Chapter 16. Mesozoic Diapsids

- Phylogenetic relationships
  - Earliest from late carboniferous “stem diapsids” – *Petrolacosaurus*
  - Lineage split into two:
    - Archosauromorpha
      - Crocs, birds, dinos, pterosaurs
    - Lepidosauromorpha
      - Plesiosaurs, tuatara, lizards and snakes (ichthyosaurs?)

Archosauromorpha

- Two minor groups and the Archosauria
  - Within Archosauria, 2 lineages of interest
    - Crurotarsi – gave rise to crocs
    - Ornithodira – dinos and birds
  - All archosaurs have antorbital fenestra

Crurotarsi

- Ancestral crocs – earliest were completely terrestrial (cat-sized)
  - In Cretaceous – diversified
  - *Deinosuchus* – skull 2m long
    - May have been 15m long total (size of T. rex)
- Extant crocodilians – 21 species
  - 3 families:
    - Alligatoridae (2 alligators, several caimans)
      - All freshwater
    - Crocodyliidae (several species)
      - Some saltwater – largest 7m (saltwater croc)
    - Gavialidae – 1 species (gharial in India) – fish specialist

Crocodilians

- Drown large prey
  - Bites pieces and rolls – tears apart
- Croc hearts – completely divided ventricle
  - Pulmonary artery and left aorta come from right ventricle
    - Foramen of panizza connects right and left aorta
    - Allows shunting of blood both ways depending on activity
      - At rest, some deoxygenated blood flows via aorta to viscera
        - Might help produce hydrochloric acid
      - During activity, FOP allows only oxygenated blood in both aortas
      - During diving, FOP allows blood to go the other way, and most blood goes to body instead of lungs
Crocs and Birds as Dino models

- Crocs and birds united with dinos by morphology
- Both also have parental care and vocal communication between offspring and adults
  - Baby alligators call before hatching
  - Distress calls summon adults
- Seems that dinos may have been similar

Pterosauria

- Not dinosaurs (different limb proportions and other characteristics)
- Late Triassic to Cretaceous
- From *Pterodactylus* (sparrow-sized) to *Quetzalcoatlus* (13m wingspan)
- Wing supported by elongated 4th finger
  - Skin web
- Convergent with birds on morphology
  - Sternum, hollow bones, large eyes
- Skull and jaws specialized for lifestyle

Dinosaurs

- Paraphyletic term – doesn’t include birds
- Two lineages: Ornithischia and Saurischia
  - Common ancestor, bipedal (long hind limbs)
  - Difference in pelvic structure
    - Two solutions related to movement of limbs under body

Ornithischia

- All herbivorous
- Quadrupedal forms
  - Stegosaurs, ankylosaurs, ceratopsians
- Bipedal forms
  - *Iguanodon*, Hadrosaurs, *Pachycephalosaurus*
- Potentially, elaborate social and parental care behaviors
Saurischia

- Two lineages: Sauropodomorpha and Theropoda
  - Sauropodomorpha all extinct
    - Basically quadrupedal herbivores
  - Theropoda (includes birds) – bipedal carnivores

Sauropodomorpha

- Largest terrestrial vertebrates ever
- Long-necked herbivores
- E.g. Diplodocus, Apatosaurus
  - Largest up to 30m long, 100,000 kg
    - Elephants 5m long, 5000 kg
- Not aquatic – skeleton could withstand terrestrial locomotion
- Browsed woody vegetation (though probably not upward too high)
- May have traveled in groups (one set of tracks of 23 individuals, with juveniles in middle of herd)

Theropoda

- Large Theropods – e.g. Tyrannosaurus
  - Could be 15m long, 6 m tall
  - Debate about hunting/scavenging
- Small theropods – e.g. Coelophysis (3m), ostrich-like
  - Ornithomimus
- Dromeosaurs – enlarged claw on second toe of hind foot
  - Includes Deinonychus and Velociraptor
  - Fleet, pack hunters
  - One large claw 35cm could be as large as T. rex

Thermoregulation

- Probably ectothermic homotherms
  - Ectothermic levels of metabolic rates
    - Otherwise, overheat due to large size
  - However, maintain body temps sufficiently higher than air (10 C for Deinonychus – 1.5m tall)
  - No turbinate bones for warming and moistening air – e.g. low respiration rate
Marine Diapsids

- Placodonts – heavy teeth and beaks
  - Turtle-like – some had dermal armor
- Plesiosaurs – paddle-like flippers
  - Long-necked and short-necked forms
  - Loch Ness monster type
- Ichthyosaurs – fish (or porpoise) like
  - Retained hind limbs (unlike cetaceans)

Extinctions

- Many Diapsid lineages went extinct at or near end of Cretaceous
  - Catastrophic – impact?
  - More gradual – ecological reasons?
  - Can’t really tell now – problem of resolution
    - A few years, vs. 100,000 years look the same

Evolution of Birds

- Endothermy and feathers – catch 22?
  - Endothermy of no use without insulation
  - Feathers of no use without endothermy
- Dromeosaurs were pursuit predators
  - Maximum aerobic metabolism correlated with resting metabolism
    - As max aerobic metabolism went up, so did resting = endothermy
    - Feathers then insulated and retained that heat

  Synapomorphies uniting birds and theropods

- S-shaped neck
- 3-toed foot; digitigrade
- Intertarsal ankle
- Pneumatic bones
- Feathers
- Posteriorly-directed pubis
  - Birds are clearly derived theropod dinosaurs
Fossil Links

- *Protoarchaeopteryx* – down feathers on body; symmetrically vaned feathers on tail
- *Caudipteryx* – down; vaned feathers on hand (primaries); vaned feathers on tail
- Neither could fly
  - Down for insulation; vaned feathers for social interactions?

Fossil Links (cont.)

- *Archaeopteryx* – earliest bird known
  - Wing feathers as primaries (on hand) and secondaries (on arm)
    - Identical to modern birds
  - Asymmetrical vaned feathers – showed adaptation to flight
  - Tail similar to other fossils (unlike modern birds)
  - Older than other fossils – coexisted with derived forms

Evolution of Flight

- 2 hypotheses:
  - Arboreal hypothesis
    - Jumped and glided from branch to branch
  - Terrestrial hypothesis
    - (cursorial theory) Ran on ground and flapped wings (like chickens)
      - Problem – inefficient for running
    - (Predatory theory) – used wings to catch prey
      - Allowed longer jumps

Early Birds

- First radiation – Enantiornithes
  - Different metatarsal fusion than modern birds
    - 140 – 70 mya – highly diverse
- Second radiation – Ornithurae – replaced earlier forms
  - Includes modern birds (Neornithes)
  - Extinct groups: Ichthyornithiformes (gull like)
    - Hesperornithiformes (flightless swimmers – paddlefooted)
Modern Birds

- Phylogenetic relationships of modern groups in flux
- Some representative clades:
  - Passeriformes – perching birds (most birds: 5500 of 9100 species)
  - Anseriformes – waterfowl
  - Galliformes – quail, grouse – “fowl”
  - Piciformes – woodpeckers
  - Strigiformes – owls
  - Falconiformes – hawks, eagles, etc.
  - Sphenisciformes – penguins
  - Apodiformes – swifts, hummingbirds

Ratites

- One big controversial issue: Do ratites (ostriches, rheas, emus, cassowaries, kiwis) represent a monophyletic lineage?
  - All flightless, similar anatomies
  - Spread on continents that were once Gondwana
  - Used breakup of GW to calibrate molecular clock (used for other relationships)
  - Potentially, show ancestral traits of several lineages
    - Fossils related to ostriches from Eocene in North America