LIFE IN ANCIENT OHIO

EARLY SILURIAN · 440 MILLION YEARS AGO

Within an ancient Silurian sea...

*...a natural garden of festively colored sea lilies adorns a shallow reef. These "lilies" are crinoids—echinoderm animals related to sea stars (see key, next two pages, numbers **19–45**). With root-like holdfasts anchoring them to the seafloor or the reef (fig. 1), the stalked crinoids elevate their branched feeding arms to capture drifting plankton and tiny particles of detritus suspended by currents washing over the reef. Another echinoderm, a rhombiferan (**47**; fig. 2), feeds similarly.*

*Built primarily of colonial corals (**14–16**, **18**; fig. 3) and calcareous stromatoporoid sponges (**54**), the reef structure works as a baffle, redirecting the water current and creating eddies that wash all parts of the reef with nutrient-laden seawater. The reef provides sheltered spaces for delicate invertebrate animals, such as clusters of cornulitids (**61**), colonies of bryozoans (**8–12**), and dendroid graptolites (**49**). Nooks and crannies in the reef provide both hiding places for trilobites (**1–4**) and marine snails (**52, 53**) and hunting grounds for trilobites and cephalopods (**50, 51**).*

The imagined scene described above is based upon actual fossils from rock units present in southern and southwestern Ohio that geologists historically referred to as Brassfield Limestone, Brassfield Dolomite, or Brassfield Formation. The depictions of these ancient animals are informed by fossils and 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 Silurian Period

During the Silurian Period (444–419 million years ago [mya]), early vascular plants colonized the land, joining previously established nonvascular plants such as mosses and liverworts. Vascular plants possess conductive tissues for transporting water and nutrients and are able to grow taller than nonvascular plants.

Among animals, some arthropod groups were early colonizers of the land. Arachnids (including scorpions and trigonotarbids—extinct, spider-like animals) and myriapods (including millipedes and centipedes) were fully terrestrial by late Silurian time.

In Silurian seas, colonial corals and stromatoporoid sponges were the principal frame builders of the earliest large, extensive reef structures. Gnathostomes (jawed vertebrates, which includes most vertebrates living today) likely evolved during the preceding Ordovician Period, but rocks of early Silurian age contain the oldest known gnathostome fossils in the form of jawed fishes.

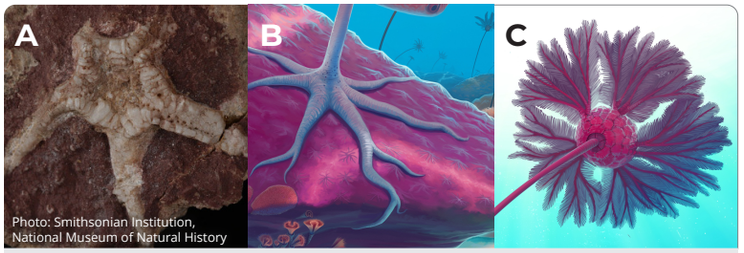


Figure 1. (A) Root-like fossil holdfast of the crinoid *Stereoaster squamosus*. Eminent Ohio paleontologist August F. Foerste, who named the species based upon this specimen, had initially misidentified it as a fossil sea star. Photo area is ~3 cm wide. (B) Living reconstruction of a *Stereoaster squamosus* holdfast attached to a stromatoporoid sponge (**54**). (C) Living reconstruction of the crown of *Stereoaster squamosus* (**38**) facing into the current. Sticky tube feet (too small to see here) line food grooves on its arms and collect plankton and suspended detritus from the lee (sheltered side) of the current.

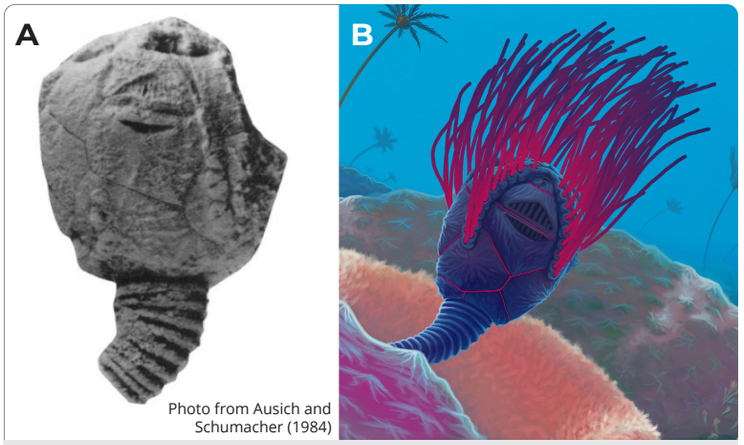


Figure 2. (A) Fossil specimen of *Anartiocystis foerstei.* This species belongs to an extinct group of echinoderms known as *rhombiferans,* named for rhombic ("diamond-shaped") areas on their bodies containing slit-like openings for respiration. Specimen is ~2 cm wide. (B) Living reconstruction of *Anartiocystis foerstei* (**47**) attached to a stromatoporoid sponge (**54**).

The Ohio region during the Silurian

Approximately 440 million years ago, during early Silurian time, the area that is now Ohio was located in a tropical latitude, between ~15–20 degrees *south* of Earth's equator. A shallow inland sea covered much of the state. 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 Silurian, Ohio seas at times received clay and fine silt sediments derived from the erosion of landmasses far to the (paleo)south and (paleo)east. These sediments formed shales and siltstones, respectively; however, deposition was primarily of carbonate rocks: limestones and dolostones. Marine limestones are mostly calcium carbonate ($CaCO_3$) produced by living organisms; dolostones are mostly calcium and magnesium carbonate, with magnesium ions substituting for some of the calcium ions [Ca, $Mg(CO_3)_2$]. Ohio's Silurian dolostones were originally deposited as

(continues on last page)



Artwork by Kyle Hartshorn of Cincinnati, Ohio

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(Based on the Brassfield rocks of southwestern Ohio)

ANIMALS

Arthropods

†Trilobites

1. *Acidaspis brevispinosa*
2. *Calymene vogdesi*
3. *Illaenus* (?*Bumastus*) *ambiguus*
4. *Illaenus daytonensis* (labeled 2x)

Brachiopods

5. *Cryptothyrella quadrangularis*
6. *Leptaena rhomboidalis*
7. *Neoplatystrophia*? (*Platystrophia*) *daytonensis*

Bryozoans

8. *Clathropora frondosa*
9. †Cystoporate bryozoan
10. †Fenestrate bryozoan
11. *Pachydictya bifurcata*
12. *Ptilodictya lanceolata*

Chordates

†Conodonts

13. *Distomodus kentuckyensis*

Cnidarians

Hexacorals

14. *Favosites* sp. (†tabulate “honeycomb” coral)
15. *Halysites* sp. (†tabulate “chain” coral)
16. *Propora* sp. (†heliolitid tabulate coral)
17. *Streptelasma* sp. (†solitary rugose coral)
18. *Strombodes socialis* (†colonial rugose coral)

Echinoderms

Crinoids

19. *Acacocrinus anebos*
20. *Bikocrinus baios*
21. *Clematocrinus ohioensis*
22. *Clidochirus americanus*
23. *Clidochirus springeri*
24. *Dendrocrinus daytonensis*
25. *Eoparisocrinus siluricus*
26. *Euspirocrinus heliktos*
27. *Floricolumnus* (column species)
†dimerocrinitid
28. *Ibanocrinus petalos*
29. *Kanabinocrinus thyaros*
30. *Kyreocrinus constellatus*
31. *Manticrinus exaitos*
32. *Paiderocrinus asketos*
33. *Paiderocrinus ochthos*
34. *Patelliocrinus planus*
35. *Phrygilocrinus batheri*
36. *Rhachicrinus wrighti*
37. *Silfonocrinus siluricus*
38. *Stereoaster squamosus*
39. *Stibarocrinus centervillensis*
40. *Temnocrinus americanus*
41. *Tirocrinus trochos*
42. *Turbocrinus punctum*
43. *Typanocrinus strombos*
44. *Xysmacrinus greenensis*
45. *Zirocrinus litos*

†Cyclocystoids

46. *Zygocycloides*? *foerstei*

†Glyptocystids

47. *Anartiocystis foerstei* (†rhombiferan)

Hemichordates

Pterobranchs

48. *Climacograptus scalaris kentuckyensis* (†graptoloid graptolite; labeled 2x)
49. *Dictyonema* sp. (†dendroid graptolite; labeled 2x)

Mollusks

Cephalopods

50. *Gomphoceras ortoni*
51. †Orthocerid cephalopod

Gastropods

52. *Bucania* sp. (†bellerophont)
53. *Platystoma niagarense*

Poriferans (sponges)

†Stromatoporoids (calcareous sponges)

54. *Clathrodictyon* sp. (labeled 2x)

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

†Chitinozoans

55. *Ancyrochitina ancyrea*
56. *Ancyrochitina primitiva*
57. *Angochitina* sp.
58. *Conochitina* sp.
59. *Coronachitina maennili*
60. *Cyathochitina campanulaeformis*

†Tentaculitoids

61. *Cornulites* sp. (†cornulitids, on stromatoporoid)

PLANTS

Chlorophytes (green algae)

62. cf. *Menieria minuta*

ICHNOFOSSILS (trace fossils)

63. *Cruziana* isp. (arthropod locomotion and/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

limestones but were later chemically altered to dolostone. During this "dolomitization" process, the calcareous (containing $CaCO_3$) shells and skeletons of marine organisms were dissolved, leaving only voids with molds of the original shells in the rocks. Fortunately for those who study these organisms, limestones in the northern exposures of the Brassfield in Ohio did not undergo dolomitization and many calcareous fossils are preserved.

The evolution of coral-sponge reefs early in the Silurian may have played a role in the formation of extensive evaporite deposits later in the period. During late Silurian time, Ohio seas were shallow and at times had restricted connections to the ocean. Barriers created by large reef complexes may have further constricted these connections, allowing for seas to become hypersaline (having above-normal salinity) as water evaporated. In northeastern Ohio, thick deposits of evaporite minerals such as halite (table/rock salt, NaCl) and anhydrite ($CaSO_4$) formed. Deposits of anhydrite near the surface were later hydrated by groundwater to form gypsum ($CaSO_4 \cdot 2H_2O$), which historically was mined for the production of plaster. Vast underground deposits of halite from Ohio's late Silurian-age rocks supply the salt for deicing Ohio roads.

Brassfield limestone in Ohio

The historical Brassfield of Ohio is currently divided into several rock units that consist of mostly limestones or dolostones, with substantial siltstones, shales, and cherts in places. The formal Brassfield Formation was originally described in 1906 as the "Brassfield limestone" by Ohio geologist and paleontologist August F. Foerste from a railroad cut in Madison County, Kentucky. The name is for a former train depot and town of Brassfield, northeast of Berea, Kentucky.

The Brassfield Formation proper is exposed in Kentucky and southern Ohio; similar and slightly younger rocks historically called "Brassfield" extend into the Dayton region, Indiana, western Tennessee, and Arkansas. Collectively, these Brassfield rocks in Ohio outcrop within a narrow (~0.5–2-mi [0.8–3.2 km]-wide) band extending from the Indiana border east to the Dayton region and then southeast to the Ohio River through Highland and Adams Counties. Overlying Upper Ordovician rocks, these rock units contain the oldest Silurian rocks in Ohio.

Life in Ohio's early Silurian seas

Small patch reefs of colonial corals (**14–16**, **18**; fig. 3) and stromatoporoids (**54**) were already present in Ohio's early Silurian seas, and reefs became larger and more extensive later in the period. However, many organisms associated with reefs also lived independently of them. Crinoids (**19–45**) often anchored directly to the seafloor. Many limestone layers are composed mostly of crinoid *ossicles* (individual skeletal pieces). A single crinoid skeleton could contain thousands of ossicles. When a crinoid died, its calcareous skeleton disarticulated (fell apart) and the ossicles became part of the seafloor sediments. Eventually, these loose sediments would form a cemented limestone containing the fossil remains of crinoids and other marine organisms.

Other invertebrate animals with calcareous shells and skeletons also contributed to the composition of the limestone, including trilobites (extinct arthropods, **1–4**), and the suspension-feeding brachiopods (**5–7**) and bryozoans (**8–12**). Mollusks with calcareous shells included shelled cephalopods (**50–51**) and marine gastropods (sea snails, **52–53**). A distinctive marker bed of yellow-brown limestone in the vicinity of Fairborn, Ohio, contains large numbers of gastropods and small cephalopods (**51**).

Depictions of the Silurian Period often feature eurypterids (sea scorpions), but in Ohio, rare Silurian eurypterid fossils are restricted to rocks that formed in nearshore environments later in the period. However, because their exoskeletons were made of chitin, a material preserved only in exceptional circumstances, it is possible eurypterids were present in Ohio's early Silurian seas but did not leave fossils.

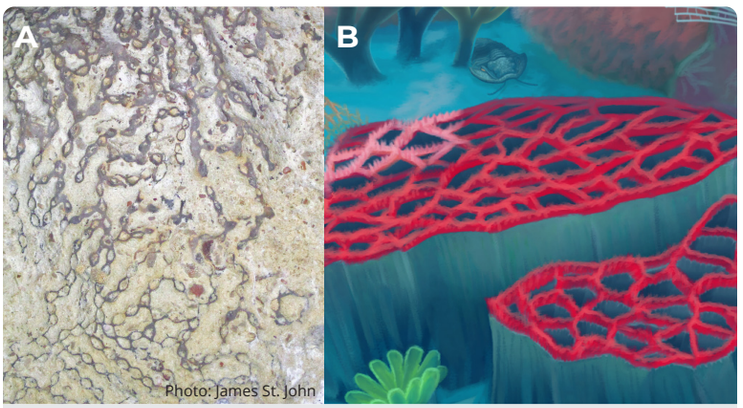


Figure 3. (A) Fossil skeleton of the "chain" coral *Halysites.* The *corallites* (skeletal tubes constructed by individual coral polyps) were joined side-by-side, giving the *corallum* (communal skeleton) a chain-like appearance when viewed from above as in this photo. Corallites are ~2 mm wide. (B) Living reconstruction of *Halysites* sp. coral colonies (**15**). Living coral polyps (imagined with a red-pink coloration) occupied the outermost communal skeleton.

An Ohio natural resource

The early Silurian-age Brassfield rocks near Fairborn, Ohio, have been economically important as a source of crushed stone and high-calcium limestone for the production of Portland cement. Rocks deposited later in the Silurian Period have been a source of limestone, dolostone, and vast salt deposits.

A former limestone quarry, the City of Fairborn's Oakes Quarry Park is an excellent place to view Brassfield rocks and to collect fossils in designated areas. Quarries and natural exposures of Brassfield limestone in the Dayton area have been invaluable to paleontologists as a rich record of marine life from the early Silurian.

Brassfield rocks also contribute to scenic geology in Ohio by their tendency to form cliffs, gorges, and waterfalls. Waterfalls with public access include Charleston Falls in Miami County and Martindale Falls and Patty Falls within Englewood Metropark in Montgomery County.

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

ohiodnr.gov/LIAO