Fossil Algae in the St. Louis Limestone of Western Indiana

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General. Various nodular structures invariably turn up in the fossil collections of the Mississippian limestones in Western Indiana. Some of these nodular and brecciated masses are the result of storms or slumps, probably shortly after the time of deposition (1). Other nodules have a more uniform biscuit-like shape, and show a microstructure of ramifying and parallel tubes peculiar to some fossil algae. This latter structure inspired the writer to search for algal limestone in Putnam County and vicinity. The St. Louis limestone with its many differing conditions of ancient sedimentation has provided collecting sites of nodular algal masses, and a number of other specimens which are probably algae. This paper deals mainly with the biscuit-like structures.

In the rocks examined, undoubtedly there are many fossil algal remains that are not recognized. Secondary mineralization has pro-

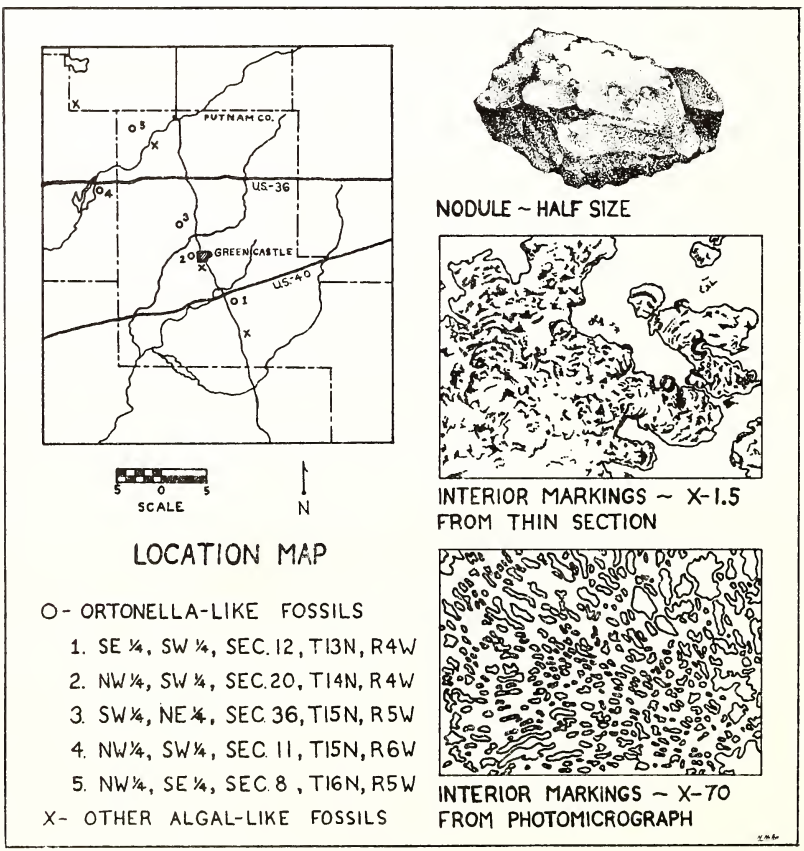

Figure 1

foundly affected the delicate structures of these fossil plants which built calcareous skeletons during Mississippian time. As with calcareous algae of the present, calcification started at the periphery and worked inward. Thus only the more mature plants could be preserved. Too, the intricate mixture of plant and animal preservations at the micro level has resulted in a petrified felt-like structure which at present defies individual identifications.

Descriptions. A representative collecting site is along the north branch of Jones Creek at Vermillion Falls (see Fig. 1), 4½ miles northwest of Greencastle. Here earlier collections have been made from the 30 feet of Mississippian limestone exposed (2). Near the base of the falls along undercut ledges fossil algae are abundant in two beds. The upper bed is two feet thick and is composed of large somewhat flattened algal balls which average 3 to 6 inches in diameter. They weather out and are carried downstream as large cobbles. Directly beneath this bed is a greenish shaly layer 6 inches thick. Smaller flattened and elongate nodules averaging one and one-half inches in diameter are scattered in the limy shale.

The exteriors of the larger nodules are uneven and crinkled, resulting from the growth pattern of the colony. The interiors are solid, but fresh breaks show splochy surfaces. Several specimens of varying sizes were sawed for interior inspection. Thin sections were likewise made and examined. The algal nodule consists of many small rounded nodes which average from one-eighth to one-fourth of an inch in diameter. The structure of each node exhibits a series of fine tubes which radiate from the center. The tubes are packed closely together, and in cross section are nearly round. When the plane of the cut is tangent to the structure the microscope reveals many parallel tubes. Branching of the tubes is limited, but when it does occur banded structure is apparent. Horizontal cuts of the flattened algal nodules produced the best sections for study.

Identification. Fossil specimens are difficult to place in the classification scheme of living material. Nevertheless the attempt is usually made. In the nodular limestones the fossil tube-like structures could be replicas of either animal or plant life. Faunal possibilities might be worm tubes, sponge, coral, echinoderm stems, or others. However, since there are so many closely packed tubes of microscopic diameters, a small bushy-type plant with hardened stems and branches is indicated. The structures are apparently those of calcareous algae.

Earlier workers have assigned such structures to the Blue-green algae, but more recently they are placed under the Green algae in the family Codiaceae (3). The collected specimens compare closely with the genus *Ortonella* (cf. *O. furcata* Garwood). The reported range for this genus is from Silurian to Upper Carboniferous age. A few of the thin section specimens compare with the genus *Garwoodia*, and others with *Solenopora*. It is probable that *Ortonella*, *Garwoodia*, and *Solenopora* are mixed in some of the samples.

Fossil relations. The algal nodules have been found mainly in the lower and middle St. Louis limestone of the Putnam County area. The

formation consists of fine to medium grained gray to dark gray limestone, interspersed in the lower and middle beds with some shaly partings. Nodule-like masses are more commonly on the top surface of a limestone bed which may be overlain with thin shaly limestone or shale. The nodules in the limy shale are small, but in more solid limestone may reach 6 inches in diameter. A few other micro-fossil fragments resembling foraminifers are in some of the algal balls. On the whole the rock in which the fossil algae are found is not fossiliferous, save for the algae.

Other questionable fucoidal and stromatolitic structures in the St. Louis limestone of the area are:

(1) chain-like tracks somewhat like small crinoid stems, but probably algae, like *Bevocastria.*

(2) scattered tubes about one millimeter in diameter, filled with calcite, resembling corallites from *Syringopora*, but probably algae, like *Palaeoporella.*

(3) thin, thread-like structures, like *Girvonella.*

(4) laminated, undulating, wavy beds much like stromatolitic limestone, which may include fossil algae, like *'Stromatolites.'*

Paleoecology. An arm of the ocean (entering from the present 'gulf' country) covered this area during lower Meramecian time. The closest shoreline at the time the St. Louis lime muds were being deposited was probably to the eastward some 50 miles (4). Structures in these sediments such as ripple marks and cross beds indicate current action, while faunal assemblages in the rock prove salt water environment. Thickness and extent of limestone in itself indicates shallow portions of warm seas (5).

The presence of fossil algae, and more particularly *Ortonella,* suggest that these conditions prevailed during lower and middle St. Louis time in this area:

(1) lime muds were accumulating on shallow flats.

(2) tides, in protected basins, were very low.

(3) temperature of the water was moderate to warm.

(4) water depth where the nodules formed was from 0-50 feet deep.

(5) variable currents swept the bottoms in gentle motion.

(6) during daylight hours the sun shone most of the time.

(7) the mineral composition of the mud was probably mainly aragonite.

(8) the flattened biscuit-like algal heads represent plant colonies that lived on a rather firm substrate in water that was relatively clear at the time.

(9) algae living in silty water did not thrive. The fossils associated with limy shale are small, and not plentiful. Extreme siltiness spelled an end for *Ortonella.*

Preservation. During St. Louis times many genera and species of algae must have been present in the shallow seas covering the area. At least some of these were lime secreting types, for fossil skeletons

are preserved. Originally the lime mud was composed of a complex mineralogical mixture in which an important mineral was aragonite. Through time this mineral has changed to calcite, a more stable form of lime carbonate. The lime from the water apparently is taken first to the outer part of the young plant, and with plant growth, gradually is taken farther into the interior of the skeleton (6). Thus with *Ortonella*, the best preserved structure is on the exterior of the small plant units, while the inside is a sponge-like mass of limestone. Even so it is hard to believe that such delicate plant structures could be preserved, especially since secondary changes have gone on after petrefaction.

Usefulness. Fossil algae take so many structural forms that even identification as a plant may be difficult. Indeed many collectors of the past have probably placed some fossil algae in various other divisions such as sponges, corals, bryozoa, crinoids, worms, and others. Some algae, like *Ortonella* are rather distinctive. For this area at least, and as now interpreted, recognition of this fossil is an aid to sequence studies in the lower and middle St. Louis limestone. Other genera of fossil algae are present in the Mississippian rocks of the area and should be collected and studied for further stratigraphic use.

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