MAMMALS

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Summary

The Cenozoic era, in which we live, is referred to as the “Age of Mammals”. This reflects the status of mammals as the dominant vertebrates on earth, not because of their diversity (there are far more species of birds and reptiles than mammals), but because mammals occupy a wider range of habitats than other vertebrates and have a profound impact on the functioning of many ecosystems.

Also, humans rely upon mammals more than any other vertebrate group for food and clothing, biomedical research, as beasts of burden, pets, for aesthetics and even therapies for the elderly or terminally-ill. It is thus alarming that mammals have been

severely impacted by anthropogenic activities, more so than any other vertebrate class, to the extent that nearly a quarter of known mammal species are threatened.This chapter examines the unique characteristics of extant mammals, and how these have contributed to their evolutionary success.

Traditional and modern classifications are reviewed, with emphasis on the dramatic changes in higher classification that have emanated from the recent application of sophisticated molecular technologies and novel analytical approaches for resolving phylogenetic relationships.

The taxonomic and biogeographic diversity of mammals is then reviewed, and the global conservation status of mammals is briefly discussed.

1. Introduction

Mammals (derived from *L.* "mamma" meaning breast, a reference to the unique characteristic of suckling young) are one of the most biologically differentiated group in the animal kingdom. No other vertebrate class shows such conspicuous variation in size, shape, and life-histories.

The tiny hog-nosed bat weighs a mere 1.5g whereas the blue whale tips the scales at 100 million times as much (130-150 tons, equivalent to 33 elephants) making it the largest animal that has ever lived. African wild dogs may roam over 4000 km^2, but many fossorial species have a home range of only a few hundred square meters and seldom leave a single burrow.

Mexican free-tailed bats congregate in colonies of more than 20 million individuals, but other mammal species are solitary. Lifespans vary from as little as 6 months in small shrews and rodents, to more than 70 years in elephants and man. Litter sizes range from only one (most bats and higher primates) to as many as 31 (in the tenrec *Tenrec ecaudatus*), and gestation periods from as little as 8 days (in the Virginia opossum) to 22 months (in the Asian elephant).

Newborn mouse opossums weigh less than a grain of rice at birth, whereas neonatal blue whales tip the scales at 3 tons! Even within orders of mammals there is considerable diversity in size, morphology and lifestyle, whereas ecology and behavior may vary extensively even within a single (usually widespread) species. Living mammals are grouped into two subclasses and three infraclasses (Table 1) according to their mode of reproduction.

The fundamental taxonomic division is between the Subclass Prototheria (*Gr.* "first wild animals"), comprising the oviparous monotremes (Order Monotremata) of Australia and New Guinea; and the Subclass Theria (*Gr.* "wild animals"), including all viviparous forms.

The Theria is further divided into two infraclasses: the Metatheria (*Gr.* "after wild animal"), for marsupials, which place reproductive emphasis on lactation in an abdominal pouch rather than gestation; and the Eutheria (*Gr.* "true wild animals") in

which the gestation period is prolonged; eutherians are colloquially (and incorrectly) referred to as “placental mammals”, and are grouped in 21 extant orders.

2. Mammal characteristics

Two fundamental characteristics that define mammals are the possession of hair and mammary glands, both closely linked to endothermy. In the most simplistic sense, mammals are endothermic, hairy amniotes in which the mother suckles her young with milk secreted by specialized skin glands.

Endothermy is not a unique mammalian character, having evolved independently in archosaurs (birds and possibly also some of their dinosaur ancestors) and the ancestors of mammals, but it has played a major role in shaping the ecomorphology, diversity and evolution of the modern mammal fauna.

The main advantage of endothermy is the ability to maintain a high body temperature and thus remain active independently of ambient temperature. This has allowed mammals to colonize all but the most extreme environments on earth, and radiate into a wide variety of niches unavailable to ectothermic vertebrates.

The high energetic expense of endothermy has, however, driven the co-evolution of a suite of distinctive morphological, physiological and behavioral characteristics to sustain a high metabolic rate at minimum metabolic cost, as outlined below.

INFRACLASS	COHORT	SUPERORDER	ORDER	COMMON NAME(S)	F	G	S	IUCN	%IUCN
Ornithodelphia			Monotremata	Monotremes (echidnas & platypus)	2	3	5	1	0.1
Metatheria	Marsupialia	Ameridelphia	Didelphimorpha	New World opossums	1	17	87	21	1.8
			Paucituberculata	Caenolestids	1	3	6	1	0.1
		Australidelphia	Microbiotheria	Monito del monte	1	1	1	1	0.1
			Dasyuromorphia	Marsupial mice, marsupial cats, Tasmanian devil, thylacine, numbats, dasyures etc.	3	22	71	16	1.4
			Notoryctemorphia	Marsupial moles	1	1	2	2	0.2
			Peramelemorphia	Bandicoots & bilbies	3	8	21	4	0.4
			Diprotodontia	Possums, koala, wombats, kangaroos, wallabies etc.	11	39	143	34	3.0
Eutheria	Afrotheria	Paenungulata	Hyracoidea	Hyraxes	1	3	4	0	0.0
			Proboscidea	Elephants	1	2	3	2	0.2
			Sirenia	Dugongs & manatees	2	3	5	4	0.4
		Afroinsectiphylia?	Tubulidentata	Aardvark	1	1	1	0	0.0
			Macroscelidea	Elephant shrews (sengis)	1	4	15	2	0.2
			Afrosoricida	Golden moles and tenrecs	2	19	51	16	1.4
	Xenarthra		Pilosa	Sloths & anteaters	5	10	10	2	0.2
			Cingulata	Armadillos	1	9	21	4	0.4
	Euarchontaglires	Archonta	Scandentia	Tree shrews	2	5	20	6	0.5
			Dermoptera	Colugos	1	2	2	1	0.1
			Primates	Primates	15	69	376	114	10.0

		Glires	Lagomorpha	Rabbits, hares and pikas	3	13	92	17	1.5
			Rodentia	Rodents	33	481	2277	316	27.7
	Laurasiatheria	Insectiphylia?	Chiroptera	Bats	18	202	1116	248	21.7
			Erinaceomorpha	Hedgehogs	1	10	24	6	0.5
			Soricomorpha	Shrews, solenodons and true moles	4	45	428	147	12.9
		Cetartiodactyla	Cetacea	Whales, dolphins & porpoises	11	40	84	14	1.2
			Artiodactyla	Even-toed ungulates	10	89	240	73	6.4
			Perissodactyla	Odd-toed ungulates	3	6	17	11	1.0
		Ferae	Carnivora	Carnivores (including seals & walrus)	15	126	286	79	6.9
			Pholidota	Pangolins	1	1	8	0	0.0
					153	**1229**	**5416**	**1142**	

Table 1. Modern classification of mammals,and the number of families (F), genera (G) and species (S) in each order. IUCN – number of species included in Threatened Categories (Critically Endangered, Endangered and Vulnerable) in the 2006 IUCN Red List of Threatened Species. %IUCN - % of threatened mammals. Question marks indicated names of clades that remain equivocal owing to conflicting evidence or only weak statistical support.

2.1 Hair

Hair is a unique mammalian invention, unlike the feathers of birds, which are modified horny scales of diapsid reptiles. Most mammals have a thick coat of hair, the pelage, comprising longer, coarse guard hairs and shorter, fine underfur, both of which can be raised by erectile muscles (arrector pili) in the skin to trap a layer of air that buffers the body from fluctuations in ambient temperature. The insulatory effect is proportional to the length and density of hairs, so the fur is often thicker and longer in mammals exposed to thermal extremes. Other functions of hair include waterproofing, camouflage, communication, and protection against mechanical abrasion, solar radiation and natural enemies.

Although some mammals have secondarily lost much of the hair on their bodies, hair can always be found in some vestigial form somewhere on the body. The naked mole-rat (*Heterocephalus glaber*) of East Africa has only a few hairs distributed sparsely over its body, since its fossorial niche is hot and thermally stable. It relies on metabolic (such as a low resting metabolic rate) and behavioral (such as huddling) mechanisms for thermoregulation. Whales and dolphins (Order Cetacea) lack underfur to facilitate streamlining, and instead rely on subcutaneous blubber for insulation; only a few tactile hairs remain on the snout. Conversely, aquatic carnivores (Order Carnivora) have very thick underfur for both thermoregulation and waterproofing – indeed, the densest fur of any mammal is that of the sea otter with 100 000 hairs/cm^2. Other species, such as porcupines, hedgehogs and some tenrecs have greatly enlarged and stiffened guard hairs forming spines or barbs that serve primarily for protection against natural enemies, but retain dense underfur for insulation.

2.2 Epidermal glands

Mammals are unique among vertebrates in having three major types of epidermal glands whose secretions are under neural and hormonal control. Eccrine glands, which open directly onto the skin surface, secrete a watery fluid for evaporative cooling. These are widely distributed over the body in humans and some ungulates, and produce copious amounts of sweat when a heat load is experienced. In most mammals, however, eccrine glands are restricted to the soles of the feet and function mainly to improve tactile perception or surface adhesion; cooling is instead achieved by other means, such as panting (Order Carnivora) or licking the forearms (in kangaroos).

The other two gland types open directly into the hair follicles. Apocrine glands are usually restricted to certain parts of the body (such as the armpits and pubic regions in humans) and produce viscous secretions primarily for chemical signaling about the sexual cycle, although in some ungulates these glands are scattered over the body surface and are used also for evaporative cooling. Sebaceous glands, which occur all over the body surface, secrete an oily substance (sebum) that conditions and waterproofs the hairs and skin.

Another two gland types, which display properties of both sebaceous and apocrine glands, also occur in the skin of mammals. Scent glands, found on places of the body that can be easily applied to objects (such as the face, chin or feet), secrete odoriferous

substances used for territorial marking and chemical communication within species, or warning and defense against enemies. (Notable examples of scent glands used as chemical weapons are the anal glands of skunks, and the poison glands associated with the hind foot spur of the male duckbilled platypus). Mammary glands, used to produce milk for suckling young, resemble both sebaceous and apocrine glands in terms of structure, distribution and the chemical composition of secretions, and may have developed as a composite gland incorporating properties of both these ancestral gland types.

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Biographical Sketch

Gary Bronner obtained his PhD in mammal systematics from the University of Natal in 1995, and served as Curator of Mammals at the Transvaal Museum (Pretoria) from 1987 – 1995. His research interests are the systematics, evolution and ecology of African small mammals, particularly the endemic and threatened golden moles. He is currently a Senior Lecturer in Zoology at the University of Cape Town, where he is responsible for a senior undergraduate course on the diversity and functional biology of vertebrates.