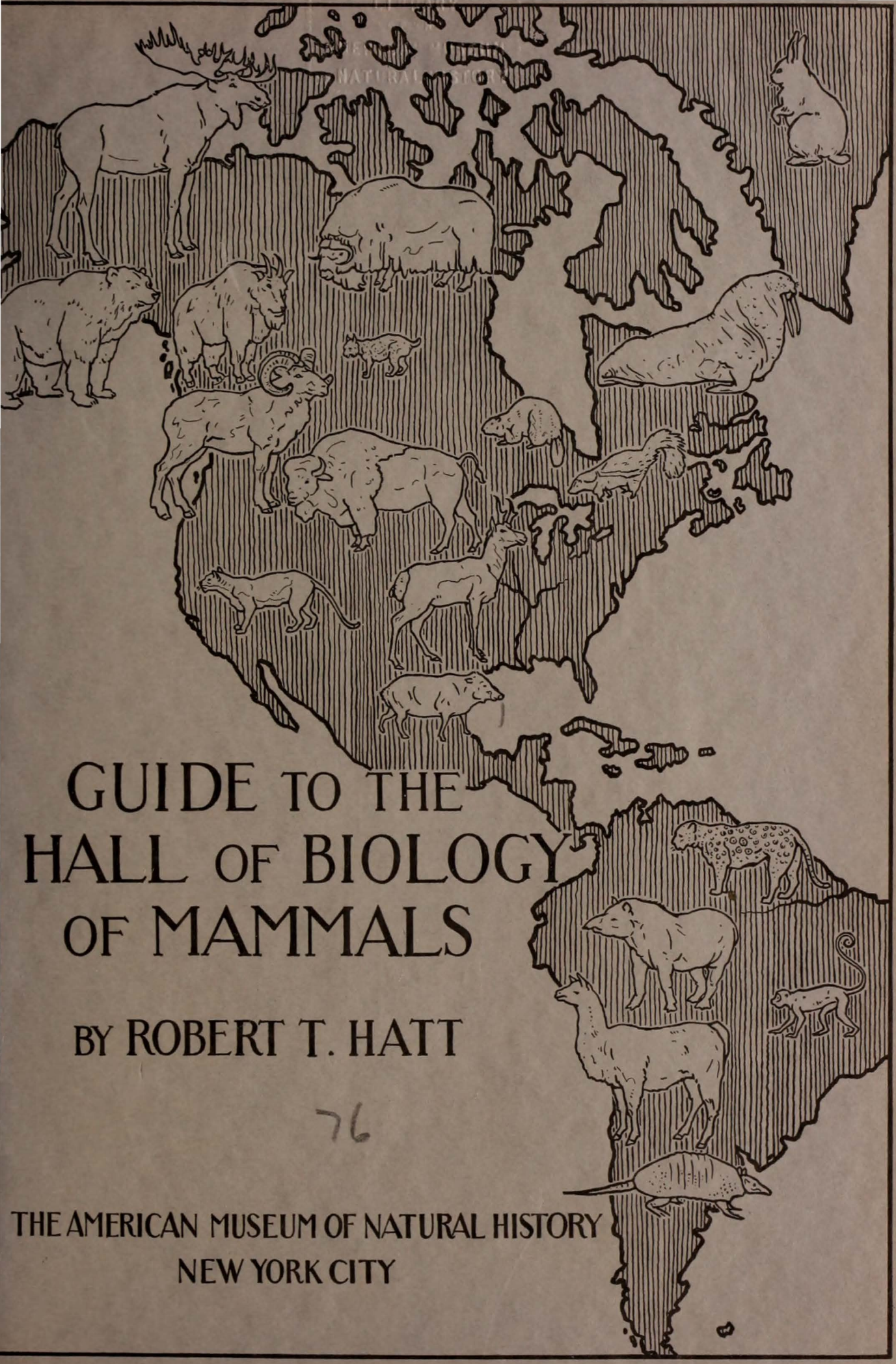


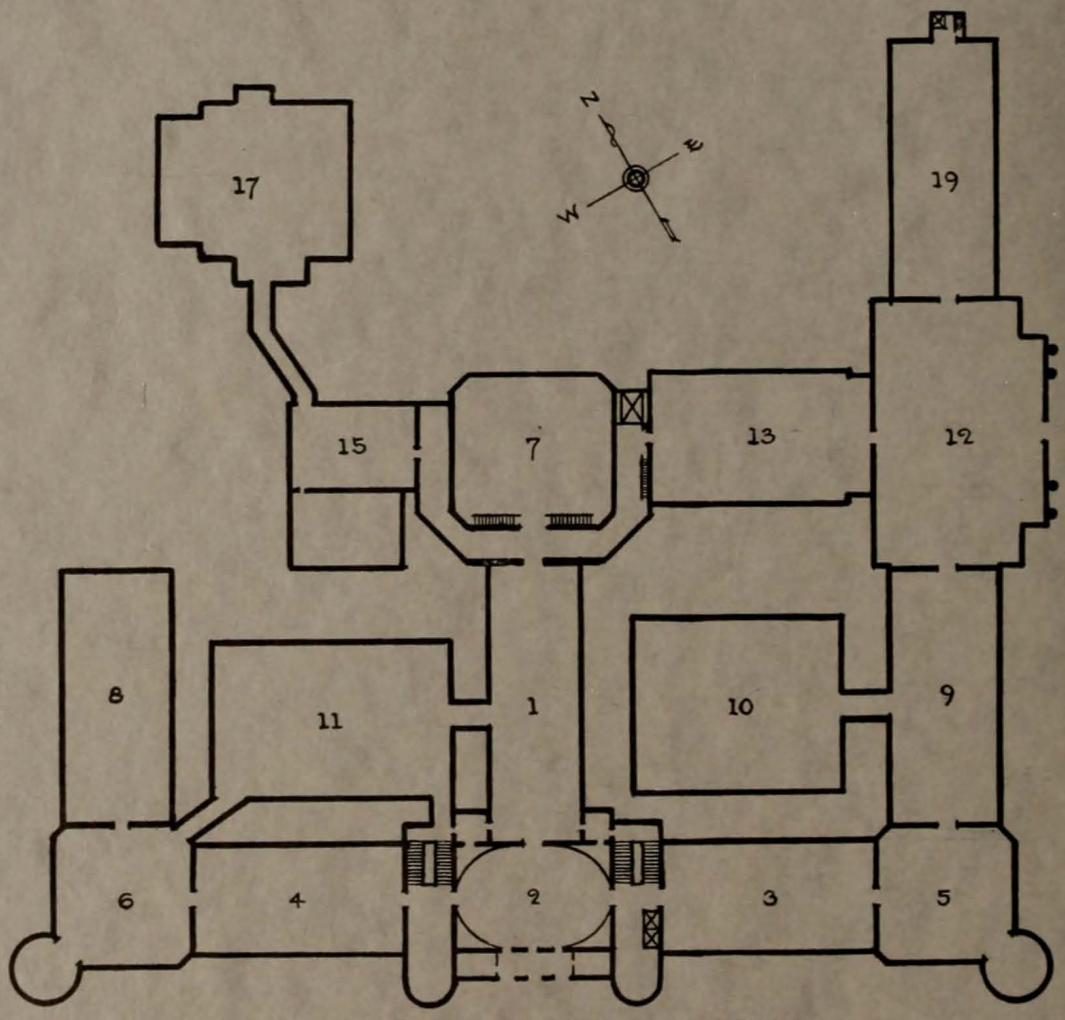
GUIDE TO THE HALL OF BIOLOGY OF MAMMALS

BY ROBERT T. HATT

THE AMERICAN MUSEUM OF NATURAL HISTORY
NEW YORK CITY

THE MAMMAL HALLS OF THE AMERICAN MUSEUM OF NATURAL HISTORY

1. Hall of the Biology of Mammals. Third Floor, Sec. 3.
2. North American Mammals. Second Floor, Sec. 3.
3. South Asiatic Mammals. Second Floor, Sec. 9.
4. Marine Mammals. First Floor, Sec. 10.
5. North Asiatic Mammals. In Preparation.
6. African Mammals. In Preparation.
7. Primates. Third Floor, Sec. 2.
8. Mammal Photographs. Third Floor, Sec. 2.
9. Horses. Fourth Floor, Sec. 2 West
10. Fossil Mammals. Fourth Floor, Secs. 2 and 3.
11. Introduction to Anthropology. Third Floor, Sec. 4.



FLOOR PLAN OF THE MUSEUM

GUIDE TO THE HALL

OF

BIOLOGY OF MAMMALS

THE FAMILY TREE OF MAMMALS

GUIDE TO THE HALL OF

BIOLOGY OF MAMMALS

IN

THE AMERICAN MUSEUM
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By ROBERT T. HATT

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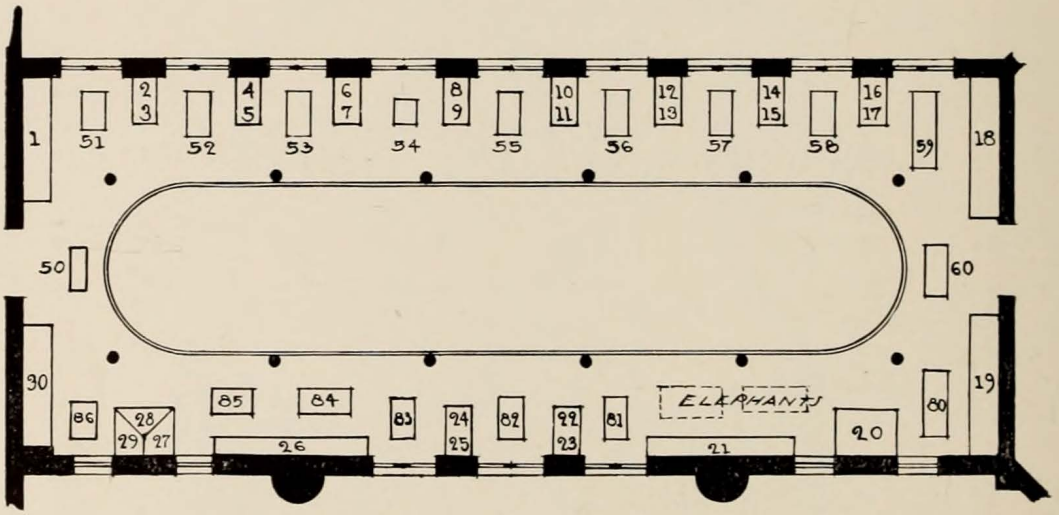


The numbers are those which may be found marked on the cases. Reference to these cases is given in bold faced type in this Guide.

GUIDE TO THE HALL OF THE BIOLOGY OF MAMMALS

By ROBERT T. HATT

This booklet is intended primarily as a guide to the synoptic series of mammals and the exhibits of mammalian biology that constitute the "Hall of the Biology of Mammals." It is hoped, however, that enough information is contained within the covers to make its interest extend beyond the walls of this Museum and that it may serve to refresh the memory of the visitor whose stay at the Museum was all too brief.

The visitor will find it convenient to study the exhibits from left to right. Doing this he will view in approximate order of specialization the larger natural groups or ORDERS of mammals. The exhibits pertaining to general mammalian biology are not, because of the limitations of space, grouped in any systematic order, but by following this guide much of broad interest may be found in the Hall that might otherwise escape notice.

THE MAMMALS PLACE IN THE ANIMAL KINGDOM

The animal kingdom is composed of an infinite variety of species which may be divided into about twenty major groups or phyla whose interrelationships are obscured by the antiquity of their origin. Some of these are structurally very simple and are thus called primitive. Others are of extreme complexity. A world-famed exhibit of these phyla may be seen in Darwin Hall on the first floor of the Museum. The mammals clearly belong among the phylum Chordata of which the chief examples are the vertebrates or back-boned animals, a group which contains five classes, the fishes, amphibians, reptiles, birds and mammals. Since the Chordata are the most highly organized of the phyla, and the mammals the most highly organized of the chordates, it is customary to place them at the head of the animal kingdom as is done in the "Tree of Animal Life" illustrated in Case 2. It must, however, be borne in mind that every living animal is in its own way greatly specialized for its particular mode of life and that the terms "highest" and "most primitive" are only relative.

What is a Mammal?

A mammal may be defined as any species of animal in which the young are nourished for a time on milk, a secretion of specialized cutaneous glands. The mammals constitute a natural though widely diversified, group of the vertebrate or backboned animals. All, at some period in their existence, bear a coat of hair, though in some groups such as the whale and man, this is largely lost before birth. In contrast to lower classes of vertebrates (fishes, amphibians and reptiles) the mammals have a comparatively constant body temperature, which is different for different species but notably lower in the primitive group, the monotremes (**3**). The body temperature may rise above normal in disease or become considerably lowered in a state of hibernation. The adrenal glands appear to act as the thermostat which coordinates the various elements of control.

This high and constant body temperature is associated with a complicated heat regulating mechanism. Among the mammalian characters composing this complex is a muscular sheet, the diaphragm, which by rhythmic pumping movements furnishes a more constant air supply than is enjoyed by other vertebrates.

A richly glandular skin by controlling surface evaporation aids in regulating body temperature. The skin contains two main types of glands, the sudoriparous or sweat glands, and the sebaceous or oil glands. These latter are ordinarily associated with hair follicles, and their secretion aids in keeping hair in good condition. The sudoriparous glands control evaporation and eliminate waste. They are regionally differentiated to several uses. The lacteal or milk glands are specialized sweat glands.

Mammals all possess a four chambered heart which keeps the well oxygenated blood coming from the lungs completely separated from the poorly oxygenated blood entering the heart from the body circulation. This efficient arrangement occurs only among the birds and mammals.

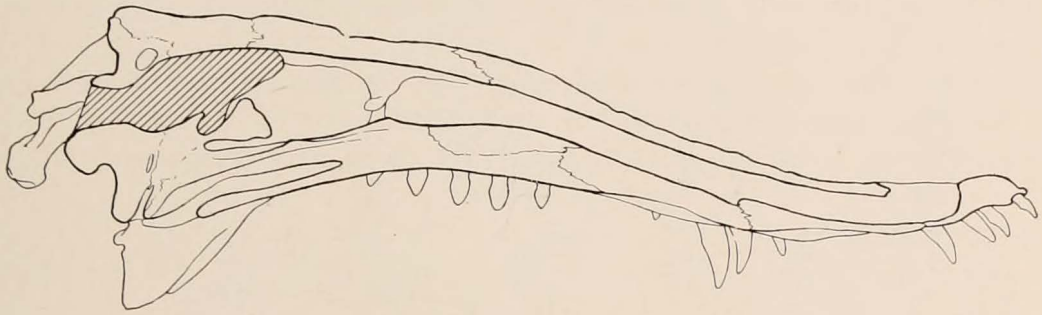
The brain is proportionately larger in the mammals than in other vertebrates by reason of enlargement of the fore brain or cerebrum. It is this part of the brain which accounts for the greater intelligence of the mammals and which is proportionately larger in man than in most other animals.

The skulls of mammals have the brain case comparatively larger than the skulls of other vertebrates, except certain birds which is an accommodation to increased brain size. The roof of the skull is simplified

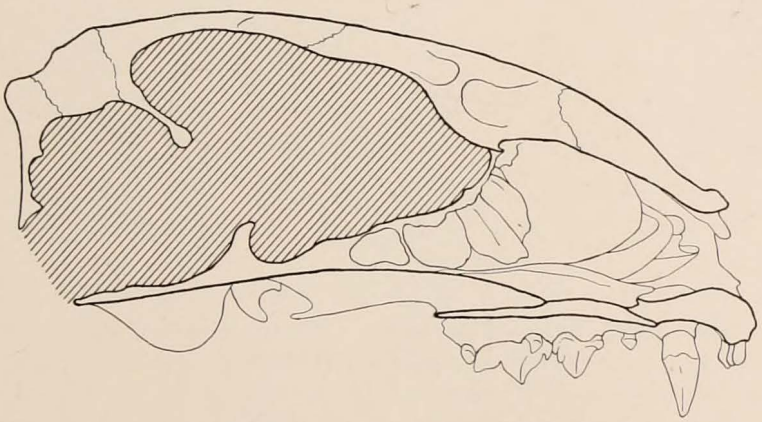
by the loss of a number of bones found in more primitive vertebrates. Similarly the mandible or lower jaw has had the number of bones reduced to one.

In mammals there has developed a secondary bony palate in the roof of the mouth. The skull is hinged on the vertebral column by a pair of condyles in contrast to the single condyle of reptiles.

Mammals have three minute bones in the inner ear which are not represented as such in other vertebrates. The history of these bones has,



THE BRAIN CAVITY OF A REPTILE SKULL



THE BRAIN CAVITY OF A MAMMAL SKULL

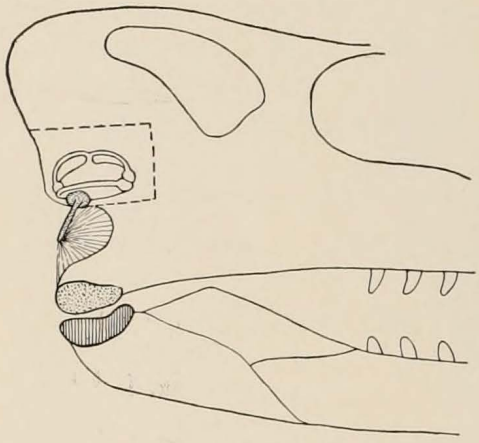
however, been traced. The *incus* or anvil bone is represented in other vertebrates as the *quadrate;* the *malleus* or hammer bone by the *articular* bone of the lower jaw. The *stapes* or stirrup bone occurs in fishes as the *hyomandibular,* and in other vertebrates as the *columella.*

The teeth of mammals are usually more highly differentiated than are those of more primitive vertebrates. Typically they are regionally differentiated from front to rear into incisors, canines, premolars and

molars. In such an animal as a monkey the incisors are used chiefly to cut off food, the canines for fighting, the premolars for further breaking up of food, and the molars for the final crushing. In various types of mammals the teeth are variously modified for special purposes. (**83**).

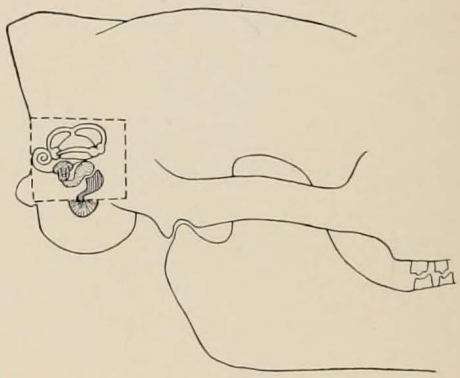
The mammals it is clear, evolved from the reptiles through a fossil group, the Theriomorpha, of which fossils are found in the Permian beds of South Africa. These animals possessed characters of the teeth and skeleton which are distinctly intermediate between those of reptiles and primitive mammals. The exhibits in Case 1 show the skulls of some Theriomorpha and many of the anatomical features by which the mammals and reptiles differ.

In mammals the vertebral column is typically well differentiated into five regions, the *cervical* or neck, the *thoracic* or rib bearing, the *lumbar*, the *sacral* which forms part of the pelvis, and the *caudal* or tail.



REPTILIAN

The forerunners of the mammalian ear ossicles as they lie in the reptile skull. The columella is indicated by horizontal hatching; the quadrate by stippling, the articular by vertical lines



MAMMALIAN

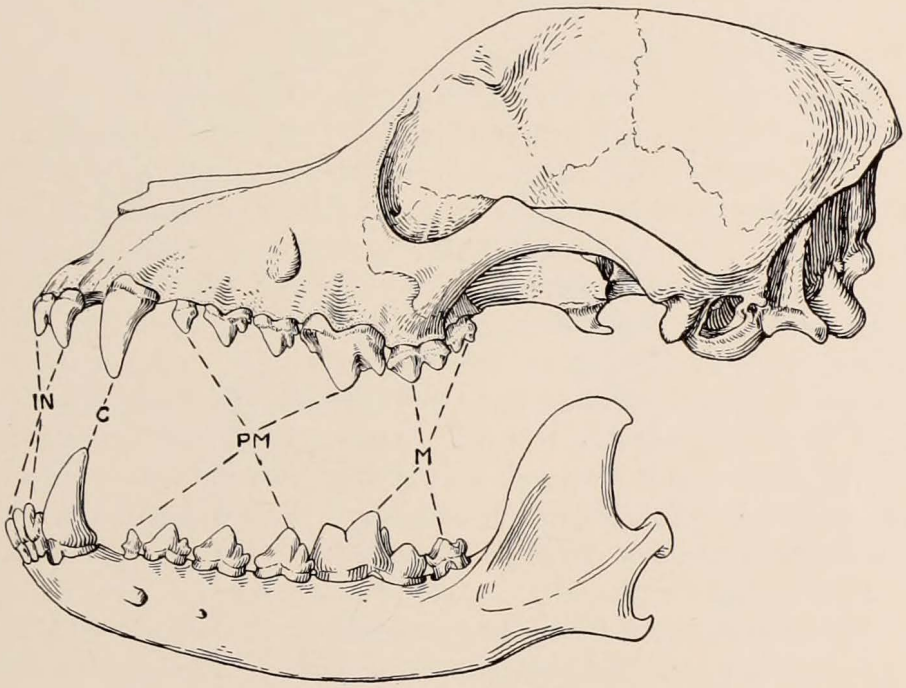
The ear ossicles of mammals. The stapes is the equivalent of the columella, the incus is derived from the quadrate, and the malleus from the articular

In almost all mammals there are seven cervical vertebræ. In the giraffe these are excessively elongated and in the whales excessively compressed. Only in the manatee (**21**) and a species of two-toed sloth (**16**) is the number reduced to six and only in the three-toed sloths is the number increased, here to nine.

The mammals develop bony ends or *epiphyses* on the limb bones (rare in reptiles) and on the vertebræ. It is between these epiphyses and

the shafts of the bones that growth in length takes place. When the sutures between them close growth stops (**23**).

The limbs of mammals are more efficiently constructed for rapid and sustained locomotion than are those of the other quadrupedal land vertebrates. The legs are brought more directly under the body, the length of the bones is usually increased and the joints tend more and more to limit motion to a fore and aft direction.



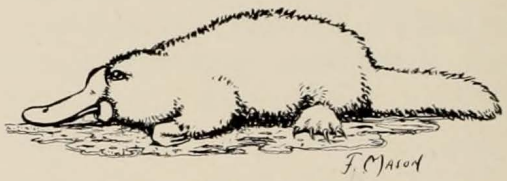
THE DENTITION OF A DOG

In generalized mammals the teeth are differentiated into incisors (IN), canines (C), premolars (PM), and molars (M)

THE LIVING ORDERS OF MAMMALS

MONOTREMATA

ECHIDNA

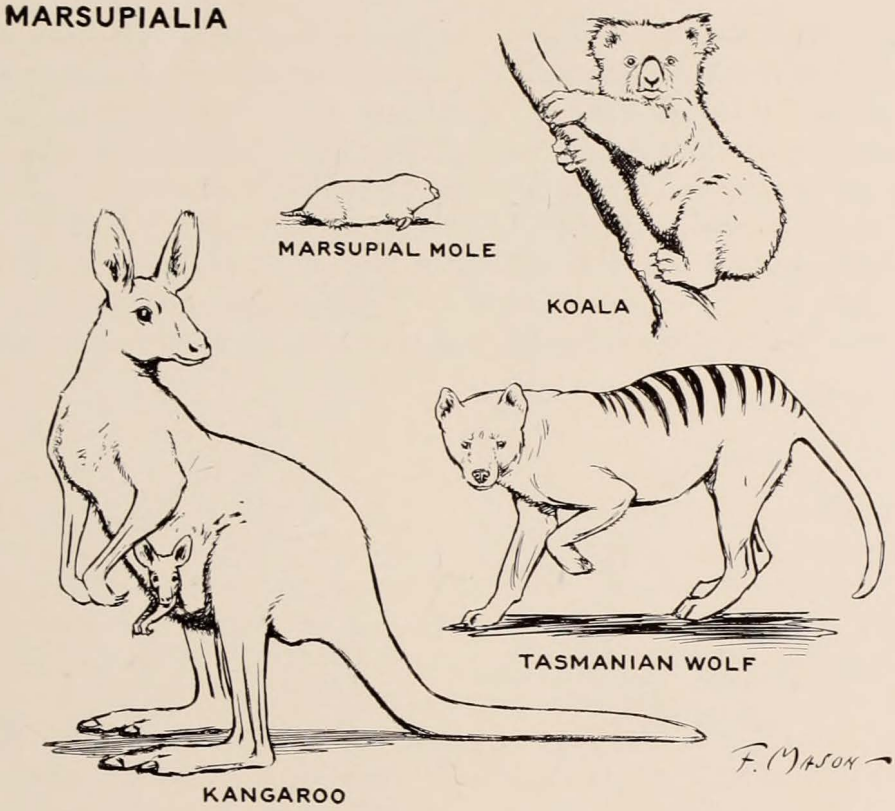


PLATYPUS

Monotremata. Egg laying mammals. Monotremes. (**3**). The monotremes are a small group of archaic mammals confined to the Australian region. They are considered the most primitive of all living mammals because they retain a number of reptilian characters among which are the reptile-like shoulder girdle, low body temperature, and egg laying habit. All higher animals and most primitive forms develop from fertilized eggs. In the monotremes, as in the birds, these eggs are surrounded with a shell and passed from the body shortly after fertilization. They are equipped with a large amount of yolk which serves as a food supply for the developing embryo. Among the higher mammals the fertilized egg contains little yolk and is retained within the body of the mother for the early period of development. The embryo here obtains nourishment from the maternal blood supply. The eggs of such mammals are never equipped with a shell.

The only representatives of the order Monotremata are the echidna or spiny anteater and the duck-billed platypus. These animals, though retaining primitive structures, are highly specialized to particular modes of life. The spines and toothlessness of Echidna are not primitive, nor are the poison secreting fighting spurs, the duck-like bill, webbed feet and horny teeth of the platypus.

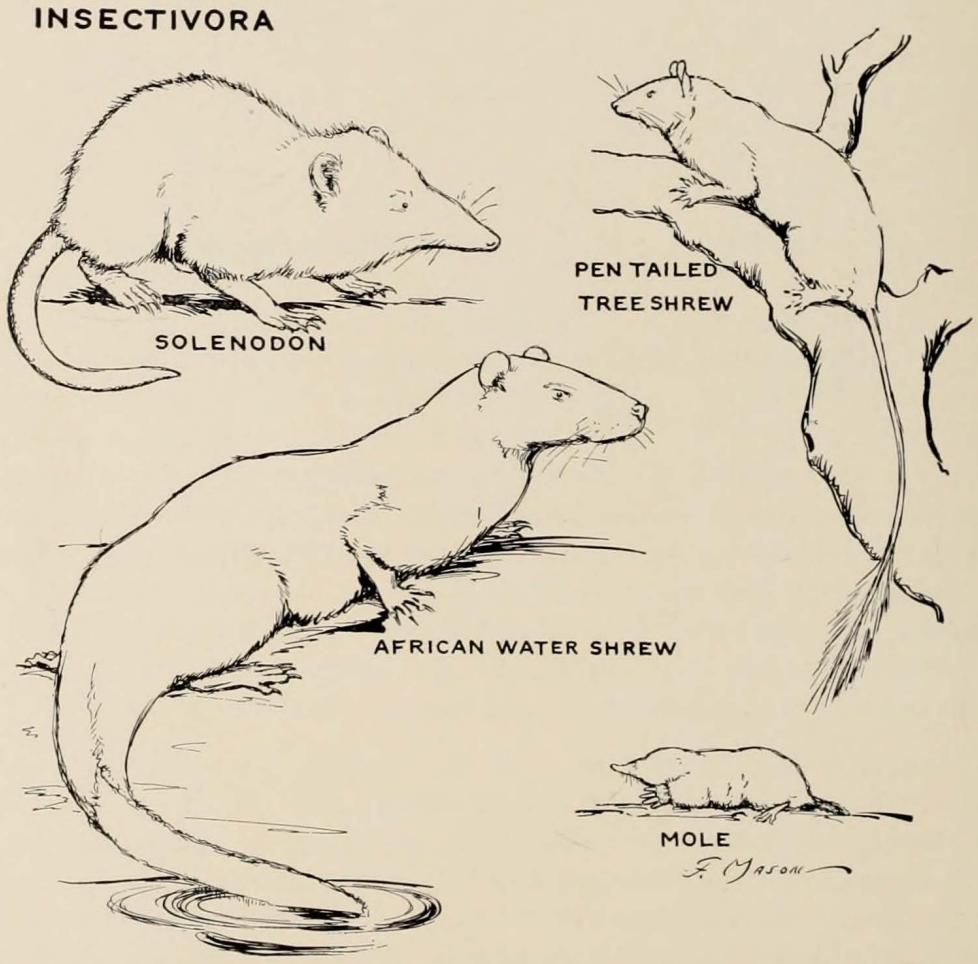
Marsupalia. Pouched mammals. (**4, 5, 52, 28, 29**). The marsupials retain more primitive characters in their structures than any order except the monotremes. They are an interesting and diversified group confined at present to the Australian region except for the opossums and Cœnolestidæ which occur in the Western Hemisphere. In the mammals of this Order the young are born at a very early stage of development and make their way into the pouch of their mother where they become fastened to nipples. In this pouch they are carried until they are able to shift for themselves. (See well-case opposite **4**).



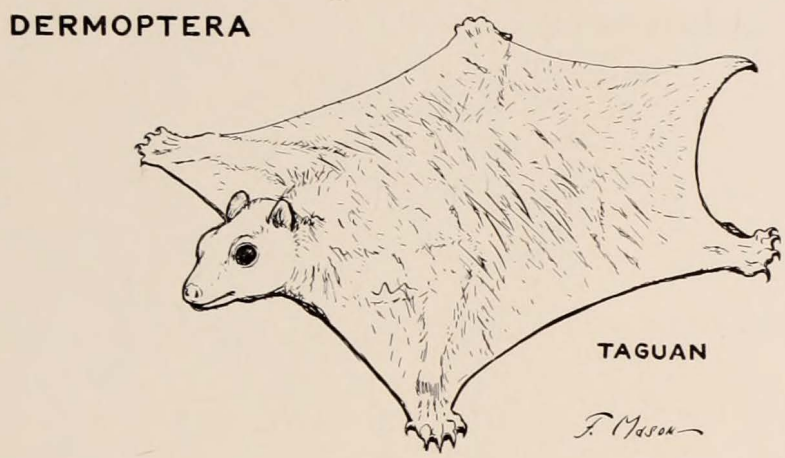
The marsupials have successfully invaded almost every realm of specialization except that of flying. Some leap, others climb, run, sail in the air, swim or dig like moles. Some eat flesh, some insects and others grass. One member of the Order, *Myrmecobius*, the marsupial anteater, possesses 54 to 56 teeth, the greatest number found in any land mammal. Marsupials are the only land mammals of Australia other than monotremes, man, bats, rats and mice, and the wild dog or dingo.

Insectivora. Insectivores. (**6, 7**). The insectivores are small primitive mammals, generally of flesh eating habits, that have survived the struggle for existence in part by the advantage of a high birth rate and the specialization to feeding habits in which few mammals compete with them. The members of the Order obtain their prey of beetles, grubs, worms and snails by burrowing in the earth, by hunting along its surface, by climbing trees, or by swimming. The muzzles of most of them are sharply pointed, a shape adapted to seeking out insects in the small cracks and holes in which they are apt to conceal themselves. Burrowing is best developed among the Talpidæ or moles, and the Chrysochloridæ or golden moles. These animals have modified the feet

into powerful digging members. An opposite extreme of locomotion is attained by the Macroscelididæ or jumping shrews which bound along in kangaroo fashion on their elongated rear legs. The Potomogalidæ or African water shrews have webbed feet and a powerful sculling tail. The tree shrews or Tupaidæ are remarkably like tree squirrels in habits and in appearance. They are of unusual interest to us in that they are probably descendants of the same stock from which the Primates (lemurs, monkeys, apes and men) originated. The hedgehogs or Erinaceidæ are spiny creatures of the old world, and externally resemble some members



of a Madagascar family of insectivores, the Tenrecidæ. The shrews or Soricidæ, whose soft velvety pelage is in extreme contrast to the spiny armour of the hedgehogs, contain among them the smallest mammals of the world. One other family, the Solenodontidæ is confined to a single genus of an ancient stock surviving because of its isolation from modern enemies on the two islands of Cuba and Haiti.

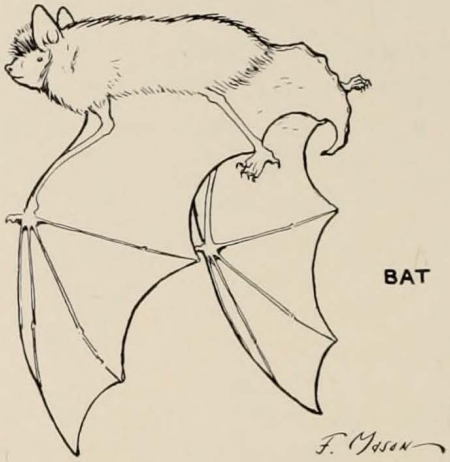


Dermoptera. Taguans. (**7**). The members of this Order are a strange group of oriental mammals which are equipped with large skin folds stretched between the legs and tail by which they glide through the air from tree to tree in the manner of our flying squirrels. One of the peculiarities of the taguans is the unique comb-like edge of the incisor teeth. Their molars are multi-cusped and suited to cutting up the leaves upon which they feed. Though having some characters of the insectivores, the Dermoptera are so entirely different from this group that they are usually placed in an order by themselves. It has been assumed that they are descendants of the same primitive stock as the bats, the tree shrews and the primates. The only English name for the taguans is "flying lemur" which is inappropriate inasmuch as they are not lemurs and do not fly.

Chiroptera. Bats. (**8, 9, 20**). The bats are the only flying mammals. They are not birds in any sense, but like other mammals give birth to living young which feed on milk. Their flying habits limit their modifications, but in spite of this they present a strong diversity, several hundred species havng been described. In size they range from the "flying foxes" of the Philippines (**20**) whose wings attain a five foot spread to tiny insect eating bats which with wings folded could rest on a silver dollar. Bats may be fruit eaters, insect eaters, blood-suckers (the vampires) or, in the case of an Indian bat, may feed on frogs, lizards, small birds, mice and even other bats. A bat of the West Indies has specialized

The comb-like incisor teeth of a taguan

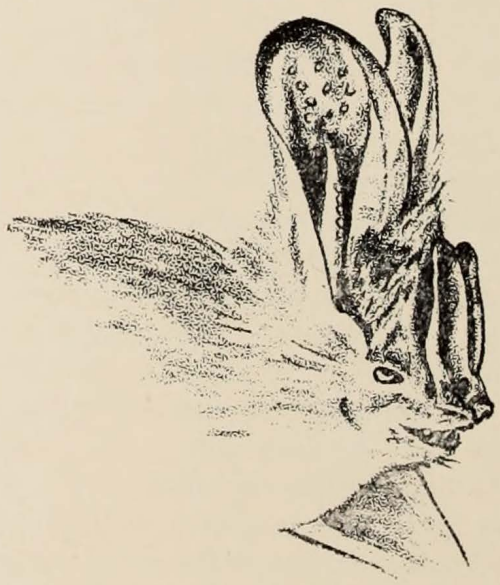
CHIROPTERA



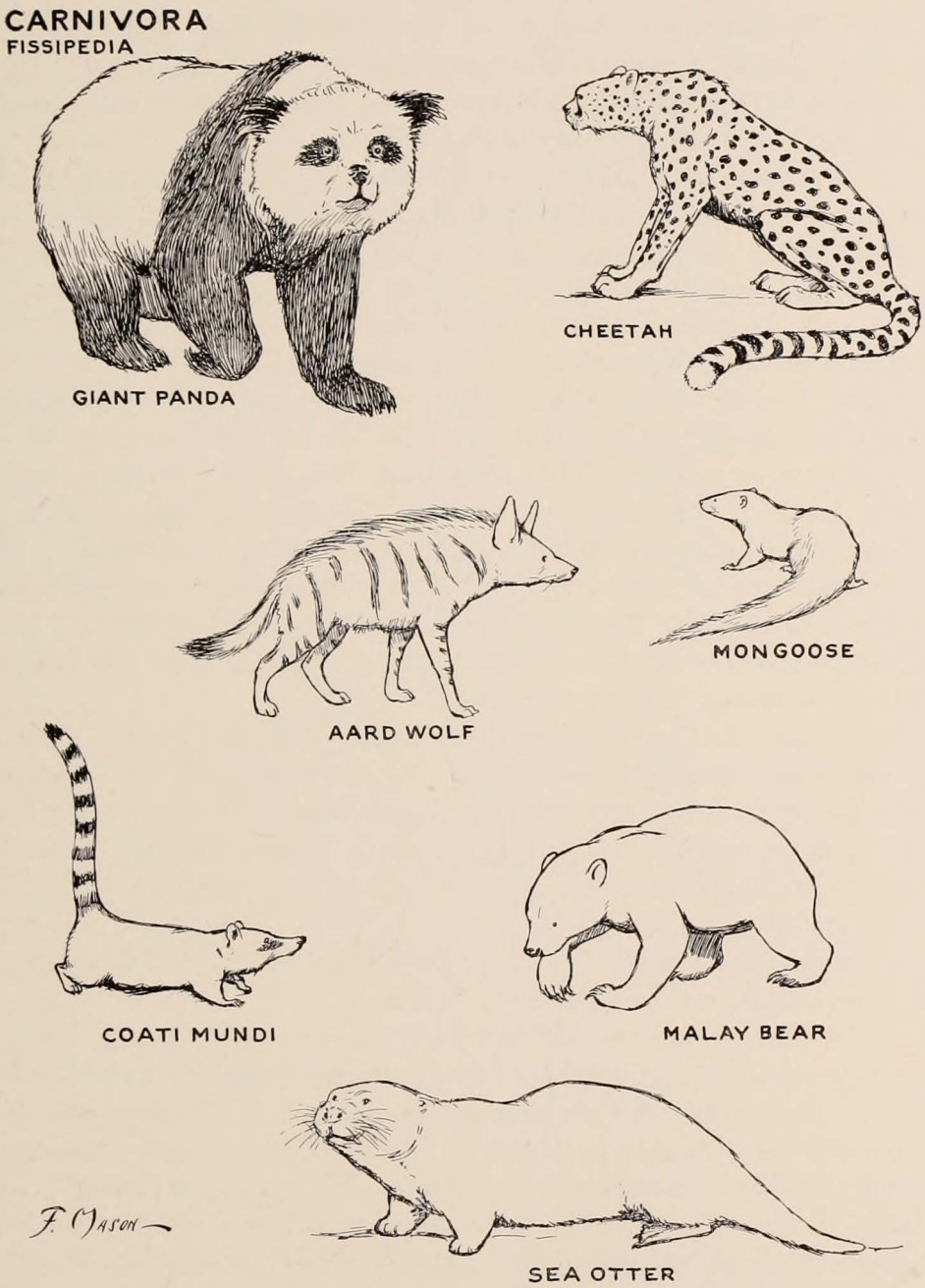
for fish-eating. Bats' teeth present many modifications of this primitive formula and range in number from 38 to 20.

Some bats are noteworthy for the peculiar skin structures developed on the face. These carry sensory nerve endings which are doubtless of great importance to them while flying in the dark. One group of bats bear suction cups on their wings, which enable them to cling to smooth surfaces.

Carnivora. Flesh eating mammals. (**10–13, 51, 53–56**). The carnivores fall naturally into two large groups that are by some consid-



The sensitive ears and skin folds of a leaf-nosed bat



ered separate orders. These are the Fissipedia or terrestrial carnivores, and the Pinnipedia or aquatic carnivores.

The Fissipedia are divided into a number of families which are of such universal interest that they may be separately characterized.

The Viverridæ, which are not represented in the New World, are

typified by the civets, genets and mongooses. One form, the fossa (*Cryptoprocta*, **53**) found in Madagascar is very cat-like. The mongoose of India is famous as a snake killer. From the civets comes a powerful musk used as the base for many perfumes.

The Hyænidæ include several African and Asiatic species which on occasion take living game but typically live off such carrion as they find at the kills of the big cats or other predators. A small relative of the hyænas, the aardwolf of Africa, subsists largely on white-ants and as other animals of similar food habits has a reduced dentition. This animal is placed in a family of its own, the Protelidæ.

The Felidæ or cats, lions, tigers, lynxes, leopards, cheetahs and others are lightly built carnivores with claws which (except in the cheetah) are retractible. They have short heads and, usually, long tails which, however, are never prehensile. The canine teeth of cats are unusually long and well suited to seizing and killing their victims. The cheek teeth are modified into sharp edged shears for slicing up the meat on which they feed. The most aberrant of the family is the cheetah or hunting leopard of Africa and Asia It is capable of great speed and is sometimes trained to hunt with men.

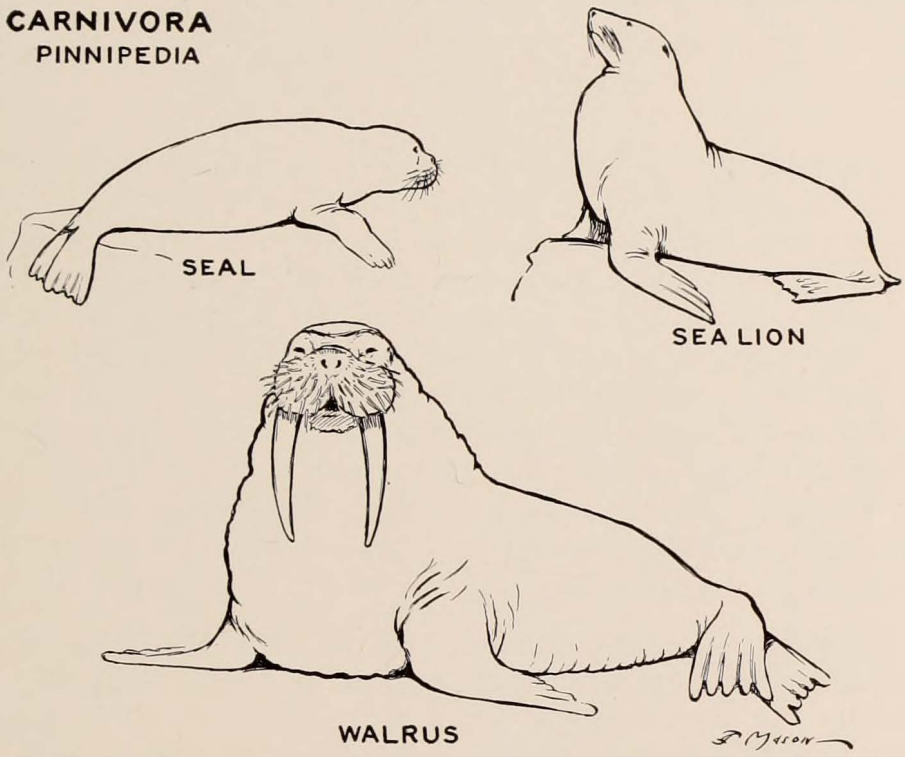
Amongst the Canidæ are wolves, jackals, dogs and foxes. They are all predatory creatures who usually obtain their prey by running it down rather than by using stealth. Among the more interesting species are the large eared fennec foxes, the short legged, web toed bush dog (*Icticyon*) of South America, and the hunting dogs of Africa, whose coat resembles that of a hyæna.

Exhibits of domestic dogs may be found in Section I on this floor, and also in the Darwin Hall on the first floor.

The Mustelidæ are differentiated as weasels, skunks, badgers, otters, wolverines and others. The family produces some of the finest furs, of which the ermine, sable and mink are well known examples. The most valuable skin individually is that of the sea otter, an animal that is as independent of land as a sea lion. Though once abundant in the North Pacific, this animal is now almost extinct as a result of exploitation. A single hide of this animal has been sold for as much as $1,400.

The Ursidæ or bears, are large massive animals with rudimentary tails and, ordinarily, shaggy fur. They are omnivorous in their feeding habits and their teeth, in consequence, are not highly specialized. Interesting members of this group are the polar bear, most aquatic of its family, the spectacled bear of the Andes, the little Malay bear which feeds mostly on fruits, and the giant brown bears of Alaska, the largest of living carnivores.

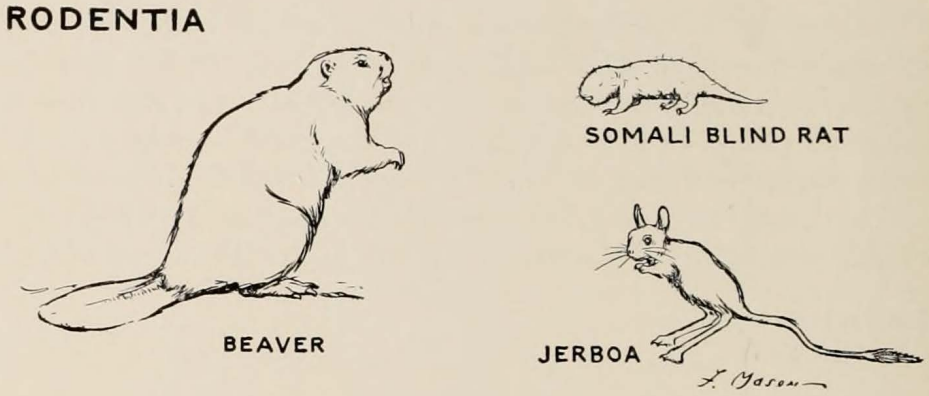
The Procyonidæ are American and Asiatic. The raccoon is here the most familiar member. The kinkajou, or honey bear (**54**), is a prehensile tailed species living in the American tropics, where one also finds the coati-mundi (**54**), a form with a long pig-like snout of good service in foraging along the forest floor. The panda, a handsome long-haired animal, brilliantly marked in red, black and white, lives in the Himalayas. In neighboring territory is found the giant panda (**56**) a rare bear-like



creature, said to feed largely on bamboo shoots. This unique animal, now placed in a family to itself (Aeluropidæ) combines characters of bears and procyonids.

The Pinnipedia or fin-footed carnivores are animals which have taken to aquatic life but which have not lost their dependence of land or ice fields for the birth of their young. The seals, sea lions and walrus which compose this suborder, represent well separated natural groups.

The true seals or Phocidæ are the most aquatic members of the order. Their hind feet are so bound together that they are unable to put them forward and can use them only for sculling action. The teeth which are sharp and often recurved are useful for seizing fish and other creatures upon which they prey, but are useless for cutting up the food.



The eared seals or sea lions (Otariidæ) have small external ears and like land mammals can place their hind feet forward for walking. The fur seals of the Pribilof Islands, of which good photographs are on exhibition in Sec. 2 on this floor, are commercially important members of this family. The California sea lion, often seen in circuses and on the stage, can be trained to do a remarkable series of tricks. The walruses (Odobænidæ) are somewhat intermediate between the eared seals and the earless seals. They are noteworthy chiefly for their long-upper canine teeth (tusks), which are used for digging up the clams on the ocean floor and for fighting. The flat and massive cheek teeth are adapted to breaking up the heavy shelled molluscs upon which they live. At present they survive only in the Arctic Seas.

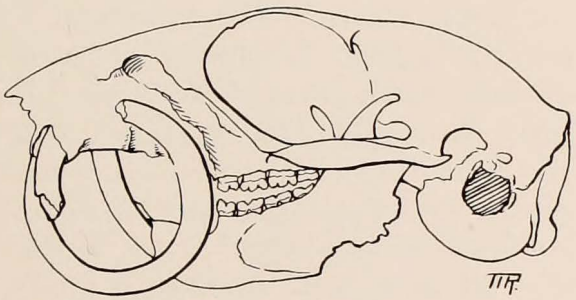
Rodentia. Gnawing animals. (**14, 15, 57**). The rodents are to the Mammalia what the insects are to all the animal kingdom, each eminently the most successful group in its field. Over 2000 species have been described, and these are spread all over the world with the exception of the Antarctic continent and a few remote Pacific islands inhabited only by bats. The rodents have adapted themselves to almost all types of life that other mammals have mastered. The great majority are however small inconspicuous rat-like creatures. The beaver, the muskrat and some others have taken to water life. The pocket gophers and mole rats have become almost as specialized for tunneling habits as have the moles. The jerboas, kangaroo rats and springhaas hop along on their rear feet as do the kangaroos. Some squirrels and other rodents are well adapted to tree living.

The diet of rodents does not vary to extremes. The dental equipment of all of them consists of four large chisel-like incisor teeth in front, a toothless diastema in the region of the lost canine, and a set of

grinding cheek teeth. The incisors consist of a strong band of enamel on the front surface backed by a core of dentine. The teeth working against each other wear away the soft dentine and leave cutting edges of enamel in front. As these teeth grow throughout life the rodent must gnaw to keep them in working order. When anything occurs to interrupt gnawing the teeth grow out in circles, which eventually prevent the animal from obtaining enough food to sustain life. Such deformed teeth may be seen in Case 67. To the rear of the gnawing teeth the lips fold in to form a curtain of skin which prevents splinters of wood, earth or other unwanted material which the animal is cutting, from entering the mouth.

The rodents are divided into many divergent groups. The most important of the sections of the Order are the following:

Lagomorpha. Hares, rabbits, pikas. These animals, which are so distinct from the other rodents, that it is sometimes questioned that they arose from the same stock, are characterized by the presence of two minute peg-like teeth immediately behind the large upper incisors.



RODENT INCISORS GROW THROUGHOUT LIFE
This squirrel suffered an accident to its mandible which resulted in faulty occlusion of its chiseling teeth. When these no longer wore against each other the teeth grew in circles

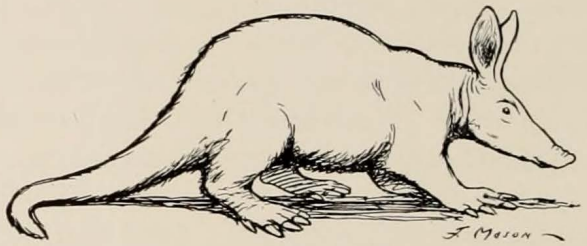
Rabbits and hares are known to all. The pikas are small relatives with short legs, short ears, and no tail. Usually, the pikas live among the rock slides of mountains, though they are occasionally found at low altitudes.

Sciuroidea. Squirrel tribe. This group of rodents contains such diverse types of animals as squirrels, woodchucks, kangaroo rats, pocket gophers and beavers.

Muroidea. Rat tribe. The most wide spread of the rodents are the Muroidea. While the best known types, the house rat and the house mouse are unattractive and are serious pests, numerous others, such as the European dormice are very pretty and interesting. By far the greater number of species are not enemies of man but are either neutral, or his benefactors.

Dipodoidea. Jerboa tribe. Though the long legged bipedal jerboas are the characteristic members of this sub-order, several other

TUBULIDENTATA



AARD VARK

families of rodents, among them the scaly tailed flying squirrels of Africa, the American sewellel, and the horned rodents of the Miocene age seem to belong here as distant relatives.

Hystricoidea. Porcupine tribe. The rat tribe is currently the most successful of the rodents, but the porcupine tribe seems to represent the culmination of rodent evolution inasmuch as its members are most highly adapted to the life of cutting and grinding vegetable matter. The porcupines are not the only members of the group. Others are guinea pigs, chinchillas, agoutis, and the largest of all rodents, the capybara (**57**). Though almost world-wide in distribution they are predominantly South American.

Tubulidentata. Aard varks. (**58**). The aard varks, (the name means "earth pig" and was applied to them by the Dutch colonists of South Africa) constitute the only instance of an order being represented by a single living genus. These animals feed almost exclusively on white ants or termites which they dig out with their powerful fore legs. The teeth of the aard-vark are simple cylinders of dentine which are traversed from base to crown by hundreds of minute passages.

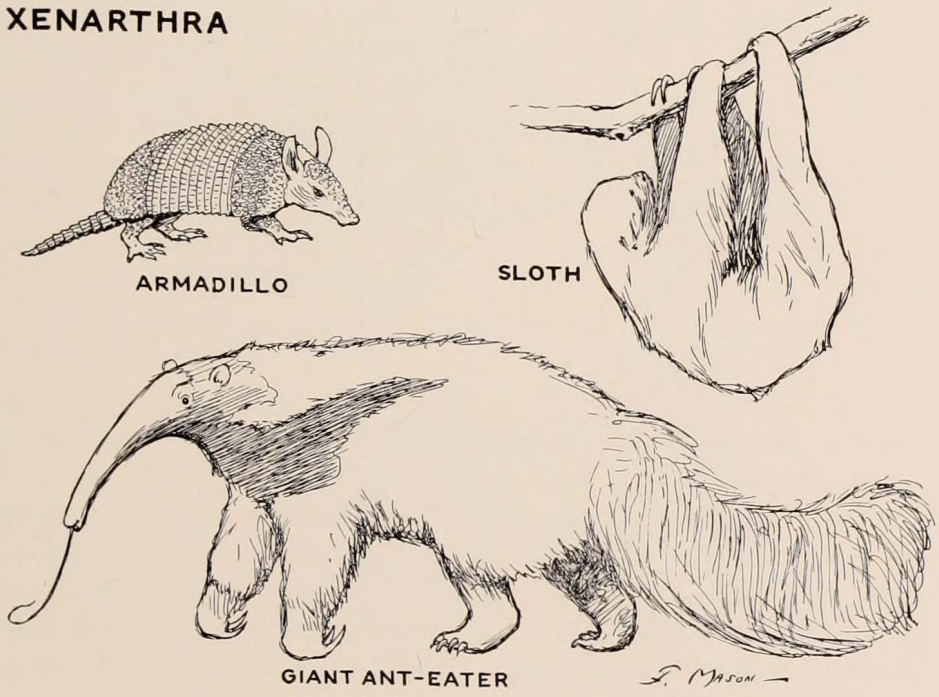
The principal foes of the aard-arks, other than arch-destroyer man, are the lions, the wart hog and the python. The lions feed upon the succulent aard varks and the latter two dispossess these termite eaters of their extensive underground retreats.

Aard varks, though known as fossils from Madagascar, Greece, India and Wyoming, are today confined to Africa. Their palaeontological record is, however, fragmentary, and offers little evidence as to their immediate antecedents. The evidence of comparative anatomy indicates that this Order arose from the fore-runners of the ungulates and that the early tube-toothed termite eaters followed an evolutionary course not dissimilar to that of the hyraxes.

Xenarthra. American edentates. (**16, 50**). The anteaters, sloths and armadillos, though all related, externally have little in common. In spite of the fact that they are called edentates, only the anteaters are truly toothless.

The anteaters have long heads which accommodate the long sticky tongue with which they catch ants. The giant anteater or ant-bear (**50**) of South America, the largest of the order, attains a length of about five feet, much of which is in its great, bristly, brush-like tail. The tamandua (**16**) or arboreal anteater, is smaller and carries a prehensile tail. The two toed anteater is also prehensile tailed and arboreal, but is only as large as a squirrel.

The sloths are so modified for tree life that they habitually hang back downwards and walk with great difficulty on the ground. The feet and



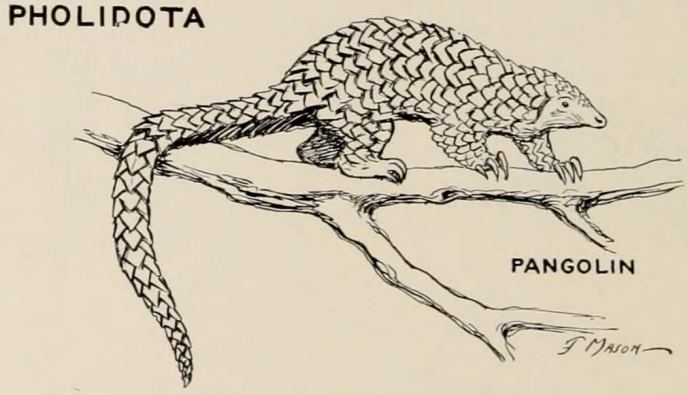
claws are modified into great hooks that circle the branches. The fur which is long and coarse, in one species harbors a growing green plant, (alga) which gives the animal a greenish tinge and makes it very inconspicuous up in the foliage.

Ground-living sloths existed in North and South America until recent times. Some of these grew to be as large as Indian elephants. Skeletons of these are on view in the Hall of the Age of Man.

The armadillos carry on their backs a jointed armour that contains bone. When attacked they roll up in this shelly armour and form an almost impregnable ball.

Only one species is found in the United States, the nine-banded armadillo. In South America lives a pygmy armadillo, the pichiciago (**16**) which dwells under ground, and carries on its rump a solid plate of bone firmly attached to the pelvis. With this it is said to block up its burrow. The largest armadillo attains a length of about three feet. A fossil related group, the Glyptodonts, sometimes attained a length of sixteen feet. Their great shells lying on the Pampas are said to have served as shelters to the first white visitors.

Pholidota. Scaly anteaters. (**17**). In Asia and Africa occur animals known as scaly anteaters, manids or pangolins. Externally they are all



much alike and bear a curious flexible coat of horny scales which probably represent fused bundles of hair or hair rudiments. The scaly coat of the pangolins serves them in many ways. Like the armadillos when attacked, they will curl up into a round ball that presents no soft parts to the enemy. When one of the tree climbing species falls it quickly curls up into a ball, and so efficient are the scales in absorbing shock that even a drop from a great height inflicts no injury. Feeding on ants as they do, pangolins are subject to the vicious attacks of swarming hoards of these biting stinging insects. Here again the smooth scales serve their wearer in good stead for a rapid quivering movement of the body sends the ants flying in all directions. The sharp edged scales of the tail are sometimes used against larger foes, and a hand caught between the scales of the tail and the body may be badly lacerated. Some of the pangolins are arboreal. In these forms the tail acts as a prop when they are climbing, and is so prehensile that it is used as a fifth arm.

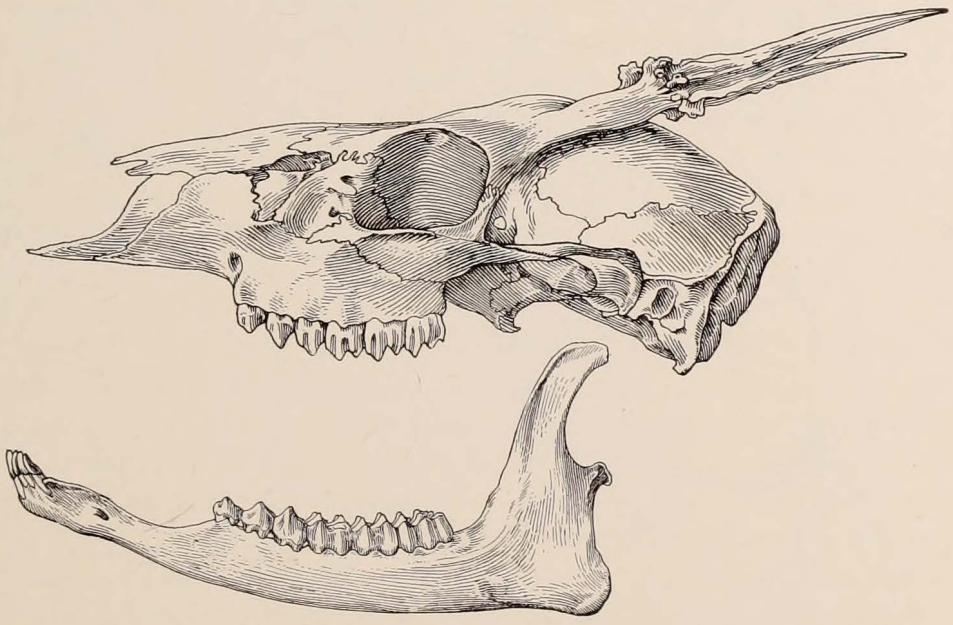
Artiodactyla. Even-toed hoofed animals. (**18, 60**). The artiodactyls are usually large animals, important to mankind in the region in which they inhabit. In the Order the main axis of the foot always passes between the third and fourth digits which are capped with hoofs. The following families constitute the group:

The Suidæ and their close relatives the Tayassuidæ are the pigs and the peccaries which may be identified by their flat-ended snouts and short tails. The diet of all of them is omnivorous.

The Hippopotamidæ are almost hairless, thick skinned aquatic vegetarians. The only living forms are the giant hippopotamus, widespread in Africa, and the pygmy hippopotamus of Liberia. Though these animals secrete a carmine colored fluid from the sweat glands they do not sweat blood as is commonly supposed.

The Tragulidæ or chevrotains (sometimes called mouse deer) are diminutive creatures living in southern Asia and West Africa. They are somewhat intermediate between pigs and deer. Their feet are pig-like, their stomachs have three divisions and the upper jaw bears long saber-like canine teeth.

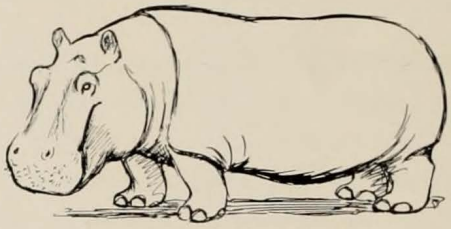
The Camelidæ are two-toed artiodactyls with a long prehensile upper lip, long necks and legs. They all have thick, long hair which is extensively used for wool. The feet are protected by soft pads of skin.



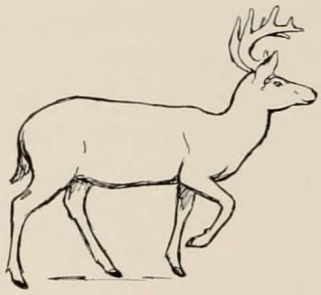
The deer skull typifies the ruminants in which group there are no upper incisors to oppose those in the mandible

ARTIODACTYLA

WART HOG

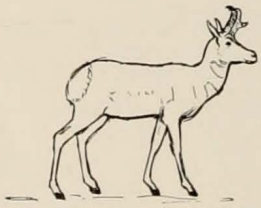


HIPPOPOTAMUS



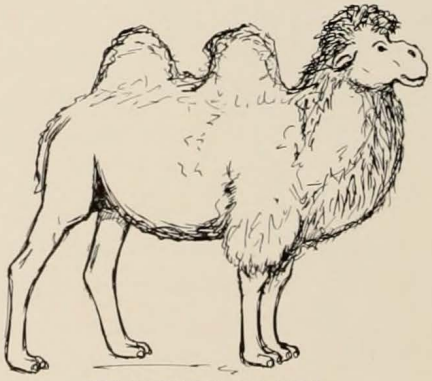
DEER

IBEX



PRONG HORN

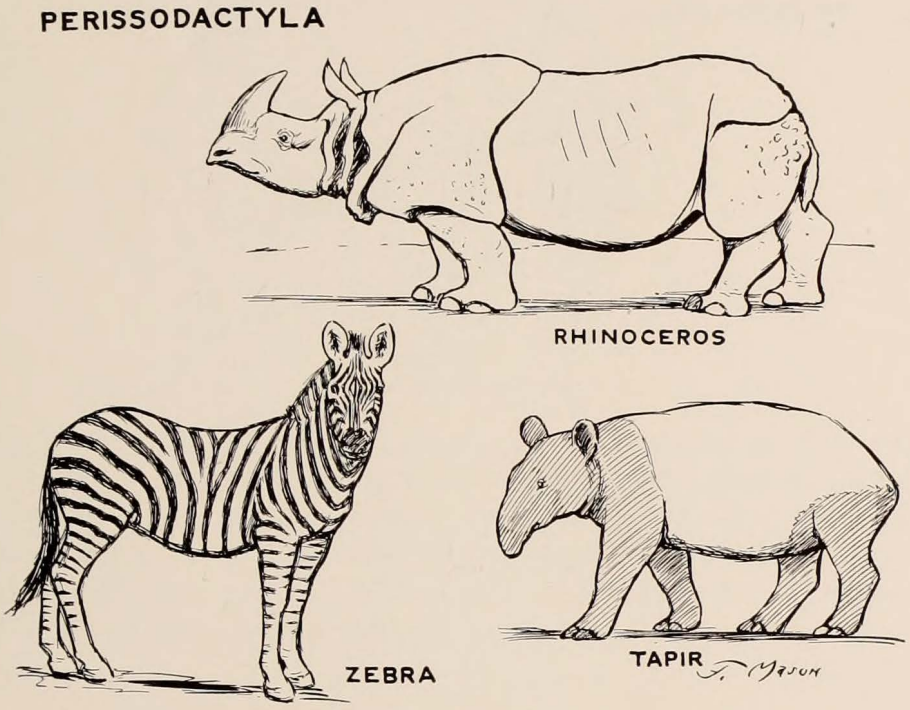
CHEVROTAIN



BACTRIAN CAMEL

GIRAFFE

F. MASON



The two species of camel are domesticated. The one-humped species ranges from North Africa to Central Asia. The two-humped or bactrian camel is exclusively Asiatic. In South America the llamas and several allied animals inhabit chiefly the Andean region where two of them, the llamas and vicunia are used as beasts of burden.

The Cervidæ, a family composed of the deer, the moose, reindeer and their allies, are typically species which develop bony antlers which are shed annually. In the caribou and reindeer, both sexes bear antlers, but in other Cervidæ the males only have these fighting weapons. Two aberrant forms, the musk deer and water deer do not have antlers but are equipped with fighting tusks.

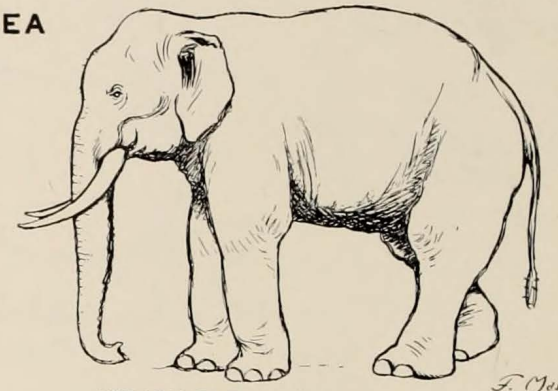
A wide variety of the deer of the world is shown in the Hall of Asiatic Mammals and the Hall of North American Mammals.

The Giraffidæ have skin covered antlers on the skulls. In the okapi, a little known animal of the Congo, these occur on the male only. In the giraffes they are found on both sexes.

The Antilocapridæ contains only the American pronghorn, the only animal which has branched hollow horns, and the only hollow horned mammal in which the horns are periodically shed.

The Bovidæ, a family including the oxen, antelopes, sheep and goats, are the hollow horned ruminants whose horns are not periodically shed.

PROBOSCIDEA



INDIAN ELEPHANT

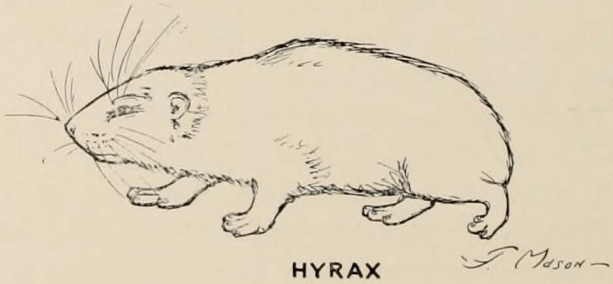
These horns are in most species present in both sexes, though they are larger in the male. As in the Giraffidæ and Cervidæ, teeth are absent in the front of the upper jaw. The stomach, as in other animals which "chew the cud" is a complicated organ with four compartments, and the intestines are extremely long. This sort of digestive apparatus enables the possessor to get the most out of the flesh-making constituents of the vegetation.

Perissodactyla. Odd-toed ungulates. (**19, 59, 80**). The Perissodactyla, or tapirs, rhinoceroses and horses, are hoofed animals in which the central axis of the foot passes through the third digit which is always large and symmetrically shaped. In the Equidæ, or horses and zebras, this is the only digit left. The tapirs have four toes on the front feet and three on the rear. Among the rhinoceroses there are three toes on each foot.

The tapirs, horses and rhinoceroses, though now most diverse, were in Eocene time very much alike.

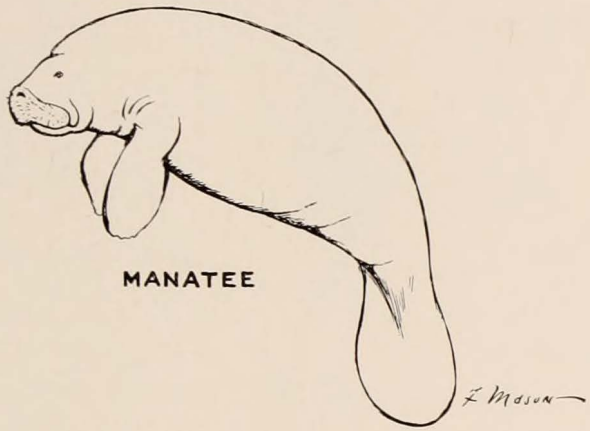
Proboscidea. Elephants. (**19**). The African and Indian elephants are the largest land living mammals, but they do not compare in bulk to the whales. Their exceptional tusks, trunk and many other character-

HYRACOIDEA



HYRAX

SIRENIA



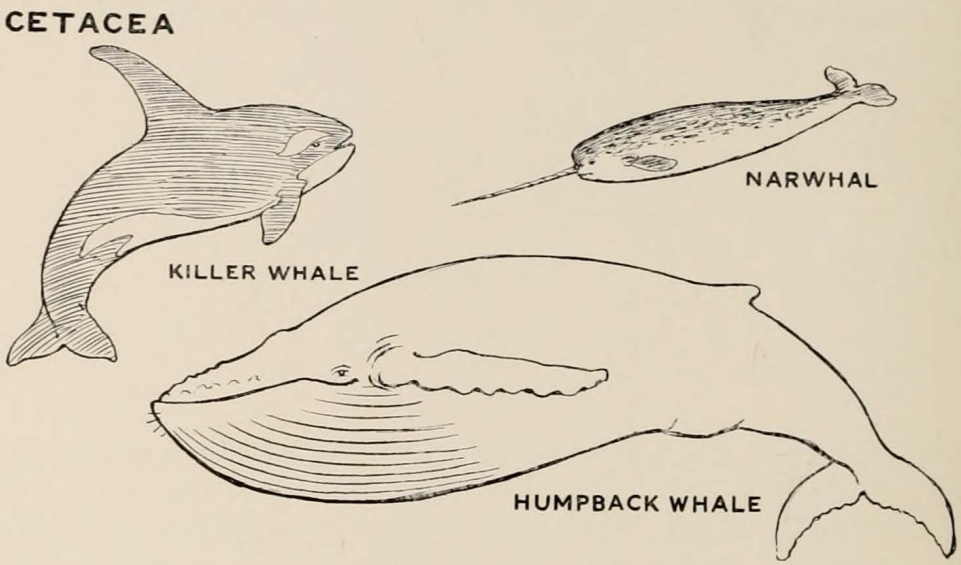
istics set them widely apart from all other mammals. The trunk, which has evolved from a shorter proboscis such as that of the tapirs, is the elephant's indispensable possession. With it he can pick up anything from a peanut to a heavy log. It serves him when he raises water for drinking, dusts or fans himself.

The evolution of the elephant is well illustrated by an extensive series of fossil elephants which may be seen on the fourth floor.

Hyracoidea. Hyraxes. (**19**). These small rabbit-like animals are, strange though it may seem more closely related to the elephants than to any other existing mammals. On their toes are small rounded hoofs, and on the soles are singular suction pads which give the hyraxes the power to climb trees and rocky surfaces. Their range covers most of Africa and Arabia. It is these animals that are called conies in the Bible.

Sirenia. Sea cows, manatees, dugongs. (**21**). The Sirenia are naked-skinned aquatic animals that, like the whales have lost their rear limbs and have developed a horizontal fleshy paddle on the end of the tail. Their bones especially in the manatee, are dense and heavy a conditon suited to their bottom feeding habits. In contrast to other mammals, their vertebræ lack epiphyses. The existing species all have teeth, but the rhytina had in their place heavy horny pads. The Sirenia are today inhabitants of warm quiet seas and tropical rivers, but the rhytina, which was exterminated by man less than two hundred years ago, lived among the Aleutian Islands.

It is probable that the myth of the mermaids had origin in distant glimpses which sailors had of these animals. With their heads out of water, and sea weed streaming from their mouths, or with a young one held up to the breast, the animals could easily give the illusion of being half human.

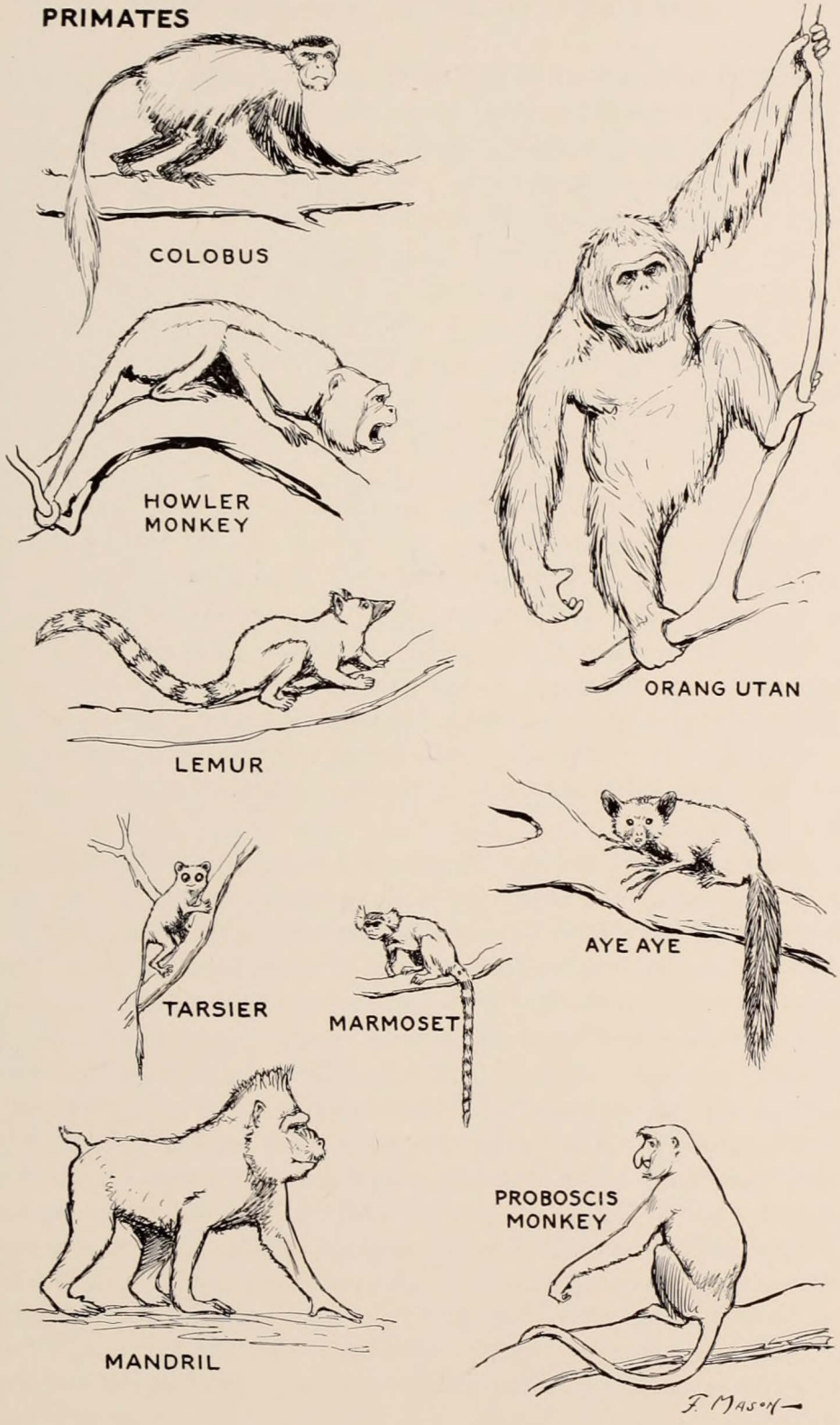


Cetacea. Whales, porpoises, dolphins. (**26**). The Cetacea are exclusively aquatic mammals which have completely lost their rear limbs, but which in some forms retain a small pair of bony rods deeply imbedded in the flesh that from muscular relations are recognized as the ischia of the pelvic girdle. The tail bears a pair of horizontal flukes that are without bony support, but which probably do all the work of propelling. Unlike the fishes, the whales breathe air into the lungs and do not possess gills. The "spouting" of certain species of whales is due to the condensation of water vapor leaving the lungs and striking the cold air. As other mammals, the whales are warm blooded, their young are born alive and are nourished on milk. The few hairs of the adults are found about the head.

Among the Cetacea are the largest mammals that have ever lived. The longest specimen ever measured was a blue whale of one hundred and three feet.

Primates. Lemurs, monkeys, apes and men. (**30**). The Primates are, on the whole, a primitive group, but certain specialized forms occur among them. Within the Order the orbit of the eye is protected by a ring of bone or is completely walled off.

Most Primates live an active life in the trees and this environment has left an indelible stamp on the whole group. All four feet are more or less hand-like, the thumb and great toe being set off at an angle to the others so that the feet are able to grasp limbs quickly and firmly. The feet of man are modified for terrestrial existence and the great toe is


PRIMATES
COLOBUS
HOWLER MONKEY
ORANG UTAN
LEMUR
TARSIER
MARMOSET
AYE AYE
MANDRIL
PROBOSCIS MONKEY
F. MASON

held parallel to the others, but there are still vestiges of the muscles that in our ancestors made this great toe an efficient grasping organ

The brain also reflects the arboreal life of the Primates. Centers of alertness, of intelligence and sight are large, while the brain center connected with smell is poorly developed.

The Lemuridæ are the most primitive members of the Order, the less modified of them have long fox-like skulls, and long tails and are arboreal in their habits. Though found chiefly in Madagascar, specialized forms such as the pottos and galagos, (bush babies) are found in Africa, while others, the lorises, occur in southern Asia. As fossils the lemurs are known from America and Europe as well as from the lands they now inhabit.

The most remarkable of the lemurs is the aye aye (*Daubentonia*) whose rodent-like incisor teeth are used to tear open the tunnels of wood-inhabiting insects, and whose third finger is transformed into a long thin searching probe for extracting the grubs upon which it feeds.

Most aberrant of the primates, possibly excepting man, is the tarsius (*Tarsius spectrum*) which has the hind feet extraordinarily elongated and possesses eyes that are so large that they very nearly touch in the middle. It is also noteworthy for its ability to turn its head in so great an arc that it is able to look directly backwards without twisting its body.

The monkeys of the New World are easily separated from those of the Old World by the character of their noses. In the former group (Platyrrhines) the nostrils are broadly separated, while in the Old World monkeys (Catarrhines) the nostrils, as in men, are close together. Other characters which are chiefly internal also separate the groups.

The New World monkeys may be divided into two families, the Hapalidæ and the Cebidæ. The Hapalidæ or marmosets are small creatures with non-prehensile tails and thumbs which are nonopposable and which, except on the great toe, bear claws instead of nails. The Cebidæ are South and Central American monkeys which usually have prehensile tails. The most familiar are the little capuchin monkeys (*Cebus*) which are common objects in zoological parks. The male howling monkeys possess enormous bony throat pouches which give their voices such tremendous power, that their calls may be heard for two miles. The spider monkeys are species with very long arms, legs and tails. The night monkeys are forms with large eyes that aid in the nocturnal wanderings.

The Old World monkeys (Cercopithecidæ) are most typically represented by the macaques of Asia and the members of the genus *Cercopithecus* of Africa. These animals have ischial callosities and, occasionally, cheek pouches, but never have prehensile tails. Specialized forms of interest are the baboons, dog-like semiterrestrial forms with long faces, powerful bodies and, usually, bad tempers. The mandril of West Africa is the most colorful of all mammals. The Abyssinian colobus monkeys are strikingly furred in black and white. It is the long hair of these animals that is sometimes used for trimming of women's wraps. A group of these monkeys may be seen at the entrance to the Primate Hall. The proboscis monkeys of Borneo are leaf eaters with enormous abdomens. Their name is given for the noses of the males which are very long and pendulous. A rare Asiatic primate, the snub nosed or golden monkey has a short nose turned up at the tip.

The remaining group of sub-human primates, the Anthropoid apes (Pongidæ) contains but five genera, the gibbon (*Hylobates*), the closely related siamang (*Symphalangus*), the orang utan (*Pongo*), the chimpanzee (*Pan*) and the gorilla (*Gorilla*). As man is so closely related to these animals some authors include him in the family, but usually he is placed in one apart, the Hominidæ, characterized by unusual enlargement of the forebrain, and upright posture.

The gibbons and siamang are extremely arboreal types whose hands almost touch the ground when the animal is standing upright. Both genera live in the Malayan countries. The orang utan is a large, tree living, red-haired ape inhabiting Borneo and Sumatra. Chimpanzees and gorillas are closely related forms living in the forested regions of central Africa. The gorilla attains the greatest bulk of any primate. Though features of advanced age mask the similarity, gorilla and man are much alike and probably arose from the same primate stocks in Miocene time.

The visitor who wishes a more comprehensive view of the primates than is obtainable in this Hall may see a wide variety of representative types mounted and as skeletons in the adjoining Primate Hall. One interested in the record of fossil man would do well to visit the Hall of the Age of Man on the fourth floor.

MAMMALIAN BIOLOGY ILLUSTRATED IN THIS HALL

Though the greater part of this Hall is devoted to a systematic arrangement of the principal orders and families of mammals, it has also been attempted to illustrate a few of the more interesting aspects of mammalian biology.

The synoptic series of mammals illustrates to some extent the range of variation in adaptation to environment. In addition to this there are special exhibits which illustrate particular phases of the adaptive radiation of mammals.

ADAPTIVE RADIATION IN THE LOCOMOTOR APPARATUS

As animals of different ancestry have adopted similar modes of life they have tended to become similar in some of their features. Thus the whales and the manatees, mammals of totally different ancestry have both lost the greater part of their hairy coats, rear limbs and external ears, while both have modified the fore limbs into paddles and developed a horizontal fluke on the tail. There are innumerable instances in the animal kingdom of animals that look alike externally and yet are fundamentally different Several examples of this principle have been assembled in case 29. This approximation of dissimilar stocks is called *convergence.*

Aquatic Adaptations

The most specialized aquatic mammals are the Cetacea, or whales and porpoises, illustrated by the life-sized model of a sulphur-bottom whale suspended from the ceiling, the porpoises above the cases, and by scale models of other whales in Case 26. Other less modified aquatic animals illustrated are the seals and sea lions (**12, 28**), the otter (**29**), the Congo water shrew (**6, 29**), the desman, an European insectivore (**29**), the manatees and dugongs (**21**), muskrat (**29**) beaver, and platypus (**3**). Specialization for aquatic life results in modification for warmth in cold water which may be a thick layer of fat, as in whales where it is known as blubber, or the development of a thick water resisting fur, as in the muskrat. Food habits become specialized too, and the food catching structures are modified accordingly. One group of whales has developed horny plates of baleen (**26**) for straining minute animal life from the water. The teeth of the seals are specialized for catching fish, while the teeth of the walrus are heavy and plate-like for cracking clams. The rhytina (**21**) which fed on soft marine plants, had lost all of its teeth.

The locomotor apparatus is highly modified. The fore limbs may become paddles (Sirenia, Pinnipedia) and the hind feet may be bound together (seals) or entirely lost (Cetacea, Sirenia). In less specialized aquatic animals the toes become webbed. The tail is often an important propulsive organ (Cetacea, *Potomogale*). The bones of the manatee are very dense and heavy to enable it to remain submerged while feeding.

Skeletons of aquatic animals are displayed in Cases 6, 21, 22, 26. Skeletons of the larger whales are on view in the Hall of Ocean Life.

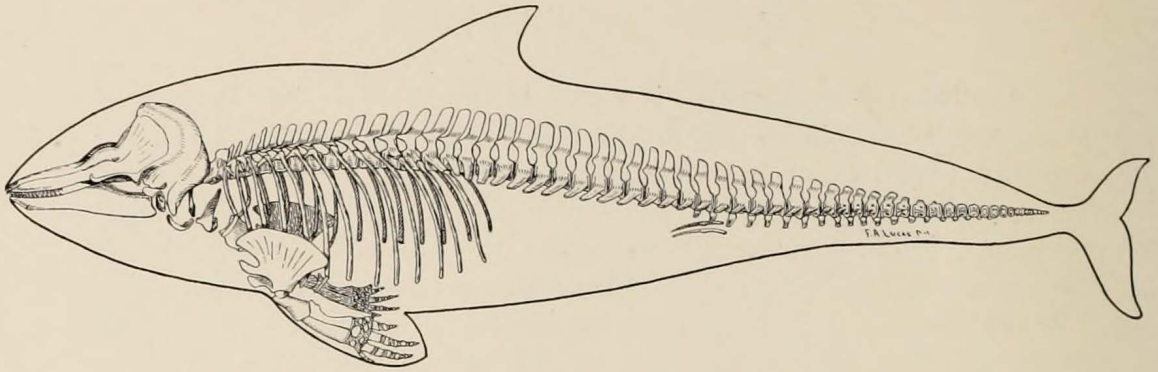
Fossorial or Digging Adaptations

In the soil lies a rich food supply of plants and animals on which many mammals are partially or totally dependent for sustenance. Several groups have become so specialized for this type of feeding that they spend virtually their whole lives in tunnels which they make under the earth. This has resulted in the reduction or total loss of their visual powers which are of no use in their dark world. The fore feet are always shortened and enlarged for digging, while the muscles that operate them are powerful. The neck becomes shortened, and the tail, which can be of little use, is usually short. The best representatives of this type of specialization are the marsupial-mole (*Notoryctes*, **29, 4**), the insectivorous garden moles and golden moles (**29, 6**), the mole-rats (**14**) and sand rats (**15**) of the Old World, and the pocket gophers (**14**) of the New World.

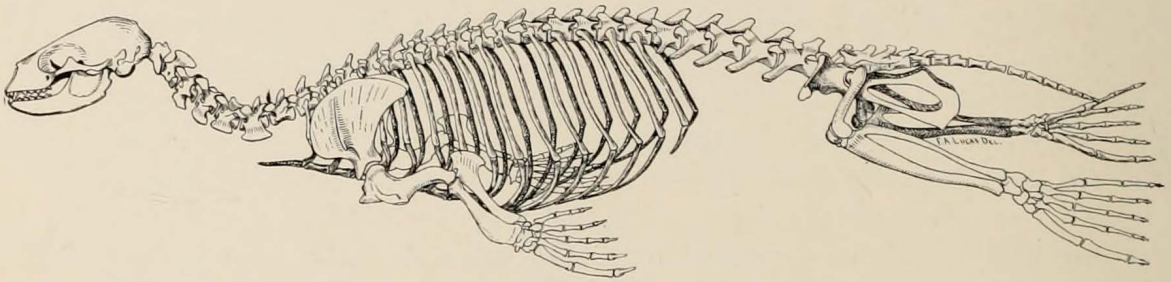
Scansorial or Climbing Adaptations

Many animals are capable of climbing trees, but for obvious reasons large animals are not successful in this life. Animals take to the trees for food to escape enemies, and to build their nests. It would be difficult to name the most successful of tree-living creatures, but without question the sloths are the most highly specialized.

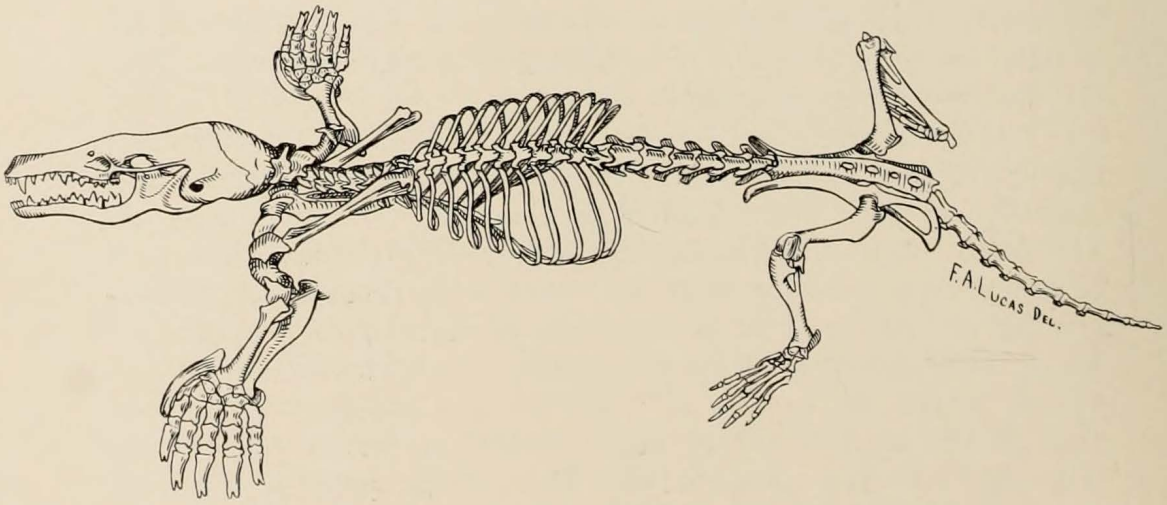
Tree living requires modification of the hands and feet or claws that enable an animal to catch hold of the bark or encircle the limbs. Cats, squirrels and many others have sharp claws for catching in the bark. The sloths (**16**) have sickle-shaped fingers and claws which enable their bearers to hang below the branches. Tree living primates (**30**) phalangers (**52**) and opossums (**4**) have strongly divergent great toes that aid the animal in grasping. Some primates such as the spider monkey and gibbon, which are capable of rapid swinging (brachiating) passage through the trees, have the thumb reduced so that it is not in the way when the hand takes hold of a limb in rapid progress. The tree hyrax, (**19**) tarsius (**30**) and a bat (*Thyroptera*) are equipped with suction



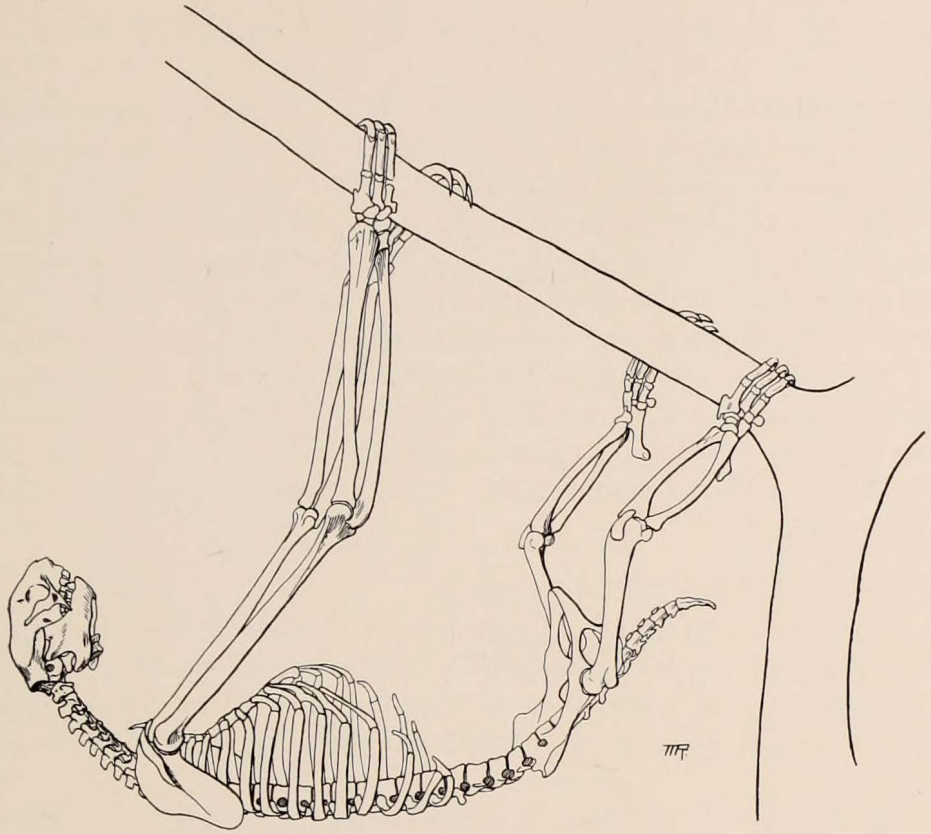
The skeleton of a porpoise, highly specialized for an aquatic life



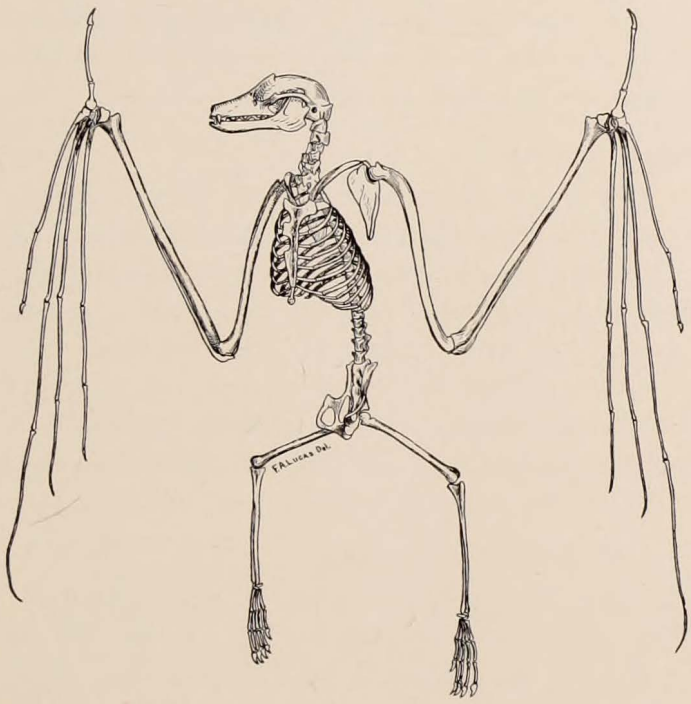
The skeleton of a seal, specialized for an aquatic life but retaining many primitive characters of a land living ancestor



The skeleton of a mole, modified for burrowing in the earth



The sloth skeleton adapted to an inverted posture



The bat skeleton, specialized for flight

devices that enable them to cling to smooth surfaces. In the hyrax the middle of the fleshy foot pad may be drawn up to create a vacuum, by which means they are said to ascend vertical tree trunks.

Many animals in many orders have developed prehensile tails that act as a fifth suspensive organ. This is found in the opossum (**4**) and phalangers (**52**), the kinkajou (**54**), the tree porcupine, the arboreal manises (**17**), the tamandua (**16**), and some New World monkeys (**30**).

Some of the animals have strong tails with which they may prop themselves against the tree when ascending. The climbing pangolins and the scaly-tailed flying squirrels (**14, 29**) have not only this adaptation, but in addition possess horny scales which effectively prevent the tail from slipping.

Volant or Flying Adaptations

Only the bats among mammals have developed into true flyers. Their evolution was so remote and the fossil record so poor that we do not know the steps by which this specialization arose. In artful dodging they are not surpassed by the birds, but when not in flight they are very awkward.

In the bats the anatomical specializations for flying have been the tremendous lengthening of the fore arms (**8, 9, 20, 22**), and the second to the fifth fingers, the great enlargement of the chest muscles which operate the wings, and the growth of the skin to form a web stretching between the fingers and the rear legs. In many of the species the skin extends between the legs and out to the tip of the tail.

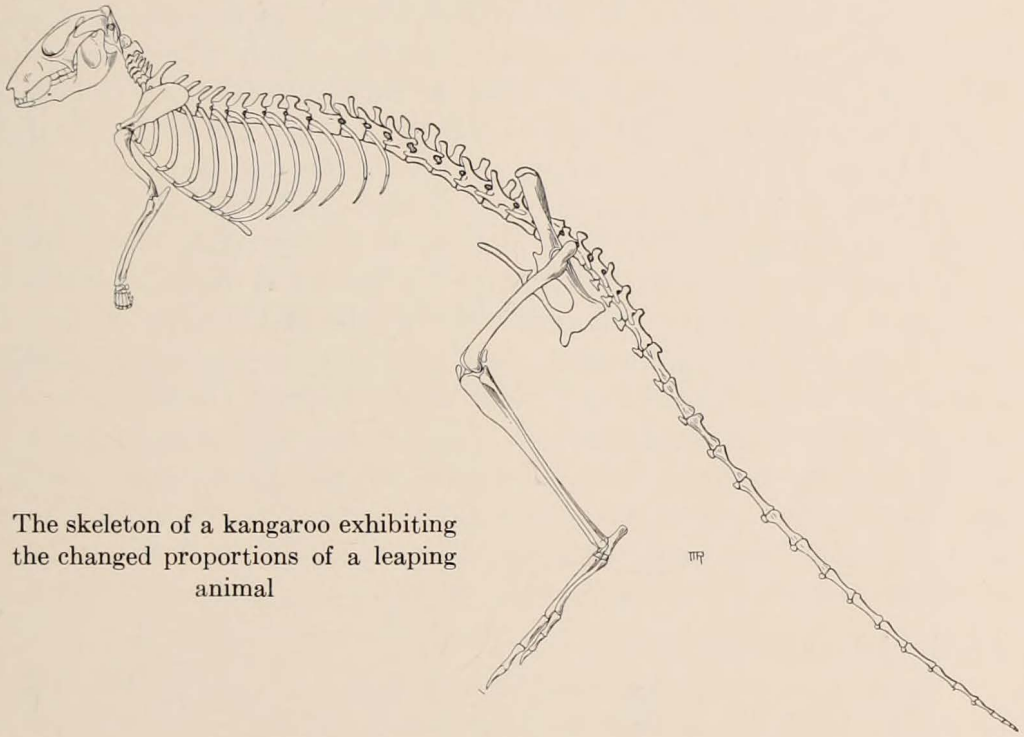
Gliding Adaptations

Though only the bats among mammals have mastered true flight, other groups have developed membranes between the fore and hind legs that enable them to glide through the air from a high point to a lower one. This modification has given all of them a superficial resemblance. No one closely acquainted with the animals or seeing them divested of their skins would, however, think of them as related. Here again is illustrated the principle of convergence. Three unrelated types, the flying phalanger, the flying squirrel and the scaly tailed flying squirrel are exhibited in Case 29. Another, the taguan is to be seen in Case 28.

Cursorial or Running Adaptations

Cursorial adaptation implies ability to move not only rapidly but to sustain high speed for a long distance. To do this the limbs must be long and straight (**81, 22**) the joints must have the movements restricted

chiefly to the fore and aft plane, and the fore and hind limbs must both be strongly developed. The adaptation is best if the point of contact with the ground is limited. The horses (**19**) are possibly the most perfect examples of this type of adaptation, though many of the artiodactyls (**18, 60**), particularly antelopes, are excellent runners. In the marsupials the Tasmanian "wolf" (**52**), is the best cursorial type while among the carnivores, the cheetah and the dogs (**53**) are the best examples.



The skeleton of a kangaroo exhibiting the changed proportions of a leaping animal

Saltatory or Leaping Adaptations

Some animals that are defenceless and much preyed upon are modified for great speed, though along lines that are not conducive to the conservation of energy. These animals progress by long bounds and some use only the rear feet when moving most rapidly. In correlation with this the animals have the hind legs greatly elongated. In some the fore legs are remarkably shortened. The tails of the bipedal animals are elongated and serve to counterbalance the body.

The kangaroos (**5**), are the most widely known of the bipedal leaping animals, but other smaller forms such as the jerboas, (*Jaculus orientalis*, **14**) are more highly modified. Other examples are the kangaroo rats (*Dipodomys*, **29, 51**), the jumping shrews (*Rhyncocyon*, **7**) and *Tarsius* (**30**).

The giant dinosaur *Tyranosaurus*, exhibited on the fourth floor, though possessing the exaggerated proportions of a jerboa, was not a leaping animal, but like man, was a bipedal runner.

ADAPTIVE RADIATION INTO AREAS OF EXTREME CLIMATE

Desert Adaptations (51)

In deserts, conditions are unfavorable to ordinary mammals. The heat during the day is apt to be extreme; the food supply is often limited to a short portion of the year, as is too, the water supply; there is little vegetation to furnish concealment or nesting sites, and the light color of the background is such as to render most mammals conspicuous.

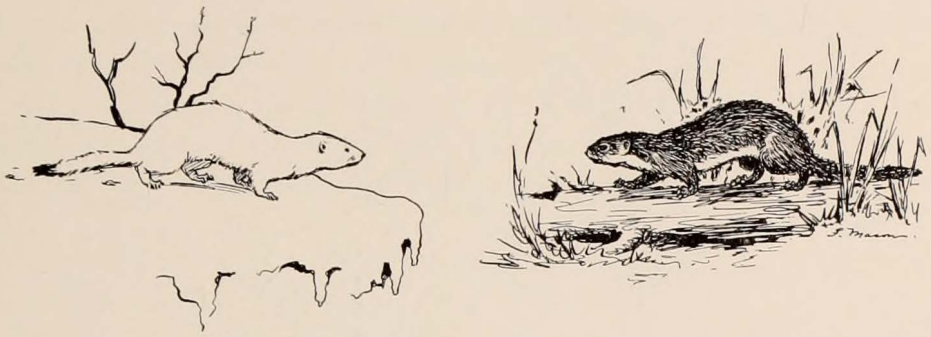
To escape the desert heat all of the smaller species are nocturnal in habits, and during the day most of them live in burrows, where the temperature is not excessive. To adapt themselves to the short season when food and water are present in sufficient abundance, some of them spend over half the year underground in a state of dormancy called æstivation. For this period of prolonged fast they lay up some stores and put on a large amount of fat.

A few animals, such as the jerboas (**14, 29**) and kangaroo rats (**29**), require exceptionally little moisture and may never drink, obtaining what they need from their food. In order to be as inconspicuous as possible desert animals are harmoniously light colored.

Arctic Adaptations

On the Antarctic continent there are no land mammals, but over the ice of the Arctic ocean some foraging species wander and in the land areas well within the Arctic Circle there is a rich fauna. The adverse conditions which the mammals must meet here are but an exaggeration of those found in the cold temperate zones; a period of cold weather which is accompanied by a failing food supply, and a transformation of the landscape into an almost unbroken white expanse against which a dark coat is too conspicuous for the success of predator or the preyed upon.

As protection against the cold, northern animals build a layer of fat which acts as an insulator and a reserve food supply. They also have luxurious fur coats for which they are relentlessly pursued by man. To become inconspicuous, some, such as the weasel or ermine, the snowshoe hare (**86**), Arctic hares and the Arctic fox change the dark coat of summer to a white coat. The polar bear and Arctic wolf remain light colored the entire year.



Seasonal coat change in some animals, as the weasel is accompanied by a color change which is protective in the harmony it shows in relation to the usual background

The adverse winter conditions are avoided by many animals by migration or by hibernation. Hibernation resembles a deep sleep, in which the pulse rate and body temperature are greatly lowered and the animal's resources are conserved to the utmost.

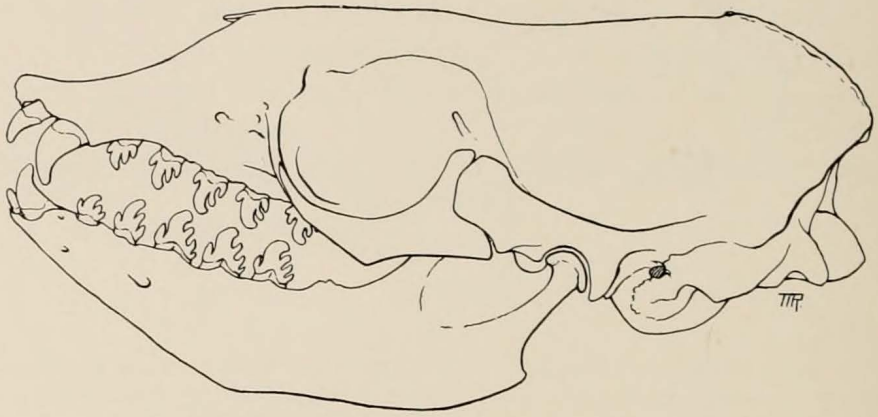
ADAPTATIONS TO SPECIAL FEEDING HABITS

Carnivorous or Flesh Eating Adaptations

Animals that prey on others must have locomotor and sensory adaptation that will enable them to come upon the other creature. In some cases such as among wolves hunting in packs, the predator depends upon long sustained pursuit to wear down the prey. In cats where hunting is usually done by solitary animals the success of the pursuit is generally dependent on a stalk which culminates in a final quick rush or spring. Once upon the prey the animal must be able to overcome and kill it, strong jaw muscles or a blow from powerful fore legs usually accomplishing this object. Most carnivores are provided with long and strong fangs (canine teeth), (**1, 22, 83**) with which they may seize and kill the victim. The incisors are short that they may not interfere with the action of the canines. The jaws are short so that leverage is at its best. The Felidæ (**10**), representing the ultimate carnivorous type, have a pair of cheek teeth modified into large slicing blades that cut the flesh into sizes that may be conveniently swallowed.

Piscivorous or Fish Eating Adaptations

Fish catching animals must first of all be efficient swimmers, and must then be able to seize and hold their slippery, elusive but not powerful prey. For this all of them have sharp recurved teeth which are eminently adapted to this end. Since most piscivorous animals swallow their



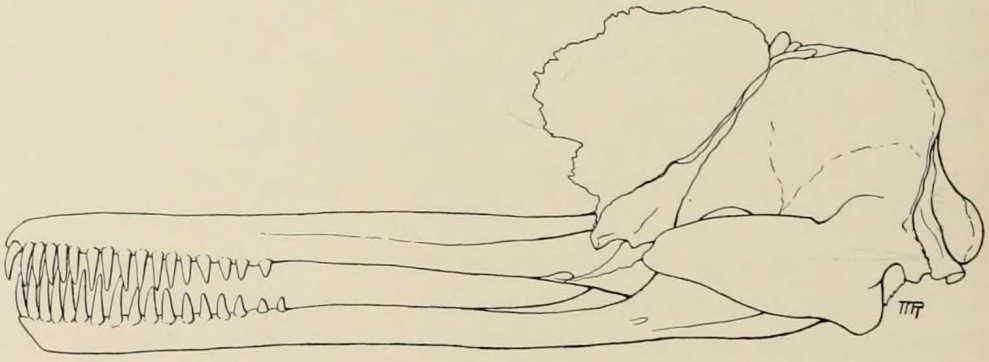
The crab-eater seal has teeth admirably suited to seizing and breaking up the hard shelled crustaceans upon which it feeds

prey whole, the teeth are not adapted to cutting up the fish. This is an advantage for fish bones are sharp and could be troublesome in the throat.

Noteworthy fishers are the otter (**27, 29**), whose smooth body form webbed feet and muscular tail make it one of the most successful of the group, the seals (**13, 28**), and porpoises (**26**). The porpoises are unique in the large number of teeth they possess, over two hundred sometimes being present. It has been suggested that this multiplication of teeth is due to the separation of the lobes of the teeth somewhat similar to those of the sea leopard (**13**).

Blood Sucking Adaptations

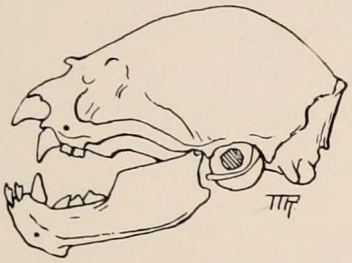
Three genera of tropical American bats live by sucking the blood of other animals which range from chickens to horses. They also are not averse to feeding on men which they attack while asleep. The victim of



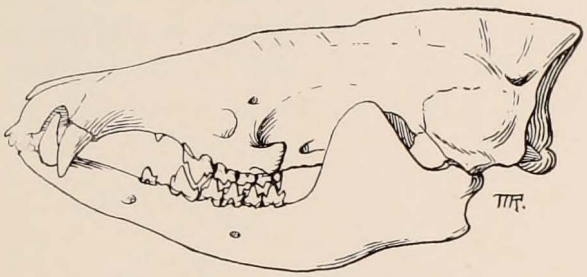
The Ganges River porpoise possesses many needle-like teeth with which it seizes its slippery prey, the fish

such a bleeding does not discover the injury until he awakens the next morning and suffers little inconvenience from it.

The upper incisors of such bats are a pair of large knife-like teeth with which they slice off a bit of the skin of the victim. The molars are small, and the stomach is a thin simple tube no larger than the intestine.



The front teeth of the vampire bat are sharp blades, which cut into the shallow-lying blood vessels of its victim



The tenrec, in common with most other insectivores has sharp teeth and a pointed nose, features attendant upon its insectivorous habits

Insectivorous or Insect Eating Adaptations

Insects are preyed upon not only by a host of small animals typically the order Insectivora and the bats, but also by many larger creatures such as baboons and bears. Such omnivorous species, as the latter, are not primarily adapted to an insect diet and may be omitted from consideration.

Insects are of diverse habits and live in many environments. Though some are soft bodied, many of them have hard shells so that insect eating species must be capable not only of catching the insects but also of breaking this shell. It is for this reason that the little insectivorous bats and the shrews have sharp teeth suited to seizing and breaking up the catch, (**6, 7, 8**). The teeth at the front of the mouth of such insectivores as shrews and hedgehogs are enlarged to enable the animals to seize quickly such active prey. Usually their muzzles are sharply pointed which allows them to seek insects that are in small cavities.

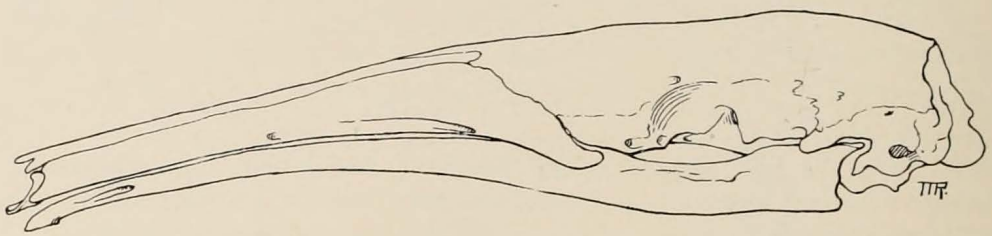
Though all primates probably eat insects, there is only one the aye aye (**30**) which is primarily adapted to such a diet. This animal has large squirrel-like incisor teeth with which it tears open branches that contain burrowing grubs. The second finger is thin and elongated that it may be introduced into insect burrows for extracting the animal. The large

ears of the aye aye may serve to improve the hearing and aid the animal in locating its food.

Certain species living chiefly on ants and termites are considered below.

Myrmecophagous or Ant Eating Adaptations

Several groups of animals have more or less independently become specialized for feeding upon ants or the somewhat similar termites. This has involved the development of strong digging claws to open up the nests, a long tongue for securing the ants, a lengthened skull for the



The giant ant eater has lost all its teeth and its skull is elongated to house the long sticky tongue

housing of such a tongue, and has resulted in the reduction or loss of teeth. Examples are the giant anteater (**50**), the pangolin (**17**), the aard vark (**58**), marsupial anteater (**4**), and the sloth bear which may be seen in the Hall of South Asiatic Mammals. The reader is referred to page 20 of this manual for notes on highly developed ant eating specializations of the manis.

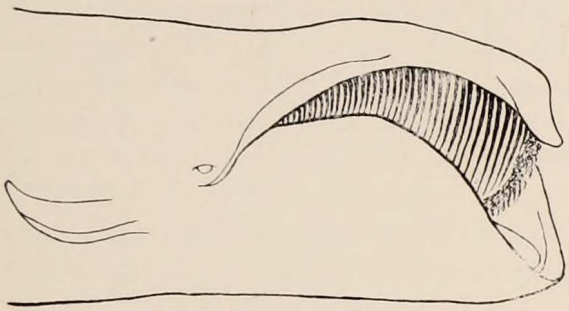
Plankton Eating Adaptations

The whale-bone whales (*Mysticeti*, **26**) are the only mammals equipped to feed on the minute animal life of the sea (plankton). They have lost all teeth but have developed great fringed, horny plates with which they may strain out these minute animals from the sea water as they swim along with mouth open. The gullets of these largest of all whales are very small and suited only to swallowing of small animals. To swallow a creature the size of a man would be an impossible feat.

Herbivorous or Plant Eating Adaptations

In typical herbivorous forms such as the horse and kangaroo the incisors are well developed for cutting off the vegetation, the canines are suppressed, or if present are used only for fighting, and the cheek teeth are large and have broad surfaces.

Animals such as the manatee (**21**), which live on soft aquatic plants have a tendency to tooth reduction, though in some cases, as in the hippopotamus (**18**), the front teeth are strong for digging up the plants.



The whale bone whales have substituted baleen for teeth. This serves as a seive for the water passing through the mouth and strains out the minute animals which are the food of these whales

A sheet of balleen

Species eating tree fruits must be climbers or fliers. Their teeth are usually simple for breaking up or crushing soft plant tissues. The taguans (**7**) and the fruit bats (**9, 20**) are good examples. The fruit bats are often large, slow flying and colonial. They do so much damage in their native countries that their importation into the United States is prohibited. One tribe of Madagascar natives evens up accounts by eating the bats.

Animals living on the bark, buds and roots of trees, and many that have softer fare, are equipped with chisel-like incisors that grow from persistent pulps. The whole group of rodents (**14**) are of this type. Their cheek teeth are typically modified to flat grinding surfaces which finely comminute the food before it is swallowed. The beaver exemplifies the power of the rodent chisel. Trees three feet in diameter have been felled by these rodents.

ADAPTATION FOR PROTECTION

Armor

Though most mammals are covered with soft hair some for protective reasons, have developed an effective armor. The armadillos (**16**) possess a jointed carapace that is reinforced by bony nodules. The pangolins (**17**) are covered with hard horny scales. The porcupines (**15, 29**) are protected by strong, sharp barbed quills which become imbedded in the flesh of an attacking animal but which cannot be thrown at the enemy. Hedgehogs (**29**), tenrecs (**6**) and the echidna (**3**) are other groups of animals defended by spiny coats that repel an attacker. All of these animals are unprotected on their ventral surface and will usually curl up when attacked, leaving only a forbidding prickly surface to the enemy.

Offensive Odor

The animal kingdom is replete with creatures that make themselves offensive by bad odors. Some of the mammals are justly famed for these special powers of protection. The llamas have the habit of spitting their unpleasant smelling saliva in the face of any one who proves obnoxious to them. Other mammals, find their defence in specialized glands, which in such an animal as the skunk, become invested with a sphincter muscle capable of ejecting the accumulated secretion of the glands. A powerful fluid ejected by the pangolins effects the mucous membranes of dogs or other creatures it strikes and causes serious illness.

Coloration

The concealing coloration of such an animal as the cottontail rabbit or a polar bear seems obvious. Other types of color patterns are, however, apparently conspicuous. The tiger, for example, in a museum case is an exhibit that would be conspicuous in the largest hall. However, when in high grass the tiger's stripes blend in with the vertical lights and shadows of its environment. The skunk with broad white bands is a conspicuous animal to us who stand above it, but the skunk does not need to hide from us. It is by its prey, such as the mice, that it must be unseen. To these smaller creatures of the ground the skunk's dark under parts and light upper parts must blend into the background with some success, the black into the heavy shadows of evening, the skunks hunting time, and the white stripes into the lighter sky. The sloth (**16**) has growing in its hair a microscopic green plant that aids the animal in concealment.

Some cases of supposed concealing coloration are open to question as to the correctness of the interpretation of concealment, but certainly

in the great majority of mammals the coat pattern and color, when seen against the animal's usual background, are concealing. If an animal is a vegetarian it has carnivorous enemies from which it must hide. If it is a meat eater it must be relatively inconspicuous in order to come up to its prey. The usual darker shades of the upper side of an animal may originally have arisen as a protection against over exposure to ultra-violet rays, or other factors. But whatever the original cause for the pattern and coloration, the result has favored concealment.

Escape

The animal that has been discovered by an enemy must defend itself, escape or be taken. The majority of animals invariably attempt to make escape. Burrowing animals scurry to their holes, arboreal creatures dash up the nearest tree, swimmers plunge into the water. Goats and sheep run to the rocky slopes where their enemies cannot keep up with them. Many species not protected by such special environments have only recourse to speed or to artful dodging. Such are the hares, the jerboas, the gazelles and the horses. The greatest speed of few animals is known. The best horses on a short course cannot exceed the rate of thirty-six miles an hour, while racing whippets attain about the same speed. The American pronghorn is reported to attain on occasion a speed of forty-three miles an hour.

Special Weapons

Horns, which may be defined as hard outgrowths of the epidermis occur in the Bovidæ (**18**), Antilocapridæ (**18**) and Rhinocerotidæ (**19**). In the first two families these horns are paired, hollow structures growing over a bony core. In the rhinoceros they are solid and grow along the mid-line. In most of the species which bear them they are used effectively against their enemies and in fighting amongst themselves. The Bovidæ present the greatest variation in horns. These range in shape from the long straight spears of the oryx to the massive coils of the mountain sheep. Only the four horned antelope and a variety of domestic sheep have more than one pair of horns.

Antlers are the periodically shed, branched, bony appendages found on the heads of the Cervidæ (**18**). Though used as defensive weapons, they are commonly employed in fighting amongst the males during breeding season, at which time they have reached their greatest development.

Tusks and fangs are enlarged canine or incisor teeth which are usualy food catching organs, but which are also brought into play for

fighting. The elephant, wild boar, chevrotain, (**18**), musk-deer, walrus (**12**), and narwhal (**26**) possess impressive structures of this sort.

Claws and hoofs though fundamentally locomotor and food getting organs, are also important in defense. The defense of the giant ant-eater (**50**) lies in the use of its huge digging claws. Ungulates which do not bear horns, antlers or tusks have only their hard tipped feet with which to defend themselves. A giraffe may kill a lion by the forceful blows of the hoofs, and the kicking ability of the horse tribe has saved many of its members from death.

Poison glands emptying through a hollow spur are found only on the hind feet of the male duckbilled platypus and echidna (**3**). It is supposed that these are used principally in fighting among the males.

Autotomy

Many of the lower animals such as crabs may break their own appendages at will in order to free themselves from an enemy. There is no comparable phenomenon among mammals except in certain rodents, among them the pocket mice (*Perognathus*, **14**), where the animals may break off their tails, when seized by that member, by running in small circles. The skin covering the tails of many other rodents will slip off if the animal is held by the tail.

Size

Some of the animals are practically immune to attack because of their size. An adult elephant or rhinoceros has nothing to fear from any mammal other than man. The largest whales, though are subject to attack by the killer-whales which run in packs and tear out the tongues of their larger relatives.

Social and Mental Traits

Mammals of some species protect themselves by pugnacity, charging any potential enemy on little provocation. An enemy is less likely to trouble an animal that is always ready to fight than one whose habit is to flee. It takes a brave animal to attack a big baboon who is equipped to fight and is ready to do so. Herbivorous animals herd together that the enemy will be the more likely to be discovered and that it may be successfully repulsed by the concerted action of the herd. Among some species a few members of the large herd will act as sentinels and give warning to others that are feeding. When wolves attack musk oxen the adults form a ring around the younger ones and all face outward so that the enemy must brave a continuous circle of forbidding sharp horns

VARIATION AND HEREDITY

The development of an individual is an exceedingly complex matter the nature of which we are only beginning to understand. The wonder grows that we are so closely alike, that variation is so small in extent. Variation is, however, of many sorts. In part it is due to changes in the germ cells and these we call genetic. Such changes are the ones that natural selection and other evolutionary processes must work from.

Other changes are due to environment, to give this term a significance so broad that it includes anything from sunlight to the influence of surrounding organs. These variations so far as we know, are never hereditary. The exact mechanism by which genetic and environmental variations are produced is imperfectly understood in all but an infinitely small number of special cases. Such variations as occurs between different races of dogs, though genetic in its background, is in some features attributable to the inheritance of certain types of glands of internal secretion. This effect is shown in Case 23 where a bulldog, a blood hound and a borzoi represent glandular strains. The bulldogs are typical achondroplastic dwarfs that owe their condition to deficient thyroid activity. This condition produces in dogs or men a stocky body with short twisted limbs and muscles that are short, thick and knotty. The base of the skull is short, the nose bridge low, and sunken, the forehead overhanging, the jaw undershot and the face flat.

The bozoi and the bloodhound are races in which the anterior lobe of the pituitary, a gland associated with the base of the brain, is overactive during part of the life. The secretion (hormone) of this gland, tethelin, stimulates growth, and when released in such quantities as to over-balance its natural checks, produces gigantism. This gland is overactive in the borzoi before the bone sutures close and as a result the bones grow to great length. In the bloodhound this same gland is overactive before the bone sutures close, with the result that these dogs develop large coarse features and loose skin, a condition named acromegaly.

The gonads of each sex secrete special hormones which produce the secondary sexual characteristics.

The environment may act directly on an animal to produce other variations. The tail length of rats is determined, within limits, by the temperature of the environment during growing period. The coat color of Siamese cats is similarly controlled by temperature.

Considering the end result, variation is correlated with several factors which may be considered separately.

Age Variation

From birth to death every mammal undergoes pronounced changes of size, proportion, coloration, habit and other characters. Striking changes in color pattern often occur. The young of the wild boar are prominently striped, as are those of the tapir. The young of many deer and cats are spotted when adults of these same species are not (**84**). Age changes in the skull (**24**), usually include the increase in size, closure of sutures, appearance and loss of a first or milk dentition, and the appearance and loss of a second set. As age progresses the ridges of the skull tend to become more pronounced in accommodation to increased muscle size.

Seasonal Variation

Animals in temperate and polar climates often undergo two complete changes of pelage annually, one of which is adapted to winter cold and the other of which is lighter for summer warmth. Frequently a color change accompanies this change in coats (**84**). The winter coat occasionally, as in the hare (**86**) the weasel and Arctic fox, is white in contrast to a dark summer coat. Other examples of seasonal variations are the growth and shedding of antlers among the deer, and the many changes due to seasonal differences in habits and nutrition.

Sexual Differentiation

Though the sexes of most mammals are colored alike, there are often differences in size and fighting equipment.

The male and female nilgai and black buck to be seen in the Hall of South Asiatic Mammals, are differently colored, as are some of the primates such as the mandril and gibbon. Male mammals are usually larger and more powerful than their mates, Instances of this disparity is size may be noted in the Virginia deer (**84**), and in many of the habitat groups of mammals in other halls. Fighting weapons such as the spurs of the platypus (**3**), the antlers of most deer (**18, 84**), and the tusks of the boar (**18, 83**) are either developed only on the males, or are better developed in that sex. The fighting among males during the breeding season is conducive to racial betterment, for in this manner the stronger males more frequently produce offspring and the weak individuals are either killed or kept from the females.

Geographical Variation

Geographic variation is intimately tied up with environmental change. Species with broad geographic spread are in most cases distinctly different in various parts of their ranges. These differences

concern coat color, size and proportions. When a form becomes isolated, as on an island, the fortuitous genetic variation arising within the species are likely to become fixed more readily than they would be within the main range of the species where greater mixture and, possibly, different enemies weaken the chance of survival of changed types. Geographic variation among mammals, notably among the white-footed mice (*Peromyscus*), is associated with change in backgrounds. Species inhabiting areas of white sands have become extremely light in color, while forms living on areas of black lava reach the opposite extreme of dark coloration.

Mutational Variation

There is a tendency for the structure upon which heredity depends to change or mutate from time to time. These changes which take place in the germ cell give rise to changes in the individuals. Should these changes be favorable the animal's chance of survival to breed and transmit the new character will be enhanced and by such changes evolution takes place. Not all such mutations are, however, favorable. Some, such as those responsible for the disappearance of pigment (albinism, **27, 85**) are unfavorable since the albino animal is more conspicuous and has eyes that cannot function well due to lack of protective pigment. As a result albino strains do not become established except where they are protected from enemies by isolation. The over production of pigment or melanin, produced occasionally by mutation, gives rise to black animals or melanos (**27**), which for one reason or another rarely become established.

The lineal transmission of mutations among mammals is illustrated in Darwin Hall on the first floor.

Size

The size of mammals is adapted to the feeding and locomotor habits, and to the environment. Burrowing mammals are small because of the mechanical difficulties attending the construction of large tunnels, and because of the impossibility of securing a large amount of food underground. The size of arboreal mammals is limited by the strength of the trees which support them. Aquatic mammals reach the extreme of size because in their environment food is plentiful and the density of the water medium buoys up the great weight of the animals.

The smallest mammal is probably a Virginian shrew, *Microsorex hoyi winnemana*, with a body length of two inches and a weight no greater than that of a slightly worn American dime. The largest mammals that exist or ever lived are the blue whales, which may attain a length of 103

feet. Their maximum weight is not known, but the 70 foot whale whose model is exhibited in the middle of this Hall weighed 61¾ tons.

The largest living land mammals are the African elephants, the tallest measured specimen having attained eleven and one half feet at the shoulder. "Jumbo" a famous captive elephant whose skeleton is exhibited in this Hall, stood ten feet ten inches at the shoulder and weighed four tons. A few fossil land mammals are known that are larger than this.

PRINCIPLES OF THE CLASSIFICATION OF MAMMALS

In order that the relationships of animals may be understood it is self-evident that we must first know the existing species of animals. It is to this end that the efforts of many of the departments of the Museum are largely devoted. Because of the enormous numbers and infinite geographical variations of mammals it is necessary to collect large series of specimens from all parts of the world. To exhibit such a wealth of material would not be feasible, nor would anything be gained by it. The great majority of specimens go into study collections of the Museum where they are studied and classified. These specimens form raw material on which all critical studies of animal distribution and relationships must ultimately rest.

Modern methods of classification aim not only to so describe and classify forms that they may not be confused, but attempt as well to express the evolutionary relationship of an animal to other species.

The system of naming which all workers now follow was founded by Linnæus in 1757. All species are given a *specific* name which is always combined with another name, the *generic*, which it shares with other closely related species. Thus the lion and domestic cat both bear the same generic name, *Felis*. The domestic cat, however, is known under the name of *Felis domesticus* whereas the lion is named *Felis leo*. To this combination is sometimes added a third name which designates a geographical variety or subspecies of the species. Thus the Asiatic lion is named *Felis leo persicus*. The genera of mammals may be readily associated with other related genera and such groups form families. The genus *Felis* and the genus *Lynx* (lynxes and bobcats) are clearly related and are placed in the same family, the Felidæ. The family Felidæ is only one of several families of flesh-eating mammals which together constitute one of the orders of mammals the carnivora. The entire range of orders shown in the Hall together with certain extinct orders constitute the class Mammalia, while the mammals, birds, reptiles,

amphibians and fishes are all classes of the phylum Chordata, a group composed of the vertebrated animals and certain aberrant sea living animals which show affinities with the vertebrates.

WHY A SCIENTIFIC NAME?

To many people a scientific name appears as an unnecessary and cumbersome appelation. It has proved impossible to use common names for animals since one species may bear a half dozen common names in a single country, and one name is often applied to several species of mammals. As examples, the rabbit's small cousin *Ochotona* (**14**) is known in the western United States as pika, rock-rabbit, haymaker and cony, whereas cony is used not only for *Ochotona*, but also for the hyraxes (order Hyracoidea, **19**). *Ochotona*, on the other hand, applies to all and only those of a group of related species whose distribution extends over two continental masses where it probably has as many as thirty "Common" names. The rules of scientific nomenclature specify that a name used for one genus of animals cannot be used for any other.

That scientific names are not necessarily too difficult is shown by the popular adoption of such scientific names as *Rhinoceros* and *Hippopotamus*. Some scientific names may be of extreme shortness such as that of a Philippine bat which is called *Ia io*. Others, it is true, are more formidable as may be illustrated by the name of a fossil mammal, *Brachydiastematherium transilvanicum*.

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ASSOCIATE MEMBER (ANNUALLY)	$3
ANNUAL MEMBER (ANNUALLY	10
SUSTAINING MEMBER (ANNUALLY)	25
LIFE MEMBER	200
FELLOW	500
PATRON	1,000
ASSOCIATE BENEFACTOR	10,000
ASSOCIATE FOUNDER	25,000
BENEFACTOR	50,000
ENDOWMENT MEMBER	100,000

For further information address the Secretary of

THE AMERICAN MUSEUM OF NATURAL HISTORY
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NEW YORK, N. Y.

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NEW YORK CITY