LIFE IN ANCIENT OHIO

LATE PENNSYLVANIAN · 305 MILLION YEARS AGO

On the bank of a lowland river during the Late Pennsylvanian…

*…a giant millipede (key, next two pages, number **2**) has emerged from a tropical rainforest. This enormous arthropod leaves a distinctive trackway (**28**) as its many legs imprint the soft clay of the riverbank. With its extreme size and protective exoskeleton, the millipede has few predators, but a crocodile-like tetrapod (**10**) could pose a threat. Atop the riverbank, a small amphibian (**12**; fig. 1) eyes a cockroach-like insect (**3**) clinging to a fern frond (**25**). Nearby, a reptile with long toes and claws (**16**) has climbed a fern-like seed tree (**26**) and captured a griffinfly (**5**).*

*In the tea-colored, tannin-tinted water of the river, a lobe-finned fish, a coelacanth (**8**), chases a school of small ray-finned fish (**9**). Periodically surfacing to gulp air, another lobe-finned fish, a lungfish (**15**), risks predation by a large freshwater shark (**14**).*

*Shrouded in morning fog, towering mature scale trees (**19**; fig. 2) comprise a relatively open forest canopy. This sparse canopy admits plenty of sunlight for other tree lycophytes (**20**) and giant horsetails (**27**) in the forest understory and for lower-growing, fern-like seed plants (**26**) and true ferns (**25**). Dead and partially decomposed plant matter from the forest forms thick accumulations of peat, which may eventually form coal deposits.*



Figure 1. (A) The *holotype* (reference specimen for the species description) of the small amphibian *Platyrhinops lyelli,* the first tetrapod described from the famous Linton locality in Jefferson County, Ohio (in Wyman, 1858). (B) Living reconstruction of *P. lyelli* (**12**).

The imagined scene described above is based upon actual fossils from rocks exposed in eastern Ohio and mostly on specimens described from two former coal mines: the Diamond Coal Mine (Linton site) in Jefferson County and the 7-11 Mine in Columbiana County. The depictions of these ancient plants and animals are informed by fossils and by living relatives of the organisms and the roles these relatives play in modern ecosystems. Although some aspects of this image are necessarily speculative, an attempt has been made to depict the organisms in a realistic manner consistent with our current knowledge of these ancient life forms and their environment.

Major events in the history of life during the Pennsylvanian Subperiod

The Pennsylvanian Subperiod of the Carboniferous Period (359–299 million years ago [mya]) was named for the period of geological time recorded by rocks occurring in the state of Pennsylvania. The Carboniferous Period, which includes both the earlier Mississippian Subperiod (359–323 mya) and the Pennsylvanian Subperiod (323–299 mya), was named for the coal beds within the rock strata representing this period.

During Pennsylvanian time, most of Earth's land masses were assembled into the supercontinent Pangaea. Part of Pangaea was located over the paleo-South Pole, allowing ice sheets to form during the Late Paleozoic Ice Age (LPIA), which had entered its peak by the Pennsylvanian and subsequent Permian Period (299–252 mya). As with the most-recent (Pleistocene) ice age, shorter-term cycles of cooler glacial periods and warmer interglacial periods during the ice age appear to be correlated with periodic changes in Earth's orbit about the Sun.

The tropics of Pangaea alternated between cooler, drier glacial periods with falling sea levels and warmer, wetter interglacial periods with rising sea levels. During interglacial periods, tropical rainforests became widespread across the lowlands of tropical Pangaea and were composed of tree lycophytes (relatives of modern quillworts and clubmosses, **19–23**), pteridosperms (treelike "seed ferns," **26**), giant horsetails (**27**), and true ferns (**25**). Conifers (**24**) and other seed-bearing plants may have been more prevalent during drier glacial intervals and in higher, better-drained areas. During later Pennsylvanian time, the once widespread tree lycophyte rainforest collapsed, with only isolated remnants remaining.

Vast amounts of carbon, in the form of dead vegetation, accumulated in the tropical forest wetlands as peat. The peat was decomposed by microbes and following burial in the subsurface, subjected to heat and pressure. After millions of years, the peat was transformed into coal.

Winged insects (**3–6**), which comprise the vast majority of insects living today, first appeared during the Mississippian Subperiod and diversified during the Pennsylvanian. Insects were the first and only animals to have evolved powered flight, as pterosaurs, dinosaurs (including birds), and mammals (including bats) had not yet evolved.

Pennsylvanian *tetrapods* (four-limbed vertebrate animals and their descendants) included some now-extinct, semiaquatic animals called *embolomeres* (**10**). These were in some ways like amphibians but would have externally



Artwork by Kyle Hartshorn of Cincinnati, Ohio

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(Based on a fossiliferous cannel coal underlying the Upper Freeport coal and deposits within the lower Conemaugh Group of eastern Ohio)

ANIMALS

Arthropods

Branchiopods

1. *Leaia* sp. (conchostracan, or "clam shrimp")

Diplopods (millipedes)

2. *Arthropleura* cf. *A. cristata* (giant millipede)

Insects

3. *Kinklidoblatta* cf. *K. lesquereuxii* (blattoid; "cockroach")
4. †Meganisopteran (griffinfly) nymph
5. †Meganisopteran cf. *Palaeotherates* sp. (griffinfly)
6. *Xenoblatta (Necymylacris) scudderi* (blattoid; giant "cockroach")

Ostracods

7. Ostracod (unspecified)

Chordates

Actinistians

8. *Rhabdoderma elegans* (coelacanth)

Actinopterygians (ray-finned fishes)

9. *Microhaplolepis ovoidea*

"Amphibians"

10. *Anthracosaurus lancifer* (†embolomere)
11. *Isodectes obtusus* (†dvinosaurian temnospondyl)
12. *Platyrhinops lyelli* (†amphibamid temnospondyl)
13. *Sauropleura pectinata* (†nectridean lepospondyl)

Chondrichthyans (cartilaginous fishes)

14. *Orthacanthus compressus* (†xenacanthid shark)

Dipnoans (lungfishes)

15. *Conchopoma exanthematicum*

"Reptiles"

16. *Anthracodromeus longipes* (eureptile)

Mollusks

Gastropods (snails)

17. Unspecified gastropods (labeled 2x)

Incertae sedis (Latin, "of uncertain placement;" higher level classification is uncertain)

†Tentaculitoids

18. "Spirorbid" †microconchids

PLANTS

Lycophytes (clubmosses, quillworts, and relatives)

19. *Lepidodendron* sp. (arborescent lycophyte; "scale tree")
20. *Sigillaria* sp. (arborescent lycophyte; labeled 2x)
21. *"Sigillariophyllum"* sp. (arborescent lycophyte leaf name)
22. *"Stigmaria"* sp. (arborescent lycophyte rooting structure name)
23. *"Syringodendron"* sp. (decorticated *Sigillaria* trunk name)

Pinophytes (conifers)

24. *Walchia* sp.

Polypodiophytes (ferns)

25. Unspecified fern

†**Pteridospermatophytes** ("'pteridosperms," or "seed ferns")

26. †Medullosan "seed fern"

Sphenophytes (horsetails)

27. *Calamites* sp. (arborescent horsetail; labeled 3x)

ICHNOFOSSILS (trace fossils)

28. *Diplichnites* isp. (arthropod walking trackway)
29. *Limnopus* isp. (tetrapod trackway)
30. *Radulichnus* isp. (trace produced by mollusk radula)
31. *Scolicia* isp. (meandering locomotion or feeding trace)

Key to Abbreviations

cf.	Latin, *conferre* (species not determined but compare with this species)
isp.	ichnospecies (of trace fossils: indeterminate ichnospecies of the ichnogenus)
sp.	species (of organisms: indeterminate species of the genus)
†	dagger symbol; indicates extinct group or type. Genera and species (italicized names) are all extinct

resembled reptiles. Embolomeres were among the largest Pennsylvanian land predators; however, the first *amniotes* also appeared during the Pennsylvanian. Amniotes are vertebrates with certain protective membranes, including an amnion surrounding the developing embryo. This group, which would become the dominant land animals by the end of Pennsylvanian time, included the first true reptiles (**16**) and would later include birds; it also contained the synapsids, a group that included large sail-backed forms like *Dimetrodon* and *Edaphosaurus* and would later include mammals.

The Ohio region during the Middle to Late Pennsylvanian

Middle to Late Pennsylvanian-age rocks, consisting of sandstones, siltstones, shales, mudstones, limestones, and coals now exposed over much of eastern Ohio, were deposited on a lowland coastal plain or in shallow marine waters between ~315 and 299 mya. By ~305 mya, this region was in a low latitude, ~0–10 degrees *south* of Earth's equator. Slow movements of tectonic plates over hundreds of millions of years have transported the Ohio region to its present latitude spanning 38–42 degrees *north* of Earth's equator.

By Middle to Late Pennsylvanian time, the Alleghenian orogeny, an episode of mountain-building that formed the Appalachian and Allegheny Mountains, was well under way. Sediments eroded from the high, young mountains, which at the time were located south of the Ohio region, were carried by rivers into the area and deposited in river channels, floodplains, lakes, deltas, and shallow marine basins.

Middle to Late Pennsylvanian-age rock strata in Ohio and elsewhere show numerous cycles of alternating terrestrial and marine rocks (which geologists call *cyclothems*), indicating

that seas were repeatedly retreating and advancing. Longer period cycles (lasting several million years) likely reflect phases of mountain-building activity; shorter period cycles (lasting an average of ~400,000 years) likely represent global sea levels falling and rising on the order of ~330 feet (ft; ~100 meters [m]) in response to glaciations and deglaciations during the LPIA.

The Upper Freeport Coal (Allegheny Group) and the lower Conemaugh Group in Ohio

The underground Diamond Coal Mine at Linton operated from 1855 to 1921 to mine the Upper Freeport (No. 7) coal. One of the world's most informative Carboniferous fossil sites, Linton has produced exceptionally well-preserved, latest Middle Pennsylvanian-age fossils of freshwater fishes and tetrapods. The Linton fossils were brought to the attention of Ohio's second state geologist, J. S. Newberry, soon after the mine opened. Newberry, a paleontologist, first described the fishes, and Jeffries Wyman and Edward Drinker Cope initially described the tetrapods. The fossils came from a *cannel coal* (a low-grade coal composed mostly of plant spores) located just below the mined coal seam. The Linton deposit has been interpreted to represent a cutoff river meander that formed an oxbow lake within a larger delta plain.

The Conemaugh Group of Late Pennsylvanian-age rocks in Ohio contains 350–500 ft (107–152 m) of marine and terrestrial deposits. The 7-11 Mine, a surface coal mine near East Liverpool, Ohio, exposed the lower Conemaugh Group, which includes rock strata lying just above the Upper Freeport coal. In addition to a diverse flora, including the conifer *Walchia* (**24**) and the conifer-like *Cordaites,* the 7-11 Mine produced rare terrestrial arthropod fossils, including a mantis-like insect, a "cockroach" 4 inches (10 centimeters) long (**6**), a small millipede, and spider-like arachnids. Much of what is known about the world's Late Carboniferous forests was discovered in Ohio coal mines.

Life in an Ohio Pennsylvanian rainforest

The scale tree *Lepidodendron* (**19**; fig. 2) formed a sparse canopy in the Pennsylvanian tropical rainforest. Most closely related to modern quillworts, these plants were unlike trees of today. After growing a root system, *Lepidodendron* sprouted as an unbranched, leafy pole and grew almost to its full height of up to 130 ft (40 m) before developing a crown of branches with leaves.

The giant millipede *Arthropleura* (**2**) is the largest terrestrial arthropod known to have ever lived, reaching a length of 6.6 ft (2 m) or more. Fragmentary body remains and trackways attributable to *Arthropleura* are known from Ohio.

Griffinflies (**4, 5**) were dragonfly-like predatory insects. Although not known from Ohio, griffinflies have been described from the Midwestern and southeastern United States. Pennsylvanian-age fossils of the giant griffinfly *Meganeura* from France indicate a wingspan exceeding 2 ft (~0.6 m).

The predatory, eel-shaped shark *Orthacanthus* (**14**) reached lengths of nearly 10 ft (3 m). It had tricuspid teeth, with two large, pointed cusps forming a "V" shape and a much smaller intermediate cusp. *Orthacanthus* sported a large dorsal spine projecting backward from its head and preceding its long dorsal fin. This shark may have lived in marine, brackish (estuarine), and freshwater environments during stages of its life.

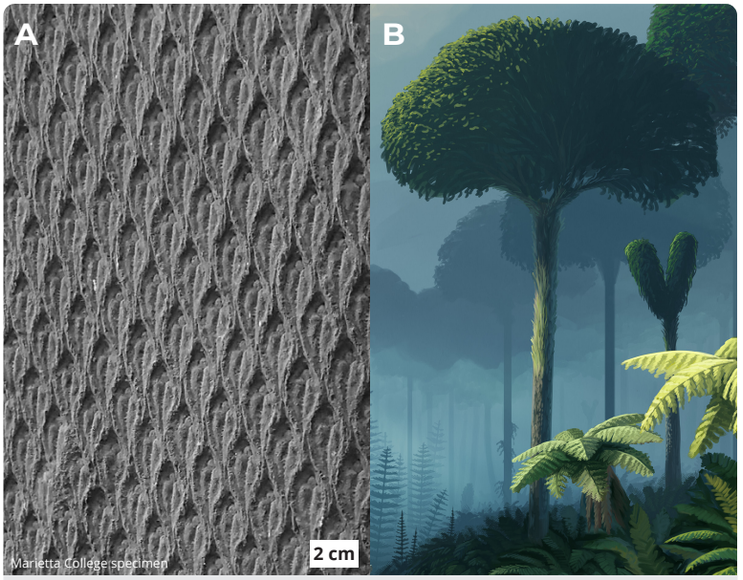


Figure 2. (A) An impression of *Lepidodendron* sp. in sandstone. *Lepidodendron*, meaning "scale tree," is a name used for impressions of the outer layer of the trunk of certain tree lycophytes or, alternatively, as a biological genus for a tree. Diamond- or spindle-shaped leaf cushions surrounded attachment points of leaves that grew directly from the trunk. (B) Living reconstruction of *Lepidodendron* (**19**).

An Ohio natural resource

Historically, Pennsylvanian-age rocks have been important for the economy of Ohio. Coal has been a valuable energy source, with more than four billion tons having been extracted from the state's surface and underground coal mines since the year 1800.

Ohio's Pennsylvanian-age sandstones have been quarried for building stone, glass sand, foundry sand, and grinding and polishing materials. A mostly sandstone rock formation, the Sharon Conglomerate occurs in many northeastern Ohio parks and features scenic cliffs, rock shelters, and waterfalls.

Iron ore, used to produce pig iron, was widely smelted in Ohio furnaces during the nineteenth and early twentieth centuries. Pennsylvanian-aged clays and shales have been used to make bricks and ceramic products.

Flint, a microcrystalline variety of quartz (SiO_2), occurs as nodules or massive beds within Ohio's Pennsylvanian-age marine limestones. Ohio flint, the official State Gemstone, was quarried and widely traded by some ancient American Indian cultures, such as Adena and Hopewell. Flint was shaped into projectile points and cutting tools. Most flint is drab, but some from Flint Ridge in Licking and Muskingum Counties is colorful and lustrous when polished.

For more information, references, and details about where to view Pennsylvanian-age rocks in Ohio, visit:

ohiodnr.gov/LIAO