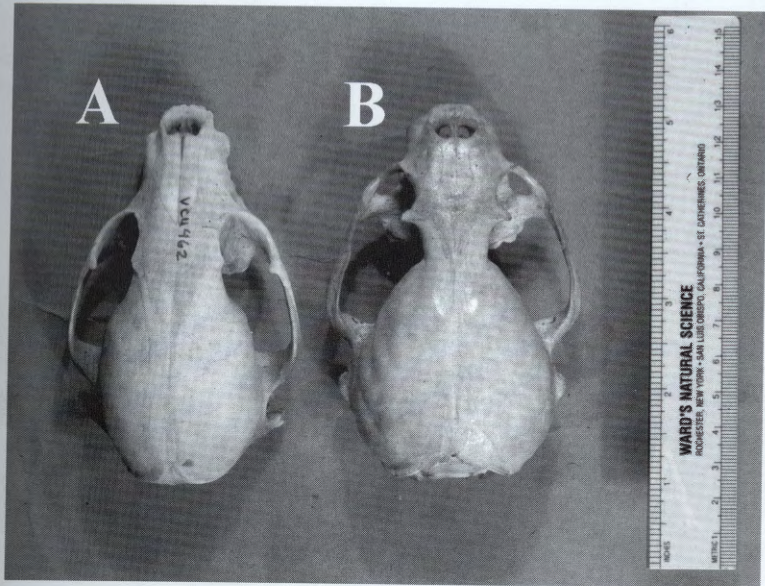


FIGURE 15. Dorsal view of the skulls of the (A) raccoon, *Procyon lotor* and (B) river otter, *Lontra canadensis*. (Photo by J. C. Mitchell)



FIGURE 16. Dorsal view of the skull of the bobcat, *Lynx rufus*. (Photo by J. C. Mitchell)

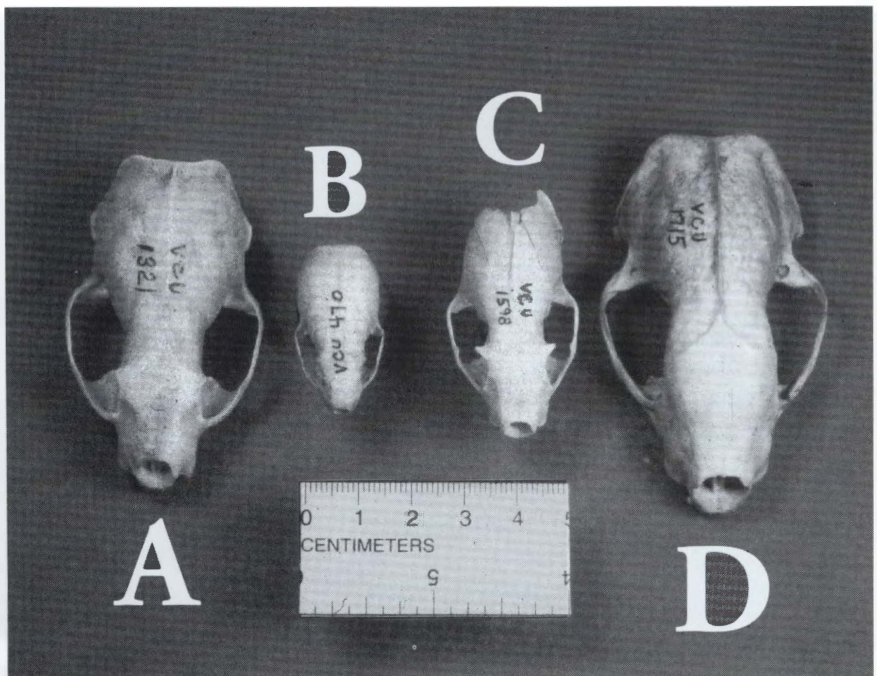


FIGURE 17. Dorsal view of the skulls of the (A) mink, *Mustela vison*; (B) least weasel, *Mustela nivalis*; (C) long-tailed weasel, *Mustela frenata*; (D) striped skunk, *Mephitis mephitis*. (Photo by A. S. Bellows)