Outline 20: Evolution of Mammals

Classifying Mammals

- Paleontologists recognize at least 5 major groups of mammals. Only 3 are still living:
  - Monotremes: lay eggs
  - Marsupials: poorly developed at birth
  - Eutherians or Placentals: well developed at birth

5 Major Groups: 3 Living
Defining Mammals

- Warm blooded
- Fur
- Milk glands
- Can lay eggs or have some form of live birth.

Recognizing Fossil Mammals

- Our definition of mammals doesn’t work with fossil bones.
- How do we recognize the first mammals?
  - Reptiles have 3 bones in lower jaw.
  - Mammals have 1 bone in lower jaw
  - Mammal teeth are specialized.

Dinosaurs have 3 bones in lower jaw

T. rex
Mammals have 1 bone in lower jaw

_Hadrocodium_, a lower Jurassic mammal with a "large" brain (6 mm brain case in an 8 mm skull)

_Eomaia_, oldest placental mammal, 125 my old, Lower Cretaceous, China
Eomaia, oldest placental mammal, 125 my old, Lower Cretaceous, China

Mammal fossil from the Cretaceous of Mongolia
Jaw bones

- Reptiles have 3 bones in their jaw: dentary, articular, and quadrate.
- Articular and quadrate bones of reptile jaw became the hammer and anvil bones of the mammalian inner ear.
- Marsupials are born with a reptilian jaw, which quickly changes before they eat solid food.

Human Ear Bones, or Auditory Ossicles

Mammal Teeth

- Teeth make excellent fossils.
- Reptile ancestors had simple, cone-shaped teeth they regularly replaced.
- Mammal teeth are specialized into incisors, canines, pre-molars and molars.
- Mammals have only two sets of teeth during their lifetime.
A Nile crocodile. Notice the unspecialized reptilian teeth.

Specialized mammalian teeth.

The First Mammals

- Mammals evolved from the Therapsid reptiles (mammal-like reptiles) during the Triassic, about 210 MY ago.
- The change was gradual. Hard to pinpoint the first mammal.
Triassic synapsid reptiles: Therapsids or mammal-like reptiles

The First Mammals

- Reptile nasal passages open into mouth cavity. Can’t breathe and chew at the same time.
- Mammals developed a secondary palate to allow breathing and chewing at the same time.

Milk Glands: to be a Mammal

- How did milk glands evolve?
- Can’t know for sure, but they are probably related to sweat glands.
- Monotremes lack nipples, milk oozes from several milk ducts in the skin.
Live Birth

- Typical of most mammals.
- Not unique to mammals. Also found in reptiles, amphibians, and fish.
- Accomplished by retaining the egg in a uterus.

Monotremes

- First appear in the Cretaceous.
- Only 2 species alive today, both found only in Australia:
  - Duck-billed platypus
  - Spiny anteater, or echidna
Monotremes: Platypus

The Platypus

adult

baby

egg

Monotremes: Echidna
The Echidna

Marsupials

- First appear in the Cretaceous.
- The most abundant mammal of the Cretaceous.
- Fetus lacks a placenta, has a less effective nutritive membrane.
- Short gestation, long lactation period.

Typical Marsupial, a Kangaroo
Poorly developed newborn kangaroo attached to a nipple in the pouch.

Australian Marsupials

Koala   Numbat   Pademelon

Australian Marsupials

Quokka   Sugar Glider
The extinct Tasmanian “Wolf”: an example of convergent evolution.

Placentals

• First appear in the Cretaceous.
• The most abundant mammal of the Cenozoic.
• Fetus has a placenta, an effective nutritive membrane.
• Long gestation, relatively shorter lactation period.
The Inferiority of Mammals

- Dinosaurs dominated mammals for 145 MY during the Jurassic and Cretaceous.
- Mammals came to dominate earth only after the extinction of the dinosaurs.

Mammals in the Age of Dinosaurs

Modern Elephant Shrew – an Insectivore
Weasel hunting at night

Bats, such as this vampire bat, hunt at night

Evolutionary Radiation of the Placental Mammals

• All placentals seem to have evolved from insectivorous Late Cretaceous mammals.
• Shrews and moles eat insects in the ground.
• Bats eat insects in the air.
• Primitive primates eat insects in trees.
Early Cenozoic Placentals

- Insectivores – moles and shrews
- Creodonts - primitive carnivores
- Edentates - anteaters, armadillos, sloths
- Primates

Middle Cenozoic Placentals: New Groups

- Bats
- Carnivores: cats, dogs, pinnipeds
- Ungulates: even-toed, odd-toed, proboscideans, sirenians
- Rodents
- Rabbits
- Cetaceans
Ungulates

- Odd-toed: horses, rhinos, brontotheres
- Even-toed: all other hoofed mammals; pigs, camels, sheep, deer, cattle, etc.
- Cooler, drier climates of the Cenozoic led to the evolutionary expansion of ungulates. Grasslands replaced many forested areas.
Life in England, last interglacial, 120,000 yrs ago

Eocene Creodonts – early carnivores

Pleistocene Sabertooth Cat
Ice Age Sabertooth Squirrel

Bengal Tiger, a modern carnivore of the cat family

*Canis lupus*: the wolf; carnivore in the dog family
Bears are carnivores, closely related to the dog family.

Polar Bears are recently evolved white Grizzly Bears.

Pleistocene Cave Bears.
Evolution of the whales

Reconstruction of an Eocene whale, *Maiacetus*. Skeleton hanging from the ceiling at the Smithsonian.

*Dorudon* from the late Eocene of Egypt with vestigial hind legs.
Hairy Rhinos from the Miocene of North America

A Titanotherium from the Oligocene of North America
“Family tree” of the horses

- **Miohippus** from the Oligocene
- **Merychippus** from the Miocene
The modern horse *Equus* from the Pleistocene and Recent

North American-South American Interchange

- Isthmus of Panama formed 5 MY ago.
- Mammals moved in both directions.
- Many South American primitive mammals, including many marsupials, became extinct.
- North America got armadillos, porcupines, and possums.
- South America got camels (llamas), lions (pumas), and jaguars (among others).

The Great Interchange between North and South America 5 MY ago
Patagonia: 12,000 years ago

Giant Pleistocene Mammals
- Mammoths
- Mastodons
- Saber-tooth cats
- Giant lions
- Giant bears
- Giant beavers
- Giant bison
- Ground sloths
- Irish Elk
- Woolly rhinos

A Pleistocene Mastodon
Mastodon skeleton, Carnegie Museum

Mastodon skull, Carnegie Museum

Mastodon molar, not similar to elephant molar
Mammoth skeleton, Carnegie Museum

Mammoth skull, Carnegie Museum

Mammoth molar, similar to elephant molar
Mammoth skull from the permafrost found during the Yukon gold rush of the 1890s.

Mammoths at LaBrea Tar Pits: Los Angeles, 10,000 years ago

Pleistocene Mammoths in Siberia
A frozen baby mammoth from Siberia, 40,000 years old.

Asian elephants are closest relatives of the woolly mammoths. Note the body hair on this baby.

Saber-tooth cat

Giant cave bear
Giant beaver and modern beaver skulls

Pleistocene bison and mammoths

Irish Elk
Extinction of Giant Pleistocene Mammals

- Not caused by climate change. They survived 2 MY of glacial-interglacial cycles.
- Extensive evidence that hunting by humans caused these extinctions.

Clovis spear point found among ribs of giant bison in New Mexico, 13,000 years old.