MEDDELELSER OM GRØNLAND
UDGIVNE AF
KOMMISSIONEN FOR VIDENSKABELIGE UNDERSØGELSER I DANMARK
Bd. 164 · Nr. 7

THE EARLY ORDOVICIAN GASTROPOD *CERATOPEA* FROM EAST GREENLAND

BY

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WITH 1 PLATE

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BIANCO LUNOS BOGTRYKKERI A/S
1964

Abstract

Opercula of two species of *Ceratopea* are described from an outcrop of the Narwhale Sound Formation on Ella Ø. This is the second known occurrence of the genus in Greenland, but is the first illustration of specimens. One of the species herein named *C. billingsi* has been illustrated at least twice from other areas; it may be useful for intercontinental correlation. The second species is not formally named as all specimens are incomplete. The two species indicate the age of at least part of the Narwhale Sound Formation as late in the Early Ordovician.

INTRODUCTION

The genus *Ceratopea* is widespread in certain Lower Ordovician limestone facies in the eastern and southwestern United States. It occurs in the northernmost part of Greenland in Peary Land (TROELSEN, 1949, p. 18) and on Bear Island (HOLTEDAHL, 1919, p. 128, pl. 12, fig. 2). Specimens have been described recently from Spitzbergen (MAJOR and WINSNES, 1955). The genus is also known in northern Scotland and in Newfoundland.

Most of our knowledge of *Ceratopea* is based on massive calcareous opercula which are commonly silicified. Where specimens are present, they usually are common to abundant. Within the United States, the species have been demonstrated to be useful in correlation, and perhaps intercontinental correlations eventually can be made among the outcrops in the boreal region where they occur.

Professor CHRISTIAN POULSEN, Copenhagen, Denmark, recently directed my attention to undescribed specimens of opercula from Ella Ø in eastern Greenland and generously arranged for a loan of the material so that it could be compared with American species. My visits to Copenhagen and to London, to examine specimens from Scotland, were made possible through National Science Foundation grant 17911 to the Smithsonian Institution. Specimens from Newfoundland were lent by the Geological Survey of Canada, through the kindness of Dr. G. W. SINCLAIR and Dr. D. J. MCLAREN.

Preservation and occurrence of specimens

Ceratopea opercula occur in the Narwhale Sound Formation of Ella Ø, east Greenland. The formation crops outs on the south coast of the island near the eastern flank of an anticline and in an arcuate belt trending east across the island.

This formation was first described by POULSEN (1930, p. 316) as a unit about 300 meters thick, divisible into a light-yellowish, thin bedded dolomite of almost 150 meters thickness, and a light-gray, thin-bedded, compact limestone of the same thickness. Later, in connection with description of the geologic map of Ella Ø, POULSEN and RASMUSSEN

(1951, p. 21) redefined the formation. They gave its total thickness as more than 600 meters and divided it into three parts. The lower unit is about 150 meters of light-yellowish-gray crystalline dolomite. The middle unit, at least 200 meters thick, consists of thin-bedded light-gray dolomite with some intraformational conglomerate. The upper unit is fine-grained dolomite limestone; its thickness, not given, is presumably more than 200 meters.

The fossils described herein were collected by H. W. RASMUSSEN in August 1946. According to his field notes the fossils were obtained from a single stratum within the lowest unit of the formation. The specimens are from "east of the Bastion Plateau, somewhat north of the Devonian boundary", an area near the center of the island. (Prof. CH. POULSEN, written communication, 1963).

The collection consists of fourteen silicified specimens of *Ceratopea* opercula which have partially weathered free from the matrix. As is characteristic of this form, only the outer surface is silicified, the inner part of the specimens consisting of light-gray limestone or sparry calcite. All the opercula were broken free from the bedrock and are more or less incomplete. Several can be identified only by reference to the better material.

The specimens are property of the Universitetets Mineralogiske Museum, Copenhagen, and are retained under number 11004.

SYSTEMATIC PALEONTOLOGY

Class **GASTROPODA**

Subclass **Prosobranchia**

Order **ARCHAEOGASTROPODA**

Suborder **Pleurotomariia**

Superfamily and Family Uncertain

Genus ***Ceratopea*** ULRICH, 1911

Discussion.—Although YOCHELSON and BRIDGE (1957, p. 296) referred this genus to the Pleurotomariacea, subsequent revision of the Paleozoic Gastropoda (KNIGHT, BATTEN, and YOCHELSON, 1960) indicated that the evidence for superfamilial assignment of the genus may be inconclusive. The more conservative taxonomic arrangement has been followed here.

The Greenland specimens, while stratigraphically important, do not materially advance our knowledge of the biology of this enigmatic genus. Characteristically, shells are not associated with the opercula and these specimens are no exception to the general rule. The cross section of the opercula implies a shell with a wide, low aperture quite in keeping with our scanty knowledge of this form; the two species differ slightly in the profile of the dorsal surface. For convenience, only the operculum will be described and no attempt will be made to reconstruct or interpret the associated shell. Terminology and orientation follow that of YOCHELSON and BRIDGE (1957).

Ceratopea billingsi YOCHELSON, n. sp.

Plate-figures 6–19.

Operculum of *Maclurea peachii* SALTER, 1859, p. 378, pl. 13, figs. 1b, 4, 5; MURCHISON, 1859, p. 217, woodcut of fossils (28) fig. 3; MURCHISON, 1867, p. 165, woodcut of fossils (27) fig. 3; MURCHISON, 1872, p. 165, woodcut of fossils (40) fig. 3.

Unnamed operculum of *Maclurea*, BILLINGS, 1865, p. 243, fig. 228.

Description.—Very strongly curved, thick, slowly expanding, distinctly torted opercula; earliest growth stages strongly hook-shaped, strongly curving so that a mature individual completes more than half a volution; carina distinct but not sharp, the carinal angle is near ninety degrees; dorsal surface flattened in early growth stages, becoming only

slightly inflated with increasing maturity; dorsal ridge ill-defined and little more than a change in slope; dorsal surface flattened and only slightly concave: umbilical ridge wide and well rounded; ventral surface smoothly and strongly inflated from umbilical ridge to carina; growth lines straight across dorsal margin and carina, then bending strongly apexward and continuing straight almost to umbilical ridge, curving slightly just prior to crossing ridge and then continuing backward, there being only a slight sinuosity at the juncture where crossing the dorsal ridge; attachment surface surrounded by a narrow rim along the dorsal margin, but a wide rim on the upper part of the ventral margin widening to a shelf at the umbilical surface, creating an elongate asymmetric trough as the attachment surface, this trough deepening toward the apex where there is a suggestion of a single deep pit beneath, just above the wide shelf.

Discussion.—The description is based on fifteen specimens; three Newfoundland and two Scottish specimens discussed in more detail below, and ten paratype specimens from Greenland. In three of the Greenland specimens the apex is more or less complete and a portion of the juvenile dorsal surface is preserved. The best specimen of these is shown as figures 8 and 9. Three specimens are only incomplete fragments showing a more mature part of the dorsal surface. Of the last four specimens, the second largest is quite poor and lacks the apex and most of the ventral umbilical surfaces. The largest specimen, shown in figures 6 and 7, lacks most of the ventral surface but in spite of this lack, presents much morphologic detail.

The two remaining smaller Greenland specimens are the most complete; these are illustrated in figures 10–13, and 14–16. There are some differences among the various specimens and particularly between these last two. While I was disposed at first to treat these two as representatives of two species, on the basis of differences in the dorsal surface and thickness, I now feel that the differences may be ascribed to individual variation, ontogenetic change, and wear by movement after death.

The three specimens preserving only the apical area show the dorsal surface to be nearly plane (figure 9), apparently similar to one of the more complete specimens (figure 10) but the tip of that specimen is broken and precise comparison cannot be made. Another specimen (figure 16) indicates that even in the earliest growth stages the dorsal surface is slightly inflated. In the more mature stages of the largest specimen (figure 7), the curvature of the dorsal surface is more distinct.

At first glance the same nearly complete specimen noted above (figure 10) appears to be higher than the others. No height can be ascribed to the largest specimen. The next more complete specimen (figure 15) has the ventral surface partly eroded. When comparison is made with the

three juvenile stages, the proportions are nearly identical. This difference is therefore judged to be due to the more complete preservation of this detail in one specimen. The only variation which can be observed among the specimens is a slight variation in relative width. This is not judged to be significant.

Ceratopea billingsi falls more readily within the group of *C. capuliformis* ODER, than within the other three species groups of *Ceratopea* which have been discriminated (YOCHELSON and BRIDGE, 1957, p. 295), and it is most like *C. germana* YOCHELSON and BRIDGE, the least typical member of the group. That species is readily distinguished by its more strongly inflated dorsal surface and its relative thinness. It may be that these two species may constitute yet another species group.

Specimens of the operculum of *C. billingsi* have been figured for a century but the distribution and biologic position of the form have not been recognized. SALTER (1859) first reported *Maclurites*, as *M. peachii*, from the Ordovician carbonate sequence in the Scottish highlands. He noted that opercula which were available from the same area differed from the opercula attributed to *M. logani*, a species that he had just described from the Middle Ordovician of Canada.

SALTER attributed the Scottish opercula to *Maclurites peachii* without any question even though he did recognize the difference between this form of operculum and that of *Maclurites*. It is easy to see how a massive calcareous operculum of one genus might be homologized by error with a calcareous operculum of another genus, particularly when one realizes that SALTER was unaware of any great age difference between the two.

Two of SALTER's specimens, here designated paratypes, are available. Both were collected at the "Old School House, Durness, Sutherland, Scotland". The better of the two, Geological Survey and Museum no. 30149, preserves most of the dorsal surface; this is the original of SALTER's figure 4 in his 1859 work. Between the dorsal ridge and the carina there is a slight concavity, but otherwise the shape is characteristic of *C. billingsi*. The second specimen, Geological Survey and Museum no. 30148, preserves the attachment surface and part of the ventral surface. This is the original of figure 5, but the figure is not accurately drawn. The specimen shows a fairly deep groove through part of the attachment surface. The half of the surface nearer the umbilical area is obscured by adhering silica. In this area, SALTER surmised that there was a homology with the muscle attachment boss of the *Maclurites* operculum. One other paratype also show this apparent boss, but in neither specimen is there convincing evidence that this detail is a real characteristic of the species.

Several years later BILLINGS (1865) described a large fauna from the Cape Norman area of Newfoundland and included at least two Lower

Ordovician gastropods referable to *Ceratopea*. Unfortunately, virtually nothing is known of the stratigraphic placement of BILLING's material (T. BOLTON, written communication, 1963). Later geologic work in the area by SCHUCHERT and DUNBAR (1934), made reference to the occurrence of several zones of *Ceratopea* but did not indicate which forms were present in each zone, and this work cannot be used to ascertain the stratigraphic position or ranges of the two described forms. It is possible that additional species of *Ceratopea* may be present in the Cape Norman sequence.

From the standpoint of nomenclature, BILLINGS' approach is most enlightened. After noting that the occurrence of several forms of opercula in the collections under investigation indicated diversity among the gastropods (BILLINGS, 1865, p. 243, figs. 228–230), he then described and named several fragmentary gastropod shells, in addition to the better material he had described in an earlier part of his book. He did not, however, either formally assign the individual forms of opercula to particular species based on the shell, or apply formal names to the opercula themselves.

A comparison of BILLINGS' figured and unfigured specimens with the Greenland material indicates that the two groups of specimens are conspecific. Because BILLINGS did not assign a name, any specimen included within the original hypodigm can be chosen as holotype.

The original specimen from which figure 228 of BILLINGS' 1865 work was drawn is here designated as holotype. This is not done for reasons of priority, nonexistent in this case, but because his specimens are adequate to characterize the species and, in several features, are more informative than the Greenland specimens.

The holotype, Geological Survey of Canada no. 7459, shows the external surface well. The silicified specimen apparently was weathered free from matrix as the attachment surface is missing, and the interior is stained by weathering. It is illustrated in figures 17–19. There are two additional specimens in the primary lot and they are here designated as paratypes. Both are smaller than the holotype, but show some details of the attachment surface; they too are silicified. The larger of the two, G.S.C. no. 7459a is more coarsely silicified, with corresponding obscurity of details of the growth lines. It is relatively wider than either the holotype or the other paratype. The smaller paratype, G.S.C. no. 7459b, has the growth lines excellently preserved, but part of the attachment surface is broken.

One unusual feature is shown in the attachment surface of the paratype no. 7459a. Near the umbilical ridge, in the area where most *Ceratopea* opercula show a pit, there is an irregular boss. It cannot be determined whether this is a natural feature, as in the operculum of *Maclurites*, or is caused by the secondary growth of silica.

Additional specimens from the Cape Norman area undoubtedly will clarify this point and presumably will better fix the placement of this species within the Lower Ordovician succession.

Ceratopea species

Plate-figures 1–5.

Description.—Fairly strongly curved, low, extremely wide opercula; apex unknown, curvature distinct, mature specimens completing nearly one-fourth whorl, this curvature being the result of both a rapidly expanding width and a slight production inward of the ventral margin near the carina; carina distinct, the angle between the carinal and ventral surfaces being nearly 60 degrees, the carina showing only slight torsion; umbilical ridge poorly developed and faint; ventral surface low, only slightly more inflated near the umbilical ridge than the carina, so that the overall impression is of low but smooth curvature; carinal surface gently excavated between relatively wide flattened areas bounding the carina and the indistinct dorsal ridge; dorsal surface poorly known, but apparently gently concave while proceeding downward and outward to join the umbilical ridge; growth lines nearly straight on dorsal surface, near the center of the depression bending slightly to the carina, immediately after crossing carina bending upward toward apex, gradually curving so that the latter half of their course on the ventral surface is less abruptly towards the apex, unknown crossing the umbilical ridge, but apparently almost immediately thereafter bending so that lines curve backward to join the dorsal surface at a widely obtuse angle; ventral margin, rounded and smooth; attachment surface unknown except that it is less than 2 mm deep within 5 mm of the central part of the ventral margin.

Discussion.—This description is based on four specimens. The most complete, shown in figures 1 and 2, preserves a portion of the carina and most of the ventral surface. The specimen shows a depression and ridge on the early part of the ventral surface paralleling the carina. This feature seems to be unique among specimens of *Ceratopea*. Because of the incomplete nature of the specimen and the amount of weathering it has undergone, no significance is attached to this particular feature. Another fragment shown as figure 5 has about half of the ventral margin and part of the carina preserved. Neither specimen retains the elongated juncture of the carina and ventral surface.

The dorsal surface is known from two incomplete specimens, the better of which is illustrated as figures 3 and 4. Only a small part of the umbilical surface is retained. In addition, one indeterminate fragment which is more suggestive of this species than of *C. billingsi* gives slight

evidence that a fairly deep cuneiform central muscle pit may have been present. In spite of the incomplete condition of all specimens, there is enough overlap of common morphological features among the three illustrated specimens to make it reasonably certain that all belong to the same species.

The material is not considered adequate to apply a formal name. The low degree of torsion, as shown by the carina and the apparently subtabular or cuneiform shape, is suggestive of the *C. keithi* group of opercula (YOCHELSON and BRIDGE, 1957, p. 295). Of the three species within this group, the Greenland form compares most favorably with *C. tennesseensis* ODER, a species which is strongly curved and expands rapidly in width. There is some difference in the course of growth lines near the area of the dorsal ridge between typical specimens of that species and these from Greenland. The Greenland specimens are more than twice as large as any known specimens of *C. tennesseensis* and the difference may simply be the result of ontogenetic change. Until more complete material is available, no closer comparisons are warranted.

STRATIGRAPHIC IMPLICATIONS

The only fossils previous described from the Narwhale Sound Formation are *Bathyurellus* sp. and *Heterochilina oliqua* POULSEN (1937, p. 59–60) although others are now known (POULSEN and RASMUSSEN, 1951, p. 21). These fossils, together with stratigraphic and structural considerations, early suggested that the formation ". . . cannot be older than Upper Canadian and not younger than the lowermost Ordovician . . ." (POULSEN, 1930, p. 316). TWENHOFEL and others (1954) placed this formation high in the Chazyan following POULSEN (1937, p. 72) although POULSEN and RASMUSSEN (1951, p. 21) noted several years earlier that new finds of bathyurid trilobites clearly indicated a late Canadian age for the formation.

The *Ceratopea* opercula confirm the late Canadian age for at least the lowest unit of the Narwhale Sound Formation. Both the cuneiform and the strongly curved forms of opercula are characteristic of the lower part of the zone of *Ceratopea.* More precise correlation must await the establishment in Newfoundland of a zonation based on the *Ceratopea* and other late Early Ordovician fossils. A prediction of the general level at which these forms may occur can be based on their morphologic development. With reference to the occurrence chart prepared by YOCHELSON and BRIDGE (1957, p. 293), the *Ceratopea* seem to have been collected from a zone correlative to the middle third of the Kindblade Formation of Oklahoma.

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Færdig fra trykkeriet den 21. december 1964.

Explanation of plate

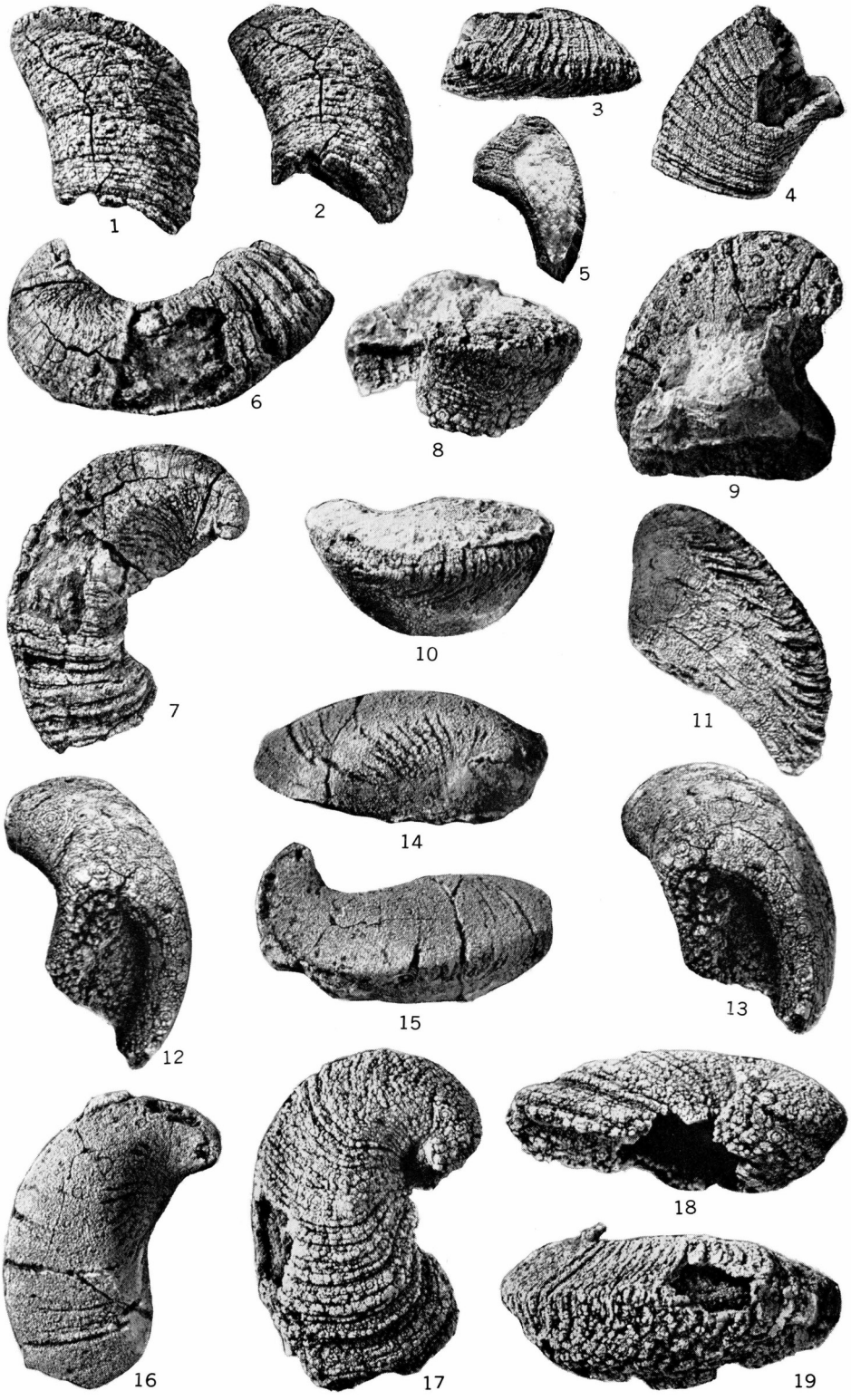
Figures 1–5. *Ceratopea* sp.

1. Ventral view of a specimen, showing the general outline; the carina and the lower part of the surface to the right are broken away. — 2. View of preceding specimen tilted to show the apex and the ridge subparallel to the carina. — 3. Carinal view of a specimen emphasizing the relatively slight amount of torsion in this species. — 4. Dorsal view of the preceding specimen; the parietal margin, although broken, follows the growth lines. — 5. Ventral view of a fragmentary specimen preserving most of the ventral margin; the juncture of the carina and ventral margin, to the lower right, is broken.

6–19. *Ceratopea billingsi* YOCHELSON n. sp.

6. The largest specimen, tilted slightly to emphasize the degree of torsion. — 7. Dorsal view of the preceding specimen, showing the strong curvature of the apex and the gentle swelling of the dorsal surface in maturity. — 8. Apical view of an incomplete specimen; the rapid thickening of the specimen in the foreground, and adhering matrix in the background, obscure the tip of the specimen. — 9. Dorsal view of the preceding specimen showing the flattened juvenile dorsal surface and the strong curvature of the apex. — 10. Very slightly oblique carinal view of a nearly complete specimen emphasizing the slight amount of torsion and minimizing the pronounced ventral thickening. — 11. Ventral view of the preceding specimen; part of the dorsal portion of the margin is broken away. — 12. Interior view of the preceding specimen showing the attachment surface, but strongly distorting the appearance of the apical portion of the operculum. — 13. Strongly oblique ventral view of the preceding specimen, oriented so that the ventral margin is nearly in one plane but thereby distorting the appearance of most of the dorsal surface. — 14. Umbilical view of a second nearly complete specimen showing the strongly hook shaped apex; compare this with figure 7. — 15. Oblique carinal view of the preceding specimen showing the very slight curvature of the juvenile dorsal surface, emphasized by the worn condition of the specimen. — 16. Dorsal view of the preceding specimen. — 17. Dorsal view of the holotype, Geological Survey of Canada No. 7459; this is the original of BILLINGS (1865) figure 228. — 18. Umbilical view of the holotype; the apex is obscured by the coarse silicification but can be seen to the upper right. — 19. Carinal view of holotype.

Illustrations 1–7 are natural size, 8 and 9 are enlarged twice natural size, and 10 through 19 are enlarged one and one-half times natural size. All specimens are from the Narwhale Sound Formation on Ella Ø, except the holotype from the St. George Series at Cape Norman, Newfoundland.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