LIFE IN ANCIENT OHIO

EARLY MISSISSIPPIAN · 355 MILLION YEARS AGO

Above a sand-filled channel within a Mississippian seafloor...

*...a spiny shark (key, next two pages, number **12**) and shelled cephalopods (**31–35**) flee in front of an underwater avalanche of seawater laden with fine sediments. This fast-flowing slurry, a turbidity current, may uproot invertebrate animals living on the sea bottom and transport them downslope. Smaller animals may be buried alive as the current slows and the sediment settles out of suspension, forming a thick blanket of mud.*

*Localized patches of shell accumulations rise like small islands above the soft, muddy seafloor and provide firm attachment sites for spiny brachiopods (**5**) and bryozoans (**9–11**). Stalked echinoderms such as blastoids (**14, 15**) and crinoids (**16–28**) prefer the stronger current of these elevated areas. Vase-shaped glass sponges (**39, 40**) also colonize these shell buildups and provide hiding places for small animals such as conodonts (**13**) and brittle stars (**29**; fig. 1).*

*In the sand-filled channel, swirling pinwheel-shaped animal feeding traces (**46**) interrupt ripples in the sand formed by water currents. A decaying log, which once floated as driftwood before it became waterlogged and sank, provides an attachment site for multiple conulariids (**41**; fig. 2) and inarticulate brachiopods (**8**), as well as hiding places for brittle stars and trilobites (**3, 4**).*

The imagined scene described above is based upon actual fossils from a unit of rocks exposed in northeastern Ohio and northwestern Pennsylvania that geologists call the Meadville Shale Member of the Cuyahoga Formation. The depictions of these ancient animals are informed both by fossils and by living relatives of the fossil animals 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 animals 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 Mississippian Subperiod

The Mississippian Subperiod of the Carboniferous Period (359–299 million years ago [mya]) was named for the period of geological time recorded by exposures of rock along the Mississippi River Valley. The Carboniferous Period includes both the Mississippian Subperiod (359–323 mya) and the subsequent Pennsylvanian Subperiod (323–299 mya).

For much of Mississippian time, Earth experienced a warm, greenhouse climate. Despite the large paleocontinent Gondwana occupying the south polar region, there were only a few short periods of glaciation. Early during the Mississippian, sea levels were high, and large parts of the interior of the North American continent were flooded with shallow inland seas. In areas of the American Midwest to the west of Ohio, seas were farther from sources of terrestrial sedimentation. In these areas, seas were clear, shallow, and warm. Such conditions were favorable for the accumulation of marine limestones—calcareous rocks which are composed mostly of calcium carbonate ($CaCO_3$).

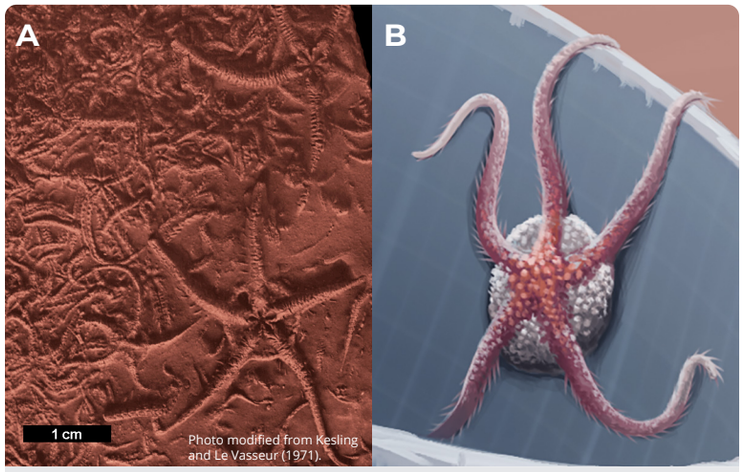


Figure 1. (A) Fossil brittle stars *Strataster ohioensis* from the Meadville Shale Member of the Cuyahoga Formation. An aggregation of these brittle stars with a density of thousands per square meter was discovered within a lens of clay and silt in Cuyahoga County. Buried alive by a blanket of mud in a catastrophic event, these sea-star relatives were exquisitely preserved. (B) Living reconstruction of *S. ohioensis* (**29**) in a glass sponge.

Certain marine animals, such as crinoids (**16–28**), thrived under these conditions, and the Mississippian is often referred to as the "Age of Crinoids." Some limestones covering large areas of the Midwestern United States are called "encrinites" because they are almost entirely composed of calcareous crinoid skeletal pieces.

Placoderm ("plate skin") fishes became extinct at the end of the Devonian Period (~359 mya). Bony fishes and cartilaginous fishes, such as acanthodians (**12**) and sharks, filled ecological niches vacated by the placoderms. Some marine fishes adapted to live in freshwater environments.

On land, the composition of forests became more diverse and plant species, including giant horsetails, tree ferns, conifers, and arborescent lycophytes ("scale trees"), were cosmopolitan (occurring broadly) from the tropics to middle latitudes. Tetrapods (four-limbed vertebrates, including all modern amphibians, reptiles, birds, and mammals) had evolved from fishes during the preceding Devonian Period (419–359 mya) and began to diversify and occupy terrestrial environments. The first fossils of winged insects, which are now the most species-rich of all animal groups, occur in latest Mississippian-age rocks.

The Ohio region during the Early Mississippian

Early Mississippian-age rocks, which are now exposed at the surface in northeastern, east-central, and south-central Ohio, were deposited within a shallow inland sea between ~359 mya and 347 mya. At that time, this region was in a middle to



Artwork by Kyle Hartshorn of Cincinnati, Ohio

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(Based on fossils of the Meadville Shale Member of the Cuyahoga Formation of northeastern Ohio)

ANIMALS

Annelids (segmented worms)
1. Unspecified polychaete worm
2. Unspecified polychaete worm

Arthropods

†Trilobites
3. *Australosutura lodiensis*
4. *Brachymetopus nodosus*

Brachiopods

Articulate brachiopods
5. *Buxtonia? newberryi*
6. *Camarotoechia* sp.
7. *Schellwienella* sp.

Inarticulate brachiopods
8. *Orbiculoidea newberryi* (labeled 2x)

Bryozoans
9. *Fenestella foliata*
10. *Fenestella* sp.
11. *Rhombopora ohioensis*

Chordates

Chondrichthyans
12. *?Gyracanthides (Gyracanthus) compressus* (†acanthodian, or "spiny shark")

†Conodonts
13. Unspecified †conodonts

Echinoderms

†Blastoids
14. †Granatocrinid blastoid
15. *Phaenoschisma* sp.

Crinoids
16. *Aorocrinus helice*
17. *Aorocrinus meyeri* (skeletal remains)
18. *Atelestocrinus meszarosi*
19. *Cusacrinus daphne*
20. *Cuyahogacrinus lodiensis*
21. *Cyathocrinites lamellosus*
22. *Cyathocrinites simplex*
23. *Goniocrinus sceletus*
24. *Histocrinus aegina*
25. *Logocrinus warreni*
26. *Paracosmetocrinus richfieldensis*
27. *Platycrinites* sp.
28. *Taxocrinus* sp.

Ophiuroids (brittle stars)
29. *Strataster ohioensis* (labeled 2x)

Mollusks

Bivalves
30. *Pernopecten shumardanus*

Cephalopods
31. *Aganides sciotoensis*
32. *Kazakhstania colubrella*
33. *Michelinoceras* sp.
34. *Muensteroceras* sp.
35. *Protocanites lyoni*

Gastropods (sea snails)
36. *Loxonema pikensis*
37. *Platyceras lodiense*

†Rostroconchs ("snout shells")
38. *Hippocardia herricki*

Poriferans (sponges)

Hexactinellids (glass sponges)
39. *Calathospongia* sp.
40. *Thamnodictya newberryi*

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

†Conulariids (probable cnidarians)
41. *Paraconularia subulata* (labeled 3x)

†Sphenothallids (possible cnidarians)
42. *Sphenothallus* sp.

ICHNOFOSSILS (trace fossils)
43. *Bifungites* isp. (labeled 2x)
44. *Helminthoides* isp.
45. *Scalarituba* isp.
46. *Zoophycos* isp. (labeled 3x)

Key to Abbreviations

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

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subtropical latitude, ~35 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.

During the latter part of the preceding Devonian Period, a major episode of mountain-building, the Acadian Orogeny, had reached its peak. By Early Mississippian time, clastic terrestrial sediments, including sands, silts, and muds that had been eroded from the Acadian highlands to the south and east, were being carried by rivers to the Ohio region. The region lay within an eastern embayment of a shallow sea that covered much of what is today the Midwestern United States. Early Mississippian-age rocks in Ohio represent nearshore marine, deltaic, and fluvial (river) deposits.

The Meadville Shale Member of the Cuyahoga Formation

The Cuyahoga Formation, named for exposures along the Cuyahoga River, is subdivided into eight or more members containing marine deposits of shales, siltstones, and sandstones. The exception is the Black Hand Sandstone Member, which likely represents a braided river deposit within a valley incised into the Cuyahoga Formation following a drop in global sea level.

Named for the city of Meadville in northwestern Pennsylvania, the Meadville Shale Member also is exposed in northeastern Ohio and is locally fossiliferous. Some beds have exquisitely preserved, articulated fossil crinoids and

other invertebrates, indicating rapid burial of the animals. Fossils in the Meadville Shale include brachiopods, bryozoans, echinoderms, arthropods, and sponges, along with rare vertebrates. Trace fossils such as burrows, trails, and feeding traces, which are evidence of animal behavior, are also present.

The Meadville Shale Member can be up to ~250 feet (ft; ~76 meters [m]) thick in Cuyahoga, Summit, Medina, and Wayne Counties in Ohio. There it consists of mostly blue-gray, or occasionally red, shales with some calcareous beds and thin, mostly lens-shaped interbeds of siltstones or sandstones. Abundant plant debris in some beds suggests proximity to land. Fossils occur throughout, but some are preserved within calcareous concretions in the shales. These concretions are hardened, rounded, mineralized masses that form within the sediment, often around a fossil nucleus (fig. 2A).

Life in Ohio's Early Mississippian seas

Conulariids (**41**; fig. 2) are extinct fossil animals that likely belong within Phylum Cnidaria, which includes, among other groups, the corals, sea anemones, hydroids, and jellyfish. Conulariids attached to firm substrates by means of short stalks, and they often lived together in small groups.

Crinoids (**16–28**), brittle stars (**29**), and the extinct blastoids (**14, 15**) belong to Phylum Echinodermata, which includes, among others, extant sea stars, sea urchins, and sea cucumbers. Crinoids and blastoids anchored to the Mississippian seafloor with a holdfast, and they caught plankton and suspended particles of organic matter from the seawater with their numerous feeding arms. Modern brittle stars sometimes feed in a similar fashion by elevating their arms into the current, but they are motile and can crawl around in search of food near the seabed.

Trilobites (**3, 4**), a diverse group of marine arthropods for much of the early Paleozoic Era, were impacted by extinctions late during and at the end of the Devonian. Their diversity of forms was greatly reduced from the Mississippian until their extinction at the close of the Permian Period (~252 mya).

Brachiopods (**5–8**) and bryozoans (**9–11**) are common fossils in Mississippian marine rocks. These invertebrate groups have a feeding organ (called a *lophophore*) that contains tentacles and finer, hair-like cilia used to capture plankton and small food particles from the seawater. Some Mississippian-age brachiopods (**5**) had hollow spines that may have been an adaptation for anchoring on unstable seafloor substrates; the same spines might have served as a deterrent to predation or have had a sensory function. Bryozoans are colonial animals that build skeletons shared by numerous tiny individual zooids. Mississippian bryozoan colonies commonly had fan-shaped skeletons with small, window-like openings (**9, 10**).

Occasional remains of fossil fishes occur in Ohio's Early Mississippian rocks. In 1873, Ohio's second State Geologist, J. S. Newberry, described the species *Gyracanthus compressus* (**12**) based in part on large (up to ~12 inches [~30 centimeters] long) fin spines from the Meadville Shale Member in Medina County. An acanthodian, or "spiny shark," this fish may have reached ~6.6 ft (~2 m) in length. Acanthodians, named for their prominent bony fin spines, are extinct fishes which may be, or are closely related to, early chondrichthyans (cartilaginous fishes).

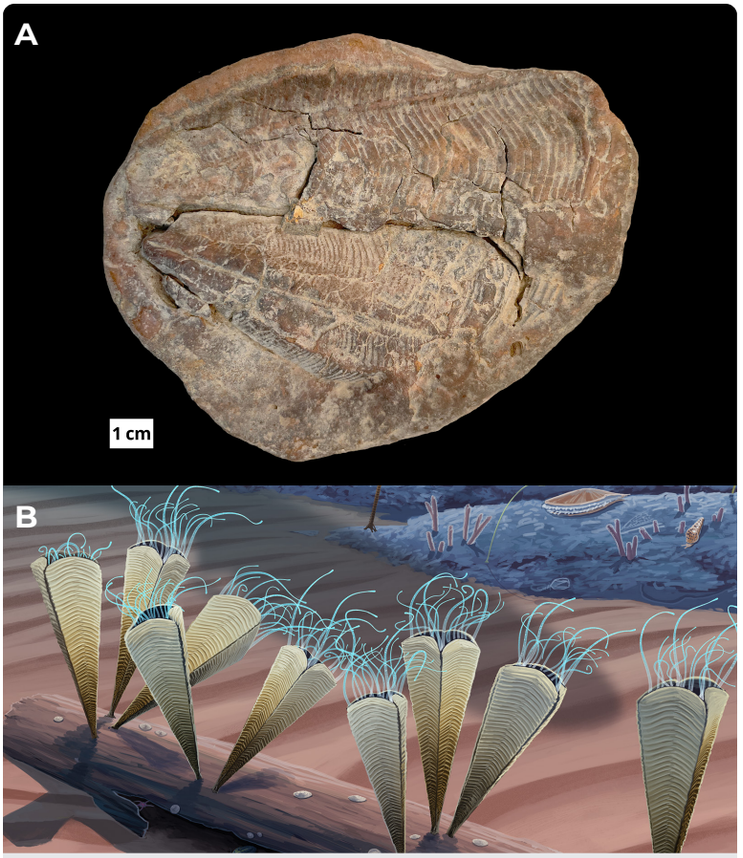


Figure 2. (A) Two partial fossil conulariids preserved in a siderite [iron (II) carbonate, $FeCO_3$] concretion from the Cuyahoga Formation. (B) Living reconstruction of several conulariids (**41**) attached to a piece of waterlogged wood.

An Ohio natural resource

Sandstones of the Cuyahoga Formation were historically used as dimension stone for buildings, bridge abutments, and canal locks. The quartzose sand has also been used to make glass. Cuyahoga Formation shales have been used to produce clay, brick, and ceramic products.

The Black Hand Sandstone provides some of the most scenic geology in Ohio, including gorges with vertical cliffs, waterfalls, and rock shelters in the Hocking Hills region in Hocking County, at Blackhand Gorge State Nature Preserve in Licking County, and in Mohican State Park in Ashland County.

The Meadville Shale Member of the Cuyahoga Formation provides a rich paleontological record of Early Mississippian life in a nearshore environment with clastic sedimentation. Fossiliferous rocks of the Meadville Shale can be viewed in Medina County along the East Fork tributary of the Black River at the Lodi Community Park.

For more information, references, and details about where to view the Meadville Shale Member, visit:

ohiodnr.gov/LIAO