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MAMMALS

Type of life science: Systematics (taxonomy)
Other fields of study: Animal anatomy and zoology

Mammals are four-legged animals with backbones; they have a number of unique characteristics, including hair, constant warm body temperatures, mammary glands, and specialized teeth that are replaced only once. Mammals originated more than 200 million years ago from "mammal-like" reptiles, and they eventually evolved into tree-dwelling, flying, burrowing, and aquatic forms.

Principal terms

GENUS (*pl.* GENERA): a group of closely related species; for example, *Homo* is the genus of humans, and it includes the species *Homo sapiens* (modern humans) and *Homo erectus* (Peking man, Java man)

MAMMARY GLANDS: the milk glands that female mammals use to nurse their young

MARSUPIAL: a mammal that gives birth to a premature embryo and then lets it finish its development in a pouch

MONOTREME: a primitive mammal, such as the platypus and spiny anteater, which lays eggs and has other archaic features

ORDER: a group of closely related genera; in mammals, orders are the well-recognized major groups, such as the rodents, bats, whales, and carnivores; humans are in the order Primates

PLACENTAL: mammals that carry the embryo in the mother until it is born in a well-developed state; it is nourished in the womb by a membrane (the placenta)

VERTEBRATES: animals with backbones; these include fish, amphibians, reptiles, birds, and mammals

Summary of the Phenomenon

Mammals are a group of vertebrates (animals with backbones) that have been the dominant animals on land and in the sea since the dinosaurs died 65 million years ago. Indeed, this period of time, the Cenozoic era, is often called "the age of mammals." About 4,170 species of mammals are alive today, but at least five times that many are now extinct. About 1,010 genera of mammals are living, but according to a 1945 tabulation, there were an additional two thousand extinct genera, and that number has greatly increased since 1945 as taxonomical research has progressed. Mammals have been very successful in occupying a great variety of terrestrial and aquatic ecological niches. These mammals include terrestrial meat-eaters and plant-eaters, tree-dwellers, burrowing forms, and aquatic forms. The largest mammals today are elephants, but the extinct hornless rhinoceros *Paraceratherium* was much larger, reaching 6 meters at the shoulder and weighing about 20,000 kilograms. The largest mammals, however, are whales, which can weigh up to 150,000 kilograms in the case of the blue whale. That is larger than even the largest dinosaurs.

Living mammals are easily distinguished from all other vertebrates by a number of unique evolutionary specializations. Unlike other vertebrates, mammals all have hair, have mammary glands to nurse their young, and bear live young (except for the most primitive egg-laying mammals, the platypus and the spiny anteater). Mammals maintain a constant, relatively high body temperature. They have a four-chambered heart and a very efficient digestive and respiratory system. Mammals grow rapidly as juveniles and then stop growing when they reach adult size, unlike other animals, which grow continuously throughout their lives.

In addition to these features, mammals have a number of features in their skeletons that make them easy to distinguish from birds or reptiles. Their limbs are designed for efficient walking or running and so are aligned straight under the body (rather than sprawling, as in reptiles). Their ribs are locked into a solid rib cage, so they do not use rib muscles to pump their lungs; instead, they have a diaphragm in the chest cavity to aid in breathing. Their skulls are highly modified, with fewer bones than in birds or reptiles. Some of these modifications include a single nasal opening, a bony palate that separates the breathing passages from the mouth, a large opening on the side of the skull for jaw muscles, and a pair of joints around the spinal column to hold up the head. They have only a single bone in their jaw, and the bones that form extra jaw bones in the reptile have been modified to form the three sound-conducting bones of the ear: the hammer, anvil, and stirrup. Finally, unlike the simple peglike teeth of reptiles, mammal teeth are highly specialized: There are nipping incisors in front, big stabbing canines for grasping prey, and grinding teeth (molars and premolars) in the back of the jaw for processing food. These teeth are replaced only once (baby teeth are replaced by adult teeth), unlike the continuous replacement found in other animals.

Living mammals can be divided into three major groups, based on their mode of reproduction. These are the monotremes (egg-laying mammals), marsupials (pouched mammals), and placentals (mammals that carry their young to full term). The monotremes include the platypus and the spiny anteater of Australia and New Guinea. They lay a leathery egg much like that of reptiles, although the young is born after ten days and is then carried in a pouch. The females have mammary glands but no nipples, so the young must lap up the milk as it oozes from their skin. Monotremes have a number of other primitive reptilian features, such as a variable body temperature and a venomous claw in male platypuses. The platypus has a flexible ducklike "bill," webbed feet, and a beaverlike tail, which it uses to swim in streams and catch freshwater insects and crayfish. The spiny anteater is covered with thick spines and lives on ants and termites, which it catches with its long, sticky tongue.

The more advanced mammals bear live young. One group, the pouched mammals, or marsupials, give birth to a premature, partially developed embryo. The embryo then climbs into the mother's pouch and fastens onto a nipple, where it finishes its development. Although this sequence makes the young more vulnerable than a

placental embryo, which is always carried in the mother, there are advantages. If conditions are bad, a marsupial mother can abort the baby without losing her own life and survive to breed again. A female marsupial can also carry one baby in the pouch and become pregnant with another, allowing a higher rate of reproduction.

The most familiar marsupials are the kangaroo, koala, Tasmanian devil, and opossum, although there have been many other types of marsupials in the past, and many are still alive today in Australia and South America. Where marsupials lived in isolation with no competition from placental mammals, they evolved into many different body forms, which converge on the body forms of their ecological equivalents in the placentals. In Australia today, there are marsupial equivalents of cats, wolves, mice, flying squirrels, rabbits, moles, tapirs, and monkeys. Among extinct marsupials of South America, there were the equivalents of lions and of saber-toothed cats. As similar as these animals look to their placental equivalents in their external body form, they are not related to true cats, wolves, or the rest, since they are all pouched mammals.

Unlike marsupials, placentals must carry the embryo in their womb through their full development. To allow this, the embryo is nourished by an extra membrane surrounding it in the womb. This membrane, the placenta, is shed when the baby is born and is part of the "afterbirth." This mode of reproduction makes the placental embryo less vulnerable than a marsupial, but it means that the mother is more vulnerable, since she must carry a larger embryo for a longer time.

After the extinction of the dinosaurs, about 65 million years ago, the earth was open for a new group of large animals to evolve and take over the vacant ecological niches. Placental mammals underwent a tremendous diversification, until they occupied many ecological niches, and some reached the size of sheep. Most, however, were no larger than a cat. The placentals soon diversified into the edentates (anteaters, sloths, armadillos, and their relatives) and the rest of the mammalian orders (groups of genera). Like marsupials, edentates had their greatest success in isolation in South America, although the armadillo is successfully spreading northward. Edentates have a very primitive womb and a slow, variable metabolism compared to other placentals. Although the name "edentate" means toothless, only the anteaters are actually toothless; sloths and armadillos have simple, peglike teeth. Anteaters and armadillos eat ants and termites, and sloths hang upside down from branches, slowly munching leaves.

The rest of the placental mammals have occupied a variety of niches. One group, the insectivores, includes the shrews, moles, and hedgehogs. All these animals are small in size and have sharp teeth for eating insects and worms. The smallest shrews are only 3 centimeters long and weigh only 2 grams. They must eat almost continuously in order to make up for their small body size and rapid heat loss. They are so active and aggressive that they will attack animals many times their size. Moles live entirely underground; they are nearly blind and have well-developed digging claws. Hedgehogs are covered with thick spines and roll up in a ball when they are threatened.

In addition to the insectivores, the primary mammalian predators are the carnivorans. They include the feliforms (cats, hyenas, and mongoose) and the caniforms (dogs, bears, seals, sea lions, walruses, pandas, raccoons, weasels, and their relatives). Carnivorans (except the panda) all live by killing prey and eating the meat. For this purpose, they have sharp cutting and slicing teeth and enlarged front canine teeth for stabbing. Most have sharp claws, and cats have claws that are retractable. Some carnivorans, such as bears, eat fruit, berries, insects, fish, and almost anything else that is available. The pinnipeds, another group of carnivorans related to the bears, have become secondarily aquatic. These include the seals, sea lions, and walruses. Their aquatic specializations include a streamlined body for swimming, with hands and feet developed into flippers.

Another group of placentals, the archontans, have taken to the trees and the air. These include the primates (lemurs, monkeys, apes, and humans), the bats, the elephant shrews, and the colugos, or "flying lemurs." Primates developed front-facing eyes with binocular color vision and agile, grasping hands and feet (with nails rather than claws) for life in the trees. Most have long tails, and New World monkeys can grasp with their tails. Apes and humans, however, have lost their tails. Most primates eat fruit, leaves, or seeds, and they have complex social behavior and well-developed brains.

Bats, on the other hand, have developed a membrane between their fingers that allows them to become excellent fliers. Most bats catch insects in flight by means of their sonar, and they fly at night, sleeping in caves during the day. Fruit bats, however, are much bigger, living in trees and eating fruit during the day.

The most successful group of mammals is certainly the Glires, or rodents and rabbits. There are more than 1,700 species of rodents alone, or about 40 percent of the mammals, and in numbers and rate of reproduction, they also are far more abundant than any other group of mammals. Rodents (including rats, mice, hamsters, gophers, squirrels, chipmunks, beavers, porcupines, guinea pigs, chinchillas, capybaras, and hundreds of less familiar forms) have developed chisel-like incisors (front teeth), which are used for gnawing. They have adapted to a tremendous variety of ecological niches, including sheep-sized browsers (capybaras), terrestrial fruit-, seed-, and insect-eaters, tree-dwellers, and a variety of burrowing forms (such as gophers, ground squirrels, prairie dogs, and mole rats). The rabbits, hares, and pikas form another group that is distantly related to the rodents. Like rodents, they have chisel-like gnawing incisors, but there are two pairs instead of the single pair found in rodents.

Most of the large plant-eating mammals are ungulates, or hoofed mammals. These include the even-toed artiodactyls (pigs, hippos, camels, deer, antelope, goats, sheep, and cattle), the odd-toed perissodactyls (horses, rhinos, tapirs, hyraxes, and their extinct relatives), the tethytheres (elephants, manatees, and sea cows), and the whales, along with a number of extinct archaic groups. Most ungulates have developed hooves, or hard protection on their toes for better running, and many have elongate limbs for fast running. Since they are nearly all herbivorous, most ungulates

have developed a complex stomach system to digest large quantities of low-quality, relatively indigestible plant material. Ungulates have also modified their teeth, so that they have larger grinding teeth, which grow almost continuously. That allows them to chew tough, gritty vegetation without becoming toothless. Whales, dolphins, and porpoises are completely aquatic, having lost their hind limbs and developed flippers for front feet. Although they do not look like other hoofed mammals, they had terrestrial ancestors that looked like large bears and were similar to the most primitive ungulates.

Methods of Study

Mammalogists use a wide variety of techniques. Traditionally, most studies of the behavior of mammals require going into the wild and observing their ecology. These are the types of studies that are most familiar from nature programs on television. Individual mammals can be studied in detail; in addition, scientists can observe and film their behavior. Often, they are trapped, labeled with a radiocollar or some permanent marking, and freed to be followed or recaptured later. To learn more, however, scientists must collect specimens and study them in the laboratory. There, the anatomy of the specimen can be studied in detail, or the specimen can be kept alive and its behavior and physiology examined much better than in the wild. Mammalogists also have begun to study the details of the biochemistry and molecular biology of mammals. Such studies allow the analysis of the genetic diversity, the evolutionary relationships, and the detailed molecular basis for many of the properties of mammals that were poorly understood before.

Context

Since humans are mammals, much of the information that has been learned by mammalogists is of interest to a wide variety of people. Mammal behavior not only is fascinating to watch but also sheds light on the basis for human behavior. Humans share most of their anatomical and physiological properties with a wide variety of mammals, so other mammals are a main source of information for medical purposes. Indeed, without other mammals (such a laboratory rats, monkeys, and rabbits) for medical experimentation, most of modern medicine would be impossible. Humans are descended from common ancestors shared with the rest of the mammals, so understanding the relationships and evolutionary history of mammals is very important to understanding humankind's origins and place in nature. Finally, mammals are among the dominant organisms in ecosystems around the world. Not only are they important in maintaining an ecosystem, but also their conservation is essential to maintaining the health of the earth.

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