Occurrence of the Crinoid Rhodocrinites nortoni (Goldring) from the Lower Devonian Seboomook Formation in the Telos Lake Area, North-Central Maine

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ABSTRACT

Specimens of the camerate crinoid Rhodocrinites nortoni (Goldring) have been recovered for the first time from the Siegenian (Lower Devonian) Seboomook Formation and are described and illustrated. Two species of brachiopods and arms of the crinoid Ctenocrinus sp. also were found at the same locality. The mode of preservation of the arms of both crinoid genera suggests that they were buried alive during a rapid sedimentation event, as might be expected in a flysch sequence such as the Seboomook Formation.

The only other reported occurrence of R. nortoni is in a glacial erratic containing the species holotype. Contrary to previous conclusions, the erratic that contains the holotype cannot confidently be assigned to the Siegenian Tarratine Formation and may have been derived from the equivalent-age Seboomook or Matagamon Formations. Rhodocrinites nortoni is the oldest known representative of its genus; Rhodocrinites is more typically found in Lower Carboniferous rocks.

INTRODUCTION

The Seboomook Formation is a widespread bedrock unit underlyng more than half of northwestern Maine (Osberg et al., 1985). Cyclically layered dark slate and sandstone dominate the Seboomook Formation (Boucot and Heath, 1969), but there is considerable lithologic variability and its internal stratigraphy is not well established (Pollock, 1983). Several papers have urged careful, detailed work on the stratigraphy of the Seboomook Formation (Boucot, 1970; Roy, 1980; Pollock, 1983), but progress has been slow because of a lack of marker beds and structural repetition due to near-isoclinal folding. Biostratigraphy has been of limited use in sorting out the Seboomook Formation because it is virtually devoid of macrofossils throughout much of its outcrop belt. In the southern end of the outcrop belt of the formation, where macrofossils are most common, brachiopods dominate collections (Boucot and Heath, 1969; Hall, 1970) and there is little evidence of other faunal elements. Thus, almost any fossil locality in the Seboomook Formation is noteworthy, especially if the locality contains fauna other than brachiopods.

This paper will focus on the occurrence of the crinoid Rhodocrinites nortoni (Goldring) at a locality in the Seboomook Formation in the Telos Lake area, Maine (Fig. 1). The larger problems of the internal biostratigraphy of the Seboomook Formation are beyond the scope of this paper, but we hope this paper will help in their eventual resolution.

THE CRINOID LOCALITY

The crinoid-bearing fossil locality was discovered during mapping of the surficial geology of the Telos Lake 15-minute quadrangle in July 1984 (Locality SK-84-508 in T6 R11 WELS; UTM: 5114700 N, 489750 E, Zone 19; 69° 07' 45" W, 46° 11' 15" N; see Fig. 1). The locality is in a shallow quarry in fine-grained sandstones and siltstones used for road material. The beds containing the crinoids were disturbed by quarry activity, but all of the specimens were obtained from a 1.5 m by 3 m strip in which virtually all clasts contained fossil crinoids. All of the crinoids in our original collection were of the same species, R. nortoni (see systematic paleontology, Appendix A). Fossil brachiopods, Acrospirifer murchisoni (Castelnau) and...
Caratunk, Maine. The holotype and the fossils described in this paper represent the only known occurrences of *R. nortoni*. We have examined the holotype, but cannot determine the formation from which the erratic was derived.

The preservation of the arms of *R. nortoni* indicates that the crinoids were buried alive during a rapid sedimentation event, such as a turbidity current or a storm. The arms are preserved in three dimensions within the rock, indicating that the sediment was water-saturated. The arm plates still contain feathery pinnules. The calyces generally are not well-preserved and show evidence of disruption, perhaps from gases produced by decay. The calyx contains most of the biomass of a crinoid and, thus, would produce the most gas during decay. Two reasonably well-preserved calyces are illustrated in this paper (Figs. 3a-3d). Approximately ten additional calyces and many calyx fragments were recovered, but most are poorly preserved.

Several slabs of rock show a concentration of brachiopod shells on their base and feathery crinoid arms "floating" within the matrix above the brachiopods. This fossil distribution, which also occurs in the erratic containing the holotype, suggests graded sedimentation wherein the arms of the crinoids caused them to settle out after the denser brachiopod shells.

**STRATIGRAPHIC SETTING**

The locality occurs in an area mapped as Seboomook Formation on the state bedrock geologic map (Osberg et al., 1985). The fossil locality is 1.1 km beyond the area mapped by Hall (1970), but the locality is on strike with his mapped Seboomook Formation outcrops. The lithologies present in the quarry are similar to sandstones and siltstones mapped as Seboomook Formation elsewhere in northern Maine. Bedrock stratigraphy and paleontology were outside the scope of the project for which this field work was conducted, but samples were collected because of the excellent preservation of the crinoids and the general scarcity of fossils in the Seboomook Formation.

The thickness of the Seboomook Formation ranges from 1200 m near Telos Lake to over 5000 m at the western limits of the unit (Neuman and Rankin, 1980; Pollock, 1983). Pollock (1983) has characterized the Seboomook Formation as monotonous, cyclically bedded limestones and sandstones — a classical shaley flysch. Hall and Stanley (1973) report that the Seboomook Formation represents submarine-slope and prodeltaic deposits. Levee-bounded channels and Bouma sequences of graded sands and graywackes indicate deposition by turbidity currents (Hall and Stanley, 1973; Pollock, 1983). Boucot and Heath (1969) inferred high rates of deposition for the Seboomook Formation, generally at depths below the bathymetric limits of the typical Lower Devonian fauna in adjacent formations. Scattered shell beds in the Seboomook Formation may be either reworked turbidite deposits, or shallow-water life assemblages associated with isolated structural highs in the basin (Boucot, 1953; Boucot and Heath, 1969).

Several substantial sandstone bodies occur within or adjacent to the Seboomook Formation (Roy, 1980; 1982). Two of the adjacent sandstones are differentiated as separate formations: the Tarratine Formation (Boucot, 1961) and the Matagamon Sandstone (Rankin, 1965) (Fig. 2). These formations have been
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SYMBOLS

Matagamon Sandstone
Tarratine Formation
Seboomook Formation
Fossil Locality

Figure 2. Generalized geologic map showing distribution of Seboomook, Tarratine, and Matagamon Formations north of 45°N latitude (after Osberg et al., 1985). Although lithologically similar, the Tarratine Formation was derived from a source to the west (Boucot and Heath, 1969; Roy, 1980), whereas the Matagamon Sandstone was derived from an emergent terrain in New Brunswick (Roy, 1980; Hall and Stanley, 1973). Fossils described in this paper are from a quarry at SK-84-508, and a glacial erratic found at Caratunk (Goldring, 1933).

interpreted as shallow-water facies in close association with the relatively deep-water basin of the Seboomook Formation (Roy, 1980; Pollock et al., this volume).

Southwest of the Telos Lake area, the Tarratine Formation, which is restricted to the Moose River synclinorium (Fig. 2), was derived from the Lower Devonian Somerset Island and nearby Lobster Mountain Volcanics (Boucot and Heath, 1969; Roy, 1980). The facies, fauna, and lithologies of the Tarratine Formation grade laterally into the Seboomook Formation because the depocenter of the Tarratine Formation intermittently supplied the basin of the Seboomook Formation (Boucot and Heath, 1969). The Tarratine Formation is dominated by dark sandstones similar to those within the Seboomook Formation, and it is, at best, very difficult to differentiate sandstones of the two formations in hand specimen. The gradational contact between the formations is arbitrarily defined; the Seboomook Formation contains less than 50 percent sandstone beds (Boucot and Heath, 1969).

The Matagamon Sandstone, which crops out south and east of the fossil locality (Fig. 2), has been interpreted as delta-top and delta-front deposits, derived from an emergent terrain in New Brunswick (Roy, 1980; Hall and Stanley, 1973; Pollock et al., this volume). The Matagamon Sandstone is dominated by dark sandstones similar to those within the Seboomook and Tarratine Formations (Rankin, 1965; Neuman and Rankin, 1980). The Seboomook Formation interfingers with, and is overlain by, the Matagamon Sandstone. The transition is marked by increases in cross-bedding, bed thickness, and sandstones, and by a decrease in graded bedding (Rankin, 1965). The contact between the formations is arbitrary, based on the Seboomook Formation containing less than 50 percent sandstone beds (Rankin, 1965). As with sandstones from the Tarratine Formation, sandstones from the Matagamon Sandstone and the Seboomook Formation cannot be distinguished in hand specimen because the depocenter of the Matagamon Sandstone was a source of sandstone for the Seboomook Formation.

AGE OF THE SEBOOMOOK FORMATION

Brachiopods found at locality SK-84-508 include abundant specimens of Acrospirifer murchisoni (Castelnau) and a few specimens of Leptostrophia cf. L. magnifica (Hall). According to Boucot and Heath (1969), A. murchisoni occurs only in Siegenian (Oriskany) age rocks of the Lower Devonian. Neither Boucot and Heath (1969) nor Hall (1970) reported Leptostrophia cf. L. magnifica (Hall) from the Seboomook Formation, but Boucot and Heath (1969) report its occurrence in the Beachia community in the Siegenian Tarratine Formation, and Rankin (1965) reports it in the Matagamon Sandstone. The fossils discussed in this study are consistent with Dr. Edwin Kirk's con-
clusion that the holotype of *R. nortoni* belongs to the *Beachia* faunal community (Boucot and Heath, 1969). A Siegenian age assignment is consistent with ages determined from other brachiopod localities in the Seboomook Formation of north-central Maine, including three localities within 10 km of SK-84-508 (Hall, 1970), a locality on Grand Lake Matagamon (25 km to the east; Rankin, 1965), and a locality on Gero Island (22 km to the west; Boucot, 1954). Microfossils collected by Pollock from the Seboomook Formation and identified by William Forbes also indicate Siegenian age (Pollock, 1983).

Although a Siegenian age for the Seboomook Formation is well documented in the Telos Lake area, the formation is virtually unfossiliferous and age assignments are tentative throughout most of its wide outcrop belt. Gedinnian (New Scotland) fossils have been reported from the lowermost Seboomook Formation in the Moose River synclinorium; however, all other fossils of the Seboomook Formation from that area are Siegenian (Boucot, 1961). Gedinnian and Siegenian fossils are also reported from the Seboomook Formation in northeastern Maine (Boucot, 1970). Reconnaissance study in northwestern Maine has uncovered three localities in the Seboomook Formation with Siegenian brachiopods (Boudette et al., 1976), but Roy (1982) suggested that parts of the Seboomook Formation in northwestern Maine are as young as Middle Devonian. The Temiscouata Formation in western New Brunswick, which is correlative to the Seboomook Formation, has yielded Emsian (latest Early Devonian: Esopus-Schoharie) brachiopods (St. Peter and Boucot, 1981). All of the fossils reported from the Tarratine Formation or the Matagamon Sandstone are Siegenian (Boucot and Heath, 1969; Rankin, 1965).

OTHER CRINOID LOCALITIES IN THE SEBOOMOOK FORMATION

Hall (1970) reports two crinoid-bearing localities in the Telos Lake area (Fig. 1). *Edrioocrinus* sp. occurred in collection BH-178-62 (USNM 11354), made 5.9 km south-southwest of SK-84-508. Hall's collection BH-191-62 (USNM 12464), obtained 5.0 km southwest (along strike) of SK-84-508, included an unidentified crinoid. The crinoid fossil was sent to Dr. G. Arthur Cooper of the United States National Museum (Hall, 1970), but attempts to relocate this specimen have been unsuccessful, and there is no record of its positive identification (Martha Hays, pers. commun., 1986). We are not aware of other crinoid-bearing localities in the Seboomook Formation.

PROVENANCE OF THE CRINOID DESCRIBED BY GOLDRING

The discovery of *R. nortoni* in the Seboomook Formation suggests re-evaluation of the provenance of the crinoid-bearing erratic described by Goldring. Originally, E. S. C. Smith assigned the erratic boulder to the Moose River Sandstone (Goldring, 1933). Later, Boucot (1961) redefined the Moose River to group status and assigned the Oriskany-age sandstones in the Moose River synclinorium to the Tarratine Formation, but he excluded other dark Oriskany-age sandstone units from the Tarratine Formation, particularly the Matagamon Sandstone. Following this revision, Boucot and Heath (1969) stated that the erratic "boulder was undoubtedly derived from the Tarratine Formation to the north as shown by *Leptocoeolia flabellites* (this form is present to the north only in Tarratine age rocks)."

Four considerations cast doubt on a Tarratine Formation provenance for the erratic. First, the Moose River Sandstone, as loosely defined early in the twentieth century, included rocks outside of Boucot's Tarratine Formation, such as the Matagamon Sandstone (Rankin, 1965). Hence, Smith's interpretation of a Moose River Sandstone provenance should not be translated directly into a Tarratine Formation provenance. Second, dark sandstone erratics derived from the Seboomook Formation would be virtually indistinguishable from dark sandstone erratics from the Tarratine Formation. The formations differ in amount of sandstone, but not in sandstone lithology (Boucot and Heath, 1969). Third, *Leptocoeolia flabellites* also occurs in the Seboomook Formation (Boucot, 1954; Boucot and Heath, 1969; Hall, 1970) and the Matagamon Sandstone (Rankin, 1965), so this species cannot be used to assign a Tarratine Formation provenance.

The fourth consideration is that ice-flow history reveals little about the possible provenance of the Caratunk erratic. Boucot and Heath (1969) implied that the crinoid-bearing erratic was transported by southward-flowing glaciers. Striations and other ice-flow indicators in north-central Maine show ice-flow directions ranging from east-northeast to slightly west of south (Kite and Lowell, 1985; Thompson and Borns, 1985; Flint, 1971). Indeed, the till stratigraphy of eastern Quebec records an early or middle Wisconsin glaciation with westward and southwestward flow from the maritime Provinces into Northern New England and adjacent Canada (Shilts, 1981). It is possible that the crinoid-bearing erratic discovered at Catatunk was transported southwestward from outcrops of the Seboomook Formation or Matagamon Sandstone in the Telos Lake area. In short, the provenance of the erratic studied by Goldring is unclear, and *Rhodocrinities nortoni* cannot confidently be assigned to the Tarratine Formation at this time.

SUMMARY

A shallow quarry in the Lower Devonian Seboomook Formation near Telos Lake, Maine, has yielded specimens of the camerate crinoid *Rhodocrinities nortoni* (Goldring). Two brachiopods, *Acrospirifer murchisoni* (Castelnau) and *Leptostrophia cf. L. magnifica* (Hall), and the crinoid *Ctenocrinus* sp. have been collected from the same locality. This is the first report of *R. nortoni*, *Leptostrophia cf. L. magnifica* (Hall), and *Ctenocrinus* sp. from the Seboomook Formation. The brachiopods suggest a Siegenian (Oriskany) age for *R. nortoni*, as was proposed by Dr. Edwin Kirk (Boucot and Heath, 1969).

The crinoids appear to have been preserved by rapid burial, possibly because of storm or turbidity currents. Rapid burial
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Figure 3. *Rhodocrinites nortoni* (Goldring): all photographs are enlarged 2 times, except e, which is actual size. (a,b) Latex cast and original mold, respectively, of the best preserved specimen from the Seboomook Formation (WVU 1101); note the stem fragment centered on the infrabasals, the radial ridges on the calyx plates, and the arrangement of the arms. (c) Latex cast of upper surface of specimen shown in d (WVU 1102), showing several well-preserved arms as well as a concavity formed by the internal mold of the theca shown in d; note that a set of arms on the left, and a set on the right, each have four branches instead of three; also note the tectonic strain shown by the wide arms on the left and the narrow arms on the right. (d) Outline of theca from specimen (WVU 1102) preserved as an internal mold and exposed on a fractured rock surface; anal tube indicated by arrow. (e) Latex cast of holotype, which is a mold, (University of Maine at Presque Isle, No. 10500); note the regenerated arms on the E-ray indicated by arrows.
and the graded bedding displayed in several crinoid-bearing slabs, including the erratic containing the holotype of *R. nortoni*, are consistent with the general stratigraphic framework for the basin of the Seboomook Formation and the adjacent depocenters associated with the Tarratine and Matagamon Formations. The occurrence of *R. nortoni* in the Lower Devonian of northern Maine apparently marks the first occurrence of the genus *Rhodocrinites* in the paleontological record. The holotype and only other known occurrence of *R. nortoni* is in a glacial erratic from Caratunk, Maine. Boucot and Heath (1969) assigned this erratic to the Tarratine Formation, but the similar lithology of Siegenian sandstones in northern Maine and the area's complex Late Quaternary ice-flow history indicate that the exact provenance of the holotype cannot be determined with certainty.

**ACKNOWLEDGMENTS**

The authors are in great debt to the field assistants for the 1984 field season: Robert Guice, who discovered the crinoids and insisted they be collected, and Dan Hostettler, who helped collect the specimens. Thomas Lowell kindly donated specimens collected at the same locality in 1986, and William Forbes allowed examination of the holotype of *R. nortoni* from the Paleontology Collection at the University of Maine at Presque Isle. This work benefited from discussion and encouragement from Arthur Boucot, Bradford Hall, and Stephen Pollock, and from thoughtful reviews of an earlier version by Boucot, William Ausich, and Dale Springer. However, we are responsible for all errors in the text. Support for the surficial geology field work came from the Maine Geological Survey.

**APPENDIX A. SYSTEMATIC PALEONTOLOGY**

Class CRINOIDEA Miller, 1821  
Subclass CAMERATA Wachsmuth and Springer, 1886  
Order DIPLOBATHRIDA Moore and Laudon, 1943  
Suborder EUDIPLOBATHRINA Ubaghs, 1953  
Superfamily RHODOCRINITACEA Roemer, 1855  
Family RHODOCRINITIDAE Roemer, 1855  
Genus RHODOCRINITES Miller, 1821  

*Rhodocrinites nortoni* (Goldring) 1933  

Figures 3a-e, 4; Table 1  

*Rhodocrinus nortoni* Goldring, 1933, p. 153-155, Pl. 3, Fig. 1-2, Pl. 4, Fig. 1-2.  

*Rhodocrinites nortoni* (Goldring), Bassler and Moodey, 1943, p. 664; Webster, 1973, p. 232.

**Diagnosis.** A species of *Rhodocrinites* with a flat, bowl-shaped calyx and an invaginated base; ornamentation consisting of stellate ridges, which cover each of the calyx plates.

**Description.** The theca is flattened, with a shallow, bowl-shaped calyx that has an invaginated base; the anal tube is small (Fig. 3d). The best preserved calyx from the Seboomook Formation (Figs. 3a-b) measures 23 mm at its greatest width and is 6 mm high (Table 1). The holotype (Fig. 3e) is between 19.5 and 23 mm in width and is approximately 4 mm high. The tegmen plates are unknown; only an outline of the theca is preserved (Fig. 3d). All of the major calyx plates are on the flattened base of the calyx. The primaxil brachial plate of each ray is at the outer margin of the flattened calyx. There are either two or three secundibrachials on the top of the calyx, which give rise to the free arms.

**TABLE 1. MEASUREMENTS (IN MM) OF RHODOCRINITES NORTONI (GOLDRING).**

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Width of theca</th>
<th>Height of theca or calyx</th>
</tr>
</thead>
<tbody>
<tr>
<td>UMPI 10500</td>
<td>19.5-23</td>
<td>4</td>
</tr>
<tr>
<td>WVU 1101</td>
<td>23</td>
<td>6</td>
</tr>
<tr>
<td>WVU 1102</td>
<td>20</td>
<td>6</td>
</tr>
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The calyx plate arrangement (Fig. 4) essentially matches that of *Rhodocrinites* illustrated in the Treatise of Invertebrate Paleontology (Ubaghs, 1978, p. T422). Five infrabasals, forming a pentagon, are visible within a circlet of five basals (Figs. 3a and 4). The radials are separated by well-developed interbrachial plates. Prominent radial ridges cover the calyx plates forming an interlocking stellate pattern (Figs. 3a and 3e). A robust radial ridge extends upward from each radial, across the primibrachials, forking at the primaxil, and extending onto the fixed secundibrachials (Fig. 3e).

The stem attachment scar does not completely cover the infrabasal plates (Figs. 3a and 4). The stem is circular in outline as indicated by dissociated pluricolumnals and the stem fragment attached to the holotype (Fig. 3e).

Each fixed arm branches once to form two sets of free arms (Figs. 3a, c, and e); free arms divide further to yield three or four arms (Figs. 3c and e). Thus, there are six or seven, but not eight, arms in each ray. Each set of arms branches endotomously with new branches added on the inside of the arms. The arms are biserial, with long pinnules (10 mm) above the secundibrachials. Partial arms from several individuals were found in the Seboomook Formation, but no complete crowns were recovered. Thus it was not possible to determine which rays produced the sets of four arms. No more than three rays, and their attached arms, were preserved on any specimen from the Seboomook Formation. Goldring (1933) indicated that there were 30 arms on *R. nortoni*, but the holotype actually has only 19 arms preserved (Fig. 3e). Thus, the total number of arms
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Figure 4. Camera lucida drawing of actual (not idealized) calyx plate arrangement of *Rhodocrinites nortoni* based largely on the holotype (Fig. 3e). Arrangement of infrabasal plates determined from specimen WVU 1101 (Figs. 3a and b). Radials shown in black; interbrachials stippled. Individual rays identified by letter.

could have ranged from 30-35.

**Remarks.** The above description is based on several partial specimens of *R. nortoni* found in the Seboomook Formation, plus the holotype, which was obtained for comparison with the Seboomook Formation material.

All the specimens from the Seboomook Formation, plus the holotype have a flattened theca. Because the calyx plates are all tightly interlocking, rather than ruptured and dissociated, the original calyx was probably not globose with vertical sides as is typical of *Rhodocrinites* (Ubaghs, 1978, p. 142). The holotype shows evidence of predation (Fig. 3e). Three of the arms on the E-ray have been partially regenerated as shown by the more slender segments on the distal portions of the arms. Additionally, the brachial plates are disrupted where the arms were nipped, and one arm regenerated two branches rather than a single branch.

The Early Devonian age of *R. nortoni* apparently makes it the oldest representative of the genus. Ubaghs (1978, p. T420) reports that the genus is found only in the Lower Carboniferous. However, *R. insculptus* (Goldring) 1935, *R. quinquelobus* (Schultz) 1866, and *R. ornatus* Dubatolova, 1964 have been reported from the Middle Devonian of New York, Belgium, and the Soviet Union, respectively (Bassler and Moodey, 1943; Webster, 1973). We have not determined whether these three species have been correctly assigned to the genus *R. Rhodocrinites*.

**Repository.** The specimens from the Seboomook Formation are deposited in the paleontological collections of the Department of Geology and Geography at West Virginia University. The two illustrated specimens are WVU 1101 and 1102. Many additional fragmentary specimens are grouped together under WVU 1110. The holotype is in the paleontology collections at the University of Maine at Presque Isle (UMPI), No. 10500 (formerly No. 4020, Portland Society of Natural History).

**REFERENCES CITED**


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