LIFE IN ANCIENT OHIO

MIDDLE DEVONIAN · 385 MILLION YEARS AGO

In a shallow Devonian sea illuminated by moonlight...

*...night has fallen, and corals are spawning in a coordinated act of reproduction, timed to occur a few days after a full Moon. Coral eggs provide a nutritious feast for small marine animals, such as ammonoid cephalopods (key, next two pages, number **46**) and orthoconic ("straight-coned") cephalopods (**45**). A larger predator, a cladodont ("branch-toothed") shark (**22**), pursues the cephalopods.*

*Higher in the water column, a tiny arthropod, an ostracod (**4**), emits a bioluminescent trail to escape a much larger phyllocarid arthropod (**3**). The phyllocarid may become prey for a large lobe-finned fish (**24**), equipped with a wicked pair of tusk whorls between its lower jaws.*

*Closer to the sea surface and surrounded by jellyfish (**34**), an armored placoderm fish (**27**) hunts another species of phyllocarid (**1**) by the light of the Moon. On the seafloor, large brachiopods (**13**; fig. 1) quietly filter the seawater while arthropods called trilobites (**5–8**; fig. 2) scavenge and hunt above and within the seafloor sediment.*



Figure 1. (A) *Paraspirifer bownockeri* brachiopod fossils with a brass-colored coating of the mineral pyrite (FeS_2) on the exteriors of the calcite ($CaCO_3$) shells. Rapid pyrite formation following the death and burial of the brachiopods has sometimes preserved the shapes of organic feeding structures inside the shells before these structures were lost to decay. Each shell is ~1.25 in (3.2 cm) wide; large *P. bownockeri* specimens can exceed twice this size. (B) Illustration of *Paraspirifer bownockeri* (**13**) feeding by filtering plankton from the seawater.

The imagined scene described above is based upon actual fossils from a rock unit of northwestern Ohio that geologists call the Silica 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 Devonian Period

During the Devonian Period (419–359 million years ago [mya]), the first trees and forests evolved, creating new habitats and profoundly affecting the composition of the atmosphere, the cycling of nutrients, the development of soils, and the weathering and erosion of rocks. Jawed fishes diversified and aquatic invertebrate animals adapted to increased predation pressure. The earliest tetrapod ancestors of amphibians, reptiles, birds, and mammals evolved from lobe-finned fishes, paving the way for the colonization of land by vertebrates during the subsequent Carboniferous Period. Two mass extinctions, one during Late Devonian time and one at the end of the Devonian Period, severely impacted marine organisms.

The Ohio region during the Middle Devonian

Approximately 385 mya, during Middle Devonian time, the area that is now Ohio was located in the subtropics, between about 25 and 35 degrees of latitude *south* of Earth's equator. A shallow inland sea periodically covered this area and other parts of the paleocontinent Laurentia, which today

(continues on last page)

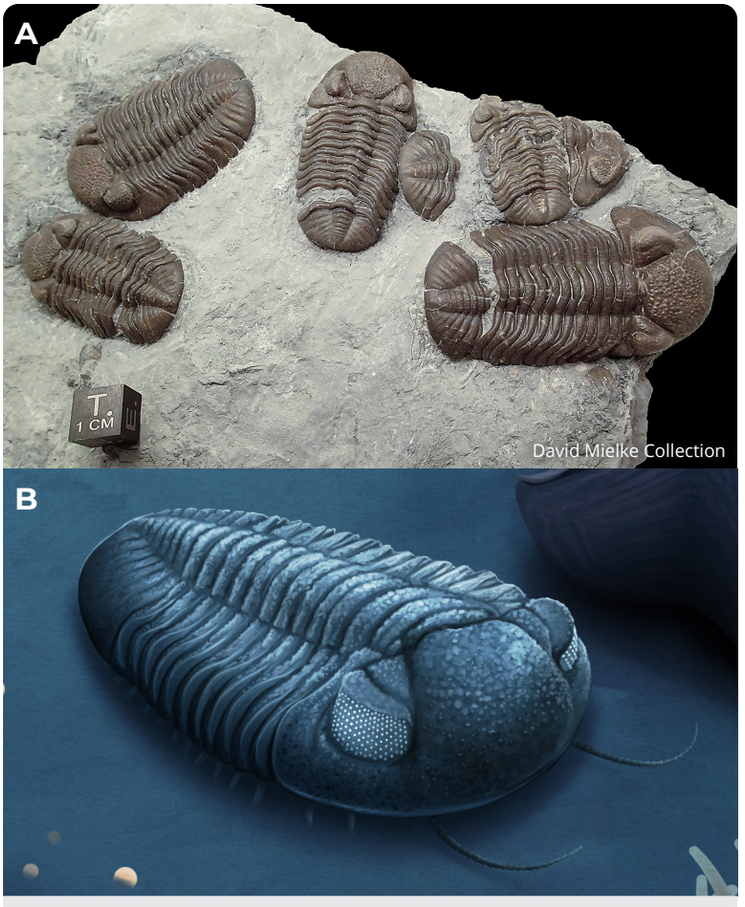


Figure 2. (A) Trilobites, such as these *Eldredgeops* from the Silica Formation, are highly prized by collectors. Exoskeletons of trilobites incorporated the mineral calcite, which contributed to their preservation as fossils. (B) Living reconstruction of *Eldredgeops milleri* (**7**) showing the antennae and the many legs.



Artwork by Kyle Hartshorn of Cincinnati, Ohio

LIFE IN ANCIENT OHIO

MIDDLE DEVONIAN • 385 MILLION YEARS AGO

(Based on the Silica Formation of northwestern Ohio)

ANIMALS

Arthropods

Malacostracans

1. *Hebertocaris wideneri* (phyllocarid)
2. *Paraechinocaris punctata* (phyllocarid)
3. *Rhinocaris ehlersi* (phyllocarid)

Ostracods

4. Unspecified ostracod (emitting bioluminescent trail)

†Trilobites

5. *Dechenella (Basidechenella) lucasensis*
6. *Eldredgeops crassituberculata*
7. *Eldredgeops milleri*
8. *Greenops chilmanae*

Brachiopods

Articulate brachiopods

9. *Cyrtina "hamiltonensis"*
10. *Devonochonetes* sp.
11. *Mucrospirifer profundus*
12. *Mucrospirifer prolificus*
13. *Paraspirifer bownockeri*
14. *Strophodonta* sp.

Inarticulate brachiopods

15. *Petrocrania hamiltoniae*
16. *Philhedra* sp.

Bryozoans

17. *Atactotoechus* sp. (on brachiopod)
18. *Botryllopora socialis* (on brachiopod)
19. †fistuloporoid bryozoan (on brachiopod)
20. *Helopora inexpectata*
21. *Sulcoretepora* sp.

Chordates

Chondrichthyans

22. *"Cladodus"* sp. (†cladodont shark)

†Conodonts

23. *Icriodus* sp.

Osteichthyans

24. *Onychodus* sp. (sarcopterygian)

†Placoderms

25. *Holonema* sp.
26. *Macropetalichthys* sp.
27. *Protitanichthys* cf. *P. rockportensis*
28. *Ptyctodus* sp.

Cnidarians

Hexacorals

29. *Aulocystis auloporoidea* (†tabulate coral)
30. *Aulopora microbuccinata* (†tabulate coral, on brachiopod)
31. *Bethanyphyllum robustum* (†solitary rugose coral)
32. *Favosites* sp. (†tabulate "honeycomb" coral)
33. *Hexagonaria* sp. (†colonial rugose coral)

Scyphozoans

34. Unspecified jellyfish medusae (presence inferred)

Echinoderms

Asteroids

35. ?*Arkonaster* sp. (multiarmed sea star)

†Blastoids

36. *Hyperoblastus reimanni*
37. *Nucleocrinus elegans*

Crinoids

38. *Arthroacantha carpenteri*
39. *Cunctocrinus fortunatus*
40. *Gilbertsocrinus ohioensis*

†Edrioasteroids

41. *Agelacrinites* cf. *A. southworthi* (on brachiopod)

Mollusks

Bivalves

42. *Grammysia* sp.
43. *Pseudaviculopecten scabridus*
44. *Ptychopteria flabellum*

Cephalopods

45. *Bactrites arkonense*
46. *Tornoceras arkonense*

Gastropods

47. *Platyceras bucculentum* (on crinoid)

†Multiplacophorans

48. *Protobalanus spinicoronatus* (stem group chiton, on brachiopod)

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

†Ascodictyids (formerly classified as bryozoans)

49. *Ascodictyon fusiforme* (on brachiopod)
50. *Eliasopora stellatum* (on brachiopod)

†Hederelloids (formerly classified as bryozoans)

51. *Hederella cirrhosa* (on brachiopod)
52. *Hederella filiformis* (on brachiopod)
53. *Hederella parvirugosa* (on brachiopod)

†Tentaculitoids

54. *Cornulites* sp. (†cornulitids, on brachiopod)
55. *Styliolina fissurella* (†styliolinid)
56. *Tentaculites* cf. *T. bellulus* (†tentaculitids)
57. "spirorbid" †microconchids (on brachiopod)

Others

58. Unnamed "worm tube" (on brachiopod)

ICHNOFOSSILS (trace fossils)

59. *Diplichnites* isp. (arthropod walking traces)

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.

forms a large portion of North America. Slow movements of tectonic plates over hundreds of millions of years have transported the Ohio region to its present latitude between 38 and 42 degrees *north* of Earth's equator.

Beginning in the Devonian, collisions of continental crust with the eastern margin of Laurentia resulted in the Acadian Orogeny, one of a series of major mountain-building episodes in the development of the modern Appalachian Mountains. Erosion of the newly formed Acadian Mountains provided a source of fine clay sediments to the Ohio region during Middle Devonian time.

The Silica Formation

Rocks of the Silica Formation consist primarily of *calcareous* (containing calcium carbonate, $CaCO_3$) mudstones and *argillaceous* (containing clay) limestones ("limey mudstones" and "muddy limestones," respectively). The muddy limestones of the Silica Formation formed mainly from calcareous skeletons and shells of organisms living in the local area, combined with fine clay sediments derived from erosion of the distant Acadian Mountains and transported as particles suspended in seawater. Conversely, the limey mudstones of the Silica Formation formed mainly from clay sediments derived from these mountains, combined with some locally formed calcareous shells and skeletons.

Silica Formation rocks are exposed near the surface in northwestern Ohio, northeastern Indiana, and southern Michigan. In Ohio, near-surface exposures are limited to a narrow band extending through the Ohio counties of Paulding, Defiance, Henry, and Lucas. However, because the low-lying, flat topography has few natural stream exposures and a cover of glacial sediments, the best exposures in Ohio have been in stone quarries, where dolostones, limestones, sandstones, and clay-rich mudstones are mined for use as aggregates in construction and for other industrial uses.

Named for an old quarry exposure close to the hamlet of Silica, near Sylvania, Ohio, the Silica Formation has yielded abundant and exquisitely preserved fossils now familiar to scientists and collectors around the world. Beginning with the first quarries in the 1920s, most of these fossils were collected during the twentieth century when mine operators provided occasional access to non-employees. For safety and liability considerations, the working quarries are now closed to amateur collecting. However, a few publicly accessible sites (see link, below) provide opportunities to sample rocks from the Silica Formation.

Life in Ohio's Middle Devonian seas

Sea life during the Middle Devonian would have been in some respects familiar and in others foreign. The Devonian Period is known as the "Age of Fishes." In addition to early sharks and bony fishes, which have living relatives today, a now-extinct group of armored placoderms, or "plate-skin" fishes, flourished with diverse forms occupying a wide variety of ecological niches. Based on their body shapes, placoderms like *Holonema* (**25**) and *Macropetalichthys* (**26**) were probably living on or near the seabed, while others, like *Protitanichthys* (**27**; fig. 3), may have prowled the water column above. Although smaller than its Late Devonian relative *Dunkleosteus terrelli* (Ohio's State Fossil Fish), *Protitanichthys* could reach 2 m (6.6 ft) in length.

Predation pressure on Devonian species from fishes and other animals, including cephalopods (**45, 46**) and phyllocarid arthropods (**1–3**), was probably intense. Evidence of this includes the prevalence of spines, which may have been antipredator adaptations, on crinoids such as *Gilbertsocrinus ohioensis* (**40**) and *Arthroacantha carpenteri* (**38**). Spines may have deterred fishes, such as the placoderm *Ptyctodus* (**28**), from preying on commensal or parasitic marine gastropods (**47**) living attached to the crinoids and feeding upon their waste. Echinoderms, such as crinoids (**38–40**) and sea stars (**35**), were capable of regenerating spines or arms lost to predators.

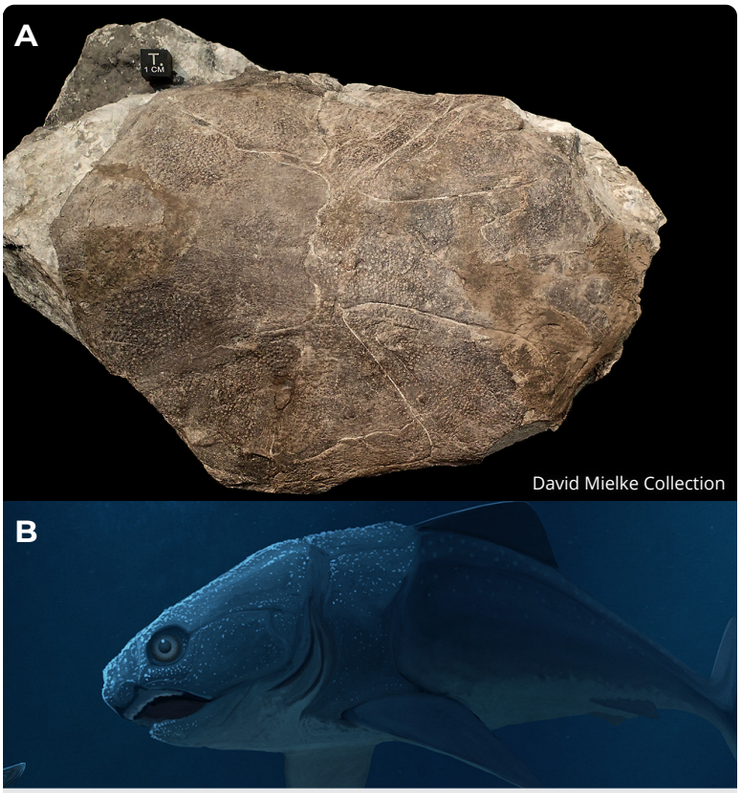


Figure 3. (A) View from above of the front portion of a dorsal head shield of the placoderm *Protitanichthys*. Like many placoderms, *Protitanichthys* is known primarily from bony plates that armored the anterior (front) portion of its body. Lines on the head shield are prominent sensory grooves and fainter plate sutures. Scale cube (top left) is 1 cm. (B) Illustration of *Protitanichthys* cf. *rockportensis* (**27**) showing the armored skull and thoracic region.

An Ohio natural resource

Silica Formation fossils representing Middle Devonian life forms are one of Ohio's most valuable paleontological resources. These fossils are an important source of data for paleontologists and are objects of wonder and beauty for collectors. Artistic illustrations of these diverse life forms can serve to inspire a new generation of paleontologists, both amateur and professional.

For more information, references, and details about where to view the Silica Formation, visit:

ohiodnr.gov/LIAO