Senior Thesis

The Paleoecology of Solitary Rugose Corals in the Portersville Shale (Pennsylvanian, Southeastern Ohio)

by

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Approved by:

Dr. William I. Ausich
ABSTRACT

Very few studies have been completed on the paleoecology of Pennsylvanian faunas in southeastern Ohio. The Portersville Shale, outcropping in southeastern Ohio, is a highly fossiliferous Pennsylvanian unit. Within this fauna is the solitary rugose coral *Lophophyllidium* sp. These Pennsylvanian rugose corals from the Portersville Shale have very well preserved lateral attachment scars. Ordinarily, basal and lateral attachment scars suggest attachment only during the brephic stage of growth. In the specimens collected at the Muskingum-Guernsey Countyline Quarry, studies of the attachment scars suggest post-brephic attachment. A study of the trophic position and life habits of the remaining faunal elements of the Portersville Shale has yielded evidence for a highly diverse community. The community was relatively stable, food resources were intermediate, and there was high space variance. In response to competition for food as well as the need for substratum stability, *Lophophyllidium* sp. developed a post-brephic mode of attachment to occupy a less competitive ecologic niche.
INTRODUCTION

The Portersville Shale is one of 4 major marine events of early middle Conemaugh. Some work has been done on the Pennsylvanian fauna in the Appalachian Basin through eastern Ohio and Kentucky, but much more is needed. Until recently, all Pennsylvanian rugose corals in this region were given the name *Lophophyllum profundum* (Condit, 1912). Today, Pennsylvanian rugose corals have been described from strata in Texas, Kansas, Oklahoma, Illinois, Missouri, Arkansas, and Ohio. Of the Pennsylvanian rugose corals reported in the Midcontinent, few have as well-preserved lateral attachment scars as those rugose corals from the Muskingum-Guernsey Countyline Quarry within the Portersville Shale unit.

The purpose of this study is to report the occurrence of rugose corals from the Upper Pennsylvanian Portersville Shale and to describe the attachment scars on these forms. Identification of the entire fauna was done to aid in the understanding of the paleoecological occurrence of rugose corals with these lateral attachment scars. The faunal specimens were collected at two localities, the Muskingum-Guernsey Countyline Quarry and an outcrop behind the Heck's Department Store on East State Street in Athens, Ohio (Figure 1). Bulk samples were collected at both localities. At the Heck's locality, one bulk sample was taken.
FIGURE 1:

Locality 1:

from Bloomfield, OH, 7.5" quadrangle

Scale 1:24,000

Locality 2:

From Athens County Quadrangle
immediately above the carbonaceous shale at the base of the Portersville and was highly fossiliferous. A second bulk sample at the Heck's locality was taken 2-4 meters below the top of the Portersville Shale unit and was slightly less fossiliferous. Bulk samples from the Muskingum-Guernsey Countyline Quarry were the only samples in this study to have rugose corals. The morphology and paleoecological occurrence of these rugose corals are studied in detail to aid the further understanding of the paleoecological communities that existed in southeastern Ohio during the Pennsylvanian Period.

PENNSYLVANIAN STRATIGRAPHY AND GEOLOGY OF SOUTHEASTERN OHIO

The Pennsylvanian rocks cover the easternmost third of the state of Ohio. These form part of the Appalachian Plateau of the central Appalachian Mountains. Uplift of Mississippian units followed by a period of erosion has resulted in a regional unconformity in this area (Kovach, 1979). Pennsylvanian rock units dip to the east 0 to 20 degrees, with faults relatively rare and generally having displacements of less than 1 meter (Collins, 1979). The northwest-southeast trending Cambridge arch is a prominent structural feature.

Pennsylvanian strata in the northern Midcontinent are dominated by transgressive-regressive lithic sequences or cyclothems (Weller, 1930). A complex repetitive sequence of sandstone, mudstone, shale, limestone, coal, and clay defines the
Pennsylvanian (Collins, 1979). Collins (1979) described the Pennsylvanian complex in Ohio as a repetitive sequence of lenticular sandstones, mudstones, freshwater and marine limestones, clays, and coals averaging about 335 m thickness. "In eastern Ohio, the Pennsylvanian system is a thick facies mosaic of complexly interbedded, coal-bearing, predominantly clastic sedimentary deposits laid down in a variety of terrestrial, freshwater and shallow-marine environments" (Kovach, 1979). In ascending order, the Pottsville Group, Allegheny Group, Conemaugh Group, and Monongahela Group constitute the Pennsylvanian rocks in Ohio. The Conemaugh Group outcrops in a broad band, 10 to 20 miles wide, across the southeastern part of Ohio. It extends eastward, under cover, into West Virginia and Pennsylvania and is again at the surface toward the eastern edge of the Appalachian coal basin (Condit, 1912).

The Appalachian Basin was probably connected with midcontinental seas by a shallow seaway in southern Ohio and northeastern Kentucky called the Ohio Seaway (Donahue and Rollins, 1974). During maximum marine transgression, the epeiric sea covered Ohio. However, "the dominant influence during deposition of the Pennsylvanian succession in Ohio was a series of prograding deltaic complexes that originated from areas to the north, south, and southeast" (Kovach, 1979). Interplay between marine and fluviodeltaic conditions caused, at least in part, lateral changes in sites of deltaic deposition and the compaction, subsidence, and subsequent marine inundation of
stagnating deltaic lobes. This produced the complex lateral and vertical alternation between marine (relatively minor) and nonmarine (dominant) deposits that are the lowest three major lithostratigraphic units (Pottsville, Allegheny, and Conemaugh) of the Pennsylvanian System in Ohio (Kovach, 1979). Donaldson (1974) stated that a fluvial-dominant, shallow-water deltaic model (involving the shallow-water delta and its adjacent strand-plain) explains the characteristics of the Conemaugh group (Kovach, 1979).

LOCALITY DESCRIPTIONS

The fauna of the Portersville Shale was collected in the strata from the two following localities:

Locality 1. Muskingum-Guernsey Countyline Quarry (Figure 1)

Small abandoned quarry located approximately 1.6 km (1.0 mi.) northeast of New Concord in W1/2 SE1/4, Sec. 25, Adams Township, Guernsey County, Ohio. (Bloomfield, Ohio 7.5-minute quadrangle)

The shale unit is described by Kovach (1976) as a marine interval 4.6 m (15 ft.) above the Anderson Coal containing an abundant and diverse molluscan fauna (Carothers, 1974) (Figure 2). This unit is a highly carbonaceous, highly fossiliferous black shale. In the bulk sample only small fossils were well preserved. The bulk sample at this locality was collected in
Shale, black, unfossiliferous.

PORTERSVILLE SHALE, basal few inches highly carbonaceous, grading into a black highly fossiliferous shale.

Shale and siltstone, brown, partly covered.

ANDERSON COAL, dark gray claystone below.

Shale, gray with abundant limestone nodules grading into a thinly bedded gray shale. Sparingly fossiliferous in lower part only, upper 10 feet unfossiliferous.

CAMBRIDGE LIMESTONE, gray, lithographic to sublithographic, medium- to thick-beded, fossiliferous upper one foot portion is a nodular limestone. Shale layers between limestone beds contain abundant mollusc fossils, bottom not exposed.

FIGURE 2-- Stratigraphic section of Muskingum-Guernsey Countyline Quarry. (After Carothers, 1974, p.37).
1986 by Dr. William I. Ausich.

**Locality 2.** Heck's Department Store (Figure 1)

Small outcrop approximately 150 to 200 yards west of Heck's department store on East State Street, east of Athens, Ohio, in Athens County.

The locality was exposed during excavations in progress during sampling in August, 1987, and the site may no longer be suitable for collecting. Identification of the Portersville Shale was difficult in this region due to the ease with which this unit weathers and slumps. The shale was a highly fossiliferous, fissile, blue-gray unit (Figure 3). Phosphate nodules up to 2 cm across (average 1 cm) were more common toward the top of the unit. The Portersville Shale measures 1.25 m at this outcrop. Two bulk samples were collected, one immediately above the carbonaceous shale at the base (unit 1), and the other 4 m below the top of unit 1.

**DISCUSSION OF FAUNAL LISTS FOR BOTH LOCALITIES**

In comparing the faunal assemblages from the two localities, it is important to note that specimens were dwarfed. Only one questionable impression of *Pseudorthoceras knoxense* was collected at locality 1; whereas, well preserved, nearly complete specimens were common at the Heck's locality. No shark remains were identified from locality 1. Few gastropods were identified at either locality. Upon inspection, the preserved specimens
Tan, iron-stained shale, blocky weathering, unfossiliferous. Rarely scattered siltstone beds.

Tan, iron-stained, fossiliferous. Limestone is a wackestone, grades laterally into a calcareous shale in one direction, and disappears in the other.

PORTERSVILLE SHALE, poorly bedded, blue-gray shale. Very fossiliferous at base, sparsely towards top. Phosphate nodules up to 2cm (ave. 1cm) diameter more common toward top. Basal 5cm unfossiliferous carbonaceous mudstone.

FIGURE 3--Stratigraphic section of Locality 2: Heck's Department Store.
from the Heck's locality are generally larger in size than the specimens from locality 1.

All materials from this study are deposited at the Orton Museum, Department of Geology and Mineralogy, The Ohio State University.

**SYSTEMATIC DESCRIPTION**

**Family** LOPHOPHYLLIDIIDAE Moore and Jeffords, 1945  
**Genus** LOPHOPHYLLIDIUM Grabau, 1928  
**LOPHOPHYLLIDIUM** sp.  
(Plate 1, figures 1-3; Figure 4)

*Description.*—Lophyllidium sp. are small solitary rugose corals. They are conical-cylindrical, trochoid, or ceratoid in shape. The solitary corallite is gently curving (Plate 1, figure 1). The calice is deep and inverted. Epithecal growth rings are present; wrinkles appear in various degrees (Plate 1, figure 2). Septal grooves are visible on some specimens. No dissepiments are present. Attachment scars are located on the concave side of the proximal region (Plate 1, figure 3). Specimens are 5mm-12mm in length. A dense axial column is in the center of the calice. Specimens are compressed, resulting in bends and breaks in some septa in the transverse sections studied. Septa are long and thin in distal portions, thicker and rhopaloid in proximal sections (Figure 4a and 4c). Only the counter septum is joined to the axial column. The cardinal septum is short and lies in a fossula. Minor septa are not easily distinguishable.
FIGURE 4: Tranverse sections of Lophophyllum sp. (x 25)
Table 1: Septal ratio calculations of Lophyllidium sp.

<table>
<thead>
<tr>
<th>Figure</th>
<th>Diameter (d)</th>
<th>Septal Number (n)</th>
<th>Septal Ratio (n/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>2.5 mm</td>
<td>7</td>
<td>2.8/mm</td>
</tr>
<tr>
<td>b</td>
<td>4.0 mm</td>
<td>16</td>
<td>4.0/mm</td>
</tr>
<tr>
<td>c</td>
<td>5.0 mm</td>
<td>14</td>
<td>2.8/mm</td>
</tr>
<tr>
<td>d</td>
<td>4.5 mm</td>
<td>14</td>
<td>3.1/mm</td>
</tr>
<tr>
<td>e</td>
<td>5.0 mm</td>
<td>14</td>
<td>2.8/mm</td>
</tr>
</tbody>
</table>

Discussion.--Rowett and Sutherland (1964) said that it is not possible to separate Steneostylus from Lophophyllidium consistently, and they considered this genus to be a junior synonym of Lophophyllidium. Jeffords (1947) stated that Lophophyllidium is distinguished easily from other genera by the nature of its axial column, which is relatively large in diameter and contains well defined radiating laminae associated with a distinct median lamina.

Range and distribution.--This genus ranges through the Pennsylvanian Period and occurs in the Western Interior United States. It is most common in the Desmoinesian (Upper Middle Pennsylvanian).

PALEOECOLOGY

Within the Portersville Shale community, the life strategies of the rugosan coral, Lophophyllidium sp. is of special interest. These corals reproduced sexually, and after fertilization, attached to the substratum (Elias, 1984). Ordinarily, attachment
scars are not preserved on adult specimens. After the first six septa appear (the brephic stage), longitudinal septal grooves and interseptal ridges appear (Sando, 1977). Usually the corallum breaks loose from its attachment when its weight becomes so great that the tip cannot support it (Sando, 1977). This usually occurs soon after the brephic stage.

The specimens collected from the Portersville Shale indicate a variation in the previously discussed early life strategy. "Lateral and basal attachment scars indicate a post-larval benthic habitat" (Ausich and Smith, 1982). The presence of attachment scars on these specimens that are in a region containing septal grooves and ridges clearly indicates that these corals were attached throughout post-larval growth. If unattached in the post-larval stage, these corals would have laid on their sides or sank into the substratum ("iceberg effect"), changing growth direction to achieve a position conducive to optimal feeding and growth (Sando, 1977). Instead, these corals were fixosessile (Neuman, 1988), attached to a hard substance with a basal disc or scar. It is likely that the attachment was to fossil fragments within the sediment. Where the apex growth lines are perpendicular to the growth axis and parallel to the substrate, upright growth was possible. Deviations from upright growth indicate adjustments made by the coral to have the calice upward (Neuman, 1988). Curvature in polyps reported by Elias (1984) was the result of inclination of the polyps into or away from currents. This is the likely cause of curvature in
Lophophyllidium sp. Straight polyps probably inhabited low energy environments (Elias, 1984). Straight and spoon-shaped attachment scars are on the specimens from the Portersville Shale (Plate 1). "Spoon-shaped depressions on the cardinal side of some specimens have been interpreted as attachment sites, and their shape suggests that the substrate was a smooth, curved surface such as a cephalopod shell (Elias, 1984). Obviously, a straight scar would indicate a flat attachment surface.

These rugose corals did not occupy this benthic community alone; they were surrounded by a variety of other organisms. These organisms can be placed into a trophic category based on "the character and location of food resources and the selection and acquisition of food" (Scott, 1976). The trophic categories are listed in Table 2, a trophic faunal listing for the two Portersville Shale localities studied. In discussing community paleoecology, it is important to recognize the possibility that more than one community can be represented in the final faunal list. Commonly, more than one layer yields fossils representative of a single rock unit, a formation, or member at one locality (Boucot, 1981).

When studying a community, "it is not uncommon to find a few of one group mixed with the other," but when comparing brachiopods to bivalves, "the fauna is clearly dominated by either brachiopods or bivalves" (Hoare, et. al., 1979). Brachiopods definitely dominate the fauna observed, chonetids in particular. The bivalves present were shallow burrowers, taking
advantage of the soft substratum. The greatest paleoecological
significance of brachiopods lies in substratum relationships and	heir interactions with other faunal elements (Sturgeon and
Hoare, 1968). Epifauna, such as bryozoans and inarticulate
brachiopods, can benefit from waste products that the host
brachiopods have in the exhalant current.

The majority of the Portersville fauna was micromorphic.
Ausich and Smith (1982) stated that small size in Mississippian
corals was due to the adaption to soft substrate conditions as
well as to the adaption to low food and oxygen concentrations.
Either low oxygen conditions or a soft substratum may explain the
micromorph condition of the Portersville fauna. Apparently,
fossil fragments served as the source of attachment for
Lophophyllidium to cope more easily with the soft substratum of
the Portersville.

In summary, the paleoecological community within which the
Pennsylvanian rugose coral, Lophophyllidium sp., existed is
highly diverse. This high diversity corresponds with a complex
food web, community stability, relatively intermediate food
resource levels, and high space variance (Boucot, 1976). It is
likely that the post-larval attachment of these corals was in
response to competition for food in the benthic marine community.
By attaching to substances on the surface rather than
"iceberging" in the muddy bottom, these corals may have
adaptively occupied a less competitive ecological niche.
Acknowledgements.--I wish to thank Dr. William I. Ausich for his assistance in the collection, preparation, and aid in identification in the fossil specimens studied within this report. Access to Myron Sturgeon's Pennsylvanian cephalopod collections located at The Ohio State University Geology Museum aided in the identification of the cephalopods in this study. I would also like to thank Mike Hansen for his suggestion of appropriate localities and William J. Sando for his confirmation of the genus Lophophyllidium for the coral specimens.
Table 2.

Locality 1: Muskingum-Guernsey Countyline Quarry

<table>
<thead>
<tr>
<th>Species</th>
<th>Trophic Position</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Crurithyrus planoconvexa</em></td>
<td>epifaunal suspension feeder</td>
</tr>
<tr>
<td><em>Chonetinella sp.</em></td>
<td>epifaunal suspension feeder</td>
</tr>
<tr>
<td><em>Neochonetes sp.</em></td>
<td>epifaunal suspension feeder</td>
</tr>
<tr>
<td><em>Pseudorthoceras knoxense</em></td>
<td>predator</td>
</tr>
<tr>
<td>ramose bryzoan (<em>Rhomбopora</em> sp.)</td>
<td>epifaunal suspension feeder</td>
</tr>
<tr>
<td><em>Lophophyllidium sp.</em></td>
<td>epifaunal suspension feeder</td>
</tr>
<tr>
<td>crinoid (fragments)</td>
<td>epifaunal suspension feeder</td>
</tr>
<tr>
<td>holothurian sclerites</td>
<td>mobile detritus feeder</td>
</tr>
<tr>
<td>ostracodes</td>
<td>epifaunal detritus feeder</td>
</tr>
<tr>
<td>gastropods (low-spired molds)</td>
<td>epifaunal deposit feeder or grazer</td>
</tr>
</tbody>
</table>

Locality 2: Heck's Department Store

<table>
<thead>
<tr>
<th>Species</th>
<th>Trophic Position</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Crurithyrus planoconvexa</em></td>
<td>epifaunal suspension feeder</td>
</tr>
<tr>
<td><em>Neospirifer dunbari</em></td>
<td>epifaunal suspension feeder</td>
</tr>
<tr>
<td><em>Neospirifer latus</em></td>
<td>epifaunal suspension feeder</td>
</tr>
<tr>
<td><em>Neochonetes granifuler</em></td>
<td>epifaunal suspension feeder</td>
</tr>
<tr>
<td><em>Orbiculoides missouriensis</em></td>
<td>epifaunal suspension feeder</td>
</tr>
<tr>
<td><em>Chonetinella sp.</em></td>
<td>epifaunal suspension feeder</td>
</tr>
<tr>
<td><em>Bellerophon pharkidonutus</em></td>
<td>epifaunal suspension feeder</td>
</tr>
<tr>
<td><em>Pseudorthoceras knoxense</em></td>
<td>predator</td>
</tr>
<tr>
<td><em>Metaceras?</em></td>
<td>predator</td>
</tr>
<tr>
<td>ramose bryzoan (<em>Rhomбopora</em> sp.)</td>
<td>epifaunal suspension feeder</td>
</tr>
<tr>
<td><em>Trigonioids (Schizodus sp.)</em></td>
<td>infaunal suspension feeder</td>
</tr>
<tr>
<td><em>Veneroids (Astartella sp.)</em></td>
<td>infaunal suspension feeder</td>
</tr>
<tr>
<td><em>Pholadomyoids (Edmondia sp.)</em></td>
<td>infaunal suspension feeder</td>
</tr>
<tr>
<td>ostracodes</td>
<td>epifaunal detritus feeder</td>
</tr>
<tr>
<td>shark teeth and bone fragments</td>
<td>predator</td>
</tr>
<tr>
<td>unidentified dwarfed gastropods</td>
<td>epifaunal suspension feeder or grazer?</td>
</tr>
</tbody>
</table>
REFERENCES


PLATE DESCRIPTIONS

Figure 1.-- Gently curving corallum showing septal grooves and growth wrinkles. Lateral attachment scar located on concave portion of corallum. (X5)

Figure 2.-- Curving corallum, coiled around a basal attachment in proximal region. Growth lines preserved as well as septal grooves. Proximal region showing more curved growth than distal region. (X5)

Figure 3.-- Straight corallum showing septal grooves. Proximal end slightly curved. Lateral attachment scar visible in proximal region. (X5.2)