Notes for the Natural History of Dinosaurs 2

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. Exam 2 is in-class on Wednesday, March 07. Happy studying!

Exam: Wednesday, March 07

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

Thyreophora: Ankylosaurs

- Shared, derived traits
  - loss of antorbital and temporal fenestrae
  - Broad pelvis
  - Wide guts
  - Dorsal osteoderms
- Major groups: Ankylosaurs vs. Nodosaurs
- Time period: late Jurassic through late Cretaceous
- Basal Ankylosauria: Minmi
- Ankylosauridae
  - well-armoured, fewer spines
  - tail club

  - short, nobbier skull
  - squamosal horns
- Nodosauridae
  - Spines are emphasized
  - No tail club
  - Longer, thinner skull than Ankylosauridae
  - No squamosal horns
- The traits of genosaurs! (ramphotheca, diastem, inset cheek teeth)
- Ankylosauridae (wide, short muzzles: generalist) vs. Nodosauridae (narrow, long muzzles: specialists)
- What fenestrae did the Ankylosaurs loose?
- Diet
  - Tooth morpholog: smaller, leaf-shaped teeth; conical shape on premaxillae of early ankylosaurs
  - Complex secondary palatte (what is this? what does it do?)
  - Wide hindquarters for **large guts**
  - No gastroliths
  - Hyoid bone (for what?)
- Nodosauridae bodies
  - Acromial process: projection on scapula for muscle attachment
  - Pillar-like hind-limb bones for weight support
  - Parascapular spines
- Ankylosauridae bodies
  - Crest on humerus (upper arm bone): large muscle attachment that indicates power-stroke with forearm (digging, running?)
  - Fusion of pelvic bones to vertebrae for weight support
  - Tail clubs
- Bonebeds? Thought to be solitary
- Float and bloat: Found upside down in ocean sediments. Why?

Ceropoda

- Major subgroups include Marginocephalia and Ornithopods
- Shared derived characteristics of Ceropoda
  - Gap btw premaxillary and maxillary teeth (Diastem)
  - 5 or less premaxillary teeth
  - widely spaced hip sockets

Marginocephalia

- major subgroups include *Pachycephalosaurs (=thick heads)* and *Ceratopsia (=horn face)*
- All bear a ridge or shelf across back of skull
- Primarily Cretaceous & Northern hemisphere

Marginocephalia: Pachycephalosaurs

- Shared derived traits
  - thickened skull roof
  - ornamentation of exterior skull
  - Ridges or grooves on vertebrae preventing large side-to-side movements
  - ossified tendons @ end of tail
- Early forms: *Yaverlandia*, *Stenopelix*
- Derived forms: *Pachycephalosaurus* (thickened skull roof, loss of upper temporal fenestra, expanded cheek bones, extensive network of ossified tendons)
- Diet
  - typical leaf-shaped teeth (herbivore)
  - front jaws had peg-liek gripping teeth surrounded by small beak
  - Cheek teeth uniformally spaced
  - Broad rib cage extended to base of tail - big guts
  - i.e. less chewing, more fermentation
- Small to moderately sized brain case; oriented at an angle; good eyesight (thickened optic nerve tells us this)
- Evolutionary trends
  - Early forms (flat heads); where are they found?
  - Later (derived) forms (fat heads); where are they found?
- Use of the dome
  - Ramming: forward rotation of skull-neck articulation; v-shaped articulation with spinal column (why?); tongue/groove morphology of back and tail vertebrae; S-shaped shock absorbing vertebral column
  - What is the evidence against ramming?
- Sexual selection vs. Natural selection
  - Why do females usually do the choosing?
  - What is the evidence for sexual selection among pachycephalosaurs?
    - 1:1 distrubution of 2 differently-sized head-domes in the record suggests that males and females sported different sizes
- Hells Creek formation and the confusing case of *Stygimoloch Dracorex*, and *Pachycephalosaurus*... 2 hypotheses:
  - Independent species
  - A growth sequence of a single species (*Pachycephalosaurus*)

Marginocephalia: Ceratopsians

- Shared, derived characteristics
  - A frill on the back of the skull resulting in a traingular-shaped skull when viewed from above
  - narrow and deep beak-like snout
  - flared cheeks
  - ***Rostral bone***: a unique bone on the tip of the upper jaw

        * covered by a horned beak
- *Psittacosaurs* (Parrot lizard)
  - shortened skull with a small naris higher on the skull
  - Relatively long forelimb... facultative quadruped? Grasping hands for feeding?
  - Skin: hollow tubular bristles arranged down tail. Convergently evolved 'feathers'
  - Evidence of nests
  - Juvenile Psittacosaurids found in mammalian stomachs
  - Featured in crappy Transformers movies
- Neoceratops: Emphasized boney frill, large head to body ratio, 3 fused vertebrae near neck to support large head; upwardly hooked beak. Includes: Protoceratopsians (early polyphyletic group), and the more derived Ceratopsidae
- Protoceratopsians
  - Paraphyletic group
  - Eastward migration during the early Cretaceous
  - More derived forms include larger frills, larger fenestrae, and broader 'honed lump' over Nares
  - Basal Protoceratopsians are Asian
    * Roy Chapman Andrews expedition to Gobi Desert
    * Nests of Protoceratops eggs turned out to be Oviraptor eggs
- Ceratopsidae: 2 major subgroups: Centrosaurs and Chasmosaurs
- Shared derived characteristics of Ceratopsidae
  - Enormous skulls
  - Western North America
  - Latest Cretaceous
  - Large frills
  - Orbital and Nasal Horns/protuberances
  - Large nasal opening
  - Complex dental battery
- Posture
  - Sprawling vs. Erect vs. Semi-erect
- Diet
  - Double-rooted teeth for structural support
  - Adjacent teeth locked together to form cutting edge
  - Large hyoid - what does this infer?
  - Large chewing muscle attached to large coronoid process at the rear of the jawbone and onto the frill
- Centrosaurs
  - Long nasal horns
  - Hooks and processes (spikes) on frill
  - Single-species bonebeds suggests herding/nesting (not known)/ family groups due to adults and juveniles aggegated together
- Chasmosaurs
  - Long orbital horns

  - Short nasal horns
  - No bone beds

Ornithopods

- = bird feet
- Shared, derived characteristics
  - Offset premaxillae
  - Very low jaw joint
- Earliest forms are bipedal
- Short upper leg bone & long lower leg bone vs. long upper leg bone & short lower leg bone (fast vs. slow)
- Iguanodontia = most diverse clade
  - Toothless premaxilla and large diastem
  - Larger bodied
  - Derived forms had expanded dental batteries & spiked thumb
  - Thumbspike is a mystery (defense, competition, diet?), and originally placed on nose by early paleontologists
  - large, derived forms had adaptations for large body size
    - Heavy shoulder girdles and forelimbs
    - Hoof-like feet
    - Massive hind limbs
    - boxwork of ossified tendons
  - Obligate vs. facultative bipedality
  - non-Hadrosaurid Iguanodontids: Mid-late Jurassic
- Hadrosauridae
  - Well-developed dental battery
  - Modifications to skull and mandible increased chewing efficiency
  - Pleurokinesis
  - Large coronoid process
  - Included the major sub-groups: Hadrosaurinae & Lambeosaurinae
  - Major evolutionary trends:
    - Dental battery
    - Larger body size
    - Bipedality -> Facultative quadrupedality -> Facultative bipedality
    - Gastroliths
    - Pleurokinesis: a new type of chewing
  - Diet: twigs, fruits, berried, ground cover; the diversity of hadrosauridae increases with the diversity of flowering plants
  - Species-specific heard ornamentation
    - Vocal adaptations? Air sacs? Visual adaptation?
    - What is the proof that these traits are due to sexual selection?
  - Much evidence for bone beds
  - Reproductive behavior: R-selected vs. K-selected

- Maiasaura: Mother Lizard
  - Eggs close together
  - Rotting vegetation to incubate nests
  - Hatchlings could not walk (are these R-selected or K-selected?)
  - Cuteness proportions