The Carboniferous
Mississippian and Pennsylvanian
Carboniferous Period (359-299 Ma)  
(Mississippian and Pennsylvanian)

- Mississippian (359-323 Ma)
- Pennsylvanian (323-299 Ma)
- Rise of complex forest ecosystems
- Renowned for coal deposits
- Formation of the Pangean Supercontinent
- The name Coal Measures was proposed by Farey in 1807 and 1811.
- The term Carboniferous was proposed by the English geologist William Conybeare and William Phillips in a paper published in 1822.
- Alexander Winchell proposed the name Mississippian in 1869 for strata along the Mississippi River
- In 1891 Henry S. Williams suggested Pennsylvanian for the Upper Carboniferous
Mississippian Life

- **Arthropods**, corals, **bryozoa**, **crinoids**, and **mollusks** flourished in warm shallow seas.
- **Echinoderms** - especially **Crinoids** were extremely numerous.
- **Trilobites** were much reduced in numbers, and confined to a single superfamily, the **Proetoidea** (also spelled Proeteacea).
- The last of the dendrite graptiloids died out.
- The first of the giant fusulinid foraminifers (marine amoebas) appear, but these are still tiny and insignificant
Marine Life in the Mississippian

• Of the nautiloid (palcephalopoda) cephalopods only the nautilida flourished.
• The giant straight-shelled *Rayonnoceras*, up to perhaps 6 meters in length died out towards the end of the Mississippian.
• The bulbous-shelled cephalopods also died out at this time.
• Many types of Ammonoid cephalopods evolved, mostly of the simple goniatitatic suture pattern.
• Vertebrates Sharks were numerous and diverse.
Climatic Conditions in the Mississippian

• The early part of the Mississippian is generally warm, but as Gondwana continues to migrate southward, glacial ice builds and causes overall cooling of the climate.
Terrestrial Life in the Mississippian

- On land, especially in the Euramerican equatorial regions are covered by forests. The moist tropical climate produces a lush plant growth, which eventually becomes the great Coal Deposits.
- The fern-like but seed-bearing pteridosperms, the huge green-stemmed *Lepidodendrale lycopods* (*Lepidodendron*, Sigillaria 35 meters tall).
- The giant sphenopsid *Calamites* (20 meters in height).
- The strap-leaved mangrove-rooted Cordaitales (*Cordaites*, up to 45 meters) are all abundant.
- The drier uplands were much more sparsely covered.
- Meanwhile, *Gondwanaland*, with its colder Antarctic climate, has its own very distinct flora, dominated by glossopterid pteridosperms.
- These ancient trees that they seemed to have sucked much of the carbon dioxide out of the atmosphere, producing a surplus of oxygen. Oxygen levels were higher during this time than at any other time in the history of the Earth.
Two Late Carboniferous Lepidodendrales.
left: *Diaphorodendron scleroticum*, right: *Lepidophloios hallii*

These ‘trees’ are actually ‘quillworts’ that grew to extreme sizes during the Mississippian.
Calamites (sphenopsid—eg horsetails) up to 60 feet in height.
Cordaites - gymnosperms
Glossopteris (Gondwana Fern)
Other Terrestrial Life during the Carboniferous

-Inhabiting the great forests were many types of insects, Encouraged by the oxygen-rich atmosphere, the abundance of food in the decaying forest leaf-litter, and the absence of large terrestrial vertebrates, many reach huge sizes. The dragonfly-like Meganeura, an aerial predator, had a wingspan of 60 to 75 cm. The inoffensive stocky-bodied and armoured millipede-like Arthropleura was 1.8 meters long, and the semi-terrestrial Hibbertopterid eurypterids were perhaps as large, while some scorpions reached 50 or 70 cm. In the water and water margins the tetrapods flourish, are the dominant life form, and many different types inhabit the rivers, ponds, and swamps of the Carboniferous tropics, including many crocodile, eel, and salamander-like forms. The largest hunters of the time were the gigantic rhizodont fish, reaching 7 meters in length. The first reptiles appear, adapted to life lived totally on land, but remain insignificant until at least the very end of the Carboniferous
arthropleurids (up to 2 meters!)
Eurypterid track
Rhizodont Fish

They may have reached sizes of six meters or more!
Early Reptiles in the Carboniferous
Tectonics of the Carboniferous

• During the late Early Carboniferous, East Gondwanaland, for the first time since Early Paleozoic, began to drift toward the South Pole.
• By early Late Carboniferous, the South American-North African margin of Gondwanaland had collided with the northern Devonian supercontinent of Euramerica becomes Laurasia by the late Carboniferous.
• There is regional subsidence of the East-European Platform (east Laurussia/Euramerica) due to compressional stresses at the platform's margins.
• The northward drifting Gondwanaland then collides with Laurasia, resulting in a fold belt and mountain building from Poland through central Europe to the Appalachians. Through the collision of these two supercontinents arises Pangaea.
• At this time Pangaea was shaped like a huge "pack man", with a huge mouth facing eastward across the equator.
• The large open mouth becomes the Tethys Ocean.
• While East Gondwanaland drifted toward the South Pole, most of the East and Southeast Asian terranes were left in equatorial positions, forming a chain of continental terranes at the eastern edge of the Tethys Ocean.
Pangea: "All lands". The face of the Earth has changed through time. 296 million years ago most of the world's landmasses were linked into one 'supercontinent' called Pangea. ISU's Paleomagnetic's lab studies the past movement of continents.
The Permian: End Paleozoic

• The Permian period was named in 1841 by the geologist Murchison after a tour of Imperial Russia to include the "vast series of beds of marls, schists, limestones, sandstones, and conglomerates" that overlay the Carboniferous formations in the eastern part of the country. He named it after the ancient kingdom of Permia and the present city of Perm near the Ural mountains.
The Permian Period (299-251 Ma)

- Pangea reaches tighest packing just at the end of the Permian.
- As the Permian opened, the polar regions were covered with deep layers of ice. Glaciers continued to cover much of Gondwanaland, as they had during the late Carboniferous.
- At the same time the tropics were covered in swampy forests.
- Towards the middle of the period the climate became warmer and milder, the glaciers receded, and the continental interiors became drier.
- Much of the interior of Pangea was probably arid, with great seasonal fluctuations (wet and dry seasons), because of the lack of the moderating effect of nearby bodies of water.
Life in the Permian

• The warm shallow oceans swarmed with many kinds of life, basically very similar to Carboniferous forms.
• Sedentary organisms like stromatolites, algae, foraminifers, sponges (*Heliospongea* (yellow)), corals, bryozoa, and brachiopods built great reefs.
• The reefs provided homes and shelter for active animals like ammonoids, nautiloids, gastropods and fish.
• Ammonoids differed from their Carboniferous predecessors in that they had far more complex suture lines, frequently with many-pointed lobes and rounded saddles.
Ammonites & Sutures

Note that the suturing in ammonites became more complex:

- **Goniatitic** - top
- **Cerratitic** - middle
- **Ammonitic** - bottom
Life in the Permian- Terrestrial

- The early Permian saw the continuation of the Carboniferous biomes, with polar tundra regions and warm wet tropical swamp forests.
- The drying climatic tendency during the mid Permian spelled death for the mighty swamp forests. Water loving plants like *Lycopods* and Sphenopsids were greatly reduced in size, becoming mere shrubs.
- Plant life consisted mainly of ferns and seed-ferns, with new plants like conifers and ginkgos coming into prominence.
- The *Glossopteris* flora predominating in Gondwanaland (the southern portion of Pangaea). It is gradually replaced by the seed-fern *Dicroidium* as the climate dries in the Late Permian.
Life in the Permian-Vertbrates

- **Lungfishes** and **coelacanths** were more diverse than they are today
- The Permian oceans were dominated by a diverse group of spiny-finned (**actinopterygian**) fishes, most of which had thick, heavy scales and rather basic jaw structures
- **Neopterygians** with more derived jaw structures probably began to appear later in the Permian
Lungfish have the ability to breathe using gills or in the absence of water, by breathing air. It’s a tremendous leap since air-breathing is far more difficult in terms of energy cost.
Actinopterygian Fish

Peipiaosteus
Neopteygian Fish - Late Permian
Evolutionary Dynasties of Synapsids (Reptiles)

- The first, the pelycosaur dynasty, included the large finbacks of the early Permian such as *Dimetrodon*, *Edaphosaurus*, *Ctenospondylus*, and *Secodontosaurus*.

- Following this was the Dinocephalian dynasty of the middle Permian (Guadalupian epoch). The Dinocephalians were among the most primitive of the therapsids or "mammal-like reptiles".

- The Dinocephalians all died out suddenly, perhaps as a result of unusual climatic factors, at the end of the Guadalupian. The Therapsids that followed them were smaller, and more mammal-like. Some may even evolved fur and the ability to control their temperatures metabolically.
Pelycosaurs

Dimetrodon - Could reach up to 11 feet in length
Dinocephalians
(Terrible Heads)

Could reach up to 18 feet in length. Shown here is Titanophoneus
Therapsids (ancestors to mammals)