The Advantage of Being a Furball: Diversification of Mammals

Differences between Reptiles and Mammals

Reptiles	Mammals
No milk	Milk
Small brain case	Expanded brain case
Jaw contains more than one bone	Jaw contains only one bone
Simple teeth	Complex teeth
One ear bone	Three ear bones
Continual growth	Limited growth (stop growing at adulthood)
Variable temperature	Constant temperature
Scales or knobby skin	Hair

Pelycosaurs

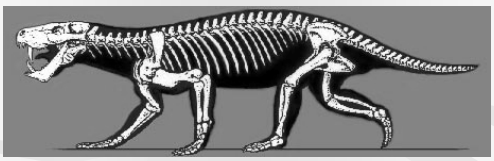
Among the earliest of the mammal-like reptiles were the pelycosaurs (evolved From anapsids by Early Permian)

Retain sprawling posture of primitive Anapsids

Distinguished by their sail

Both carnivorous and herbivorous forms

Therapsids (mammal-like reptiles)



Succeeding the pelycosaurs were the therapsids or mammal-like reptiles.

Got off to a pretty good start, diversified in the mid-to-late Permian - things went downhill from there !

Therapsids themselves hard-hit by end-Permian mass extinction, then again by the End-Triassic extinction, and totally wiped out by early Cretaceous

Therapsids

Placerius

Cynognathus (a cynodont)

Primitive mammal-like reptiles had decidedly reptilian characteristics

More advanced mammal-like reptiles have sprawling stance, but very mammal-like in many other skeletal features (pits in skulls of some forms even suggest whiskers !)

True Mammals

By a stroke of luck, one group of therapsids gave rise to mammals during the Triassic
(The first true mammals appeared on Earth together with the earliest dinosaurs during the Triassic)

Hadrocodium (Early Jurassic)
Member of extinct group of early mammals

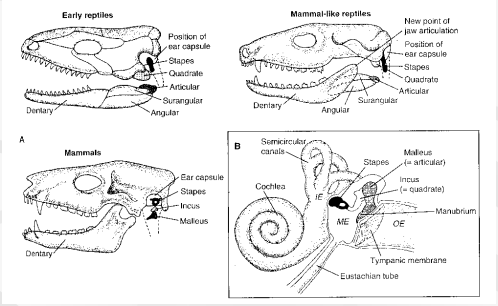
A few early groups of mammals lived during Mesozoic, but went extinct by Early Cenozoic

The remaining group, the "Therian" mammals, which originated during the Jurassic survive today

3 major groups of living mammals (the Therians):

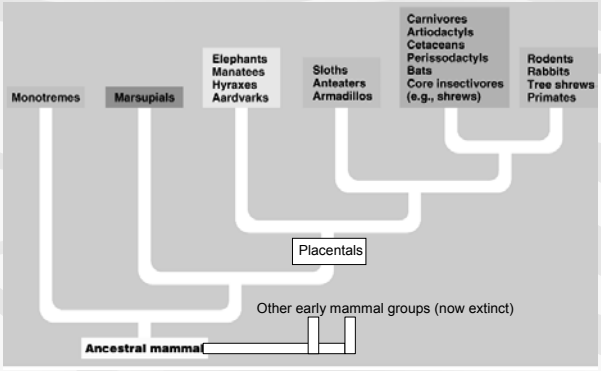
1) Monotremes – egg-laying mammals
2) Marsupials – pouched mammals
3) Placentals – mammals with placenta

Reptiles to Mammals: hearing with our jawbones (an important example of skeletal modification)



Evolution of Ear: stapes acquires "stirrup" shape
articular bone in jaw becomes malleus
quadrate bone in jaw becomes incus
Note also increasing sophistication of teeth as mammals evolve!

Phylogeny of Therian Mammals



Mammal groups show remarkable degree of evolutionary convergence (especially marsupials and placentals)

Mammalian Milestones

Life obviously recovers after major extinctions. This is beautifully Illustrated by mammalian evolution

But two factors are now clear.

1. The process is slow by ecological standards,
   because entire ecosystems have been destroyed beyond recognition, as many or even most of their species have become extinct.
2. The process is extremely fast by evolutionary standards,
   showing that exceptional conditions are in effect, promoting extraordinarily rapid evolution.

The link between these two factors is that ecosystems are reconstituted anew after mass extinctions

Post-Cretaceous Recovery

Dominant land vertebrates of the Late Cretaceous (the dinosaurs) are not replaced for 5 to 10 million years.

During that time there are no large herbivores, and few predators of any size at all.

Yet by the early Tertiary there are several different lineages of 4- to 5-ton herbivorous mammals, which are of different ancestry on the separate continents; and there are large carnivorous birds.

No mosasaurs, ichthyosaurs, or plesiosaurs survive the K-T extinction, but by Eocene times there are very large mammals eating fish in the oceans (whales).

The incumbency effect

There is a major conservative effect in evolutionary ecology: the incumbency effect.

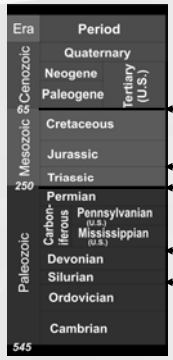
It is difficult to remove an incumbent politician (i.e. one who is already in power), and in much the same way it is difficult for a species to evolve to displace a species which is already well adapted to its niche.

Typically, it is invaders that can displace incumbents, rather than species evolving in the same ecosystem.

The Force of Incumbency

Obviously, the force of incumbency is much diminished if an ecosystem is drastically affected in a mass extinction.

Little wonder that we have subdivided the geologic time on this basis, with the P-Tr and the K-T extinctions marking the ends of eras.



The "Big 5" Mass Extinctions

- Cretaceous - Tertiary
- Triassic -Jurassic
- Permian -Triassic
- Late Devonian
- Ordovician - Silurian

Mass Extinctions Reset the Clock

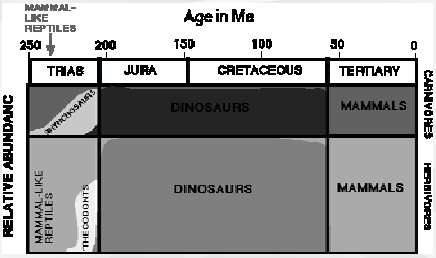
So mass extinctions indirectly bring about major renewals in the history of life, by bringing about major catastrophes.

This is not a political statement: but it is a statement of evolutionary reality.

In particular, the processes of renewal after mass extinctions are overdue for studies as detailed as those that have been devoted to the extinctions.

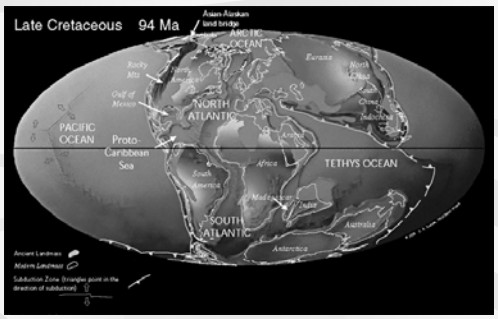
That's likely to be a major item on the evolutionary agenda over the next twenty years.

Relative Abundances of Large Land Animals



Note:
1. Mammal-like reptiles suffer from T-J extinction, replaced by dinos.
2. It took a mass extinction to oust dinos and replaces them with diminutive mammals that evolved from mammal-like reptiles

Land Vertebrates: A Little More Complex



The Mesozoic World was warm, with poorly defined latitudinal climatic variations
Land bridges were widespread despite many inland seas (sea level fall at end of Cretaceous aided in land bridge formation too)

END OF LECTURE