

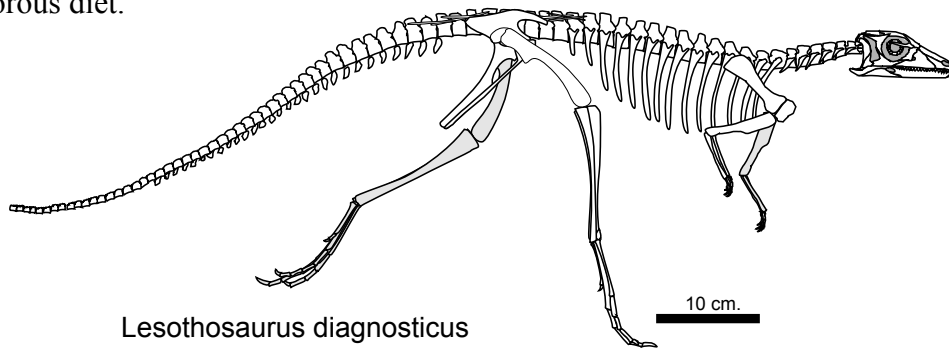
Geo 302D: Age of Dinosaurs

LAB 6: Dinosaur diversity- Ornithischians

By the end of this class you should have a clear idea of what is a dinosaur, and what is not. This assumes that you know the unique synapomorphies that diagnose Dinosauria, and can identify them in a skeleton. Dinosauria is divided into two major clades, Ornithischia and Saurischia. This lab and the following lab will focus in greater detail on the diversity and form of members of these two clades, as well as some of their biology and lifestyles.

Ornithischia

Ornithischian dinosaurs represent a diverse lineage of highly successful taxa. The lineage diverged from the ancestral dinosaur and became highly modified for an herbivorous diet. This was a radical change in the evolution of Dinosauria. The ancestral dinosaur, and most other archosaurs for that matter, was a carnivore. Meat is easy to digest and is high in nutritional value, yet ornithischians adopted a completely herbivorous diet.



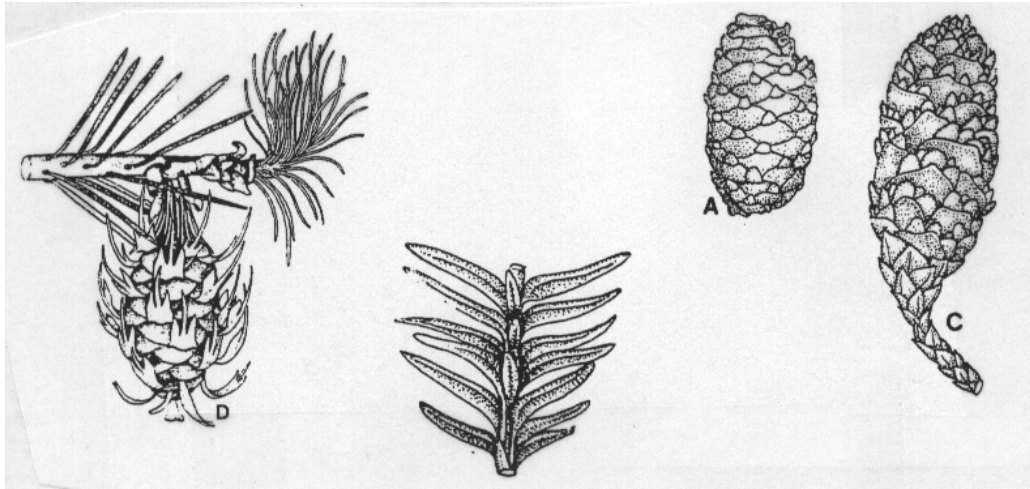
Lesothosaurus diagnosticus

Keeping these advantages and disadvantages in mind, consider the kinds of plants early ornithischians had available to them in the early Mesozoic Era.

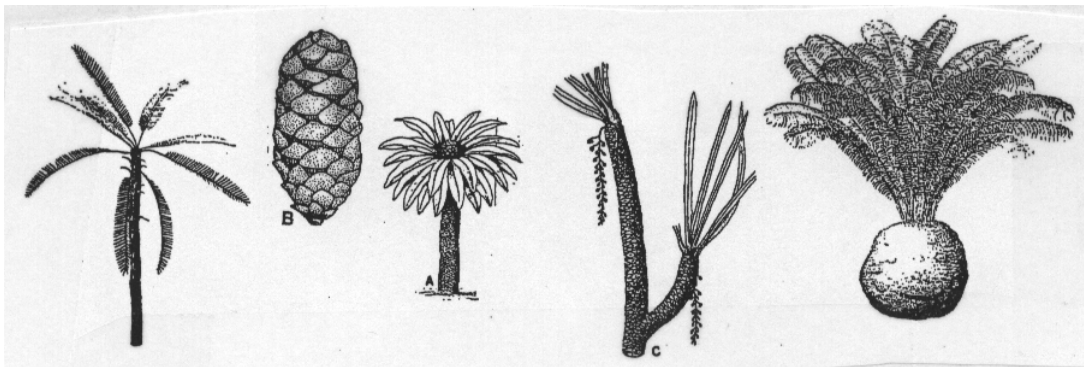
Mesozoic plants

When dinosaurs first appeared (probably Middle or Late Triassic) the terrestrial flora of this planet was quite different from what you are familiar with today. Flowering plants, the angiosperms, had not evolved and would not appear for nearly a hundred million years. Grasses (a very successful group of angiosperms) would not evolve for over 200 million years. In the time up until the appearance of angiosperms, the terrestrial megafloa (big plants) was dominated by gymnosperms (the classical group “Gymnosperma” is paraphyletic in the context used by most people and grade school textbooks). Gymnosperms are characterized by having relatively exposed, naked seeds. A couple of types constituted the majority of large plants at this time.

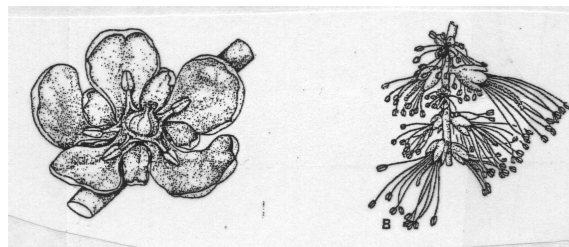
Conifers are familiar to most of us. They include all pines, spruces, junipers, and their kin. Conifers are characterized by having very narrow, reduced leaves, with a thick waxy outer layer called a cuticle. We commonly refer to these tough, narrow leaves as needles. Narrow leaves and heavy cuticle were probably evolved by conifers to withstand dry, windy, or cold environments. Conifers reproduce using cones that dangle from the tips of branches. Male and female cones are found on the same plant. Today there are approximately 300-400 species of conifer. They are most diverse in relatively cooler or higher altitude environments.



Cycads are less well known. In the Mesozoic they were abundant, but they have declined in diversity and range since then. Now they are mainly restricted to the tropics and subtropics. Cycads also reproduce with cones, but the cones are nestled in the center of the plant, with large frond-like leaves radiating outward from the central hub. Each cycad plant is either male or female, unlike conifers. A few species of cycads are hardy enough to withstand the climate of southern North America, and are used as ornamental plants.



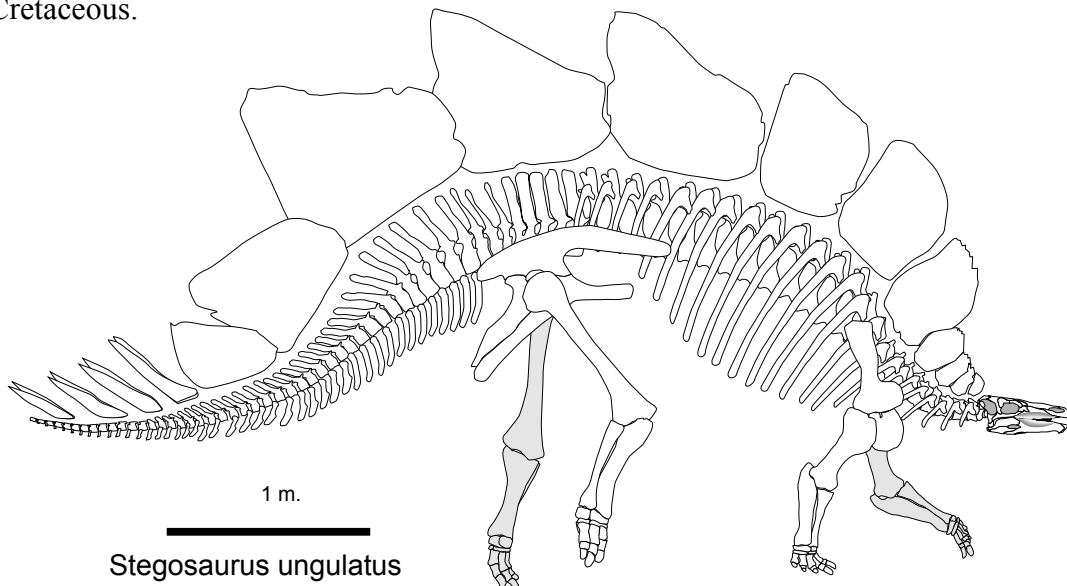
The first **angiosperms** appeared in either the latest part of the Jurassic, or the Early Cretaceous. Angiosperms differ from their gymnosperm cousins in that they reproduce with flowers, and the seed is usually enclosed or covered by some sort of fleshy layer, or fruit. Angiosperms quickly spread across the globe during the Cretaceous, and became the dominant type of terrestrial plant on Earth. There are thousands of species alive today, and there is a long fossil record for some groups.



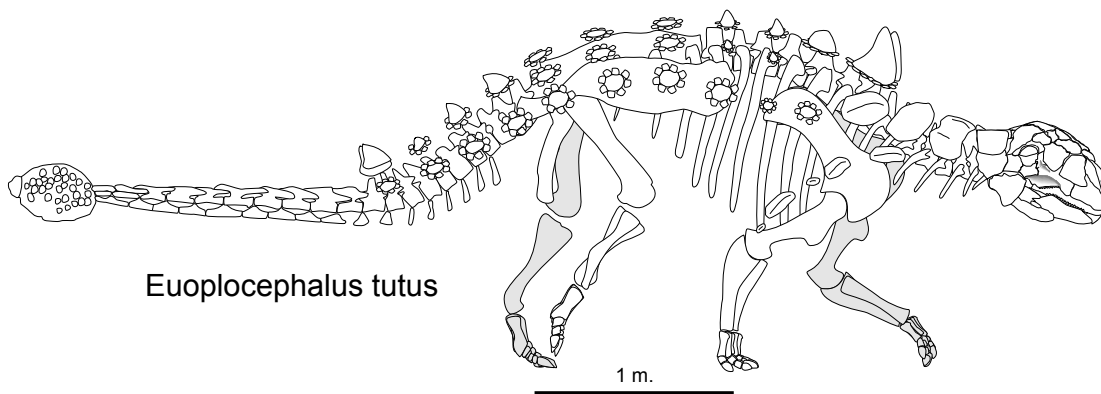
Ornithischian diversity

The earliest ornithischian fossils known are Late Triassic in age. By the Early Jurassic the group had diversified into at least two main lineages, **Thyreophora** and **Cerapoda**. Thyreophora is characterized by extensive osteoderms set in the skin on the body. The earliest member of this group is *Scutellosaurus*, a small (~1.5 meter) animal known from Early Jurassic rocks of Arizona. In many respects *Scutellosaurus* is similar to primitive ornithischians like *Lesothosaurus*, except that numerous small osteoderms adorn the sides, back, and neck. From an ancestor similar to *Scutellosaurus*, the two main thyreophoran lines developed, **Stegosauria** and **Ankylosauria**.

Stegosaurs are among the most publicly recognized dinosaurs. Instead of scattered, circular osteoderms found on primitive thyreophorans, the osteoderms are aligned in a double row along the back of the animal. Different taxa of stegosaurs have variable combinations of flattened plates or large spikes along the back. Many also have some arrangement of spines near the tip of the tail. The fossil record of stegosaurs is most diverse during the Jurassic, but the group declined and finally went extinct in the Cretaceous.

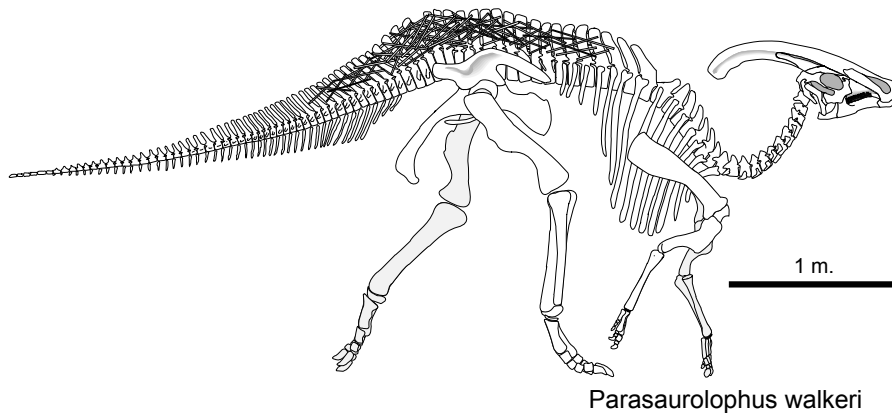
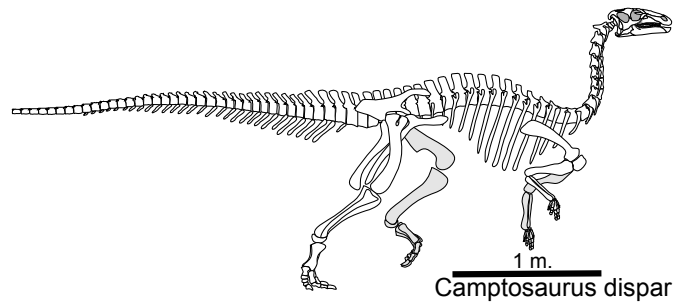
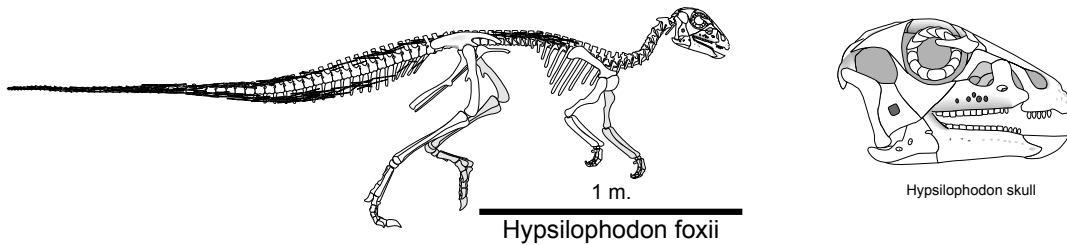


Ankylosaurs take a different approach to their osteoderms. The number and size of the osteoderms is increased, until they form a mosaic of bony plates covering the dorsal surface of the body. Even the skull gets added layers of bony armor, including an osteoderm within the eyelid. In some forms the osteoderms on the tip of the tail are enlarged and fused to form a huge club. Ankylosaurs first appear in the Early Cretaceous, and their fossils are found in rocks until the end of that Period.

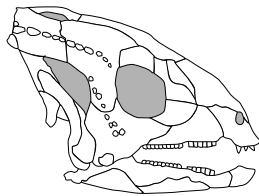


Cerapoda is made up of two main lineages, **Euornithopoda** and **Marginocephalia**. Ornithopods have a long fossil record, extending from at least the Middle Jurassic to the end of the Cretaceous. Ornithopods look somewhat dull when compared to their thyreophoran and marginocephalian cousins. They lack osteoderms, horns, or spikes. However, ornithopods are far superior to other ornithischians in the degree of development of their chewing apparatus. Unlike the simple slicing and dicing motion used by most other ornithischians, ornithopods evolved a unique hinge in the upper jaw, a pleurokinetic hinge. This allowed the tooth-bearing bone in the skull (the maxilla) to flex laterally when the jaw closed. This created a degree of shear in the chewing, and was far more efficient at mechanically breaking down the cellulose walls of plants.

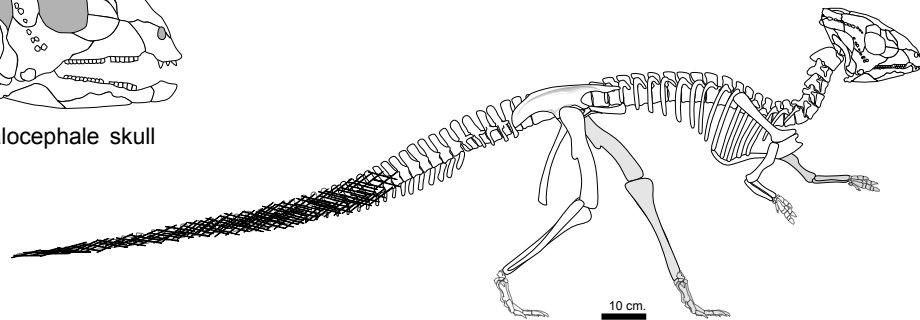
In the Late Cretaceous, the most diverse ornithopods were the hadrosaurs. Hadrosaurs represent the most derived of ornithopods in terms of their dental batteries. In addition, some hadrosaurs evolved elaborate crests on their skulls. Most of these crests were hollow structures connected to the nasal passageways. Over the years, numerous hypotheses have been raised to explain the function of these crests.



Marginocephalians sport some of the most garish headgear of any dinosaur. The group is composed of two smaller clades, **Pachycephalosauria** and **Ceratopsia**. You saw a cast of the skull of *Pachycephalosaurius* at the museum. The most distinctive feature of pachycephalosaurs is the massive thickening of the skull roof. In addition to the thickened skull dome, the rear margins of the skull are often marked by stout knobs, bumps, or spines. As was mentioned in last week's lab, a popular hypothesis concerning these animals is that they used their thickened heads as battering rams, much as bighorn sheep butt heads do today to vie for harems of females. This hypothesis is not universally accepted. Pachycephalosaurs are relatively rare fossils, and are known only from the Late Cretaceous.

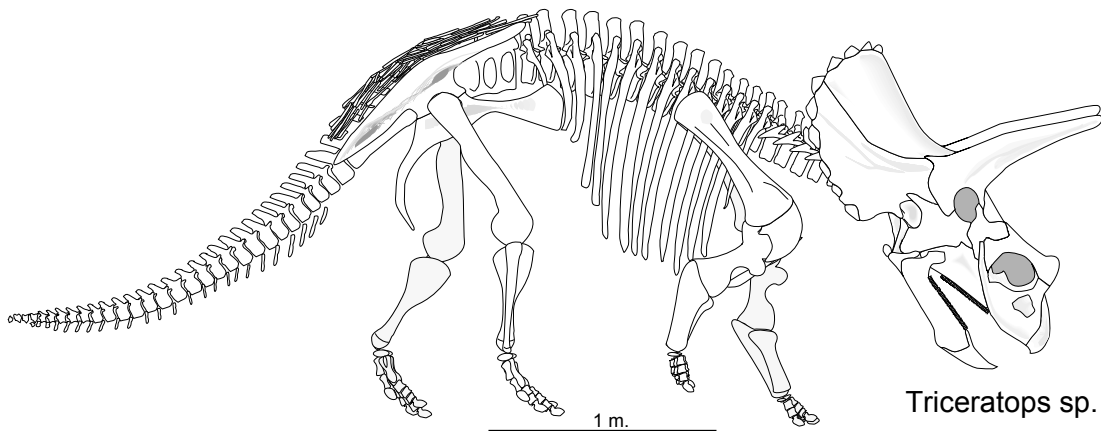


Homalocephale skull



Homalocephale calathoceros

Ceratopsians are well represented as fossils from the Cretaceous Period. Some of the earliest and most primitive members of this clade are known from the early Late Cretaceous of Asia, and they increased in diversity and size until the end of the Cretaceous. Instead of the large grinding surfaces present in the jaws of hadrosaurs, ceratopsians tackled their food with a one-two punch. First, the tip of the upper jaw was narrow and downturned to form a massive, parrot-like beak. Second, the teeth were arranged to create a scissor-like slicing edge when the jaws closed. Ceratopsians were probably able to snip through and slice up even the toughest plants. The back of a ceratopsian skull is greatly expanded to form a large frill that projects dorsally and posteriorly from the head. Often the frill is ornamented with knobs or spikes. In addition, many ceratopsians have additional horns or knobs projecting from their snouts and/or over their orbits.



Triceratops sp.

5. Name the two sister taxa that together with their most recent common ancestor make up Ornithischia.

6. Some stegosaurs sport very large, flat plates along their backs. What are some possible functions of these large plates?

7. The headcrests of some hadrosaurian ornithopods are highly complicated in form, and the air passages within them are complex. What possible functions can you think of for the hollow head crests of hadrosaurs?

8A. In the Late Cretaceous of western North America, in the swamps and river deltas that bordered the Cretaceous Intercontinental Seaway, remains of several species of ceratopsians are found in the same place from rocks of the same age. With so many different kinds of ceratopsians wandering the area, can you think of a potential problem faced by individual ceratopsians during mating season?

8B. Given what you know about ceratopsians, list as many possible reasons why each species of ceratopsian appears to exhibit a different arrangement of frills and horns.

9. List one synapomorphy for Ceratopsia.