Notes for the Natural History of Dinosaurs 1

A word of warning... these notes are to give you the basic structural backbone for concepts in the course. This should help you study for the exam, but you should not study from it by itself. Make sure that you read the required chapters in the book, and study both your notes and the slides of the course that have been posted online. Your sectional materials will also be helpful in getting familiar with cladograms and the usefulness of parsimony. Exam 1 is in-class on February 12. Happy studying!

Exam: Friday, February 12

Basic Concepts

Fossilization

- Trace fossils: Coprolites, gastroliths, trackways
- Organic part of bone (collagen) vs. nonorganic (Apatite)
- Permineralization
- Remineralization
- Carbonization
- Molds and Casts: Impressions, amber, brain casts
- Age of the oldest fossils? Oldest bone? Oldest DNA?

Taphonomy

- Life assemblage (pre-burial)
- Death assemblage (post-burial)
- Paleoenvironments
- Preserved (autochthonous) vs. transported (allochthonous)

Sedimentology, Chonology, and Earth History

- Old on bottom; New on top
- Absolute vs. relative dating
- Last appearance, Lazarus taxa
- Biostratigraphy
- Know the emphasized eras, periods, and epochs (and their associated dates)
- Why are oceans imporant to climate?

Evolution

- Lamarckian vs. Darwinian evolution
- Evolution via natural selection requires:
  - Inheritance
  - Variation
  - Selective force (differences in fitness = fecundity + survivorship)
- Directional vs. Stabilizing vs. Disruptive selection (speciation)
- Evidence for natural selection
  - Homologous vs. analogous traits
  - Vestigial traits
  - Transitional forms in the fossil record
  - Evidence of contemporary evolutionary events (finches & beakes)
- Coevolution (Darwin's moth)

Cladograms (!!!!)

- An hypothesis of evolutionary relationships
- Kingdom / Phylum / Class / Order / Genus / Species
- Ancestral (basal) vs. derived species
- Monophyletic, paraphyletic, polyphyletic groups
- Polytomy (uncertain) branching points
- Parsimony: competing hypotheses of evolutionary relationships
- Ancestral traits (do not have ancestry information)
- Shared derived traits (does have ancestry information)
- Make sure you understand the worksheet from Section...

Life Before the Dinosaurs

The Cambrian Explosion to the Permian

- Cambrian and Rise of Vertebrata
  - Crazy life forms
  - Ancient sea bed
  - Soft parts of fossils impressed into shale
  - Evolution of vertebrates
  - Bilateral symmetry
  - Notochord
- Jaws in the Ordovician... how did jaws evolve?
- *Dunkleosteus* as the Devonian apex predator
- Carboniferous environments
  - Lepidodendron forests
  - High oxygen concentration in the atmosphere
  - Giant insects and how it relates to high O2

  - Carboniferous swamps as zones of refugia for older plant forms
  - Carboniferous drylands as sites of evolutionary innovation
  - Evolution of hardened seeds: seed ferns
- Tetrapod characteristics
  - Four weight-bearing limbs & a neck
  - Lungs
  - Understand the advantage of having limbs articulating directly with the body (hip and shoulder girdles)
  - Tetrapod body plan
  - Acetabulum, ilium, ischium, pubis, astragalus, calcanium
  - Maxilla, dentary, schlerotic ring, premaxilla
- Anthracosaurs & Temnospondyl amphibians
  - Temnospondyl radiation during late carboniferous, early Permian
- *Diadectes* is the first tetrapod herbivore (Anthracosaur)
- Rise of the amniote
  - Advantages of carrying young in eggs?
  - Amniota: Anapsids vs. Synapsids vs. Diapsids (know fenestrae!)

The Permian

- Convergence of Pangea - what did this do to climatic fluctuations, seasons?
- Gondwanaland in the south (glossopterid forests & seed ferns) and Laurasia in the north (conifers)
- Pelycosaurs!
  - early Permian
  - diverse
  - Edaphosaurids
  - herbivores and carnivores
  - *Edaphosaurus* herbivore qualities (peg teeth, big gut, angled jaw... why?)
  - Sphenacodontids
  - *Dimetrodon*
  - What is the advantage of having a sail & why would it have been an advantage in Pangaea?
  - Diverse tooth morphology - origin of canine teeth
  - Therapsids: Dicynodonts / Gorgonopsids / Cynodonts
  - Enlarged temporal fenestra
  - Reduction in palatal teeth
- Anapsids: Pareiasaurs (ugly vegetarians)
- Diapsids
  - Petrolacosaurs: basal
  - Prolacertiforms: many adapted to arboreal lifestyle
- Permian extinction
  - 95% of species lost (sea + land)
  - Dicynodon zone vs. *Lystrosaurus* zone... differences?

  - Evidence: extinctions, plant dieback, fungal explosion, coal gap
  - Hypothesized cause: Siberian traps => atmospheric changes (acid rain, aerosols, CO2) => collapse of primary productivity and chemistry to oceans
  - *Lystrosaurus* as a disaster taxon... why did it survive? What allowed it to expand?

Archosaurs

- Rhyncosaurs (early Triassic)
  - Herbivorous
  - Pen-knife mouth for shearing plants
- Archosauria!
  - Basal archosaurs, Crurotarsi, Ornithodira (= Pterosaurs + Dinosaurs)
  - Antorbital fenestra, mandibular fenestra
  - *Euparkeria*: Facultative vs. obligate biped
- sprawling vs. semi-erect vs. erect posture
- Pillar-erect (some Crurotarsans) vs. buttress-erect (parasagittal) posture (dinosaurs)
- Rotating (crocodiles) vs. hinge ankle (dinosaurs)
- Dinosaur locomotion constrained to plane that is parallel to its body
- Were early crocodylomorphs aquatic or terrestrial?
- Rise of the dinosaurs: competitive replacement vs. opportunistic scenario

Dinosauria

Early dinosaurs

- Saurischia vs. Ornithischia
- Perforated acetabulum
- Bipedal and carnivorous

Ornithischia (basal)

- Predentary, low jaw joint, inset cheek teeth, opisthopubic pelvis
- Ossified tendons above sacral vertebrae (providing support for big guts)
- Genosaurs = 'Cheeky'-saurs... dinosaurs that chewed
- The chewing process: Front teeth or ramphotheca (cropping); diastem (manipulation with tongue); inset cheek teeth (chewing and grinding), coronoid process (bite force)
- Scissors-like chewing (carnivores) vs. angled chewing (herbivores)
- *Heterodontosaurus* 3 kinds of teeth: snipping, chewing, and tusks for display

Thyreophorans: Stegosauria

- Basal forms are bipedal and small
- Evolve large body sizes, become quadropeds w/ short stocky front legs and long back legs
- Osteoderms (boney scutes)
- Loss of ossified tendons
- Hooved feet
- Tall thoracic vertebrae... why???
- Diversification during the Jurassic
- Diet
  - Narrow snout, low coronoid process (what does this mean?)
  - Small, leaf-shaped teeth spread out in jaw
  - Lack of wear-surfaces
  - Chewing not a priority
  - No gastroliths
  - Wide vs. narrow snouts <==> specialized vs. generalized foraging
  - Median keel along palate... breathe while chewing!
- Brains
  - Very small (0.001% of body mass)
  - Large olfactory gland...
  - Enlarged vertebral canal... second brain? No... Glycogen body?
- Posture
  - Elephantine hind feet
  - Facultative tripodality
  - Stocky forelimbs could be used for turning/posturing
  - Graviportal locomotion (a body built to support weight)
- Armour
  - Species specific arrangement of spines/plates
  - Plates paired or staggered
  - Rotation? Unlikely due to symmetrical surface markings
  - Thermoregulation (blood vessel grooves)
  - Signalling: Mate recognition, male-male competition
  - Defence??? Juveniles had very small plates - not very helpful
- Spines
  - Shoulder (parascapular) spines: *Kentrosaurus*
  - Tail spines (Thagomizer - named after the late Thag Stevens): *Kentrosaurus* and *Stegosaurus*
- Distribution
  - Not abundant compared to other herbivores
  - Worldwide distrobution
  - Most diverse in the late Jurassic
  - No evidence of sociality except for a bone-bed composed only of *Kentrosaurus* fossils from multiple individuals