CENOZOIC HERBIVORES & CARNIVORES

f1 Living mammals are placentals (eutheria), marsupials, and monotremes < aardvark, opossum, platypus >

The term *Mammal* is artificial and has no exact equivalent in the true vernacular of any language. ... The older English names, such as 'beast' and 'quadruped,' are not quite the same as 'mammal,' for they do not include men, bats, or whales and their allies, which are unmistakable mammals. It was one of the happiest inspirations of Linnæus to segregate all the mammiferous animals,—the hairy quadrupeds, the sirenians, and the cetaceans—in a single class. No one before had appreciated the closeness of the relations of the several types and there was no name for the new class, as there was for all the others, fishes, reptiles and birds. The name '*Mammalia*' was taken from the Latin *mamma* [mammary gland] and made in analogy with *animalia* (Gill).
—W. B. Scott.[1]

Figure f1.1 [3] The bareness of the cliff along the western shore of the Chesapeake Bay in Maryland shows that wave erosion, which cuts at its base, causes it to retreat more rapidly than vegetation can take hold. The slope angle of the cliff indicates that weakly consolidated material is exposed. The outcrop is of the middle Miocene Choptank Formation. Halfway down the cliff, a shell bed containing a rich fauna of mollusks protrudes as a narrow shelf.

Underlying this exposure (and here at the level of the bay) is the middle Miocene Calvert Formation with fossils of large bivalve mollusks of the scallop family and abundant vertebrate fauna of hammerhead sharks (*Sphyrna*), sand sharks (*Odontaspis*), six-gilled sharks (*Hexanchus*), giant white sharks (*Carcharodon*), and eagle rays (*Myliabatis*), and aquatic placental mammals: early baleen whales (*Pelocetus*), long-spouted dolphins (*Eurhinodelphis*), short-spouted dolphins (*Kentriodon*), and carnivorous sperm whales (*Orycterocetus*).

The evolutionary history of the Cenozoic mammals (placentals, marsupials and monotremes) is better known than that of any other class of vertebrates.[2] This is so because continental terrestrial sediments of this age are fairly complete (except in Australia and Antarctica), accessible (near surface and exposed by gullying), and easily worked (unconsolidated mostly as for example in the Calvert Cliffs State Park, Chesapeake Bay, MD, ***Figure f1.1).***

The living members of the class Mammalia include only one order each of monotremes (subclass Prototheria, order Monotreata) and marsupials (subclass Theria, infraclass Metatheria, order Marsupialia), and many orders of placentals (subclass Theria, infraclass Eutheria).

Malcolm C. McKenna and Susan K. Bell in their *Classification of Mammals: Above the Species Level*, 1989, list 425 families (70% extinct) in which, distributed among 24 extant and 22 extinct orders are some 5000 genera (79% extinct).[4] In this classification, twenty four hundred genera of extinct mammals were added (and more in 1997) as a result of fossil finds since George Gaylord Simpson published his classification of mammals in 1945.[5]

The characteristic difference between placentals (90% of all living mammal species) and marsupials, is how the embryos of each are provided for. Placental embryos, nourished by a placenta, complete their development (gestate) in their mother's uterus and are born by her labor. Marsupial embryos develop in uterus to a "rice sized, premature form" that enables them to wriggle from there, sluglike, to the mother's abdominal area or pouch. There they attach their mouth to a lactating nipple to complete, over a period of several months, their development.

In semiarid environments, marsupial's lengthy lactation for slow growth of "joey" and low metabolic rates of (about 70% of equivalent placentals) have survival advantage.[6]

Monotremes are mammals as they have hair, and each side of their lower jaw is a single bone (mandible). The first to be described formally, arrived in England in 1799. This, a "platypus" skin preserved in rum, a furry animal with a broad ducklike bill called by early British colonists in Australia a "water mole," initially struck Dr. George Shaw as nothing more than a hoax and he took up a pair of scissors to reveal the stitches (there weren't any!) attaching the bill to the skin. Twenty-five years later, Johann Meckel discovered the presence of mammary glands (which, Yann Barrandon in 2003 can explain develop from the same discrete accumulation of stem cells resting in the outermost cell layer of an embryo, as do sweat glands and hair follicles).[7] "If these glands produce milk, let's see the butter," retorted one disbeliever. But indeed, from their mother's lactating nipples, the young lap milk, affirming the mammalian status of the "platypus." "And therefore, went the reasoning," David Penny writes, "it must give birth to live young. There was no 'sense' in laying eggs if the young were to suckle—even if the aborigines said that the platypus laid eggs (are *oviparous*). Thousands of platypuses were shot to settle the question. This is the dark side of zoological history, the 'search and destroy' attitude that turned zoological research into killing fields. One Scottish naturalist, William Caldwell, returned home from Australia with the remains of more than 1,300 echidna (the other oviparous mammal)."[8] Monotremes are reptilian in several details of their skeleton (emphatically so, as described by Alfred Sherwood Romer (1894-1973), in their shoulder girdle structure).[9] Living monotremes, the "platypus" (*Ornithorhynchus*) and spiny anteater (*Echidna*), are native to Australia but their fossil record there before 15 million years ago is a blank.[10]

During the Cenozoic, marsupials in the southern continents evolved in isolation from carnivorous placentals. Placentals that had spread to South America were edentates and the herbivorous ungulate (hoofed) condylarths. Australia remained isolated until the late Pleistocene. South America's isolation ended when the Panama land bridge formed in the interval early Pliocene – late Miocene and had been briefly compromised in the Oligocene.[11] Africa's isolation of marsupial animals had ended during the Oligocene when also did Madagascar's (see ***Footnote f1.1***). The existence of marsupials and no placentals in the southern continents before these times is not because marsupials originated in the southern continents. The marsupials there had stemmed from marsupials that had migrated from North America and Europe where placentals *and* marsupials existed early in the Cenozoic with equal diversity: eight families of each. The ancestral marsupials of the southern continents were thus escapees from competition and the physical isolation of the southern continents, while these were island continents, afforded them a run of evolutionary experimentation.

Old World placentals included our primate ancestors. The oldest of these, the middle Eocene primate family Eosimiidae, is known from sites in central and eastern China and Myanmar.

The mammals of the world at the beginning of the Cenozoic were themselves survivors of a time of great extinctions when the last dinosaurs and many of their reptilian relatives went extinct. The Cenozoic, the so-called "Age of Mammals" which continues, began 65.5 million years ago.[12] However, for 100 million years before their deliverance, conservative stocks of ancestor mammals survived in the reptilian dominated world of the Mesozoic.

Classification of mammals of the Mesozoic is difficult as their fossils (in 1878, Marsh collected the first found Jurassic ones from dinosaur—as *Brontosaurus*—yielding Como Bluff, Wyoming)[13] are mostly extinct orders and clear differences between them is sometimes only the result of lack of information. For example, modern placental mammals do not have small bones called *epipubic* bones that in living marsupials and monotremes are attached to both sides of the pubis. This diagnostic distinction is assumed to hold for all ancient placental mammals. But not always so. Recently, these same bones have been found in a Cretaceous-age mammal that (from its dentition) was an insect-eating placental (unearthed in Mongolia and called *Ukhaatherium nessovi* by its finder Mochael J. Novacek).[14]

A diagnostic feature of ancestral placentals and marsupials and Mesozoic-monotremes are tribosphenic (Gk. *sphene* meaning wedge) molars. These teeth aid efficient food processing that the high metabolic rate of tiny mammals demands.[15] Anne Weil describes their action so: "As a tribosphenic mammal bites down, a large cusp on the upper molar settles, mortar-like, into a pestle-like basin of the lower molar. Simultaneously, notched shearing crests on the sides of the triangular upper molar scissor against those of the lower molars. This combination of shearing and grinding has long been considered a key innovation in the clade containing marsupial and placental mammals—indeed, as the innovation that was possibly most significant in the spread and diversification of mammals."[16] ❑

Footnote f1.1 A land bridge hypothesis

In Madagascar, human occupation is fast driving to extinction animals with a native ancestry that dates back to the Oligocene. These Madagascans, such as tenrecs and unusual rodents found nowhere else on Earth, and lemurs known also in Ceylon (Sri Lanka), puzzled Philip Lutley Sclater (1829-1913) who in 1864 proposed a once land bridge (Lemuria) to explain. However, DNA studies indicate that their ancestors diverged from their relatives in Africa (including the lemur related descendants—humans—who are now causing their extinction) about twenty-five million years ago (Late Oligocene). How these ancestral forms got into Madagascar, where the evolutionary pressure on them for change was evidently less, is still something of a mystery:

> Madagascar, charming for such oddities as Dracula ants whose queens live by sucking the blood of their larvae, is an island separated from all other land masses, and retaining an ancient semiarid baobab-dominated scrubland, since the Late Cretaceous. Its narrowest separation from other lands has been the two hundred fifty miles width of the Mozambique Channel that during the Late Jurassic opened as deepsea floor between East Africa and Madagascar. Placental Madagascans' ancestors were not present in these land areas 160 million years ago. The traditional explanation is that they entered Africa in the Late Oligocene and crossed then to Madagascar as passengers aboard drifting logs or rafts of vegetation swept into the Mozambique Channel by African floods. But why, until the very recent arrival of humans and their introduced animals and plants, did passage to Madagascar not continue? Modern monkeys, wild cats and the dogs were in Africa by twenty million years ago and these did not make the trip to Madagascar. So, what ever had allowed the Madagascans to arrive was not long in operation.[17]

As Robert A. McCall has said, "I can't believe primitive mammals, like femurs, were simply more suited to rafting than more recent groups, like monkeys."[18] His explanation is that a land bridge linked Africa to Madagascar, sometime 26-45 million years ago, which provided a "dry" (*sic*: false image, invokes *Genesis* 1-11, and is redundant) migration route for animals and plants.

Evoked to pop up and disappear on cue to provide explanations, no longer present land bridges demand close scrutiny:

> In the Mozambique Channel, more than a thousand feet of ocean covers the shallowest seamount crests on the long Davie Fracture Zone ridge which is the transform fault that displaced Madagascar from East Africa. McCall suggests that reactivation of this fault by compression (unrelated to its long-ago horizontal motion) squeezed chunks of crust upward along the old fault that now makes up the Davie ridge. This tectonics he suggests resulted from stress that existed in the Indian Ocean crust when India "slammed" into Asia and was reciprocal to the crumpling that raised the Himalayan mountains.[19] The Davie ridge does contain some continental rocks that deepsea drilling has located. At 3,300 to 5,000 feet below sealevel, mascarine terrain (pitted limestones with knife-edge ridges evidencing rain erosion) and laterite (an iron-rich soil that usually turns up only in wet tropical well-drained areas) have been found. These samples do not prove Oligocene uplift, which McCall would have. More likely they evidence small continental fragments that sank isostatically during Cretaceous beginning Late Jurassic rifting that opened the Mozambique Channel.