Dinosaur Behavior

Four main sources of information for forming behavior hypotheses:

- Analogy to modern animals (i.e., horns in modern mammals compared to horns in ceratopsids)
- Phylogenetic distribution of behaviors in modern animals (i.e., behaviors shared by crocs & birds would be expected in all dinosaurs)

- Biomechanics to determine whether certain behaviors were feasible under laws of physics
- Sedimentary record where unusual preservation suggests certain behaviors (i.e., bone beds made up almost exclusively of centrosaurines suggests these dinosaurs lived in herds)

Some behaviors to consider:

- Displays: sexual, territorial, defensive
- Combat: as in display
- Locomotion: adaptations for weight bearing vs. speed
- Feeding: different types of carnivory; different herbivorous specializations

Important to consider the difference between intraspecific and interspecific displays:

- Intraspecific: within a species
- Interspecific: between species

Living dinosaurs (birds) and their closest living relatives (crocodilians) share many derived features of reproduction; these are probably synapomorphies of Archosauria and so would be expected to be found in all extinct dinosaurs:

- Eggs with a hard calcium carbonate shell (as opposed to the leathery shells of lepidosaurs, turtles, egg-laying mammals)
- Nests built of vegetation (rather than buried in sand)
- Vocal communication between parents and offspring prior to hatching
- Some degree of parental care (typically shorter term in crocs than birds)

- Some dinosaur nests associated with covered mats of vegetation: probably helped to keep warm (as in croc nests).
- Some dinosaurs (maniraptorans) found in "brooding position" over nests; unlikely to be found in dinosaurs which are too large (i.e., tyrannosaurids, hadrosaurids, sauropods, etc.).

- Most primitive modern birds are ground nesters; suggests that tree nesting did not evolve until well into the modern bird (Aves) radiation.

- Dinosaurs tend to have nests of about a dozen or so eggs each: more than found in modern birds, less than in (for example) turtles. This is regardless of size: troodontids to titanosaurids!
- Implies that unlike placental mammals, dinosaurs could produce a dozen or so offspring a year regardless of size; among placental mammals, larger body size means LONGER gestation periods.

Two main potential life habits upon hatching:

- Precocial: able to move around easily shortly after birth.
- Altricial: nest-bound, wholly dependant on parents for food.
- Both conditions are found in modern birds (chickens vs. robins, for example) and modern mammals (horses vs. bears).

Some evidence of these habits in hatchling dinosaurs:

- Some baby hadrosaurines have poorly developed joint surfaces in the legs (unable to move well), but have worn teeth (were feeding): suggests altricial.
- Some other baby dinosaurs (such as troodontids) have fully formed joints prior to hatching: would have been able to move from day 1.

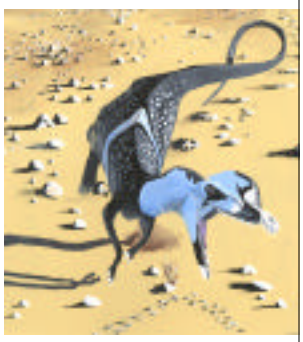
- Dinosaur growth rate: VERY HIGH compared to typical reptiles, particular in big dinosaurs. Estimates (based on bone "growth rings", and other features) indicate only 3-7 years for big ceratopsids and hadrosaurids to reach adult size, and only 10 years for big sauropods (e.g., Apatosaurus) to reach adult size.
- (In contrast, big crocodilians from the Late Cretaceous seem to have taken 50 years or so to reach the same size as big hadrosaurs).

- Since most animal populations stay generally stable over time, more baby dinosaurs died before reaching adult size than in typical populations of modern birds or mammals (imagine herd of antelope where every female produced a litter of 12 every year!).

External Appearance

- Fossilized skin impressions are known for ornithopods, theropods, and ceratopsians.
- They indicate that the skin of the dinosaur was covered with scales similar to those of living reptiles.
- Yes there now is conclusive evidence that some theropods did have feathers !

- Dinosaur color is totally a matter of speculation - most artists tend to paint dinosaurs in the same colors and modern reptiles, though there are some who use brilliant colors.



- The posture and overall shape of a dinosaur is determined from the skeletal anatomy and the muscle attachment areas.
- Areas of speculation -
  - fat or thin ?
  - skin flaps ?
  - soft tissue adaptations ?

Weight

- two methods of weight estimation
  - measuring cross-sectional area of weight bearing bones (femur …) This area can be plugged into an equation. The larger the area, the more weight it bears.
  - scale models are used to determine the volume of water displaced, this volume is multiplied by the cube of the linear scale of the model and than multiplied by 0.9 kg/liter into a mass

- Growth - modern reptiles grow throughout their lives, though the rate at which they grow decreases as they age - indeterminate growth
- Modern mammals and birds stop growing once they reach adulthood - determinate growth

- In general indeterminate growth slower (in rate) than determinate growth
- Another factor which affects growth is metabolism - on average warm-blooded animals grow 10x faster than cold-blooded animals. Smaller animals tend to grow faster than larger animals.

- Age and growth rate of dinosaurs is usually estimated from growth rings in bones - though the time interval represented by the growth ring is not clearly known).
- Can also infer growth rates and ages from the developmental rates of modern vertebrates. - warm-blooded verses cold-blooded ?

- Feeding
  - examination of dentition tells you Carnivore verses Herbivore
  - some dinosaurs have unusual dentition the function of which is unclear

- Determining exactly what a dinosaur ate is very difficult
  - stomach contents (fairly rare !)
    - have evidence of cannibalism in some meat eaters
    - mummified hadrosaurs with conifer needles and and twigs
  - composition of coprolites

- Feeding range
  - Inferred from body shape and neck length
    - suggests favored food sources
  - Sauropods crop tops of trees
  - Stegosaurs bend down and crop vegetation on the ground

Parenting

- Dinosaurs reproduced via eggs
- There is evidence of group nesting behavior in herbivorous dinosaurs.
- In Montana - evidence of parenting behavior exists at some of these nest sites
  - baby hatchlings still associated with nest
  - babies and adults around nesting area
  - little to no evidence of parental care in any other group

- Nesting is the basis of much social behavior

Group Behavior

- Display structures - ceratosaur crests, hadrosaur crests and tubes - the existence and sexual dimorphism of these structures strongly implies societal behavior in seeking and selecting potential mates.

- Sexual dimorphism - is most prevalent in animals which live in groups/herds. Often used for mate selection and for intraspecific territorial defense.

- Mass-death assemblages - dinosaurs which lived in herds would occasionally die in large groups. Mass-death assemblages can also be created by river-transport or artificial accumulations.

- Nesting behavior already discussed.

- Group Trackways - multiple trackways of dinosaurs walking in the same direction (parallel) at roughly the same time.