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What is a Mammal?



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Defining mammals

The Class Mammalia includes about 5000 species placed in 26 orders. Systematists do not yet agree on the exact number or on how some orders and families are related to others. The Animal Diversity Web (ADW) generally follows the arrangement used by Wilson and Reeder (2005). Exciting new information, however, coming from phylogenies based on molecular evidence and from new fossils, is changing our understanding of many groups. For example, skunks have been placed in the new family Mephitidae, separate from their traditional place within the Mustelidae (Dragoo and Honeycutt 1997, Flynn et al., 2005). ADW follows this revised classification. Whales almost certainly arose from within the Artiodactyla (Matthee et al. 2001; Gingerich et al. 2001). The traditional subdivision of the Chiroptera into megabats and microbats may not accurately reflect evolutionary history (Teeling et al. 2002). Even more fundamentally, molecular evidence suggests that monotremes (Prototheria, egg-laying mammals) and marsupials (Metatheria) may be more closely related to each other than to placental mammals (Eutheria) (Janke et al. 1997), and placental mammals may be organized into larger groups (Afrotheria, Laurasiatheria, Boreoeutheria, and others) that are quite different from traditional ones (Dragoo and Honeycutt, 1997; Flynn, et al., 2005; Gingerich, et al., 2001; Janke, et al., 1997; Matthee, et al., 2001;

Murphy, et al., 2001; Nowak, 1991; Teeling, et al., 2002; Vaughan, et al., 2000; Wilson and Reeder, 1993)

All mammals share at least three characteristics not found in other animals: three middle ear bones, hair, and the production of milk by modified sweat glands called mammary glands. Hair has several functions, including insulation, color patterning, and aiding in the sense of touch. All female mammals produce milk from their mammary glands in order to nourish newborn offspring. Thus, female mammals invest a great deal of energy caring for each of their offspring, which has important ramifications in mammalian evolution, ecology, and behavior (explained in more detail in Development and Reproduction sections).

Although mammals share several features (see Habitat, Physiological Characteristics, and Behavior), Mammalia contains a vast diversity of forms. The smallest mammals are found among the shrews and bats, and can weigh as little as 3 grams. The largest mammal, and indeed the largest animal to ever inhabit the planet, is the blue whale, which can weigh 160 metric tons (160,000 kg). Thus, there is a 53 million-fold difference in mass between the largest and smallest mammals! Mammals have evolved to exploit a large variety of ecological niches and life history strategies and, in concert, have evolved numerous adaptations to take advantage of different lifestyles.

Habitat, physiological characteristics, and behavior

Different species of mammals have evolved to live in nearly all terrestrial and aquatic habitats on Earth. Mammals inhabit every terrestrial biome, from deserts to tropical rainforests to polar icecaps. Many species are arboreal, spending most or all of their time in the forest canopy. One group (bats) has even evolved powered flight, only the third time that this ability has evolved in vertebrates (the other two groups being birds and extinct Pterosaurs).

Many mammals are partially aquatic, living near lakes, streams, or the coastlines of oceans (e.g., seals, sea lions, walruses, otters, muskrats, and many others). Whales and dolphins (Cetacea) are fully aquatic, and can be found in all oceans of the world, and some rivers. Whales can be found in polar, temperate, and tropical waters, both near shore and in the open ocean, and from the water's surface to depths of over 1 kilometer. (Nowak, 1991; Reichholf, 1990a; Vaughan, et al., 2000)

All mammals have hair at some point during their development, and most have hair their entire lives. Adults of some species lose most or all of their hair but, even in mammals like whales and dolphins, hair is present at least during some phase of ontogeny. Mammalian hair, made of a protein called keratin, serves at least four functions. First, it slows the exchange of heat with the environment (insulation). Second, specialized hairs (whiskers or "vibrissae") have a sensory function, letting an animal know when it is in contact with an object in its environment. Vibrissae are often richly innervated and well supplied with muscles that control their position. Third, hair affects appearance through its color and pattern, helping to camouflage predators or prey as well as signal to predators a defensive mechanism (for example, the conspicuous color pattern of a skunk is a warning to predators). Hair also communicates social information (for example, threats, such as the erect hair on the back of a wolf; sex, such as the different colors of male and female capuchin monkeys; or the presence of danger, such as the white underside of the tail of a white-tailed deer). Fourth, hair provides some protection, simply by providing an additional protective layer (against abrasion or sunburn, for example) or by taking on the form of dangerous spines that deter predators (porcupines, spiny rats, others). (Klima and Maier, 1990; Vaughan, et al., 2000)

Mammals are typically characterized by their highly differentiated teeth. Teeth are replaced just once during a mammal's life (a condition called diphyodonty). Other characteristics found in most mammals

include: a lower jaw made up of a single bone, the dentary; four-chambered hearts; a secondary palate separating air and food passages in the mouth; a muscular diaphragm separating thoracic and abdominal cavities; a highly developed brain; endothermy and homeothermy; separate sexes, with the sex of an embryo being determined by the presence of a Y or 2 X chromosomes; and internal fertilization. (Klima and Maier, 1990; Vaughan, et al., 2000)

Development

There are three major groups of mammals, each united by a major feature of embryonic development. Monotremes (Prototheria) lay eggs, which is the most primitive reproductive condition in mammals. Marsupials (Metatheria) give birth to highly altricial young after a very short gestation period (8 to 43 days). The young are born at a relatively early stage of morphological development. They attach to the mother's nipple and spend a proportionally greater amount of time nursing as they develop. Gestation lasts much longer in placental mammals (Eutheria). During gestation, eutherian young interact with their mother through a placenta, a complex organ that connects the embryo with the uterus. Once born, all mammals are dependent upon their mothers for milk. Aside from these few generalities, mammals exhibit a diversity of developmental and life history patterns that vary among species and larger taxonomic groups.

Reproduction

Most mammalian species are either polygynous (one male mates with multiple females) or promiscuous (both males and females have multiple mates in a given reproductive season). Because females spend a long period of time in gestation and lactation, it is often the case that males can produce many more offspring in a mating season than can females. Thus, the most common mammalian mating system is polygyny, with relatively few males fertilizing multiple females and many males fertilizing none. This causes intense competition between males in many species, and the potential for females to be discriminating in choice of sire for offspring, leading to complex behaviors and morphologies associated with reproduction. Many mammal groups are marked by sexual dimorphism as a result of selection for males that can better compete for access to females.

About 3 percent of mammalian species are monogamous, males mating with a single female each season. In these cases, males provide at least some care to their offspring. Often, mating systems may vary within species depending upon local environmental conditions. For example, when resources are low, males may mate with a single female and provide care for the young. When resources are abundant, the mother may be able to care for young on her own and males will attempt to sire offspring with multiple females.

Other mating systems, such as polyandry, can be found among mammals. Some species (e.g. common marmosets and African lions) display cooperative breeding, in which groups of females, and sometimes males, share the care of young from one or more females. Naked mole rats have a unique mating system among mammals. Like social insects (Hymenoptera and Isoptera), naked mole rats are eusocial, with a queen female mating with several males and bearing all of the young in the colony. Other colony members assist in the care of her offspring and do not reproduce themselves.

Mammals range from many altricial young in each bout of reproduction (rodents and insectivores) to those species that give birth to one or a few precocial young. The former tend toward high early mortality and short lifespans, while the latter invest energy in a few offspring that develop into efficient competitors, living longer in generally stable environments (Cetaceans, primates and artiodactyls). Most mammals make use of a den or nest for the protection of their young. Some mammals, however, are born well developed and able to locomote on their own soon after birth. Most notable in this regard are

artiodactyls such as wildebeest or giraffes. Cetacean young must also swim on their own shortly after birth.

Generally, smaller mammals live short lives and larger mammals live longer lives. Bats (Chiroptera) are an exception to this pattern, being relatively small mammals that can live for one or more decades in natural conditions, considerably longer than natural lifespans of significantly larger mammals. Mammalian lifespans range from one year or less to 70 or more years in the wild. Bowhead whales may live more than 200 years.

Behavior

There are mammal species that exhibit nearly every type of lifestyle, including fossorial, aquatic, terrestrial, and arboreal lifestyles. Locomotion styles are also diverse: mammals may swim, run, bound, fly, glide, burrow, or climb as a means of moving throughout their environment.

Social behavior and activity patterns vary considerably as well. Some mammals live in groups of tens, hundreds, thousands or more individuals. Other mammals are generally solitary except when mating or raising young. Mammals may be nocturnal, diurnal, or crepuscular.

Olfaction, hearing, tactile perception, and vision are all important sensory modalities in mammals. Olfaction plays a key role in many aspects of mammalian ecology, including foraging, mating and social communication. Mammalian hearing is well developed as well. In some species, it is the primary form of perception. Echolocation, the ability to perceive objects in the external environment by listening to echoes from sounds generated by an animal, has evolved in several groups, including microchiropteran bats (Chiroptera) and many toothed whales and dolphins (Odontoceti). Vision is well developed in a large number of mammals, although less important in many species that live underground or use echolocation.

Mammals can be carnivores (e.g., most species within Carnivora), herbivores (e.g., Perissodactyla, Artiodactyla), or omnivores (e.g., many primates). Mammals eat both invertebrates and vertebrates (including other mammals), plants (including fruit, nectar, foliage, wood, roots, and seeds) and fungi. Being endotherms, mammals require much more food than ectotherms of similar proportions. Thus, relatively few mammals can have a large impact on the populations of their food items.

Economic impact on humans

Mammals are a vital economic resource for humans. Many mammals have been domesticated to provide products such as meat and milk (e.g., cows and goats) or fiber (sheep and alpacas). Many mammals are kept as service animals or pets (e.g., dogs, cats, ferrets). Mammals are important for the ecotourism industry as well: people travel to zoos and throughout the world to see animals like elephants, lions, or whales. Bats often help control populations of crop pests. Norway rats and domestic mice are vitally important in medical and other scientific research, serving as models in human medicine and research.

On the other hand, some species have a detrimental impact on humans and the ecosystem. Many mammals that eat fruit, seeds, and other types of vegetation are crop pests. Carnivores are often a threat to livestock and even to human lives. Mammals common in urban or suburban areas have caused automobile accidents when straying into roads and have become household pests. A few species coexist exceptionally well with people, including some feral domesticated mammals (e.g., rats, house mice, pigs, cats, and dogs). As a result of intentional or unintentional introductions near human habitation, these animals have had considerable negative impacts on the local biota of many regions of the world, especially the endemic biota of oceanic islands.

Many mammals can transmit diseases to humans or livestock. The bubonic plague is perhaps the most well-known example, spread via fleas carried by rodents. Rabies, which can be transmitted among mammalian species, is also a significant threat to livestock and can kill humans as well.

Conservation status

IUCN Red List of Threatened Species

Overexploitation, habitat destruction and fragmentation, the introduction of exotic species, and other anthropogenic pressures threaten mammals worldwide. In the past five centuries, at least 82 mammal species have gone extinct. Currently, the International Union for Conservation of Nature and Natural Resources (IUCN) has listed about 1000 species (roughly 25% of all known mammals), as being at some risk of extinction. Species that are naturally rare or require large home ranges are often at risk due to habitat loss and fragmentation. Species that are seen to threaten humans, livestock, or crops may be directly targeted for extirpation. Those species that are exploited by humans as a resource (e.g., for their meat or fur) but are not domesticated are often depleted to critically low levels. Finally, global climate change is adversely affecting many mammals. The geographic ranges of many mammals are shifting as species lose the ability to adjust to increasingly rapid changes in local temperatures and climate (Vaughan, et al., 2000).

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