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CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

BULLETIN 38

PETROLOGICAL SCIENCES DIVISION

ORDOVICIAN CEPHALOPODS FROM CORNWALLIS AND LITTLE CORNWALLIS ISLANDS, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES

By

Walter C. Sweet and A. K. Miller

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
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PREFACE

The authors of this report are carrying on a comprehensive study of Ordovician cephalopods of the so-called 'Arctic' fauna. Although attached to the Ohio State University and the State University of Iowa and in no way connected with the Geological Survey of Canada, they kindly offered to study and prepare a report on collections from Cornwallis and Little Cornwallis Islands made by R. Thorsteinsson of the Geological Survey of Canada.

GEORGE HANSON,
Director, Geological Survey of Canada

OTTAWA, July 12, 1956

ORDOVICIAN CEPHALOPODS FROM CORNWALLIS AND LITTLE CORNWALLIS ISLANDS, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES

INTRODUCTION

Interest in the Arctic has greatly increased in recent years. As a result of this fact and especially because of the availability of air transport, our knowledge of the geology of the region has increased rapidly. The most pronounced advances have perhaps been made in those parts of the Canadian Arctic Archipelago that have been particularly difficult of access because they are remote from the usual sea routes.

The Geological Survey of Canada has participated extensively in this exploration and has greatly expanded its program in the Arctic. During four consecutive summer seasons, 1950-53, field parties were maintained on Cornwallis Island, near the geographic centre of the Canadian Arctic Archipelago; and in 1952 the investigation was extended to include nearby Little Cornwallis Island, which had not been visited previously. The work was inaugurated by Y. O. Fortier and R. Thorsteinsson in 1950, and in the three subsequent field seasons was carried on by Thorsteinsson. The following is a summary of the geology of these two islands with special emphasis on the local succession at the fossil localities that have provided the faunas described in this report.

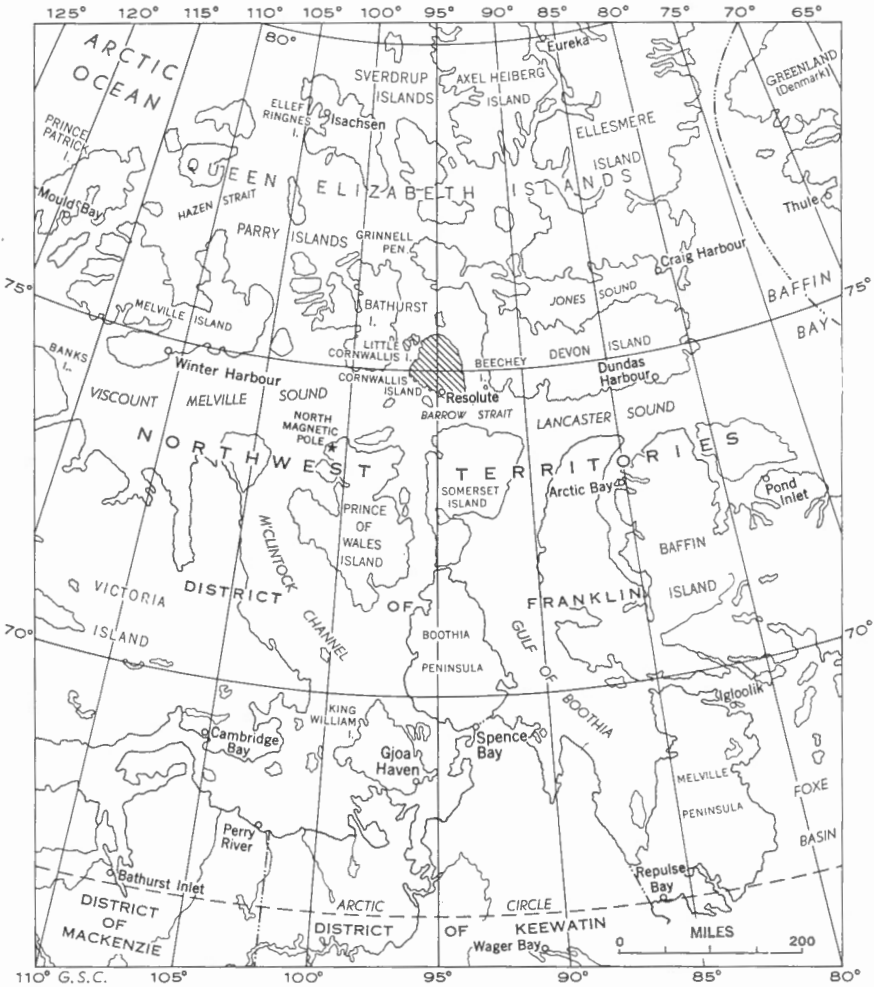

Figure 1. Index Map showing location of Cornwallis Island and Little Cornwallis Island.

SUMMARY OF THE GEOLOGY OF CORNWALLIS AND LITTLE CORNWALLIS ISLANDS

by R. Thorsteinsson

Cornwallis and Little Cornwallis Islands are situated in the approximate geographic centre of the Canadian Arctic Archipelago, some 8 degrees north of the Arctic Circle (*see* Figure 1). They comprise areas of about 2,850 and 190 square miles, respectively. The Royal Canadian Air Force station Resolute, which is accessible by aircraft throughout the year, is situated on the south-central coast of Cornwallis Island. The island is also accessible to ships for two or three months of the summer and fall.

Cornwallis Island is characterized by two dissimilar physiographic divisions of different relief and stage in the erosion cycle. One of these is represented by a plateau remnant, resulting from advanced peneplanation effected at some remote time. This plateau is situated approximately in the southeastern quarter of the island where it borders about 20 miles of the south and east coasts that face Barrow Strait and Wellington Channel, respectively. A height of 1,350 feet, measured by aneroid, about 7 miles southwest of Read Bay, is, in all likelihood, the highest point on the plateau and Cornwallis Island. The surface of the plateau is undulating and truncates several major structures. It is crossed by several streams, steep in gradient and characterized by canyons with numerous waterfalls, but large intervening areas are apparently devoid of drainage lines. At present these streams are actively down-cutting and extending headwards. The remainder of Cornwallis Island is physiographically of more mature aspect. West and northwest from the southeastern plateau, elevation above sea-level decreases, stream systems are more integrated, and a generally more rugged terrain prevails. Increased dissection coupled with incomplete emergence of the island has resulted in much of the western and southwestern coasts having features characteristic of drowned topography. Many parts of the west and northwest coastal regions are low-lying plains that slope gently seaward and on which major streams flow through generally well-graded stream channels, commonly several miles in length, before reaching the sea. The largest streams on Cornwallis Island are outside the southeastern plateau.

The maximum elevation of Little Cornwallis Island is about 525 feet. The physical features of this island are comparable to those of adjacent regions of Cornwallis Island.

Numerous erosional and depositional features of glaciation are present on the Cornwallis Islands. Available evidence indicates that these islands were covered by local ice-caps and on Cornwallis Island, at least, the glacier is believed to have moved out from a central location on the southeastern plateau. There the lower reaches of several major stream valleys are characteristically U-shaped and contain streams flowing at grade for shorter or longer distances before reaching Wellington Channel. Traced inland, at various distances, all U-shaped valleys end abruptly to give way to V-shaped valleys. Sophia and Eleanor Lakes, and the largest of the Laura Lakes as well as several other unnamed finger lakes, occupy segments of such U-shaped valleys and apparently owe their origin to local excavation of the floors of pre-existing stream channels by seaward advancing ice-tongues. Such prominent coastal indentations, as, for example, Barlow Inlet and Helen Haven, can only be described as fiords, although the term may seem inappropriate because of the non-mountainous terrain in which they are formed.

For the most part, Cornwallis Island is barren of vegetation, and this barrenness, together with the comparatively low relief of the island, has produced a generally desolate landscape. Uplands in excess of about 300 feet above sea-level have little or no plant cover. By far the greater part of the surface of the island is covered with clay admixed with frost-shattered debris from bedrock or of frost-shattered debris (felsenmeer) only. The mixture is either till or regolith, but it is difficult to differentiate between the two everywhere because the original characteristics have been obliterated in many places by widespread solifluction. Much of the present mantle can only be described as resulting from this process, the origin of the material being in doubt. Plants, represented mainly by grasses, lichens, and mosses, are, however, more plentiful in other areas, particularly in broad valley floors and in low-level areas below about 300 feet which occur mainly in the vicinity of the coast. On Cornwallis Island, plant-covered areas are common along the fringe of the west and northwest coasts where moderately large areas lie close to sea-level. Even there vegetation can seldom be described as more than sparse.

Little Cornwallis Island has about half the elevation of its sister island, and much of its terrain lies well within 300 feet of sea-level. In marked contrast to Cornwallis, Little Cornwallis Island is characterized by considerable plant cover, the total area of which probably equals that of the larger island.

Emerged strand lines and intervening swales are conspicuous topographic features on the Cornwallis Islands and are best developed where the land slopes gently to the sea. They have been observed up to elevations of

about 325 feet above sea-level and may be seen sweeping up the sides of the valleys of the major streams, bays, and fiords. Their development and emergence clearly post-date the development of major streams, the development of the general configuration of the islands, and the period of glaciation. Smaller, second-cycle streams have cut channels more or less at right angles across the raised beach deposits.

Summary Description of Formations

A thick, folded and conformable sequence of marine formations of miogeosynclinal origin that ranges in age from Middle Ordovician to Late Silurian or Early Devonian comprises by far the greatest thickness of exposed bedrock in the Cornwallis Islands. Small isolated patches of two younger formations rest with structural unconformity on these older rocks (*see* Figure 2).

The Eleanor River formation (thickness, 500+ feet) is the oldest exposed in the region and consists of limestone. The base has not been observed. Outcrops of this formation are restricted mainly to the central part of Cornwallis Island, but a small outcrop area occurs near the northern extremity. No fossils have been discovered in this formation which is, however, tentatively regarded as of Ordovician age.

The Cornwallis formation (approximate thickness 5,000 feet) overlies Eleanor River strata and comprises mainly limestone and dolomite beds, with lesser clastic rocks and gypsum. About 800 feet of gypsum, gypsiferous shale, and siltstone marks the base of the Cornwallis formation. This formation occurs also on Little Cornwallis Island where it is the oldest rock exposed. The oldest faunas in Cornwallis beds are of Middle Ordovician age but the youngest faunas are those of "Arctic Ordovician" aspect variously regarded as of Middle or Upper Ordovician age.

Regional facies changes occur in the strata that rest conformably on the Cornwallis formation. The zone of facies separation trends somewhat south of west across the approximate centre of Cornwallis Island, roughly from Stanley Head on the west-central coast to Snowblind Bay on the east-central coast. This is referred to as the Stanley Head-Snowblind Bay line of facies change. A graptolitic facies represented by the Cape Phillips formation (approximate thickness 8,500 feet), occurs to the north of this line on Cornwallis and Little Cornwallis Islands. This formation ranges in age from Late Ordovician to Late Silurian and comprises a highly varied assemblage of rock types, the most important of which are calcareous shale, argillaceous limestone, shale, cherty argillaceous limestone, and limestone. The principal faunal elements are graptolites, radiolarians, and cephalopods. Cephalopods of "Arctic Ordovician" aspect occur in basal beds of this

formation, and these constitute the majority of forms described in this report by Sweet and Miller.

South of the Stanley Head-Snowblind Bay line of facies change are two formations that together correspond to much of the Cape Phillips formation. Both formations bear shelly faunas and are of purer carbonate composition than Cape Phillips strata. The older of these is the Allen Bay formation (approximate thickness 5,500 feet), which is composed mainly of a uniform sequence of dolomite. It ranges in age from Late Ordovician to Middle Silurian. The Read Bay formation (approximate thickness 8,500 feet), composed mainly of limestone and argillaceous limestone, overlies the Allen Bay dolomite and ranges in age from Middle to Late Silurian. The well-known Arctic "*Atrypella* fauna" is well developed in this formation.

The Snowblind Bay formation (thickness, 800+ feet) rests with conformable and seemingly gradational contact on Read Bay beds. Outcrops of this formation consist mainly of coarse limestone breccia and conglomerate with lesser amounts of sandstone and siltstone, and are restricted to one locality between Read Bay and Snowblind Bay on the east coast of Cornwallis Island. This formation has yielded vertebrate faunas and is considered Late Silurian or Early Devonian in age.

The Disappointment Bay formation (maximum thickness 280 feet), comprises beds of dolomite, sandstone, and a basal limestone and chert conglomerate. This formation is represented by two small outcrop areas near the northern extremity of Cornwallis Island where it rests with angular unconformity on the Cape Phillips formation. On the basis of a marine invertebrate fauna, the Disappointment Bay is correlated with Late Silurian rocks of the Appalachian region. However, the structural relationship of Disappointment Bay beds clearly indicates that this formation postdates the deformation of the older, conformable series of lower Palæozoic formations that include Snowblind Bay beds. Because of the established age of the Snowblind Bay formation, the age of the Disappointment Bay formation is also regarded as Late Silurian or Early Devonian.

The Intrepid Bay formation (maximum thickness 2,000 feet) is the youngest unit in this region and consists of nonmarine Pennsylvanian sand, sandstone, clay, and coal deposits. This formation is represented by two relatively small outcrop localities in the western part of Cornwallis Island where Intrepid Bay beds are preserved along the downthrown side of normal faults.

Structure

The conformable sequence of lower Palæozoic formations has been gently to moderately folded to produce structures that strike northwest. The ages of the Snowblind Bay and Disappointment Bay formations narrowly limit the time of folding to the Caledonian period of deformation and

probably to the Erian phase of that orogeny. Snowblind Bay beds are probably, in part at least, nonmarine; seemingly they herald the deformation of the geosyncline.

Normal faults that post-date deposition of the Intrepid Bay formation are the youngest structural features in the Cornwallis Islands. With local deviations, the trend of these faults roughly parallels that of the regional strike of lower Palæozoic structures.

Description of Cephalopod Localities

Locality 34 (*see* Figure 2): The uppermost unit of the Cornwallis formation consists of greyish green shale with minor discontinuous interbeds and concretions of light to medium grey, sublithographic limestone, 28 to 40 feet thick. These beds form a well-marked line separating the Cornwallis formation from the overlying Cape Phillips and Allen Bay formations, north and south of the Stanley Head-Snowblind Bay line of facies change respectively. The uppermost shale and limestone unit and roughly 60 feet of the underlying limestone are the most fossiliferous strata on the Cornwallis Islands. Literally tons of fossils could be collected at a single locality.

The following section was measured in uppermost beds of the Cornwallis formation about 3·25 miles east of the head of Intrepid Bay. Corals, brachiopods, and arthropods have been identified by A. E. Wilson. T. E. Bolton identified the bryozoans. Identifications of graptolites in this report are by the writer. The cephalopods, *Charactocerina thorsteinssoni* and *Cyrtogomphoceras baffinense* (described in this report by Sweet and Miller) were obtained from this locality.

Section of Cornwallis Formation
in the Southwestern Part of Cornwallis Island (Loc. 34)

Unit No.		Thickness in feet
	Overlying strata, Allen Bay formation	
5	Shale and minor limestone; greyish green shale interbedded with minor discontinuous beds and concretions of medium grey, hard, dense, sublithographic limestone; concentrations of *Receptaculites arcticus* Etheridge near base; remainder of fauna weathers loose from shale or occurs in limestone strata and concretions; *Streptelasma* ? *arcticum* Wilson, *Persicaria patella* Nelson (MS), *Lyopora* sp. A aff. *L. franklini* (Salter), *Calapoecia arctica* Troedsson, *C. anticostiensis* Billings, *C. canadensis* Billings, *Palæophyllum* sp. A, *Halysites* sp. cf. *H. delicatulus* Wilson, *Halysites agglomeratiformis* Whitfield, *Glyptorthis insculptus* (Hall), *Dinorthis* sp., *Hebertella* sp. A, *H.* sp. B, *Öpikina* sp., *Rafinesquina lata* Whiteaves, *Strophomena* sp., *Rhynchotrema* n. sp. ?, *R.* cf. *R. capax* (Conrad), *Trochonema coxi* Wilson, *Maclurites septentrionalis* Wilson, *Hormotoma* sp., (=*H.* n. sp. Troedsson, 1928, Pl. 4, fig. 5), *Loxonema* sp., *Charactocerina thorsteinssoni* Sweet and Miller, *Cyrtogomphoceras baffinense* Foerste, ? *Whitfieldoceras* sp., *Bumastus* sp. A, *B.* sp. B, *Leperditia* sp., *Glyptograptus* n. sp. A.....	

Unit No.		Thickness in feet
4	Limestone; greyish red, weathering greyish yellow, very thin bedded, flaggy, hard, dense, sublithographic	3
3	Limestone; light grey to olive-grey, weathering similar, thin bedded, flaggy, hard, dense, sublithographic; bedding planes irregular and composed of shale partings up to 0·25 inch; *Streptelasma* sp. B cf. *S. breve* Winchell and Schuchert, *Nyctopora* sp. A, *Calapoecia canadensis* Billings, *Halysites* n. sp. ?, *Batostoma* sp., *Chasmatopora* sp. A, *C.*sp. B, *Glyptorthis insculpta* (Hall), *Dinorthis* sp., *Strophomena fluctuosa* Billings, *Öpikina* sp., ? *Resserella* sp., *Sowerbyella* sp., *Rhynchotrema* sp. cf. *R. capax* (Conrad), *R.* sp., ? *Liospira* sp., *Bumastus* sp. C, *Ceraurus horridus* Troedsson, *C.* sp., *Ceraurinus daedalus* Cox, *Basslerites* sp., ostracods, unidentified	10
2	Limestone; greyish red, weathering greyish yellow, thin bedded, flaggy, hard, dense, sublithographic	6
1	Limestone; light grey to olive-grey, weathering similar, thin bedded, flaggy, hard, dense, sublithographic; bedding planes irregular with shale partings; *Streptelasma* sp. A, *Calapoecia canadensis ungava* Cox, *C. anticostiensis arcticus* Cox, *Batostomella* sp., *Leptaena* sp., *Endoceras* sp. cf. *E. magniventrum* Hall, trilobite fragments, ostracods, unidentified	20
	Total thickness	67

Underlying strata, covered interval in Cornwallis formation.

Locality 48: Halysites n.sp., identified by A. E. Wilson and ? *Spyroceras* sp., described in this report by Sweet and Miller, were collected about 8 miles southeast of the head of Read Bay. These fossils were obtained from beds a few feet below the uppermost shale and limestone unit of the Cornwallis formation. Much larger and varied collections could have been made at this locality had circumstances permitted.

Locality 46, Marshall Peninsula, Cornwallis Island: Graphic measurement indicates that about 450 feet of the lowermost Cape Phillips beds are exposed in this northwest coastal region of the island. A variety of cephalopods (described in this report by Sweet and Miller), one species of graptolites and one species of trilobites (identified by A. E. Wilson) were obtained from a 32-foot section of alternating dark grey argillaceous limestone and dark grey petroliferous shale. The base of this fossiliferous interval lies approximately 125 feet stratigraphically above the base of the formation. There, as elsewhere, no fossils were observed in the lowermost hundred or more feet of the Cape Phillips formation. The graptolite and trilobite species occur in prodigious numbers and no zonal sequence was

apparent among the fossils collected in the 32 feet of strata. The fauna is as follows:

Fossils of Cape Phillips Beds on Marshall Peninsula

Charactocerina eximia Sweet and Miller
Cyclendoceras intermedium Sweet and Miller
Endoceras proteiforme Hall
Ormoceras cornwallisense Sweet and Miller
Probillingsites sutherlandi Sweet and Miller
Parryoceras euchari Sweet and Miller
Spyroceras ? *nodosum* Sweet and Miller
Spyroceras ? spp.
Pseudogygites latimarginatus (Hall)
Orthograptus n.sp. A

Approximately 55 feet stratigraphically above the interval in which the foregoing fauna was found, 16 feet of dark grey concretionary limestone beds yielded numerous uncompressed specimens of *Climacograptus latus* Elles and Wood. From an isolated outcrop, approximately on strike with exposures yielding *C. latus*, a single limestone concretion yielded several specimens of *Climacograptus supernus* Elles and Wood. The outcrops containing these two climacograptid species are about 400 feet apart. Although it is reasonably certain that *C. supernus* lies stratigraphically above beds bearing the above-listed cephalopod fauna, its exact stratigraphic relationship to the *C. latus* band is uncertain. *C. latus* and *C. supernus* were first described from the Upper Ordovician (zone of *Dicellograptus anceps*) of Scotland and it is reasonable, therefore, to assume that on Cornwallis Island they are very close in age.

Approximately 175 feet of apparently unfossiliferous strata overlie the *C. latus* band, and above this dolomite concretions yielded ? *Armenoceras donetti* Foerste (described in this report by Sweet and Miller), *Orthograptus* n.sp. B aff. *O. bellulus* Tornquist, and *Climacograptus* n.sp. A aff. *C. rectangularis* (McCoy). By themselves these graptolites can only suggest a Lower Silurian age. Both species, however, occur associated with numerous graptolites at another locality on Cornwallis Island that permits a fairly accurate correlation with the European zone of *Monograptus cyphus* of the Llandoverian. At any rate, it is obvious that the 175 feet of underlying unfossiliferous strata transgresses the Ordovician-Silurian boundary.

Locality 41, southeastern Little Cornwallis Island: Outcrops of Cape Phillips beds are scarce at this locality. Fossils were collected from a dark

grey argillaceous limestone stratum, 2 to 3 feet thick, which is estimated to lie somewhere within the basal 200 feet of the Cape Phillips formation. This thin stratum has yielded the following (the cephalopods are described in this report by Sweet and Miller):

Fossils of Cape Phillips Beds on Little Cornwallis Island

? *Apsidoceras elegans* Troedsson
Billingsites borealis (Parks)
Charactocerina borealis Sweet and Miller
Charactocerina thorsteinssoni Sweet and Miller
Diestoceras brevidomum Foerste
Endoceras bellicinctum Sweet and Miller
? *Gorbyoceras maro* (Billings)
Westonoceras greggi Roy ?
Pseudogygites latimarginatus (Hall)
Orthograptus n. sp. A

Locality 44, southeastern Little Cornwallis Island: A faunal succession is found there in the lower part of the Cape Phillips formation that is broadly comparable to that found at Locality 46 on Marshall Peninsula, Cornwallis Island. From a 9-foot exposure of dark grey, medium-bedded, argillaceous limestone, situated approximately 125 feet stratigraphically above the base of the Cape Phillips formation, the following intimately associated fauna was found (the cephalopods are described in this report by Sweet and Miller):

Fossils from Cape Phillips Beds on Little Cornwallis Island

Apsidoceratidae gen. and sp. indet.
Beloitoceras spp.
? *Billingsites deformis* (Eichwald)
Billingsites sp. cf. *B. bellicinctus* Miller
Diestoceras arcticum Sweet and Miller
? *Narthecoceras* sp.
Nybyoceras ventrolineatum Sweet and Miller
Oncoceras sp.
Richardsonoceras bellatulum Sweet and Miller
Pseudogygites latimarginatus (Hall)
Climacograptus latus Elles and Wood
Orthograptus n.sp. C

Pseudogygites latimarginatus occurs sparingly in this fauna, but approximately 30 feet stratigraphically lower in the formation it is abun-

dantly represented in a small isolated exposure of dark grey bituminous shale. At this locality the basal 125 feet or so of Cape Phillips beds is for the most part not exposed. *P. latimarginatus* is a common trilobite in the Collingwood formation of Utican age in Ontario. It has also been reported from the Cobourg formation at Collingwood, Ont., and in the state of New York.

Approximately 170 feet (covered interval) stratigraphically above strata yielding the cephalopod fauna, graptolite-bearing concretions were found with forms that permit close correlation with the upper Llandoverian zone of *Monograptus turriculatus*. A younger age than that of the Lower Silurian graptolites occurring stratigraphically above the Ordovician cephalopod fauna on Marshall Peninsula (Locality 46) is thus indicated.

Locality 22, western region of Little Cornwallis Island: At this locality about 70 feet of Cape Phillips beds are exposed along a small creek. They comprise alternating dark grey, thin-bedded, flaggy, finely crystalline to sublithographic argillaceous limestone and dark grey shale. *Digenuoceras latum* (Foerste) and *Huroniella* sp., (described in this report by Sweet and Miller) were collected in about the middle of this exposure, but the stratigraphic relationship of these cephalopods to one another could not be determined. Stratigraphically higher and separated by a considerable covered interval, late Llandoverian graptolites were observed in outcrops along the same creek, but none was collected. The stratigraphic relationship of the above named cephalopods to the Ordovician cephalopod assemblages of Localities 41, 44, and 46 is not known. Presumably they too occur in the lower part of the Cape Phillips formation.

Locality 40, southeastern coastal region Cornwallis Island: Monograptus bohemicus (Barrande) occurs throughout about 130 feet of calcareous shale and argillaceous limestone within the Read Bay formation, where it forms a well-marked zone that is traceable from the latitude of Snowblind Bay to the south coast of Cornwallis Island. This is the only graptolite discovered in the Read Bay formation which is dominated by shelly faunas. *M. bohemicus* has a world-wide distribution in beds of lower Ludlovian (Upper Silurian) age. Associated with this graptolite on Goodsir Creek near the east coast of Cornwallis Island, the cephalopod *Gasconsoceras* sp., (described in this report by Sweet and Miller) was found.

Locality 19, northeastern coast of Cornwallis Island: The cephalopods *Michelinoceras* ? sp., and *Kionoceras* sp., (described in this report by Sweet and Miller) were collected in association with Wenlockian (Middle Silurian) graptolites.

THE CEPHALOPOD FAUNAS, THEIR OCCURRENCE AND SIGNIFICANCE

Previous Work

Cornwallis Island was sighted and named by Sir William Edward Parry as early as 1819, but its shores were not charted until some three decades later. In 1850 and 1851, during the search for possible survivors of Sir John Franklin's ill-fated expedition, members of three British naval squadrons, commanded by Captains H. T. Austin, W. Penny, and Sir John Ross, explored much of the coastline of Cornwallis and neighbouring islands. The surgeon to Penny's squadron, Dr. P. C. Sutherland (1852, 1853), gave us our first accounts of the coastal features of these islands.

Sutherland, assisted by members of Penny's crew, collected a large number of fossils from Cornwallis and Griffith Islands, which are very close to each other; and a study of them by J. W. Salter was appended to the published journal of the expedition. In addition to corals, brachiopods, gastropods, trilobites, and ostracods, Salter described a few cephalopods from Cornwallis Island under the following headings:

Lituites n. sp.
Orthoceras Ommaneyi Salter
Orthoceras sp. 1
Orthoceras sp. 2

Orthoceras sp. 2, was also reported from Griffith Island. It should be noted that all of Sutherland's fossils from Cornwallis Island were collected on the southeast and east coasts, and Salter concluded that they (particularly the corals: *Halysites*, *Favosites*, etc.) indicated a Silurian age for the containing strata.

In 1857 Haughton reported that *Orthoceras griffithi* is "found in great abundance at Griffith's Island, where Captain Austin's squadron wintered". He illustrated several specimens, which presumably had been collected by members of Austin's expedition.

From 1857 to 1947, no further geological work was done on Cornwallis Island or its small neighbours, and the locality was rarely visited by white men during this period. In 1927 and 1928 Foerste, at first in collaboration with Savage, restudied Salter's and Haughton's nautiloids and figured and described them under the following names:

Armenoceras donetti Foerste
Armenoceras cf. *A. ommaneyi* (Salter)
Sactoceras ? sp.
[?] *Ophidioceras extricatum* (Sowerby)
Orthoceras sp.
Ormoceras sp.

All of these appear to be Silurian species. Hence, Salter's early conclusion that strata of this age form most of the west side of Wellington Channel was substantiated by the restudy of the cephalopods. Thorsteinsson's recent investigations make it clear that these rocks are indeed Silurian, though a formation of limited areal extent and possibly early Devonian age was found along the east coast of Cornwallis Island.

It should perhaps be emphasized that Silurian cephalopods have been known from both Cornwallis and Griffith Islands for nearly a century. However, until quite recently there has been no reference in the literature to the large well-preserved Ordovician fauna that occurs in the western and southwestern parts of Cornwallis Island and the eastern part of nearby Little Cornwallis Island.

Recent Investigations

After the extensive search for Sir John Franklin's expedition of 1845, Cornwallis Island seems to have been rarely visited until the summer of 1947, when a weather station was established at Resolute Bay, near the centre of the south coast of the island. This station served as a base for the field parties that secured the wealth of material on which the present report is based.

In the northwestern part of Cornwallis Island, that is, on the Marshall Peninsula, and across the strait on Little Cornwallis Island, the Ordovician strata have yielded an abundance of invertebrate fossils, including trilobites, graptolites, and especially cephalopods. The last are quite varied and are remarkably well preserved—one of those secured even retains colour markings. A few cephalopods have been collected from the Ordovician in the interior of Cornwallis Island and from the Silurian strata comprising the southeastern part of that island. The present report consists primarily of a detailed study of the Ordovician cephalopod faunas, but an account of the Silurian forms is included, largely for the sake of completeness.

With the exception of four specimens from the Cornwallis formation, all the Ordovician cephalopods secured from both islands are believed to represent a single fauna. They are very much alike lithologically, being from a dark grey bituminous limestone, and there is nothing incompatible in their association. Those obtained in situ on the smaller island seem to be from the same beds of the Cape Phillips formation on opposite flanks of an anticline; and those secured from the adjacent part of the main island (the Marshall Peninsula) appear to be from the same strata along the strike. Altogether 23 species of cephalopods, belonging in 21 genera, are now known from the Ordovician of Cornwallis Island and from its small neighbour to the

northwest. In addition, we have representatives of 3 nautiloid genera from Silurian strata which outcrop along the east coast of the larger island, as well as a single Silurian specimen from the Cape Phillips formation on the Marshall Peninsula of the same island.

Correlations

The local occurrences of the nautiloid genera and species now known from the Ordovician rocks of Cornwallis and Little Cornwallis Islands are summarized in Table I. This summary makes it clear that the Cape Phillips formation yielded the majority of the species. From the Cornwallis formation, we have two specimens of *Cyrtogomphoceras* and one of *Charactocerina*, collected in the southwestern part of the larger island, and a doubtful representative of *Spyroceras*, found in the southeastern interior of that island. With the exception of these four specimens, all the Ordovician cephalopods are preserved in dark grey bituminous limestone and are intimately associated with numerous trilobites and a profusion of exceptionally well-preserved graptolites. The entire collection is believed to represent a single general fauna. It should perhaps be pointed out that the Ordovician of Little Cornwallis Island has yielded *Billingsites* in some abundance, whereas *Probillingsites* is known from comparable strata on the nearby Marshall Peninsula of Cornwallis Island. *Probillingsites* has been believed to be ancestral to *Billingsites*, so it may be that the assemblage from the Marshall Peninsula is somewhat older than that from Little Cornwallis Island. It is not inconceivable that these two genera could occur in direct association, and any difference in age that might be indicated is probably not very great. The few nautiloids known from the Cornwallis formation probably represent the same general fauna, for they cannot be much different in age.

The Ordovician cephalopods of both Cornwallis Islands are part of the so-called "Arctic" fauna, which is widely distributed in the northern hemisphere. This assemblage is perhaps best known from the Red River formation of southern Manitoba, the Bighorn formation of Wyoming, and the comparable strata at Silliman's Fossil Mount in southern Baffin Island. However, it is also well developed in the Cape Calhoun beds of northwestern Greenland, the Nelson River and Shamattawa formations of northeastern Manitoba, the Whitewood dolomite of South Dakota, the Fremont formation of Colorado, and the Stewartville formation of Iowa and Minnesota. In addition, the faunas of the English Head, Vauréal, and Ellis Bay formations of Anticosti Island are closely similar, and assemblages that probably represent extensions of the same general fauna are known from Estonia, Sweden, and Norway. The widespread occurrence of these cephalopod-

bearing strata led Foerste (Strand, 1934, p. 110[1]) to interpret them "as representing one formation [*s. l.*] and thus affording an illustration of an enormous epicontinental embayment with Arctic connections".

TABLE I

Local Occurrence of Palæozoic Cephalopods on Cornwallis and Little Cornwallis Islands

Formation and locality / Nautiloid Species	Cornwallis formation	Cape Phillips formation				Read Bay formation
	Interior Cornwallis Island (Locs. 34 and 48)	West part Little Cornwallis Island (Loc. 22)	East part Little Cornwallis Island (Locs. 41 and 44)	Marshall Peninsula, Cornwallis Island (Loc. 46)	Northeast coast, Cornwallis Island (Loc. 19)	Southeast coastal region, Cornwallis Island (Loc. 40)
Endoceras bellicinctum, n. sp.	—	—	X	—	—	—
Endoceras proteiforme Hall	—	—	—	X	—	—
Cyclendoceras intermedium, n. sp.	—	—	—	X	—	—
Narthecoceras ? sp.	—	—	X	—	—	—
Armenoceras donetti Foerste?	—	—	—	X(Sil.)	—	—
Nybyoceras ventrolineatum, n. sp.	—	—	X	—	—	—
Huroniella sp.	—	X	—	—	—	—
Deiroceras subfusiforme, n. sp.	—	—	X	—	—	—
Ormoceras cornwallisense, n. sp.	—	—	—	X	—	—
Michelinoceras ? sp.	—	—	—	—	X	—
Kionoceras sp.	—	—	—	—	X	—
Spyroceras ? *nodosum*, n. sp.	—	—	—	X	—	—
Spyroceras ? spp.	X	—	—	X	—	—
Gorbyoceras maro (Billings)?	—	—	X	—	—	—
Probillingsites sutherlandi, n. sp.	—	—	—	X	—	—
Billingsites borealis (Parks)	—	—	X	—	—	—
Billingsites deformis (Eichwald)?	—	—	X	—	—	—
Billingsites cf. *B. bellicinctus* Miller	—	—	X	—	—	—
Oncoceras sp.	—	—	X	—	—	—
Beloitoceras spp.	—	—	X	—	—	—
Richardsonoceras bellatulum, n. sp.	—	—	X	—	—	—
Digenuoceras latum (Foerste)	—	X	—	—	—	—
Diestoceras arcticum, n. sp.	—	—	X	—	—	—
Diestoceras brevidomum Foerste	—	—	X	—	—	—
Westonoceras greggi Roy?	—	—	X	—	—	—
Cyrtogomphoceras baffinense Foerste	X	—	—	—	—	—
Parryoceras euchari, n. gen., n. sp.	—	—	—	X	—	—
Gasconsoceras sp.	—	—	—	—	—	X
Apsidoceras elegans Troedsson?	—	—	X	—	—	—
Charactocerina borealis, n. sp.	—	—	X	—	—	—
Charactocerina eximia, n. sp.	—	—	—	X	—	—
Charactocerina thorsteinssoni, n. sp.	X	—	X	—	—	—
Apsidoceratidae, gen. and sp. indet.	—	—	X	—	—	—

[1]Names and dates in parentheses are those of references cited in the bibliography at the end of this report.

Miller, Youngquist, and Collinson (1954) have recently described the Ordovician cephalopods known from Silliman's Fossil Mount in southern Baffin Island. Their report contains a synthesis of our knowledge of the Upper Ordovician in regions where strata bearing the characteristic "Arctic" fauna occur. The authors have drawn heavily on this work in preparing the following discussion concerning the age and relationships of the cephalopod fauna from the Cornwallis Islands.

The several Baffin Island collections are the largest and perhaps the most significant that have previously been made from the Ordovician of the Canadian Arctic Archipelago. From Silliman's Fossil Mount we now know 23 genera of cephalopods, and a variety of corals, graptolites, bryozoans, brachiopods, pelecypods, gastropods, ostracods, and trilobites. Although only 7 of the nautiloid genera found on Baffin Island are present in the collections from the Cornwallis Islands, the two faunas are similar in overall aspect. It should be pointed out that *Probillingsites* is abundant in the strata at Silliman's Fossil Mount, whereas *Billingsites* is the dominant ascoceratoid genus in the collections from the Cornwallis Islands. This fact may indicate that the strata at the latter locality are slightly younger, but it is doubtful if there is any great difference in age.

The Upper Ordovician rocks of Anticosti Island have been divided into three formations, the English Head, Vauréal, and Ellis Bay. These strata were studied in detail by Twenhofel (1928), and the many nautiloids collected from them were described by Foerste. In general aspect, the faunas of these three Upper Ordovician formations are very much alike. It is probably significant that certain elements are conspicuous in the Ordovician cephalopod assemblage of the Cornwallis Islands and also in those of each of the three Anticosti Island formations. For example, *Apsidoceras* and *Billingsites*, which are present in some abundance in the English Head, Vauréal, and Ellis Bay formations, are also represented in the collections studied. The general similarity of the Upper Ordovician faunas of Anticosti Island and those of Baffin Island has been noted by Miller, Youngquist, and Collinson (1954, pp. 32-33), and the present collection is closely comparable and cannot be much different in age.

The faunas of the Nelson River and Shamattawa limestones southwest of Hudson Bay have been carefully studied by Parks (1913, 1915) and by Foerste and Savage (1927). From the Nelson River limestone, we know only 4 nautiloid genera: *Cyrtogomphoceras*, *Diestoceras*, *Endoceras*, and *Westonoceras*. However, the overlying Shamattawa formation has yielded 23 cephalopod species, representing 21 genera. The collections from the Cornwallis Islands are similar to those from the Shamattawa, which, in addition to a host of other forms, contain *Apsidoceras* and *Billingsites*.

The cephalopod assemblages of both these Ordovician formations of the Hudson Bay region are closely related to each other, as well as to the one under consideration. Extensive collections from along the Churchill and Knife Rivers, just west of Hudson Bay, are being studied by S. J. Nelson, and his results will undoubtedly help to clarify the faunal and stratigraphic relationships of these beds.

TABLE II

Chief Distribution of Ordovician Cephalopod Genera Represented on Cornwallis and Little Cornwallis Islands

Genus \ Horizon and locality	Silliman's Fossil Mount, Baffin Island	Cape Calhoun beds, northwest Greenland	Nelson River limestone, Hudson Bay region	Shamattawa limestone, Hudson Bay region	Red River formation, south Manitoba	Bighorn formation, north and west Wyoming	Whitewood dolomite, southwest South Dakota	Fremont formation, central Colorado	Stewartville dolomite, Iowa and Minnesota	Maquoketa formation, northeast Iowa	Richmond group, Ohio and Indiana	English Head formation, Anticosti Island	Vauréal formation, Anticosti Island	Ellis Bay formation, Anticosti Island	Lyckholm formation, East Baltic region
Endoceras	X	X	X	X	X	X	X	X	X	X	X	X	—	X	X
Cyclendoceras	X	—	—	—	X	X	X	X	—	X	—	—	—	—	—
Narthecoceras	—	X	—	—	X	—	—	—	—	—	—	—	—	—	—
Nybyoceras	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X
Huroniella	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Deiroceras	—	—	—	—	X	—	—	—	—	X	—	—	—	—	—
Ormoceras	X	X	—	—	X	—	—	—	—	X	X	—	X	X	X
Spyroceras	X	X	—	X	X	X	X	X	—	X	X	X	X	X	X
Gorbyoceras	—	—	—	—	—	—	—	—	—	—	X	—	—	—	—
Probillingsites	X	—	—	—	—	—	—	X	X	X	X	—	—	—	—
Billingsites	—	—	—	X	X	X	—	—	—	X	—	X	X	X	X
Oncoceras	—	—	—	—	—	—	—	—	—	—	X	X	—	—	—
Beloitoceras	—	—	—	—	—	X	—	X	—	X	X	X	X	X	—
Richardsonoceras	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—
Digenuoceras	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—
Diestoceras	X	X	X	X	X	X	X	X	—	—	X	X	X	X	X
Westonoceras	X	X	X	X	X	X	X	X	X	X	X	—	—	—	—
Cyrtogomphoceras	X	X	X	X	X	X	X	X	—	—	—	—	—	—	X?
Parryoceras	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Apsidoceras	—	X	—	X	—	—	—	—	—	—	—	X	X	X	—
Charactocerina	—	X	—	—	X	X	—	—	—	—	—	—	—	—	—

A long northwestward-trending belt of Ordovician strata occurs along the western shore of Lake Winnipeg in southern Manitoba. These rocks consist of the Winnipeg sandstone, the Red River formation, and the Stony Mountain formation (*see* Baillie, 1952). The middle one, which is about 170 feet thick, is divided into the Dog Head, Cat Head, and Selkirk limestone members, all three of which have long been known to contain

cephalopods in some abundance. In 1929 Foerste published a detailed study of the many Red River nautiloids, of which there are 46 known species distributed among 29 genera. Twelve of these genera occur also in the fauna from the Cornwallis Islands. The latter can perhaps be said to be closest to the assemblage known from the Dog Head, which contains 10 of the cephalopod genera common to the two formations. However, most of these are also represented in the Cat Head and the Selkirk limestones, a fact which tends to weaken the suggested correlation. The presence of *Billingsites* in the Dog Head, the basal member of the Red River, may indicate that the entire formation is younger than the Ordovician strata of the Marshall Peninsula but is approximately contemporaneous with the Cape Phillips formation of Little Cornwallis Island. We doubt the validity of this inference, however, because of the general similarity of the three faunas.

The Bighorn formation of Wyoming and the stratigraphically equivalent Whitewood dolomite of the Black Hills of South Dakota have yielded a great many cephalopods. Of the 33 nautiloid genera known from the Bighorn, including the introductory Lander sandstone member, 10 occur in the Ordovician of the Cornwallis Islands. The Whitewood dolomite has yielded 12 genera of cephalopods, of which at least half are present in the collections studied. The general similarity of these three faunas is so striking that there can be little question but that all of them came from formations which are, in part at least, contemporaneous.

The cephalopod fauna of the Fremont dolomite of central Colorado has recently been studied by Sweet (1954, 1955). In general, it is closely comparable to that of the Red River-Bighorn fauna taken as a whole. The presence of *Probillingsites* in the Fremont, rather than *Billingsites*, may indicate that it is somewhat older than the Bighorn but approximately equivalent in age to the strata at Silliman's Fossil Mount on Baffin Island and to the Cape Phillips formation on the Marshall Peninsula of Cornwallis Island. Nevertheless, the general similarity of the faunas of all these stratigraphic units indicates that they cannot be very much different in age.

Only a few poorly preserved cephalopods were collected from the Silurian of Cornwallis Island. These are referable to 4 nautiloid genera, 3 of which are known to occur in the Silurian strata of other parts of the Canadian Arctic Archipelago. These 3 (*Armenoceras*, *Kionoceras*, and *Michelinoceras*) have such a long range in the Early Palæozoic that they are of little value for precise stratigraphic work. A single specimen, which is referred to *Gasconsoceras*, probably represents a genus which has been reported previously from the Middle Silurian of Gaspé and from Tasmania. As a result of these several facts, we are not able to determine satisfactorily the age of this material, but none of it is inconsistent with a Silurian assignment for the rocks from which it was collected.

Colour Markings on Nautiloid Cephalopods

Modern *Nautilus* provides one of the best illustrations of protective coloration among present-day shelled invertebrates, and for this reason it has received careful consideration (*see* Miller, 1947, pp. 15-16). This study suggests that a correlation exists between the development of colour markings and ontogenetic variations in the living position and habits of the animal; hence, investigations of comparable markings on fossil cephalopods may yield information as to their living position and habits. At least two authors (Schindewolf, 1928; Iredale, 1944) have expressed the opinion that the configuration and hue of colour markings may well be properties of specific value in cephalopod taxonomy.

The surface of the conch in mature representatives of modern *Nautilus* is ornamented by broad transverse colour bands, which are irregular in width and continuous across the venter, except in the adoral half of the outermost volution of mature individuals. In addition, there is a lunate patch of solid colour in the umbilical region. The colour markings on all of the many specimens examined are some shade of brown, varying from a light yellowish tone to a deep reddish brown or lake. The hue differs in the individuals of an apparently homogeneous morphological species, but it appears to be constant throughout a single specimen. The bands are more or less symmetrical, having a tendency to form shallow ventral sinuses and one or more lateral salients. When studied in detail the markings are found to vary greatly from place to place on opposite sides of a conch.

The adapical whorl of very young individuals is completely coloured except in the immediate vicinity of the umbilicus. During ontogenetic development bands of white appear on the lateral zones, becoming larger and more prominent as the size of the shell increases. *Nautilus* lives in a nearly horizontal position with the early colour-marked volutions of the conch buoyed upward and with the unmarked white surface downward. The absence of a light-coloured ventral region in immature individuals suggests that they are benthonic.

Several specimens of *Nautilus*, secured from the coasts of northern Queensland and from an island in the Abrolhos Group of Western Australia, were described by Iredale in 1944. He established two additional species of *Nautilus* (*N. alumnus* and *N. repertus*) apparently on the basis of variations in the colour patterns and pigment tint alone. We have not had an opportunity to examine Iredale's specimens, but several individuals in collections available are similar to those he illustrates. A careful examination of them indicates that the hue and configuration of the colour markings vary considerably, but no significant morphological differences can be found other than those that may be attributable to sexual dimorphism. Irregularities in the bands and the presence of offsets and longitudinal white

patches in otherwise coloured areas were presumably caused by injuries that affected the pigment-producing glands. Consequently, such features are probably of no significance in specific differentiation.

Our knowledge of colour markings on fossil cephalopods is limited and is practically confined to the 41 species discussed by Foerste in 1930. Of these 41 species, 39 are from rocks of Palæozoic age, 1 from Mesozoic strata, and 1 from the Tertiary (of southern France and Italy). Twenty-two of the 39 Palæozoic species were collected from Silurian rocks in a relatively small area north of Prague, Czechoslovakia. Only 9 of the species listed by Foerste are from North America, and 6 of these were secured from Ordovician strata. Foerste's discussion also indicates that the markings on all of the fossil cephalopods are some shade of brown. Such coloration appears to be most common in the breviconic cyrtocones, although a few pigmented orthocones are known.

In general, the colour patterns in fossil nautiloids fall into two categories. A majority of the colour-bearing specimens have transverse zigzag bands of varying complexity, whereas a few are ornamented by a series of essentially parallel longitudinal stripes. It is interesting to note that the Liassic ammonite *Androgynoceras* illustrated by Spath in 1935 shows spiral colour bands that continue to the aperture only in the lateral zones; whereas specimens of *Amaltheus* described by Schindewolf (1928, 1931) from the European Jurassic are stated to have colour markings that are transverse to the axis of the conch and are parallel to the ornamentation of the test. Specimens of *Orthoceras anguliferum* from the Middle Devonian of Paffrath, Germany, and from the Devonian Alpena limestone of Michigan are of considerable interest in that their colour markings are restricted to one side of the conch. Both Dunbar (1924) and Foerste (1930) believed such a distribution to indicate that these forms lived in an essentially horizontal position, with the colour-marked side up.

As fossil nautiloids retaining traces of the original shell coloration are rare, the discovery of such an individual in the Ordovician of Cornwallis Island is of more than ordinary interest. This specimen is an incomplete partly testiferous cyrtogomphoceratoid, which we are describing as *Parryoceras euchari*, n. gen. and sp. A part of the original test adheres to the internal mold at the adoral end of the phragmocone and completely covers the dorsal half of the specimen; none remains on most of the ventral side. The test fragment is a deep yellowish brown and is marked by prominent reddish brown longitudinal stripes on its dorsal and lateral zones. The pigment appears to be restricted to a very thin zone in the peripheral part of the test. The darker bands are regular in their spacing and width, four occurring on that part of the test preserved. The background colour and the darker hue of the bands are uniform over all of the test fragment, and there is no indication that the coloration diminished ventrally.

The orientation of *Cyrtogomphoceras*, the typical genus of the family to which *Parryoceras* belongs, has recently been discussed in some detail (Miller, Youngquist, and Collinson, 1954, p. 104; Sweet, 1955, p. 84). Although the evidence is equivocal, it appears that the concave, siphuncular side of representatives of that genus is the venter, and the conch should therefore be regarded as endogastric. The type species of *Parryoceras* has a shallow spout-like sinus on the siphuncular side of the aperture, indicating that the concave side is ventral and that the conch is endogastric. Consequently, if these animals lived in an essentially horizontal position, one would expect the external coloration of the dorsum to be darker than that of the venter, as is the case in *Nautilus*. Although our specimen is incomplete ventrally it should be noted that, when it is viewed normal to the dorsum, all of the longitudinal bands are clearly visible, the ventral edges of those in the lateral zones corresponding almost exactly with the lateral profiles of the conch. When the specimen is viewed normal to the venter, the colour bands are not visible (*see* Pl. V, figs. 1-4).

Because so few colour-marked fossil cephalopods are known and their palæozoological potentialities are so great, we wish to emphasize one point: over half the specimens in which traces of coloration have been recognized were collected from one small area, presumably from a single stratigraphic unit. This fact suggests to us that these features are preserved only under exceptional conditions. The presence of a colour-marked specimen is a tantalizing indication that an exhaustive search of the stratum from which it came might yield many more.

SUMMARY AND CONCLUSIONS

Dark grey Ordovician limestone outcrops over a large part of Cornwallis and Little Cornwallis Islands. These strata have yielded a variety of invertebrate fossils, chiefly trilobites, graptolites, and nautiloid cephalopods. All the nautiloids appear to represent the same general fauna, and they are undoubtedly a part of the well-known widespread "Arctic Ordovician" cephalopod assemblage.

The age of the "Arctic Ordovician" has long been a subject of discussion, for its fauna is known to contain a curious "mixture" of forms having both Trentonian and Richmondian affinities, with, perhaps, a preponderance of the former. It is indeed difficult to relate the "Arctic Ordovician" to the standard Ordovician section of North America. The chronology of the North American Ordovician was developed largely in northeastern United States, and the strata there were deposited in a sedimentary basin more or less isolated from the much larger "Arctic" embayment, so that migration between the two was not easy.

From the extensive work of Flower (1946), it seems that in the Cincinnati region the boreal fauna makes its first appearance in the Waynesville formation of the type Richmond and reaches the climax of its development there in the Whitewater and Saluda formations of the same subseries. This observation indicates that, at least by early Richmondian time, the barriers between the two basins had disappeared.

In a continuation of his excellent work on Ordovician nautiloids, Flower (1952, p. 26) has described representatives of a number of boreal genera from rocks of "uppermost Trenton" age in northeastern United States and adjacent parts of Quebec. He correctly points out that, with the exception of those genera known solely from "Arctic" assemblages, only *Schuchertoceras*, *Billingsites*, and *Huronia* are unknown in the typical Trenton. Of these, *Schuchertoceras* alone occurs in undoubted Richmondian strata. It should be emphasized that many species of the other characteristic boreal genera (for example, *Apsidoceras*, *Charactoceras*, and *Diestoceras*, as well as gibbous representatives of *Beloitoceras*) are more closely related to Richmondian species than to congeneric Middle Ordovician forms.

After careful evaluation of all elements in the "Arctic" fauna from Silliman's Fossil Mount, Baffin Island, Miller *et al.* (1954) reached the conclusion that an early Upper Ordovician age assignment for the assemblage was most consistent with the known stratigraphic extent of its components. Sinclair (1956) has taken exception to this interpretation, finding nothing (except the presence of the brachiopod *Austinella*) in the Baffin Island fauna to "demand" an early Upper, rather than a Middle Ordovician age for the strata from which it was collected. Sinclair cor-

rectly points out that the presence of *Dicranograptus* in the Baffin Island strata suggests a pre-Ashgillian age for the fauna, a point which Miller *et al.* presumably would not dispute. However, he appears to assume that Upper Ordovician and Ashgillian are synonymous, when it is probably true that the Eden and perhaps the Maysville groups of the North American Upper Ordovician are at least as old as the upper Caradocian zone of *Pleurograptus linearis*. Eden conodonts now being studied by a group of graduate students at Ohio State University are strikingly similar to those reported from the zone of *Pleurograptus linearis* in Wales (Rhodes, 1953), and the Eden is Upper Ordovician by definition. The Terrebonne cephalopod fauna of southeastern Quebec, studied by Flower (1952) and cited by Sinclair as an example of the Trentonian occurrence of "Arctic" cephalopods, is not as significant as the mere listing of its generic components makes it seem. Flower has found in it several atypical representatives of "Arctic" genera, but for the most part these are not well preserved, nor in detail are they much like those of the Red River-Bighorn fauna or those from the Cornwallis Islands. It seems possible to us that the Terrebonne limestone, like the Stewartville of Iowa, and perhaps also part of the Cynthiana of the Ohio-Kentucky region, may be the late parts of a carbonate facies, the lower units of which are Trentonian, whereas the upper parts are early Upper Ordovician. Each of the limestones cited carries a small cephalopodan fauna of "Arctic" aspect, and is followed stratigraphically by shales and limestones in which cephalopods are for the most part rare. The fauna undoubtedly had a long development and seems to be associated dominantly with carbonate rocks. Conditions favourable to rather pure carbonate deposition apparently persisted in the Arctic embayment throughout much of the Ordovician, whereas such conditions in the eastern and central parts of the United States and Canada were interrupted late in Middle Ordovician time by orogenic disturbances and resultant gradual replacement of clear waters by muddy environments inhospitable to the growth and development of typical "Arctic" cephalopods. Presumably, these molluscs were more or less continuous inhabitants of the clear Bighorn-Red River-Fremont seas in Western United States and Canada, and migrated into the central part of the continent only at times and in places where bottom conditions were favourable. Faunal associations on the Cornwallis Islands, and on Anticosti Island, suggest that the "Arctic" cephalopod fauna may have persisted throughout the entire Upper Ordovician in these places. In other associations, such as in the Bighorn and Fremont formations of Western United States, the fauna seems to occur in and be confined primarily to strata of pre-Richmondian age. We agree with Sinclair that the evidence for an early Upper Ordovician age for the faunas here considered is not definitely established and must await further careful stratigraphic work such as that recently carried

out by Thorsteinsson and his associates. However, we believe that the exclusively Upper Ordovician elements in the general fauna, few as they may be, should be given most weight in stratigraphic evaluation, for, in any such evolving population, changes are slow, and the "holdovers from the past" may not be nearly as significant as the "heralders of the future".

At locality 44 on Little Cornwallis Island, an "Arctic" cephalopod assemblage occurs in direct association with the graptolite *Climacograptus latus* Elles and Wood, first described from the *Dicellograptus anceps* zone of the Scottish upper Ashgillian. A perhaps more primitive assemblage of "Arctic" cephalopods is also present about 55 feet below the *C. latus* band on the Marshall Peninsula of Cornwallis Island. Both of these facts tend to make an Upper Ordovician age for this general "Arctic" fauna more probable than the Middle Ordovician age apparently preferred by Sinclair. It seems to us that the strata at localities 41 and 44 on Little Cornwallis Island must be virtually contemporaneous and not greatly different in age (although probably somewhat younger) from those at locality 46 on Cornwallis Island.

In connection with our discussion of the age of the strata in which "Arctic" cephalopods occur, it should be noted that Duncan (1956, p. 209) concludes from her extensive studies of corals from many of these same units:

"In the writer's [Duncan's] opinion, the evolutionary stage of development exhibited by the horn corals in the basal strata of the Bighorn strongly favors a Late Ordovician—though probably a pre-Richmond—age for the lower part of the formation." She further states (p. 220), however, that ". . . the lower Upper Ordovician rocks (Eden and Maysville groups) of the Cincinnati region are not coral bearing. This circumstance is one of several that has made it difficult to evaluate the age of Ordovician coral assemblages developed in other areas". These conclusions, reached independently by Duncan, indicate to us that, as suggested by the cephalopods and graptolites, an early Upper Ordovician age for the "Arctic Ordovician" fauna is most consistent with its overall stage of development.

In 1925 and again in 1930, Kirk suggested that these "Arctic Ordovician" strata be regarded as Cincinnatian—in the sense of being post-Trenton but pre-Richmond in age—a view which Flower (1952, p. 26) was apparently inclined to accept, and one which we find to be most satisfactory for the fauna under consideration. That is, whereas the faunas reported from the "Arctic Ordovician" rocks contain a large number of forms with Trentonian characteristics, there is a not-inconsiderable minority with Richmondian affinities. It appears that this general fauna is transitional between those typical of the Trenton and those characteristic of the Richmond, and the more advanced forms in it (those with Richmond affinities) should be given the most weight in stratigraphic evaluation. It should be

pointed out that the Eden and Maysville groups, which occupy such a critical position in the standard Ordovician sequence of North America, do not contain many cephalopods. Hence, it is not possible for us to demonstrate conclusively where in this range the "Arctic" fauna belongs.

One of the most striking features of the "Arctic" cephalopod fauna, taken as a whole, is the large size of the individual specimens. Many of these forms, when compared with representatives of closely related species from the contemporaneous sedimentary basin of eastern United States, are truly "giants". Many of the specimens in the collections from the Cornwallis Islands are partly testiferous, and, almost without exception, the test material is thick and well developed. All of these observations tend to indicate that the waters of the "Arctic" embayment were warm, shallow, and hospitable to life. Flower (1946, p. 126) has pointed out that the large size of the boreal invertebrates as compared with those of the type Cincinnatian may well indicate that the "Arctic" sea was tropical in character, whereas that of the Cincinnati-Nashville area was "at the best temperate". The presence of a colour-marked nautiloid in the Ordovician collections from Cornwallis Island suggests that further collecting there will probably yield more well-preserved material.

SYSTEMATIC PALÆONTOLOGY

Family ENDOCERATIDAE Hyatt, 1883

Genus ***Endoceras*** Hall, 1847

Endoceras bellicinctum n. sp.

Plate II, figures 2, 3

The collections made from the Ordovician strata of Little Cornwallis Island contain two holochoanitic endoceratoids which are apparently conspecific and clearly belong in the genus *Endoceras*. Although both specimens are incomplete adorally and adapically, each retains a large portion of externally ornamented test. The ornamentation seems to be sufficient to set these specimens apart from the host of other forms previously referred to the genus; hence we are placing them in a distinct species, *Endoceras bellicinctum*.

The larger of the two specimens (G.S.C. No. 12210), which is illustrated by figure 2 on Plate II, represents 146 mm. of the phragmocone of a rather large individual. This specimen, which is almost completely testiferous, is circular in cross-section and its diameter increases from 48 mm. near its adapical end to 61 mm. at its adoral end. The siphuncle is large, ventral in position, and circular in cross-section; and it has a diameter of 26 mm. at the adoral end of the specimen, where it is 1 mm. from the venter. Much of the interior of this individual has been recrystallized and filled with bituminous material; however, a longitudinal dorso-ventral section indicates that the siphuncle is holochoanitic in structure and that its segments contract slightly within the camerae.

The shell is externally ornamented by numerous, closely spaced, adorally imbricating bands, which are transverse to the long axis of the conch. Although these bands are irregular in their development and spacing, they are about 2 mm. in width, and their adapical margins have a relief of nearly 1 mm. above the general surface of the conch.

The smaller of the two specimens (G.S.C. No. 12211), which is portrayed by figure 3 on Plate II, is similar to the one just described in all major respects. Its diameter measures 28 mm. near its adapical end and 48 mm. at its adoral end. It is longer than the larger specimen, for it represents nearly 167 mm. of the phragmocone. The test has weathered away adapically, and the sutures are thereby exposed. They are simple, straight, and directly transverse except on the venter where they form deep, rounded lobes immediately adjacent to the siphuncle. The spacing of the sutures near the adapical end of the specimen indicates that there are six camerae in a length equivalent to the corresponding diameter of the conch. At the adoral end of the specimen the siphuncle is circular in cross-section, ventral in position, and 21 mm. in diameter.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 41).

Types. Syntypes, G.S.C. Nos. 12210, 12211.

Endoceras proteiforme Hall

Plate I, figure 6; Figure 3

1847. *Endoceras proteiforme* Hall, *Pal. New York,* vol. 1, pp. 208, 311, Pl. 46, figs. 1a-2; Pl. 48, figs. 1, 4; Pl. 49, figs. 1a-1c; Pl. 55, fig. 1; Pl. 85, figs. 1a-1f.

1915. *Endoceras proteiforme* [part] Bassler, *U. S. Natl. Mus.*, Bull. 92, p. 483.

1924. *Endoceras proteiforme* Foerste, Denison Univ. Bull., *J. Sci. Labs.*, vol. 20, pp. 210-212, Pl. 21, figs. 1-3; Pl. 22, figs. 1-3; Pl. 23, figs. 1-3; Pl. 25, fig. 2.

1926. *Endoceras proteiforme* Troedsson, *Med. om Grønland,* Bd. 71, pp. 27-30, Pl. 1, fig. 1; Pl. 6, fig. 2; Pl. 7, figs. 1, 2; Pl. 8, fig. 4.

We have an internal mold from the eastern part of Little Cornwallis Island that is typical of *Endoceras* and that is referable to the type species of that genus. It is 182 mm. in length and represents portions of 20 camerae of a gradually expanded phragmocone. The conch is circular in cross-section, and the sutures are straight and directly transverse to the long axis. The diameter of the specimen increases from 44 mm. at its adapical end to 52 mm. near its adoral extremity, indicating an apical angle of about 3 degrees. The camerae increase in length orad, five occurring in a length equivalent to the maximum diameter of the conch in the adapical portion of the specimen, and six occurring in a comparable length in the adoral part of it. The septa have a concavity equivalent to about three-fourths the length of a camera.

The siphuncle is large, having a diameter of 21 mm. at the adapical end of the specimen, where it is 5 mm. from the venter. Figure 3 portrays

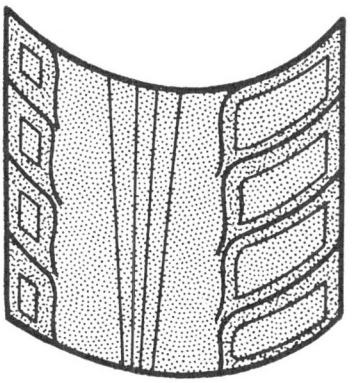

Figure 3. *Endoceras proteiforme* Hall

Diagrammatic longitudinal section through the siphuncle of the specimen represented by figure 6 on Plate I, x1.

a diagrammatic dorso-ventral section through the conch, and as shown by this drawing, the siphuncle is holochoanitic, its segments expanding slightly within the camerae. A well-developed endocone is recognizable near the adapical part. Like the internal mold, its surface is smooth, but it has dimensions that indicate an apical angle of about 9 degrees.

Discussion. Our specimen is not precisely comparable with the individual selected by Foerste (1924, pp. 210-212) as the type of *E. proteiforme* Hall, but it appears to be closer to it than to any of the numerous other forms referred to *Endoceras*. In the holotype, the camerae are slightly shorter, and the sutures form distinct ventral lobes due to the marginal position of the siphuncle. The siphuncle occupies a somewhat smaller proportion of the conch width. However, our specimen differs only slightly from the holotype in all these features, so we are placing it in Hall's species.

Occurrence. Cape Phillips formation, Marshall Peninsula, Cornwallis Island (loc. 46).

Type. Hypotype, G.S.C. No. 12212.

Genus ***Cyclendoceras*** Grabau and Shimer, 1910

Cyclendoceras intermedium n. sp.

Plate II, figure 1

The collections from the Cape Phillips formation of Cornwallis Island contain a well preserved but incomplete specimen of *Cyclendoceras*, and it appears to represent an unnamed species. The length of this individual is 130 mm., of which 62 mm. represents five camerae of the phragmocone; the remaining 68 mm. is an internal mold of a part of the siphuncle. The conch is circular in cross-section, and its diameter ranges from 80 mm. at the adapical extremity of the holotype to 88 mm. at its adoral end, indicating a very small apical angle. The sutures are simple, straight, and directly transverse to the long axis of the conch, except along the venter where they are deflected apicad to form rounded lobes with a depth of some 6 mm. The camerae are relatively long; the septa have a convexity equivalent to the length of about 1·5 camerae. The siphuncle is marginal and is 32 mm. in diameter at the adapical end of the specimen. The internal mold of the siphuncle indicates that it is holochoanitic and that its segments are slightly expanded medianly.

The surface of small parts of test that adhere to the internal mold of the phragmocone bears faint annulations that are directly transverse to the long axis of the conch. On the ventral part of the specimen the annulations are not parallel to the sutures.

Discussion. Forms belonging in *Cyclendoceras* exhibit a great deal of variation in the size, spacing, and relationships of the annulations, as well as in cameral length, apical angle, and configuration of the sutures. As a result, it is doubtful if much taxonomic importance should be attached to slight differences in these highly variable characteristics. The presence of a ventral lobe in the sutures of many orthoceraconic nautiloids appears to be a function of the size and proximity of the siphuncle to the ventral wall of the conch, and perhaps only of secondary significance in specific differentiation.

Our specimen differs from similar forms in that the transverse annulations, which characterize *Cyclendoceras*, are only weakly developed; hence, it seems to be intermediate between *Endoceras* and *Cyclendoceras*. It is probably closest to *C. costelliferum* Miller from the Lander sandstone of west-central Wyoming; but in that Wyoming form the annulations are not parallel to the sutures throughout most of their length, and the cross-section of the conch is elliptical (rather than circular).

Occurrence. Cape Phillips formation, Marshall Peninsula, Cornwallis Island (loc. 46).

Type. Holotype, G.S.C. No. 12213.

Genus ***Narthecoceras*** Hyatt, 1895

Narthecoceras ? sp.

Plate III, figure 2; Figure 4

We have a unique specimen of which the generic affinities are indeed uncertain. It is 175 mm. in length and exteriorly is faintly, though irregularly, annulated. Details of a partial longitudinal cross-section are illustrated by Figure 4. As shown by this drawing, the interior of the

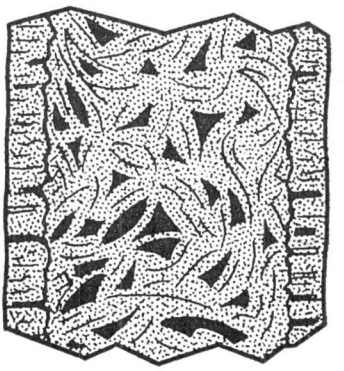

Figure 4. *Narthecoceras* ? sp.

Diagrammatic longitudinal section of the specimen represented by figure 2 on Plate III, x1.

specimen is filled with irregular, curving lamellae which seem to have no particular orientation. Such structures are not characteristic of *Narthecoceras*, nor are they actinoceratoid. This specimen may well be an incomplete spiculum, but we are so doubtful as to its relationships that we attach little significance to it. A discussion of it is being included largely for the sake of completeness.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 44).

Type. Hypotype, G.S.C. No. 12214.

Family ARMENOCERATIDAE Troedsson, 1926

Genus ***Armenoceras*** Foerste, 1924

Armenoceras donetti Foerste ?

Figure 5

1852. *Orthoceras Ommaneyi* Salter, *in* Sutherland, "Journal of a Voyage in Baffin's Bay and Barrow Straits", vol. 2, Appendix, pp. ccxxii-ccxxiii, Pl. 5, fig. 17 [*not* Pl. 5, fig. 16].
1888. *Endoceras ? Ommaneyi* [part] Foord, Cat. fossil *Cephalopoda*, British Museum, Part I, pp. 155-156.
1927. *Armenoceras donetti* Foerste *in* Foerste and Savage, Denison Univ. Bull., *J. Sci. Labs.*, vol. 22, Pl. 3, fig. 6.
1928. *Armenoceras donetti* Foerste, Denison Univ. Bull., *J. Sci. Labs.*, vol. 23, pp. 82-85, Pl. 24, figs. 3A, 3B.

We have a specimen from the Cape Phillips formation of Cornwallis Island that appears to be a typical but somewhat distorted representative of this species. Its internal structures do not seem to be preserved, and therefore its affinities are uncertain.

The specimen is about 27 mm. in length and represents eight camerae of a gradually expanded phragmocone. It is obliquely compressed and was presumably circular in cross-section prior to distortion. The camerae are relatively short, six occurring in a length equivalent to the maximum adapical diameter. A circular structure, 8 mm. in diameter and marginal in position, occurs at the adapical end of the specimen, and it may well represent the siphuncle.

Discussion. The specimen at hand is at least superficially similar to the holotype described by Foerste from the eastern portion of Cornwallis Island. The similarity is greater if the adapical circular structure is considered to represent the siphuncle.

Occurrence. Silurian part of Cape Phillips formation, Marshall Peninsula, Cornwallis Island (loc. 46).

Type. Hypotype, G.S.C. No. 12215.

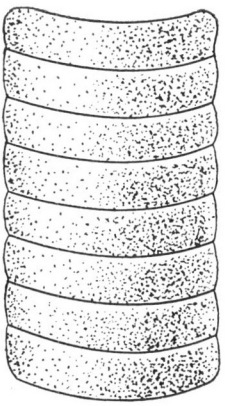

Figure 5. *Armenoceras donetti* Foerste ?
Ventral view, x2. Silurian part of Cape Phillips formation, Marshall Peninsula, Cornwallis Island (loc. 46). Hypotype, G.S.C. No. 12215.

Genus ***Nybyoceras*** Troedsson, 1926

Nybyoceras ventrolineatum n. sp.

Plate III, figure 3; Figure 6

A single large specimen of *Nybyoceras* was obtained from the Ordovician strata that outcrop in the eastern part of Little Cornwallis Island. It is a well-preserved internal mold, 145 mm. in length, which represents eight camerae of the phragmocone. It is circular in cross-section, and its diameter increases from 82 mm. at its adapical extremity to 101 mm. at its adoral end. The sutures are straight and directly transverse to the long axis of the conch. The camerae are each 16 mm. long, and the septa have a concavity equivalent to slightly more than the length of one camera. On the venter there is a well-defined longitudinal ridge that marks the position of a rounded groove on the inner surface of the original test. Flower (1939, pp. 10-13) refers to such a structure as a "conchial furrow", which he believes is probably "to be correlated with the entire area subtended by the pair of aponeurotic bands of *Nautilus*".

Details of the siphuncular and cameral structure of *Nybyoceras*

ventrolineatum are elucidated by Figure 6. As shown by this diagram, the siphuncle is large, ventral in position, and nummuloidal in form. In the four adapical camerae, the siphuncle is 9 mm. from the venter and has a diameter of 14 mm. at its passage through the septa. Within the camerae,

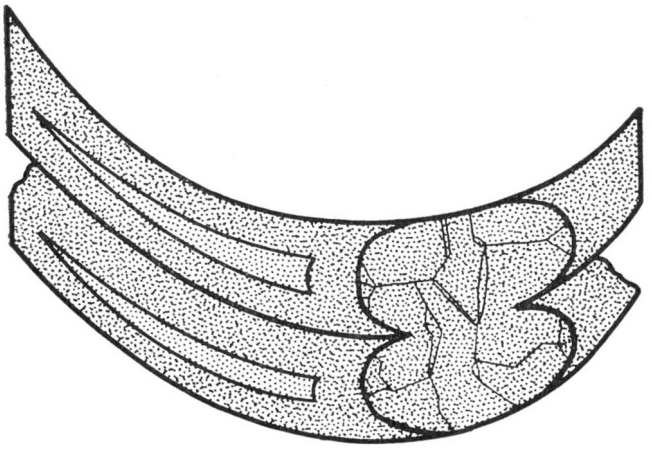

Figure 6. *Nybyoceras ventrolineatum* n. sp.
Diagrammatic longitudinal section through the siphuncle of the holotype (figure 3 on Plate III), x1.

the segments of the siphuncle expand to a diameter of 29 mm. As indicated by Troedsson (1926, p. 107), in typical *Nybyoceras* the septal necks are not distinguishable. In our specimen, the connecting rings are adnate ventrally to the adoral surface of the adapical septum of each camera, with the area of adnation being slightly more than 8 mm. in width. On the dorsal side of the siphuncle, however, the reverse is true; the connecting rings are adnate to the adapical surface of the adoral septum of each camera, with the area of adnation having a width of about 8 mm.

The width of the endosiphuncular canal is about a third the maximum attained by the siphuncle, and it gives rise to a system of irregularly branching radial canals near the mid-length of each camera. The perispatium is very narrow and appears to have been completely filled with calcareous deposits.

Discussion. *Nybyoceras ventrolineatum* compares most closely with the type species of the genus, *N. bekkeri* Troedsson from the Lyckholm beds at Nyby, Esthonia. Our specimen is much better preserved and exhibits many features that are not apparent in the individual on which the genus was founded. In transverse section, the septa of *N. bekkeri* are slightly

sigmoidal adjacent to the siphuncle, whereas the septa of *N. ventrolineatum* curve smoothly to the septal foramen. In other respects the two are closely similar.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 44).

Type. Holotype, G.S.C. No. 12216.

Family HURONIIDAE Foerste and Teichert, 1930

Genus ***Huroniella*** Foerste, 1924

Huroniella sp.

Figure 7

A single poorly preserved cephalopod was collected from the western part of Little Cornwallis Island which seems to be referable to *Huroniella* but which is so incomplete that we cannot determine its specific affinities. It is an internal mold of four camerae of a phragmocone, which appears to have been only gradually expanded and nearly circular in cross-section.

Figure 7 is a diagrammatic representation of a dorso-ventral section through the siphuncle. As shown by this illustration, the siphuncle is large, ventral in position, and greatly expanded within the camerae. No septal necks can be distinguished, and the profile of the adapical area of adnation in each camera is distinctly concave.

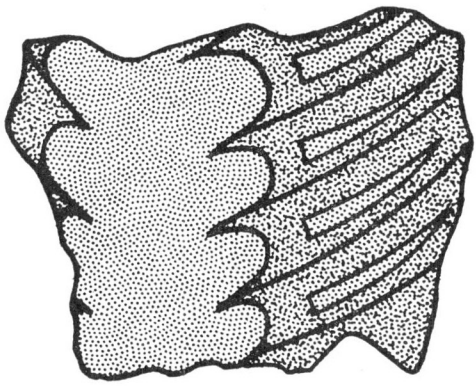

Figure 7. *Huroniella* sp.

Diagrammatic longitudinal section through the siphuncle, x1. Cape Phillips formation, southwestern part of Little Cornwallis Island (loc. 22). G.S.C. No. 12217.

Discussion. The siphuncular structure of the specimen at hand is intermediate between typical *Armenoceras* and *Huroniella*, but it is probably more like the latter, as forms characteristic of *Armenoceras* do not have adapically concave connecting rings like those of our specimen. That shape is characteristic of *Huroniella*, in typical representatives of which the concave area of adnation is almost longitudinal. It should perhaps be pointed out that *Huroniella* has heretofore been known only from rocks of Silurian age. Consequently, our specimen represents the oldest recorded occurrence of the genus.

Occurrence. Cape Phillips formation, southwestern part of Little Cornwallis Island (loc. 22).

Type. Hypotype, G.S.C. No. 12217.

Family ORMOCERATIDAE Saemann, 1853

Genus ***Deiroceras*** Hyatt, 1884

Deiroceras subfusiforme n. sp.

Plate I, figures 9, 10; Figure 8

Although the type species of *Deiroceras* is from the Selkirk limestone of Manitoba, the genus has not been identified heretofore from other strata in which the "Arctic" cephalopod fauna is known to occur. However, a well-preserved internal mold was collected from the Ordovician of Little Cornwallis Island which is clearly referable to it. This specimen, which represents 16 camerae of a phragmocone, is 116 mm. in length and is almost circular in cross-section. The venter is slightly flattened so that the height of the conch is 1 mm. less than the corresponding width. The diameter of the conch increases from 18 mm. at the adapical end to 28 mm. at the adoral extremity, which indicates an apical angle of about 5 degrees. The sutures are straight and directly transverse to the long axis of the conch except on the venter where they are deflected apicad to form broad shallow lobes. Near the adapical end of the specimen, there are four camerae in a length equivalent to the maximum diameter of the conch, whereas four and a half camerae occur in a corresponding distance at the adoral end.

As indicated in Figure 8, the siphuncle is located 4 mm. from the venter at the adoral end of the specimen. The septal necks are cyrtochoanitic and are about 1 mm. in length. The connecting rings, which are more convex ventrally than dorsally, thicken within the camerae and are adapically adnate to the septal necks for nearly a half millimetre. The

siphuncle is 3 mm. in diameter at the septal foramen and expands to a width of 4 mm. near cameral mid-length. Neither siphuncular nor cameral deposits are recognizable in our specimen.

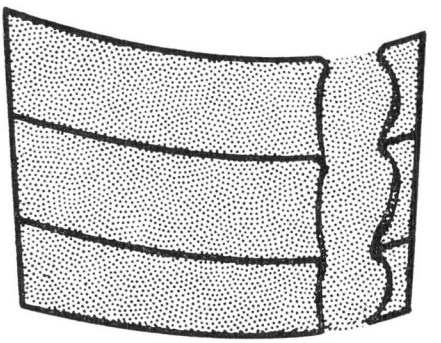

Figure 8. *Deiroceras subfusiforme* n. sp.

Diagrammatic longitudinal section through the siphuncle of the holotype (figures 9 and 10, Plate I), x2.

Discussion. The specimen studied has no close counterpart among the known species of *Deiroceras.* In the strong dorsal flattening of the siphuncular segments, it is perhaps closest to *D. curdsvillense* Foerste and Teichert from the Middle Ordovician Curdsville formation of Kentucky, the siphuncle of which shows a considerably greater ventral than dorsal convexity.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 44).

Type. Holotype, G.S.C. No. 12218.

Genus ***Ormoceras*** Stokes, 1838

Ormoceras cornwallisense n. sp.

Plate I, figure 8

Long, slender, orthoceraconic nautiloids with straight transverse sutures and central to subcentral siphuncles are abundant in the Ordovician strata of Cornwallis Island. Many of these cephalopods are exceedingly well preserved, and details of their siphuncular structure indicate that they should be placed in *Ormoceras.* All our specimens appear to represent a single species, for which we are proposing the name *Ormoceras cornwallisense.*

The most nearly complete individual in our collection, which we are

designating as the holotype, is illustrated by figure 8 on Plate I. This specimen, which is 91 mm. in length, represents 26 camerae of a phragmocone that is circular in cross-section and expands from an adapical diameter of 6 mm. to an adoral diameter of 17 mm. The sutures are simple, straight, and directly transverse to the long axis of the conch. The camerae increase in length adorally. Near the adoral end of the specimen, there are three camerae in a length equivalent to the adoral diameter of the conch, whereas at the adapical extremity of the specimen there are four camerae in a corresponding measurement.

The siphuncle is central to subcentral in position, and throughout the length of the specimen it maintains a diameter of 1 mm. at the septal foramina. Its segments expand slightly within the camerae to a maximum diameter of a little more than 1·5 mm. The septal necks are short and cyrtochoanitic.

The collections also contain internal molds of three body chambers that belong in *Ormoceras cornwallisense*. All of these have a prominent constriction just apicad of the apertural margin, a feature which we interpret to be diagnostic of maturity. Such a constriction in the internal mold represents an adapertural thickening of the test, presumably to strengthen the delicate edge of the shell. One specimen has a rather long body chamber, and the constriction occurs near the mid-length of it. Presumably, in this individual, additional growth took place subsequent to a period of apertural strengthening.

The remainder of the specimens agree closely with the holotype in measurements, cameral ratio, and siphuncular structure. The diameter of the conch in the larger specimens suggests that many of them were a foot or more in length.

Occurrence. Cape Phillips formation, Marshall Peninsula, Cornwallis Island (loc. 46).

Type. Holotype, G.S.C. No. 12219.

Family MICHELINOCERATIDAE Flower, 1945

Genus ***Michelinoceras*** Foerste, 1932

Michelinoceras ? sp.

Plate I, figure 7

A number of long orthoceraconic nautiloids were collected from Silurian strata that outcrop in the northeastern coastal region of Cornwallis Island.

All of these specimens are similar in that they represent parts of closely septate moderately expanded phragmocones. Unfortunately, most of them have been recrystallized, and we have no very exact knowledge of their internal structures.

The individual which is portrayed by figure 7 on Plate I is better preserved than the others. It is 108 mm. in length, circular in cross-section, and represents 48 camerae of the phragmocone. The sutures are simple, straight, and directly transverse to the long axis of the conch. Weathering has apparently etched the cameral fillings, so that the sutural areas stand out as faint ribs or ridges. The interior of the specimen has been recrystallized, but a cylindrical central area, which is filled with solid bitumen, presumably represents the original location of the siphuncle. This structure is about 1 mm. in diameter at the adapical extremity of the figured individual.

Occurrence. Silurian part of Cape Phillips formation, northeast coast of Cornwallis Island (loc. 19).

Type. Hypotype, G.S.C. No. 12220.

Genus ***Kionoceras*** Hyatt, 1884

Kionoceras sp.

Plate II, figures 4, 5

In the collections from the east coast of Cornwallis Island, there are a number of longitudinally ridged longicones that clearly belong in the genus *Kionoceras*. As all of these specimens are incomplete and none retain a trace of the internal structures, we cannot identify them specifically. For the sake of completeness, two of them are illustrated by figures 4 and 5 on Plate II.

Both of the figured specimens are partly testiferous, rather rapidly expanding internal molds which are preserved in such a fashion that no septa are discernible. The surfaces of both the test fragments and the internal molds are marked by a series of fine longitudinal ridges, which are considerably narrower than the concave interspaces. In addition, on both specimens there are a number of widely spaced faint transverse ridges. The latter are less prominent than the longitudinal ribs. No trace of the internal structures remains in either individual.

Occurrence. Silurian part of Cape Phillips formation, northeastern coastal region of Cornwallis Island (loc. 19).

Types. Hypotypes, G.S.C. Nos. 12221, 12222.

Genus ***Spyroceras*** Hyatt, 1884

Annulated orthoceracones are evidently not rare in the Ordovician strata of the Cornwallis Islands, and there are a large number of them in the collections studied. In all of these specimens the internal structures have been destroyed by recrystallization so that we are uncertain as to the generic affinities of most of them. The genus *Spyroceras*, to which nautiloids of this type have long been referred, has been so subdivided (Shimizu and Obata, 1935, pp. 3-6; Flower, 1939, pp. 109-111) that, on the basis of surficial characters alone, it is impossible to determine in which of several genera a specimen should be placed. We are tentatively assigning all but one of the annulated longicones to *Spyroceras s. l.*, even though they probably do not belong in that genus as it is strictly interpreted. A precedent for this practice was established by Flower (1946, pp. 131-139) who found it desirable to use *Spyroceras s. l.* for similar Ordovician forms of which "the internal structure of the species is still unknown".

Spyroceras ? nodosum n. sp.

Plate I, figure 5

The single specimen on which we are basing this species is a partly testiferous internal mold 72 mm. in length, and it represents eleven camerae of a gradually expanded phragmocone. It is circular in cross-section and has adapical and adoral diameters of 18 mm. and 22 mm., respectively. The surface of the internal mold and of the test is marked by sharply rounded annulations which, like the sutures, are simple, straight, and directly transverse to the long axis of the conch. The camerae are uniformly 6½ mm. in length on the preserved part of the phragmocone. The annulations are also evenly spaced, one occurring near the adapical end of each camera.

The exterior of the test is marked by groups of prominent longitudinal ridges separated from adjacent groups by a conspicuous rib or ridge which forms sharp pointed nodes where it crosses an annulation. Each of the groups consists of seven ridges and maintains a rather constant width of

5 mm. The groups of longitudinal ridges are not reflected on the surface of the internal mold, but the position of the nodes is clearly marked there.

Discussion. The longitudinal rows of nodes, which form such a distinctive feature on both the shell and the internal mold of our specimen, distinguish it externally from all other spyroceratoids with which we are familiar.

Occurrence. Cape Phillips formation, Marshall Peninsula, Cornwallis Island (loc. 46).

Type. Holotype, G.S.C. No. 12223.

Spyroceras ? spp.

Plate I, figures 1, 2; Plate VI, figure 7

The collection includes four annulated orthoceracones from the Ordovician strata of the Cornwallis Islands. Three of them are illustrated here although we cannot identify any of the four with certainty because of their poor preservation. The largest of these specimens (G.S.C. No. 12224), portrayed by figure 2 on Plate I, is a weathered internal mold, representing 11 camerae of a phragmocone. It is 85 mm. in length and presumably circular in cross-section. The annulations are uniformly spaced 7 mm. apart, and they occur near the mid-length of the camerae. Both the annulations and the sutures are simple, straight, and directly transverse to the long axis of the conch. The surface of the internal mold is further ornamented by a number of closely spaced longitudinal ridges which appear to be of equal size and spacing. The specimen retains no trace of the siphuncle.

The spyroceratoid (G.S.C. No. 12225) illustrated by figure 1 on Plate I is an internal mold 30 mm. in length and circular in cross-section. It represents 10 nearly complete camerae of a very small phragmocone. The sutures and annulations are equidistant in their spacing; both are simple, straight, and directly transverse, the annulations occurring at the adapical end of the camerae. The siphuncle is central in position and slightly less than 1 mm. in diameter. No trace of its structure could be ascertained, however, from a longitudinal section.

The remaining two specimens are both from the same locality and are nearly identical in that they are approximately the same size and shape. We are illustrating only the better of the two (G.S.C. No. 12226), figure 7 on Plate VI. These specimens are each 47 mm. in length, and represent

part of the phragmocone and the adjacent part of the body chamber. Only the mid-portions are annulated, the upper and lower thirds being nearly smooth. The central position of the siphuncle is indicated at the adapical end of both specimens, but longitudinal sectioning failed to expose any of the internal structures.

Occurrence. Cornwallis formation, southeastern interior of Cornwallis Island; and Cape Phillips formation, Marshall Peninsula, Cornwallis Island (locs. 48, 46).

Types. Hypotypes, G.S.C. Nos. 12224-12227.

Family STEREOPLASMOCERATIDAE Kobayashi, 1934 ?

Genus ***Gorbyoceras*** Shimizu and Obata, 1936

Gorbyoceras maro (Billings) ?

Plate I, figure 3

(?) 1859. *Orthoceras maro* Billings, *Canadian Natur. and Geol.*, vol. 4, p. 461.
(?) 1938. *Spyroceras maro* Foerste, *Geol. Soc., America*, Spec. Paper 11, pp. 93-95, Pl. 18, fig. 4; Pl. 20, figs. 1, 10.

One of the spyroceratoids in our collection is at least superficially similar to the Mingan Islands specimen described by Foerste as *Spyroceras maro*. The diagrammatic cross-sections published with Foerste's description of this specimen indicate that the septal necks of the small subcentral siphuncle are cyrtochoanitic, and hence that the species is referable to *Gorbyoceras* of Shimizu and Obata. However, our specimen reveals nothing of the structure of the siphuncle so we cannot positively identify it with the Mingan Islands form.

The individual studied is a nearly complete, testiferous internal mold 94 mm. long. About 76 mm. of its length represents nearly 21 camerae of the phragmocone, the remaining 18 mm. consisting of the adapical part of the body chamber. The conch is slightly curved throughout its length, and its surface is marked by prominent transverse annulations that parallel the septa and occur near the mid-length of the camerae. In addition to the annulations, the external surface of the test is reticulate, as it bears a series of fine transverse and longitudinal lirae, which, unlike the annulations, are also well developed on the surface of the body chamber.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 41).

Type. Hypotype, G.S.C. No. 12228.

Family HEBETOCERATIDAE Flower, 1941

Genus ***Probillingsites*** Foerste, 1928

Probillingsites sutherlandi n. sp.

Plate IV, figures 5, 6

The dark grey bituminous limestone on the Marshall Peninsula of Cornwallis Island has yielded a typical representative of *Probillingsites*, which we are describing as a distinct species, *P. sutherlandi*. The specimen is subovoid and has a maximum overall length of about 45 mm., of which 30 mm. represents body chamber, the remainder representing the adoral four camerae of the phragmocone. The conch attains its maximum height and width near the proximal end of the body chamber, measurements at that place being 31 mm. and 33 mm., respectively. The venter is regularly convex throughout its length, as are the lateral zones. The dorsum is convex adapically, becoming concave on the body chamber. Although the apertural margin is not preserved, the configuration of the adoral extremity of the conch indicates that the aperture slopes dorsad, and the convexity of the venter and lateral zones indicates that it is somewhat smaller in diameter than the maximum measurements of the conch.

The sutures are simple, crossing the venter transversely and curving orad on the lateral zones so as to be farther apart and closer to the aperture on the dorsum. The septum of truncation is asymmetrically subhemispherical, its area of maximum curvature occurring ventrad of the centre of the conch. The siphuncle is ventral and marginal in position, and its location is marked on the ventral margin of the adapical septum by a shallow rounded groove that has a width of about 1 mm.

Remarks. This specimen is typical of *Probillingsites*, and among described representatives of the genus it probably stands closest to *P. lebanonensis* Flower from the Arnheim formation of Kentucky. However, *P. sutherlandi* is regularly convex throughout its length, whereas the body chamber of *P. lebanonensis* is "tubular" in its adoral half. The sutures of our specimen depart more from parallelism than do those of Flower's species. It is perhaps significant that in general *P. sutherlandi* is more like the Upper Ordovician species of the genus than those known from the Middle Ordovician, in which the sutures are nearly parallel. The specific name is in honour of Dr. P. C. Sutherland, whose journal of Captain Penny's 1850 Arctic voyage contains the first geological accounts of Cornwallis Island.

Occurrence. Cape Phillips formation, Marshall Peninsula, Cornwallis Island (loc. 46).

Type. Holotype, G.S.C. No. 12229.

Family Ascoceratidae Barrande, 1855

Genus ***Billingsites*** Hyatt, 1883

Billingsites borealis (Parks)

Plate IV, figures 3, 4

1913. *Ascoceras boreale* Parks, *Ont. Bur. Mines*, Ann. Rept., vol. 22, pt. 1, p. 192.
1915. *Ascoceras boreale* Parks, *Roy. Can. Inst., Trans.*, vol. 11, p. 32, Pl. 2, figs. 8, 9.
1927. *Billingsites boreale* Foerste and Savage, Denison Univ. Bull., *J. Sci. Labs.*, vol. 22, pp. 30-31, Pl. 3, figs. 2-4D.

Faunal collections from the eastern part of Little Cornwallis Island contain a weathered internal mold of an ascoceratid conch which is indistinguishable from the Shamattawa limestone species described by Parks as *Ascoceras boreale* and later redescribed as *Billingsites boreale* by Foerste and Savage. The specimen, which is incomplete dorsally and orally, represents only the adoral, obese, ovoid expansion of the conch, and it consists of a part of the body chamber and the adoral four camerae of the phragmocone. The subovoid conch, which is dorso-ventrally depressed, is 108 mm. in length, and 74 mm. orad of its adapical extremity, it has a maximum width of 65 mm. The known part of the conch is narrowly rounded apicad and somewhat contracted orad.

The septum of truncation is sharply convex apicad, subovate in outline, asymmetrically subhemispherical in shape, and strongly oblique to the long axis of the conch. It slopes orad from the venter at an angle of approximately 35 degrees. The next four sutures are essentially parallel and almost indistinguishable from one another along the ventral and ventrolateral sides of the conch; but along the dorsolateral sides they curve abruptly ventrad and orad and continue in that direction to the middle of the lateral zones of the conch. At this point the adapical suture gradually ceases to swing ventrad and then curves rather abruptly dorsad and apicad, presumably crossing the dorsolateral and dorsal sides as a nearly straight line transverse to the long axis of the conch. The succeeding three sutures follow a similar pattern on the lateral, dorsolateral, and dorsal zones, but are separated from one another by a distance of 11 mm. in the adoral part of the lateral zones and on the dorsum.

The position of the siphuncle is indicated by a subcircular structure about 5 mm. in diameter on the ventral margin of the septum of truncation. Our specimen was not sectioned, but the structure of its siphuncle is presumably similar to that of the type species, *B. canadensis*, a representative of which has been described in detail by Miller (1932, p. 26).

Remarks. The specimen at hand is closely similar to the one described by Parks from the Shamattawa limestone, and it is comparable to but somewhat larger than the two additional individuals collected by Savage

from the same locality. The septum of truncation in our specimen is more strongly inclined than that of the holotype, and the lateral curvature of the sutures is slightly more abrupt than that of comparable structures in the Shamattawa specimens. It seems probable that our specimen was slightly distorted during preservation and that these differences are more apparent than real. Our specimen is also close to the type species, *B. canadensis* (Billings) of the English Head and Vauréal formations of Anticosti Island. It differs in that it is more depressed, its adoral sutures are more abruptly curved, and the suture of its septum of truncation is not parallel to the adjacent suture. The Little Cornwallis Island specimen is of additional interest in that it has affixed to one of its lateral zones the pygydial part of a trilobite identified as *Pseudogygites latimarginatus*, a species characteristic of the upper Utica of southern Ontario and New York.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 41).

Type. Hypotype, G.S.C. No. 12230.

Billingsites deformis (Eichwald)?

Plate IV, figures 1, 2

(?) 1857, 1860. *Ascoceras deforme* Eichwald, *Lethaea Rossica*, vol. 1, sec. 2, p. 1192, Pl. 49, fig. 18. [Illustration published in 1857, description in 1860.]

(?) 1929. *Billingsites deformis* Foerste, Denison Univ. Bull., *J. Sci. Labs.*, vol. 24, p. 51.

(?) 1929. *Billingsites deforme* Foerste, Denison Univ. Bull., *J. Sci. Labs.*, vol. 24, pp. 142, 157, Pl. 20, fig. 4.

(?) 1934. *Billingsites deformis* Strand, *Norsk geol. tidsskr.*, bd. 14, h. 1, pp. 54-55, 105, 107, Pl. 4, fig. 7.

The collections include a single specimen, preserved in black bituminous limestone, that resembles an individual described long ago by Eichwald from the Lyckholm formation of Dagö Island, Esthonia. The specimen, however, is so incomplete that we can not be certain that it is conspecific with the Esthonian holotype or with the similar individual from the Gastropod limestone (5a) of Norway that Strand referred to this species in 1934.

The specimen under consideration consists of the internal mold of a depressed body chamber 64 mm. long and elliptical in cross-section. Near its mid-length, it attains its maximum width and height, about 46 mm. and 34 mm., respectively. The shape of the known part of the conch is subovoid, being rather narrowly rounded apicad and slightly contracted orad.

An impression of the adoral suture is retained at the adapical end of the body chamber. This suture crosses the venter as a broad shallow lobe and curves orad across the lateral zones to the dorsolateral margins of the

conch, where it sweeps broadly ventrad and orad to near the mid-length of the conch. At this place, it is again deflected dorsad in a broad curve, and it crosses the dorsum as a nearly straight line, directly transverse to the long axis of the conch.

The position of the siphuncle is indicated by a circular, ring-like ridge near the ventral margin of the adoral septum. Presumably this ridge represents a septal neck.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 44).

Type. Hypotype, G.S.C. No. 12231.

Billingsites cf. *B. bellicinctus* Miller

Plate IV, figure 7

(?) 1932. *Billingsites bellicinctus* Miller, *Conn. Acad. Arts Sci., Trans.*, vol. 31, pp. 242-243, Pl. 10, figs. 3-5.

The collections include one fragmentary internal mold from Little Cornwallis Island that compares favourably with the holotype of *Billingsites bellicinctus* from the Lander sandstone of west-central Wyoming. Our specimen, however, is incomplete adapically and dorsally so that detailed comparisons are not possible.

The Little Cornwallis Island specimen is 45 mm. in length, and represents the major part of the adoral obese expansion of the conch. The specimen was almost certainly subovoid in shape and strongly elliptical in cross-section. Near its mid-length, it has an estimated maximum width and height of 38 mm. and 24 mm., respectively, indicating that it was strongly depressed dorso-ventrally. The lateral zones converge regularly towards the aperture, and the adoral few millimetres of the body chamber project as a short tubular extension. The aperture slopes dorsad, and no trace of a hyponomic sinus could be found on the preserved part of it.

One of the lateral zones is crossed by three sutures, which are about 6 mm. apart on the dorsolateral margin of the conch. From the dorsolateral margin, these three sutures curve gradually ventrad, but near the ventrolateral margin they coalesce and swing abruptly apicad and dorsad to the dorsolateral margin as a single suture. Presumably they again reverse direction and continue as one suture across the venter. Neither the septum of truncation nor any trace of the siphuncle is present.

Discussion. The specimen studied is more strongly depressed than is the holotype of *B. bellicinctus*, and the adoral slope of the sutures on the adoral part of the lateral zones is more distinct in our specimen than it is in

the one from the Lander sandstone. Much of this difference may be due to distortion during fossilization.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 44).

Type. Hypotype, G.S.C. No. 12232.

Family ONCOCERATIDAE Hyatt, 1884

Genus ***Oncoceras*** Hall, 1847

Oncoceras sp.

Plate I, figure 4

The collections from Little Cornwallis Island contain a poorly preserved and fragmentary specimen that seems to be referable to *Oncoceras* but cannot be placed with assurance in any known species of that genus. It is 54 mm. in length and represents the complete body chamber and eight camerae of the phragmocone. The conch is slightly compressed, the venter being more narrowly rounded than the dorsum. The maximum width and height of the conch occur near the proximal end of the body chamber, the measurements at that place being approximately 30 mm. and 26 mm., respectively. The preserved part of the venter is regularly convex throughout its length. The dorsum is concave on the adapical part of the phragmocone but becomes slightly convex on the adoral part and the adjacent part of the body chamber. Near the apertural margin, the dorsum is again concave.

The sutures are straight and directly transverse to the curving axis of the conch. The camerae are longer on the venter than on the dorsum. The sutures form very broad shallow lateral lobes and sharply crested ventral and presumably dorsal saddles.

The apertural margin is nearly complete. It slopes dorsad and on the venter shows a slight apicad deflection, which represents a hyponomic sinus. A row of elongate quadrangular depressions occurs at the adapical extremity of the body chamber, and the surface of that part of the conch is marked by a series of very faint lirae.

Discussion. Among described representatives of *Oncoceras*, the specimen studied most closely resembles *O. arlandi* Flower from the Liepers formation of Kentucky. The latter, however, is not as strongly curved, and its dorsal gibbous region is more prominent.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 44).

Type. Hypotype, G.S.C. No. 12233.

Genus ***Beloitoceras*** Foerste, 1924

Beloitoceras spp.

Plate VI, figures 4, 5

In the collections studied, there are two fragmentary specimens that are not conspecific but both of which are referable to *Beloitoceras*. One of these (G.S.C. No. 12234), which is illustrated by figure 4 on Plate VI, is a greatly distorted internal mold 60 mm. in length. It represents 19 camerae of the phragmocone and a part of the body chamber. That part of the conch preserved suggests that before distortion it expanded rather uniformly towards the aperture, and there is no indication of a gibbous region on either the phragmocone or the body chamber. The surface of the phragmocone is marked by a number of longitudinal lirae, which are spaced about 3 mm. apart and are normal to the sutures. As the specimen has been greatly compressed dorso-ventrally, it is not possible for us to ascertain the original shape of the cross-section or comment upon the configuration of the sutures.

The other specimen (G.S.C. No. 12235), which is illustrated by figure 5 on Plate VI, consists of an almost completely testiferous internal mold 55 mm. in length. It represents 38 mm. of the phragmocone and the adjacent part of the body chamber. It is laterally compressed, and near the adapical end of the body chamber it has a maximum height and width of 30 mm. and 26 mm., respectively. The venter is uniformly convex throughout its length; the dorsum is concave in its adapical part, becoming straight to slightly convex on the aboral part of the body chamber. The sutures are simple, forming slight lateral lobes and more narrowly rounded dorsal and ventral saddles. The test is slightly more than 1 mm. thick, and its surface is marked by numerous closely spaced growth lines, which indicate the successive positions of the hyponomic sinus.

Discussion. The development of a slight dorsal gibbosity on the body chamber of the second specimen described indicates that it is most probably representative of a group of species more characteristic of Richmond than Trenton strata. Flower (1946, p. 276) points out that these faintly gibbous representatives of *Beloitoceras* appear to be confined to the Upper Ordovician and might serve as useful stratigraphic indices in rocks of that age.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 44).

Types. Hypotypes, G.S.C. Nos. 12234, 12235.

Genus ***Richardsonoceras*** Foerste, 1933

Richardsonoceras bellatulum n. sp.

Plate VI, figure 6

A well-preserved unique specimen in the collections studied seems to represent an undescribed species of *Richardsonoceras*. It is a small cyrtoconic internal mold 69 mm. in length, and it represents 24 camerae of the phragmocone and a nearly complete body chamber 23 mm. long. The specimen is laterally compressed, and at the adapical end of the body chamber it has a height and width of 14 mm. and 11 mm., respectively. In transverse section, the conch is ovate in outline, the venter being acutely rounded. The sutures form shallow lateral lobes and subangular ventral and narrowly rounded dorsal saddles. The conch is rather strongly curved and not greatly expanded adorally. The body chamber is "tubular" and contracts orad slightly. The siphuncle is ventral in position, circular in transverse section, and elliptical in outline on the inclined septal face.

Discussion. The specimen at hand is a typical representative of *Richardsonoceras* and among described species of the genus it is probably closest to *R. simplex* (Billings) from the Middle Ordovician (Black River) of eastern Ontario. The Ontario forms are more rapidly expanded, however, and the camerae are slightly longer than are those of *R. bellatulum*. In addition, the latter is more compressed laterally than the described specimens of *R. simplex* (Billings).

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 44).

Type. Holotype, G.S.C. No. 12236.

Family Brevicoceratidae Flower, 1941

Genus ***Digenuoceras*** Foerste, 1935

Digenuoceras latum (Foerste)

Plate VII, figure 3; Plate VIII, figure 1

1929. *Oxygonioceras ? latum* Foerste, Denison Univ. Bull., *J. Sci. Labs.*, vol. 24, pp. 218-219, Pl. 18, figs. 1, 2.
1935. *Digenuoceras latum* Foerste, Denison Univ. Bull., *J. Sci. Labs.*, vol. 30, p. 43.
1935. *Digenuoceras* cf. *D. latum* Foerste, Denison Univ. Bull., *J. Sci. Labs.*, vol. 30, pp. 44-45, Pl. 19, fig. 5.
(?) 1947. *Oxygonioceras* ? sp. Miller and Youngquist, *J. Paleont.*, vol. 21, p. 418, Pl. 56, fig. 5.

Only two cephalopods have been collected from the Ordovician strata that outcrop in the western part of Little Cornwallis Island. One of these is clearly referable to *Digenuoceras;* furthermore, it is closely similar to the

type species of that genus, *D. latum*, from the Red River formation of southern Manitoba.

This specimen is a nearly complete internal mold of a rapidly expanding cyrtocone 243 mm. in length. About 81 mm. of this represents body chamber; the remainder represents ten adoral camerae and the adapical part of the phragmocone in which the sutures are not exposed. The regularly curved conch is strongly compressed laterally and narrowly elliptical in cross-section, and it has angular dorsal and ventral margins. At the proximal end of the body chamber, it has dorso-ventral and lateral measurements of 103 mm. and 35 mm., respectively. The venter is uniformly convex and has a radius of curvature of about 100 mm.; the dorsum is concave and has a radius of curvature of about 41 mm.

The sutures are simple, forming shallow lateral lobes and subangular saddles on the ventral and dorsal margins. The camerae are longer on the ventral side of the conch than on the dorsal. Ten camerae occupy a length of 35 mm. on the dorsum, and a length of 104 mm. on the venter.

The surface of the phragmocone bears a series of very faint longitudinal lirae, which are normal to the sutures and parallel to the dorsal and ventral margins of the conch. These raised lines are approximately 2 mm. apart near the adoral end of the phragmocone, and are more prominent on the dorsolateral zones than on any other part of the mold. The condition of the specimen precludes sectioning it, but presumably, like other species of the genus, it has a small ventral siphuncle.

Discussion. Representatives of *Digenuoceras* and the closely related *Oxygonioceras* are not common fossils. The specimen studied is more nearly complete than is the holotype of *D. latum* (Foerste), and it appears to be more expanded. Both specimens have acutely angular dorsal and ventral margins and similar radii of curvature, so there is little question but that they are conspecific.

Occurrence. Cape Phillips formation, western part of Little Cornwallis Island (loc. 22).

Type. Hypotype, G.S.C. No. 12237.

Family DIESTOCERATIDAE Teichert, 1939

Genus ***Diestoceras*** Foerste, 1924

Diestoceras arcticum n. sp.

Plate III, figure 1

The single specimen for which this species is being established is a partly testiferous internal mold 115 mm. in length. It represents a nearly

complete body chamber, 63 mm. long, and seven camerae of the phragmocone. An additional eight camerae are indicated by impressions in the matrix at the adapical end of the specimen. The breviconic conch is dorso-ventrally depressed, straight, and lachrymiform in cross-section; the body chamber contracts orad to the aperture, which has incurved margins and is more narrowly rounded ventrally than dorsally. The maximum dorso-ventral and lateral measurements of the conch are attained near the junction of the phragmocone and the body chamber, and they are 59 mm. and 67 mm., respectively.

The sutures are simple, forming broad lateral lobes and dorsal and ventral saddles; those on the venter are more narrowly rounded than those on the dorsum. The camerae are relatively long, about six occurring in a distance equivalent to the maximum dorso-ventral measurement of the conch.

The surface of the internal mold is marked by a series of prominent longitudinal ridges which extend orad from a row of quadrangular depressions at the adapical extremity of the body chamber and which are spaced uniformly $3\frac{1}{2}$ mm. apart. Similar though less conspicuous ridges also appear on the surface of the test, fragments of which adhere to the body chamber.

The siphuncle is circular in cross-section and is located 11 mm. from the venter at the adoral end of the phragmocone. At this place, it has a diameter of 6 mm.

Discussion. *D. arcticum* is perhaps most closely comparable to *D. cooperi* Foerste from the Ordovician of Gaspé Peninsula. Both have relatively long body chambers which are subtriangular in cross-section, and both are markedly gibbous at the adoral end of the phragmocone. *D. cooperi* is smaller than our specimen and it is not as inflated. Furthermore, its body chamber is not as noticeably contracted orad as is that of the form described here.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 44).

Type. Holotype, G.S.C. No. 12238.

Diestoceras brevidomum Foerste

Plate II, figure 6

1936. *Diestoceras brevidomum* Foerste, *J. Paleont.*, vol. 10, p. 383, Pl. 54, figs. 3-5.

We are referring to this species an internal mold which, like the holotype, represents only the body chamber of a large individual. It is

41 mm. in length, ovate in cross-section, and has a maximum height and width of 80 mm. and 72 mm., respectively. The known part of the conch contracts orad regularly, having dorso-ventral and lateral measurements of 56 mm. and 47 mm. at the aperture. The aperture has incurved margins and is more narrowly rounded ventrally than dorsally. At the adapical end of the body chamber, there is a transverse serrate groove which presumably indicates the position of a similarly serrate ridge on the inner surface of the test. Recrystallized parts of the test, which remain affixed to the internal mold, indicate that it had a thickness of nearly 4 mm. close to the aperture and at least 2 mm. on the adapical part of the body chamber.

Discussion. As noted by Foerste (1936, p. 383) the body chambers of *D. brevidomum* of the Whitehead formation of Gaspé and *D. arenicolum* Foerste of the Ellis Bay formation of Anticosti Island are similar in that they are relatively short, and both have comparable dorsal and ventral profiles. The apertural outline of *D. brevidomum* is subtriangular, however, whereas that of the Anticosti form is elliptical to subovate.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 41).

Type. Hypotype, G.S.C. No. 12239.

Family WESTONOCERATIDAE Foerste and Teichert, 1930

Genus ***Westonoceras*** Foerste, 1924

Westonoceras greggi Roy?

Plate VI, figure 8

(?) 1941. *Westonoceras greggi* Roy, *Field Mus. Natur. Hist., Geol.*, Mem., vol. 2, pp. 109, 141-143, 180, 189, 195, text-fig. 104.

(?) 1954. *Westonoceras greggi* Miller, Youngquist, and Collinson, *Geol. Soc. Amer.*, Mem. 62, pp. 91-92, Pl. 42, fig. 2.

A single representative of *Westonoceras* was secured from the Ordovician strata of the Cornwallis Islands. It is an internal mold of the adapical part of a fairly large phragmocone whose general appearance is reminiscent of *W. greggi* Roy from the Ordovician strata at Silliman's Fossil Mount on Baffin Island. The specimen is incomplete adorally, so that we cannot be sure of its specific affinities.

The specimen studied is 151 mm. in length, and it represents 24 or 25 camerae of a partly testiferous phragmocone, which is very slightly curved lengthwise. It is faintly ovate in cross-section, the venter being more narrowly rounded than the dorsum. Near the adoral end, the specimen

has dorso-ventral and lateral measurements of 49 mm. and 47 mm., respectively.

The surface of the internal mold of the phragmocone bears coarse longitudinal markings that are narrower than the flat interspaces. These markings are especially conspicuous near the mid-length of the conch, but they are also well developed adapically. The test is marked by a number of closely spaced transverse growth lines that indicate successive stages of a hyponomic sinus by a rather strong adapical deflection on the venter.

The sutures are simple and directly transverse to the long axis of the conch at the adapical end of the specimen; they slope orad from the dorsum on the adoral third of the phragmocone. Because of the narrowly rounded venter, the sutures form very slight ventral saddles.

Discussion. The preservation of the specimen under consideration makes detailed specific comparisons difficult. It is quite similar to the adapical part of the specimen secured by Roy from Baffin Island, which, however, is more nearly complete. Both are large, almost straight longitudinally, and only slightly compressed laterally. The adoral septum of the specimen studied indicates that the adoral part of the phragmocone was broadly inflated dorso-ventrally, as is true of the Baffin Island individual.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 41).

Type. Hypotype, G.S.C. No. 12240.

Family CYRTOGOMPHOCERATIDAE Flower, 1940

Genus ***Cyrtogomphoceras*** Foerste, 1924

Cyrtogomphoceras baffinense Foerste

Plate V, figures 7, 8; Figure 9

1928. *Cyrtogomphoceras baffinense* Foerste, Michigan Univ., *Mus. Paleont.*, Contr., vol. 3, pp. 34, 63-64, Pl. 4, fig. 1; Pl. 11, fig. 4.

(?) 1928. *Cyrtogomphoceras* cf. *C. baffinense* Foerste, Michigan Univ., *Mus. Paleont.*, Contr., vol. 3, p. 65, Pl. 4, fig. 2.

(?) 1941. *Cyrtogomphoceras baffinense* Roy, *Field Mus. Natur. Hist., Geol.*, Mem., vol. 2, pp. 147-148, 180, text-fig. 107.

1954. *Cyrtogomphoceras baffinense* Miller, Youngquist, and Collinson, *Geol. Soc. Amer.*, Mem. 62, pp. 105-106, Pl. 43, fig. 6; Pl. 53, figs. 1-3.

Two weathered specimens of *Cyrtogomphoceras* were collected from the Cornwallis formation in the southwestern part of Cornwallis Island. Both are well preserved in fine-grained olive limestone, and they are apparently conspecific. They compare most favourably with the type specimens of *C. baffinense* Foerste, and we are assigning them to that species without question.

The larger of our two specimens (G.S.C. No. 12241), represented by figures 7 and 8 on Plate V, is 104 mm. in length; it consists of the internal mold of a body chamber, 34 mm. in length, and 12 camerae of the phragmocone. The endogastrically curved conch is short and obese, being contracted both orad and apicad. It is elliptical in outline, and 48 mm. orad of the adapical extremity it has a maximum height and width of 62 mm. and 49 mm., respectively. The dorsal and lateral profiles of this specimen are uniformly convex; the ventral profile is nearly straight, becoming slightly concave on the adapical part of the phragmocone.

The aperture slopes ventrad, is ovate in outline, and has dorso-ventral and lateral measurements of 37 mm. and 30 mm., respectively. No trace of a hyponomic sinus is present.

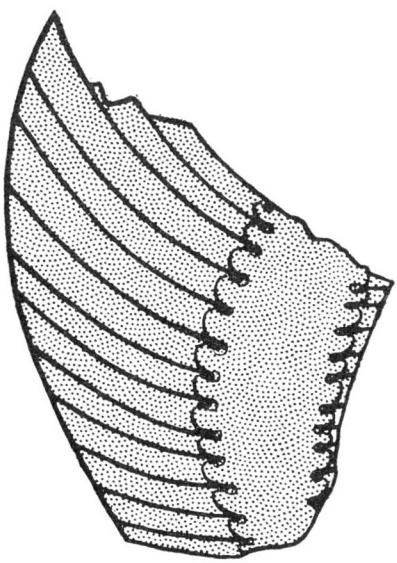

Figure 9. *Cyrtogomphoceras baffinense* Foerste

Diagrammatic longitudinal section through the siphuncle of an incomplete specimen from the Cornwallis formation in the southwestern part of Cornwallis Island (loc. 34), x1. G.S.C. No. 12242.

The 12 camerae of the phragmocone gradually increase in length orad, and the adoral camera is considerably shorter than the one immediately preceding it, indicating that this specimen represents a fully mature individual. Adapically, the sutures are straight and directly transverse to the long axis of the conch. Adorally they become progressively more curved, so that in the adoral part of the phragmocone they are strongly inclined orad from the venter. The siphuncle is large, ventral in position, and about 6 mm. in diameter where it passes through the adapical septum.

The smaller of our specimens (G.S.C. No. 12242) is not as nearly complete as the one just described, but clearly it is conspecific. It is 69 mm. in length and represents the adapical 13 camerae of a phragmocone.

Details of a longitudinal dorso-ventral section cut through this specimen are elucidated by Text-figure 9. As shown in this drawing, the siphuncle is relatively wide in comparison with the width of the conch, and it consists of greatly expanded nummuloidal segments. The septal necks are relatively long and are strongly cyrtochoanitic. Siphuncular deposits appear to consist of annuli alone, developed as constrictions in the septal foramina.

Discussion. The specimens studied compare closely with the holotype of *C. baffinense* from Baffin Island. Our specimens have their maximum height and width more apicad than does the holotype. Furthermore, the ventral profile of the Cornwallis Island forms is straight to slightly concave adapically, whereas the ventral profile of the holotype is faintly convex near the junction of the body chamber and the phragmocone.

Occurrence. Cornwallis formation, southwestern part of Cornwallis Island (loc. 34).

Types. Hypotypes, G.S.C. Nos. 12241, 12242.

Genus ***Parryoceras*** n. gen.

Type species: *Parryoceras euchari* n. sp.

In the collections from the Marshall Peninsula of Cornwallis Island, there are two endogastric cyrtocones which are apparently conspecific but which we believe differ sufficiently from comparable forms to be regarded as generically distinct. We are proposing the name *Parryoceras* for these specimens in honour of Sir William Edward Parry, the discoverer of Cornwallis Island.

Parryoceras may be diagnosed as consisting of slender, laterally compressed, endogastric cyrtocones that are almost straight and are ovate in cross-section, the venter being more sharply convex than the dorsum. The camerae are short, and the sutures form shallow lateral lobes and narrowly rounded dorsal and ventral saddles. The dorsal margin of the conch is broadly convex, becoming more strongly curved adorally. The ventral margin is nearly straight adapically but faintly convex on the adoral part of the phragmocone and body chamber. The apertural margin is inclined ventrad and has a shallow ventral sinus, the development of which is reflected by a slight median adapical deflection of growth lines. The inner part of the mature shell is markedly thickened just apicad of the aperture so that there is a pronounced transverse constriction of the internal mold near the oral end of the body chamber. Both the phrag-

mocone and the body chamber bear relatively coarse longitudinal ridges which are continuous with a transverse row of quadrangular depressions at the adapical end of the body chamber.

The siphuncle is ventral in position and about a fifth as wide as the conch. In structure its segments are very much like those of *Strandoceras* Flower. That is, the septal necks are relatively long and are so strongly cyrtochoanitic as to be almost recumbent. The free parts of the connecting rings are nearly straight and are thickened adorally. Adapically the rings are thinner, and they are adnate to the inner parts of the septal necks throughout most of the length of those structures. No cameral or siphuncular deposits have been identified in the type specimens.

Discussion. *Parryoceras* clearly belongs with the Cyrtogomphoceratidae, and, of the genera previously assigned to this group, it is most closely related to *Strandoceras* Flower. In details of siphuncular structure, these two genera are closely comparable. However, the siphuncular segments of *Strandoceras* are broadly expanded and occupy a greater proportion of the shell width than is the case in *Parryoceras*, in which the siphuncular segments are but slightly expanded and are only about a fifth as wide as the conch. *Strandoceras* is rather strongly curved both dorsally and ventrally, whereas *Parryoceras* has a broad dorsal convexity but is straight to slightly convex ventrally. These differences are perhaps largely conditioned by the habit of growth of the shell. However, it seems to us that in combination, they are sufficiently significant to distinguish *Parryoceras* from *Strandoceras*, but small enough to indicate that the two genera are very close.

Parryoceras euchari n. sp.

Plate V, figures 1-6; Figure 10

Of the two specimens upon which this species is based, the one represented by figures 1-4 on Plate V (G.S.C. No. 12243), seems to be the best, and it is designated the holotype. Its maximum overall length measures 68 mm., of which 34 mm. represents an internal mold of a complete body chamber, and the remaining 34 mm. consist of six camerae of a partly testiferous phragmocone.

The known part of the conch is endogastrically curved. The dorsal profile is regularly convex, and the ventral profile is straight to slightly convex on the phragmocone and adapical part of the body chamber, becoming concave near the aperture. The conch is laterally compressed and elliptical in outline; the venter is acutely rounded. The conch attains dorso-ventral and lateral dimensions of 29 mm. and 22 mm., respectively, at the junction of the phragmocone and the body chamber. The aperture slopes apicad towards the venter, and a slight spout-like process on its ventral margin marks the position of the hyponomic sinus. A transverse

constriction occurs 11 mm. apicad of the aperture, indicating the location of a ridge-like adoral thickening of the mature test. The surface of the body chamber bears a series of longitudinal ridges which are continuous with a transverse row of quadrangular depressions at the adapical end of the body chamber.

The sutures are simple, forming broadly rounded lateral lobes and more narrowly rounded dorsal and ventral saddles. The camerae of the holotype are of equal length, 5 occurring in a length equivalent to the maximum dorso-ventral dimension of the conch. The septa are subhemispherical in shape, having a concavity equivalent to slightly less than the length of one camera.

Details of the test, fragments of which cover the dorsal and lateral parts of the phragmocone, are shown in figure 4 on Plate V. It is 2 mm. thick and is marked by a series of fine, closely spaced, transverse lirae which presumably represent growth lines. Four longitudinal colour bands are preserved on the surface of the holotype, one at mid-width of each of the lateral zones and one on each of the dorsolateral zones. These bands are reddish brown in colour and uniformly 2 mm. in width.

As is shown in Figure 10, the siphuncle is ventral in position, and about a fifth as wide as the conch. The septal necks are relatively long and are so strongly cyrtochoanitic as to be almost recumbent. The free parts of the connecting rings are nearly straight and are thickened adorally. Adapically these rings are thinner, and they are adnate to the inner parts of the septal necks throughout most of the length of these structures.

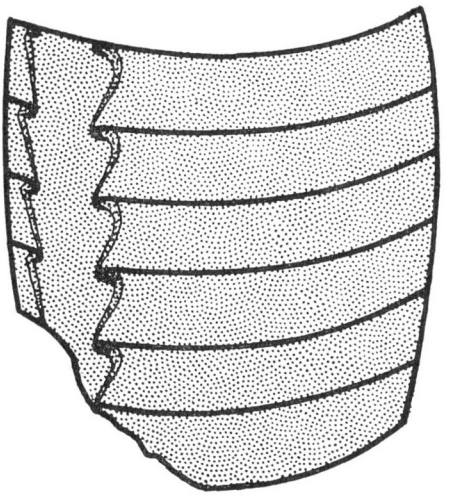

Figure 10. *Parryoceras euchari* n. gen., n. sp.

Diagrammatic longitudinal section through the siphuncle of the holotype (figures 1-4 on Plate V), x2.

A second specimen, which is being referred to this species, is illustrated by figures 5 and 6 on Plate V. It is 84 mm. in length, and represents the partly testiferous internal mold of a nearly complete body chamber, 29 mm. long, and 15 camerae of the phragmocone. Like the holotype, it is endogastrically curved, laterally compressed, and elliptical in transverse section. Although adapically it is more nearly complete than the holotype, it shows none of the internal structures so well exhibited by that specimen. In this individual, both the body chamber and the phragmocone are marked by a series of coarse longitudinal ridges, and a corresponding series of longitudinal lirae are developed on fragments of the test that adhere to the adoral part of the body chamber.

Occurrence. Cape Phillips formation, Marshall Peninsula of Cornwallis Island (loc. 46).

Types. Holotype, G.S.C. No. 12243; paratype, G.S.C. No. 12244.

Family BARRANDEOCERATIDAE Foerste, 1925

Genus ***Gasconsoceras*** Foerste, 1936

Gasconsoceras sp.

Plate VIII, figure 2

A thin slab of dark grey bituminous limestone from the Silurian Read Bay formation bears a distorted cast of *Gasconsoceras* on one of its sides. This specimen consists of the adapical whorl of a loosely coiled conch which expands rather rapidly and has a number of prominent transverse ribs on its outer surface. Although most of the specimen almost certainly represents the phragmocone, it is preserved in such a manner that none of the septa is discernible. However, the configuration of the transverse ribs indicates the development of a deep sinus on the venter. There is a series of very fine, closely spaced growth lines, which are parallel to the ribs and are also deflected apicad on the venter.

Discussion. The Cornwallis Island specimen studied has been considerably distorted during preservation, but the prominent ribs, the mode of coiling, and the deep ventral sinus indicate that it is closely similar to forms discussed by Foerste (1936) from the Middle Silurian of Gaspé Peninsula. It differs from a specimen described by Teichert and Glenister (1953) from the Middle Silurian of Tasmania, in that the adapical part of its conch is ornamented, whereas the early part of the austral form is smooth.

Occurrence. Read Bay formation of Cornwallis Island (loc. 40).

Type. Hypotype, G.S.C. No. 12245.

Family APSIDOCERATIDAE Hyatt, 1884

Genus ***Apsidoceras*** Hyatt, 1884

Apsidoceras elegans Troedsson?

Figures 11, 12D

(?) 1926. *Apsidoceras elegans* Troedsson, *Med. om Grønland*, Bd. 71, pp. 38-39, Pl. 13, figs. 2, 3; Pl. 14, figs. 2, 3; Pl. 15, fig. 1; Pl. 16, fig. 1.

The collections from Little Cornwallis Island contain a large specimen that clearly belongs in *Apsidoceras* but which is so incomplete that its specific affinities cannot be determined with certainty. Its transverse section compares very closely with that of *A. elegans* Troedsson from the Cape Calhoun beds of northern Greenland, so we are placing it in that species with question.

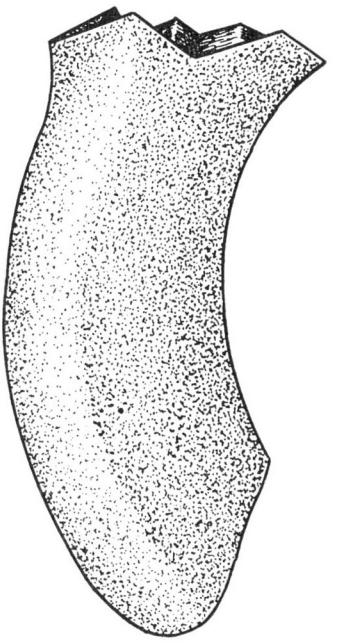

Figure 11. *Apsidoceras elegans* Troedsson?

Lateral view of the internal mold of a large body chamber, x½. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 41)—*see also* Figure 12D. G.S.C. No. 12246.

The specimen studied is 170 mm. in length, and represents an internal mold of the adoral part of a body chamber which is subtriangular in outline. The venter is broadly convex, the lateral margins are acutely rounded, and the dorsum is more narrowly rounded than the venter. There is no

indication of an impressed zone on the dorsum. The ventral and dorsal sides of the known part of the conch are regularly curved throughout their length. The lateral profiles are almost straight, flaring slightly orad.

Discussion. The specimen under consideration has a transverse outline indeed reminiscent of the type of *A. elegans* Troedsson. It differs from the latter in that the degree of curvature of its venter is slightly greater, and it is more depressed than Troedsson's specimen. Our form is also similar to *A. magnificum* (Billings) from the Ordovician of Anticosti Island from which it differs in that its lateral margins are not as abruptly curved, nor is its venter as noticeably flattened.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 41).

Type. Hypotype, G.S.C. No. 12246.

Genus ***Charactocerina*** Foerste, 1935

Charactocerina borealis n. sp.

Plate VII, figures 1, 2; Figure 12C

(?) 1926. *Charactoceras* sp. ind. II Troedsson, *Med. om Grønland*, Bd. 71, p. 41, Pl. 17, figs. 1, 2.

The specimen for which this species is being established is 140 mm. in length, and consists of a little less than half a volution of a phragmocone that is dorsally impressed, is subtrapezoidal in cross-section and, bears transverse ribs in its dorsolateral zones. The conch expands orad from dorso-ventral and lateral dimensions of 37 mm. and 64 mm. adapically to corresponding measurements of 46 mm. and 76 mm. adorally. The venter is broadly convex both laterally and longitudinally, the lateral zones are flat, and the dorsolateral and ventrolateral margins are acutely rounded. The dorsal impressed zone is concave and concentric with (although slightly less than half the width of) the venter.

Eleven camerae of the phragmocone are preserved. They are 13 mm. in length ventrally and 8 mm. long dorsally. The sutures form broad dorsal, ventral, and lateral lobes, separated by angular dorsolateral and ventrolateral saddles. The siphuncle is circular in cross-section and subcentral in position, and it is 4 mm. in diameter at the adapical extremity of the specimen.

The lateral zones and the ventrolateral margins bear coarse annulations that are parallel to the sutures and alternate with them in position, one annulation occurring near the mid-length of each camera.

Discussion. *C. borealis* is not particularly close to any of the forms that have previously been referred to the genus. It differs from these species primarily in the strongly subtrapezoidal transverse outline of the conch, a shape which is more nearly comparable to that of *Apsidoceras.* The volutions of the latter genus, however, are not in contact, hence the presence of an impressed zone on the dorsum of our specimen indicates that it belongs in *Charactocerina.* The relationship between this form and the poorly preserved Cape Calhoun individual that Troedsson described in 1926 is very uncertain.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 41).

Type. Holotype, G.S.C. No. 12247.

Charactocerina eximia n. sp.

Plate VI, figures 1, 2; Plate VIII, figure 3;

Figure 12A

In the collections from Little Cornwallis Island there are two well-preserved specimens of *Charactocerina* which are clearly conspecific but are not particularly close to any known species of the genus. The specimen illustrated by figure 3 on Plate VIII (G.S.C. No. 12248) is nearly complete, so we are designating it the holotype. It is a partly testiferous internal mold with an overall dimension of 75 mm. (measured across the volutions), and it represents three full whorls of the phragmocone and the adapical 85 mm. of the body chamber. The conch is subreniform in transverse outline. It expands fairly rapidly from dorso-ventral and lateral dimensions of 5 mm. and 7 mm. at the apical end to corresponding diameters of 20 mm. and 46 mm. at the junction of the body chamber and phragmocone. The venter and lateral zones are broadly convex transversely; the intervening ventrolateral margin is sharply rounded. The dorsal impressed zone is concave and is about a third as wide as the venter.

The sutures form broad shallow lobes on the dorsal, ventral, and lateral zones. The ventral and lateral lobes are separated by sharply rounded saddles on the ventrolateral margins, and there are low broadly rounded saddles on the dorsolateral zones. The camerae are shallow; they increase in length orad and are slightly longer ventrally than dorsally. The siphuncle is subventral in position and circular in cross-section.

The ventrolateral parts of the conch are marked by a series of annulations that are more prominent adapically than adorally and that form an acute angle with the sutures. The shell is further ornamented by a series

of reticulating longitudinal and transverse lirae, the latter of which form ventral sinuses, indicating a shallow hyponomic sinus on that side.

An incomplete specimen (G.S.C. No. 12249) which we are also referring to this species is portrayed by figures 1 and 2 on Plate VI and by Figure 12A. It is 85 mm. in overall length, consists of eleven camerae of the phragmocone, and represents a little less than half a complete volution. Although it is larger than the corresponding portion of the holotype, it is closely similar in dimensional ratios and in general appearance.

Discussion. *C. eximia* is similar to the Bighorn forms *C. washakiensis* (Miller), *C. costatula* (Miller), *C. kirki* Foerste, and *C. multicamerata* Foerste. Our specimens differ from all of these in that their lateral zones are less strongly convex, their camerae are longer, and their marginal annulations are less numerous and meet the sutures at a lower angle. The sutures of all these forms have broad ventral lobes, as do those of our specimens; however, they do not develop prominent ventrolateral saddles as is the case in the Cornwallis Island individuals.

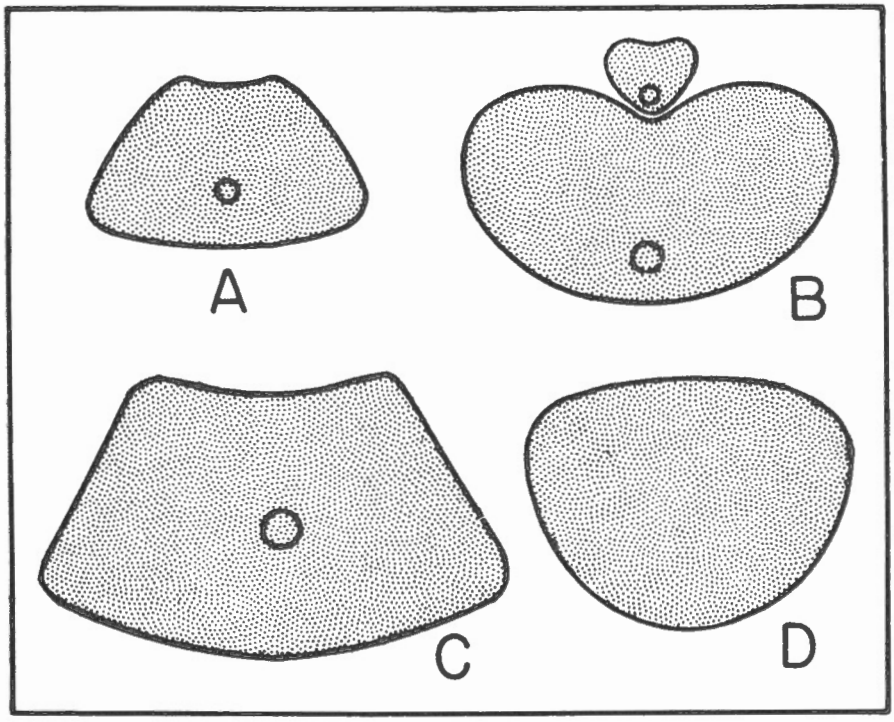

Figure 12. *Charactocerina* and *Apsidoceras*

Diagrammatic transverse sections of (A) the paratype of *Charactocerina eximia*, n. sp., x1; (B) the holotype of *Charactocerina thorsteinssoni*, n. sp., x1; (C) the holotype of *Charactocerina boreale* n. sp., x1; (D) *Apsidoceras elegans* Troedsson?—*see also* Figure 11.

Occurrence. Cape Phillips formation, Marshall Peninsula, Cornwallis Island (loc. 46).

Types. Holotype, G.S.C. No. 12248; paratype, G.S.C. No. 12249.

Charactocerina thorsteinssoni n. sp.

Plate VI, figure 3; Figure 12B

The collections contain a well-preserved specimen and a fragmentary internal mold of a second individual that seem to represent an undescribed species of *Charactocerina*. We propose to name it in honour of R. Thorsteinsson of the Geological Survey of Canada, in recognition of his geological investigations on the Cornwallis Islands.

We are designating as the holotype a partly testiferous internal mold of a nearly complete individual, which represents three full volutions of the phragmocone and a complete body chamber 83 mm. long. This specimen is portrayed by figure 3 on Plate VI (G.S.C. No. 12250). The phragmocone consists of at least 40 camerae, which are considerably longer ventrally than dorsally. In transverse outline the conch is subcordate adapically, becoming reniform in its adoral portion. In the first two volutions, the venter is subangular, the lateral zones broadly convex, and the dorsolateral margins narrowly rounded. In the peripheral volution the venter loses its angularity and becomes broadly rounded.

The sutures form dorsal and lateral lobes and ventral saddles, which are subangular on the first two volutions and broadly rounded on the peripheral whorl. The ventrolateral margins of the conch bear prominent rounded annulations that intersect the sutures obliquely and cross one and a half to two camerae.

Small fragments of the recrystallized test, nearly 4 mm. in thickness, adhere to the adoral part of the body chamber. The surface of these fragments is marked by prominent marginal annulations, and by a series of growth lines whose configuration indicates the presence of a shallow hyponomic sinus on the venter.

The second specimen (G.S.C. No. 12251) was secured from the Cornwallis formation on Cornwallis Island. It is a weathered fragment of an internal mold and is closely comparable to the holotype in that it is reniform in transverse cross-section and has sutures that form broad ventral saddles. Like the holotype, on its ventral margins there is a series of rounded annulations that intersect the sutures obliquely.

Discussion. *C. thorsteinssoni* differs from other congeneric forms in several respects. The ventral angularity of the early volutions and the

resulting development of ventral saddles (rather than lobes) are features that are sufficient to distinguish our specimens from any others with which we are familiar.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 41, holotype); and Cornwallis formation, southwestern part of Cornwallis Island (loc. 34, paratype).

Types. Holotype, G.S.C. No. 12250; paratype, G.S.C. No. 12251.

Apsidoceratidae, gen. and sp. indet.

Plate VIII, figure 4

From the dark grey bituminous limestone that outcrops in the eastern part of Little Cornwallis Island, a testiferous internal mold of an apsidoceratid was collected, which we are illustrating but which we cannot identify generically. It is 240 mm. in length (measured along the venter) and represents the body chamber of a curved rapidly expanding conch. A reconstruction of the transverse cross-section suggests that it is broadly rounded ventrally, slightly concave laterally, and sharply convex dorsally. The ventrolateral margins are narrowly rounded. The configuration of the adapical extremity of the body chamber indicates that the sutures were nearly transverse ventrally, forming shallow lobes on the lateral zones and narrowly rounded saddles on the dorsum.

The adoral part of the internal mold retains a large fragment of the recrystallized test, which is nearly 10 mm. in thickness and which bears on its surface a series of broadly rounded annulations and a finer series of closely spaced growth lines. The annulations are nearly transverse laterally, curving apicad on the ventrolateral margins to form deep lobes on the venter. The growth lines are parallel to the annulations, and they indicate the presence of a deep hyponomic sinus on the venter. Dorsally, both the annulations and growth lines swing orad, forming salients that are more broadly rounded than the dorsal saddles of the sutures.

Discussion. The curvature and rapid expansion of the conch and its cross-section indicate that the specimen should be referred to the Apsidoceratidae. It shows no indication of an impressed zone on the part of the dorsum preserved, so it may well be referable to *Apsidoceras* rather than to *Charactoceras* or *Charactocerina*.

Occurrence. Cape Phillips formation, eastern part of Little Cornwallis Island (loc. 44).

Type. Hypotype, G.S.C. No. 12252.

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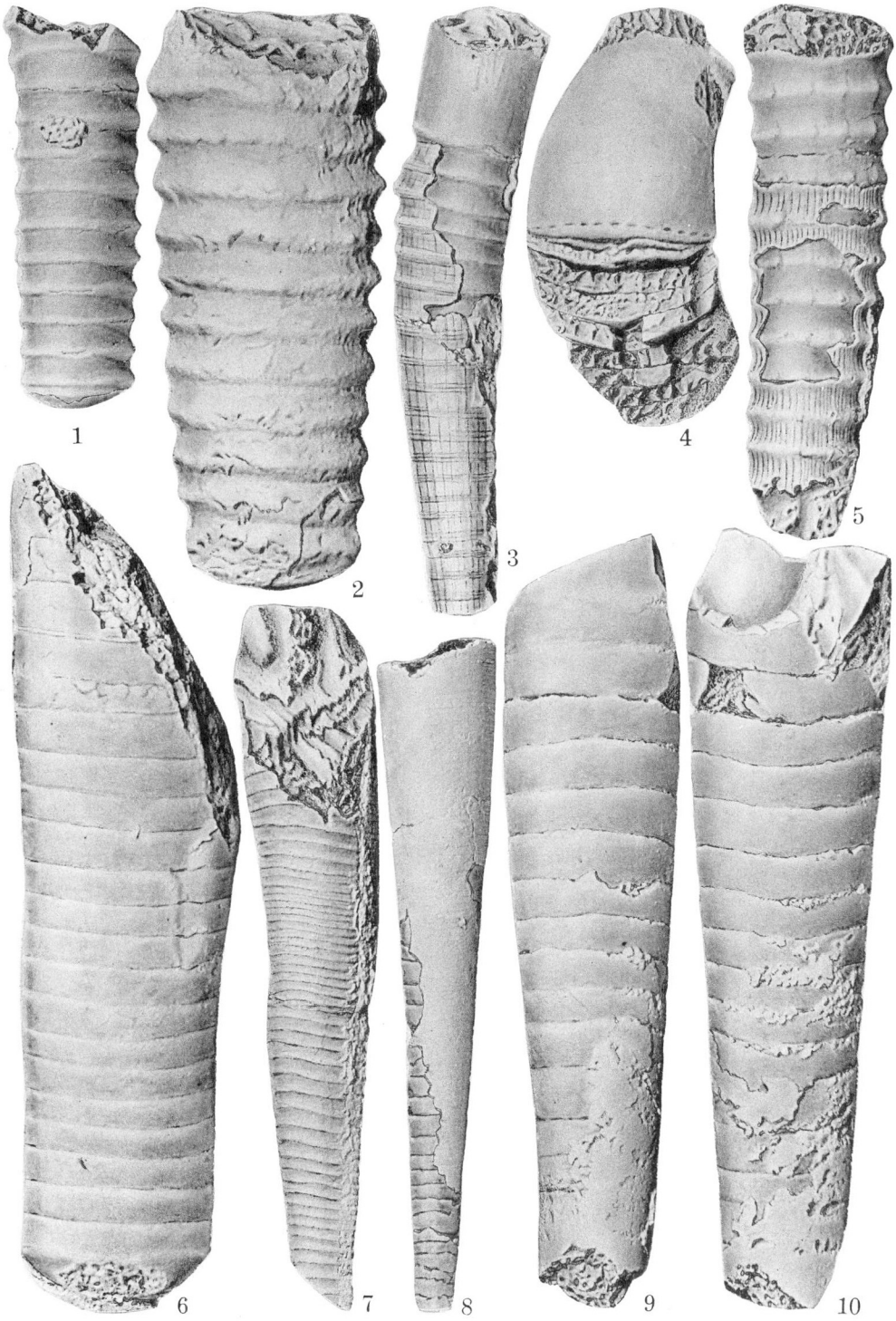

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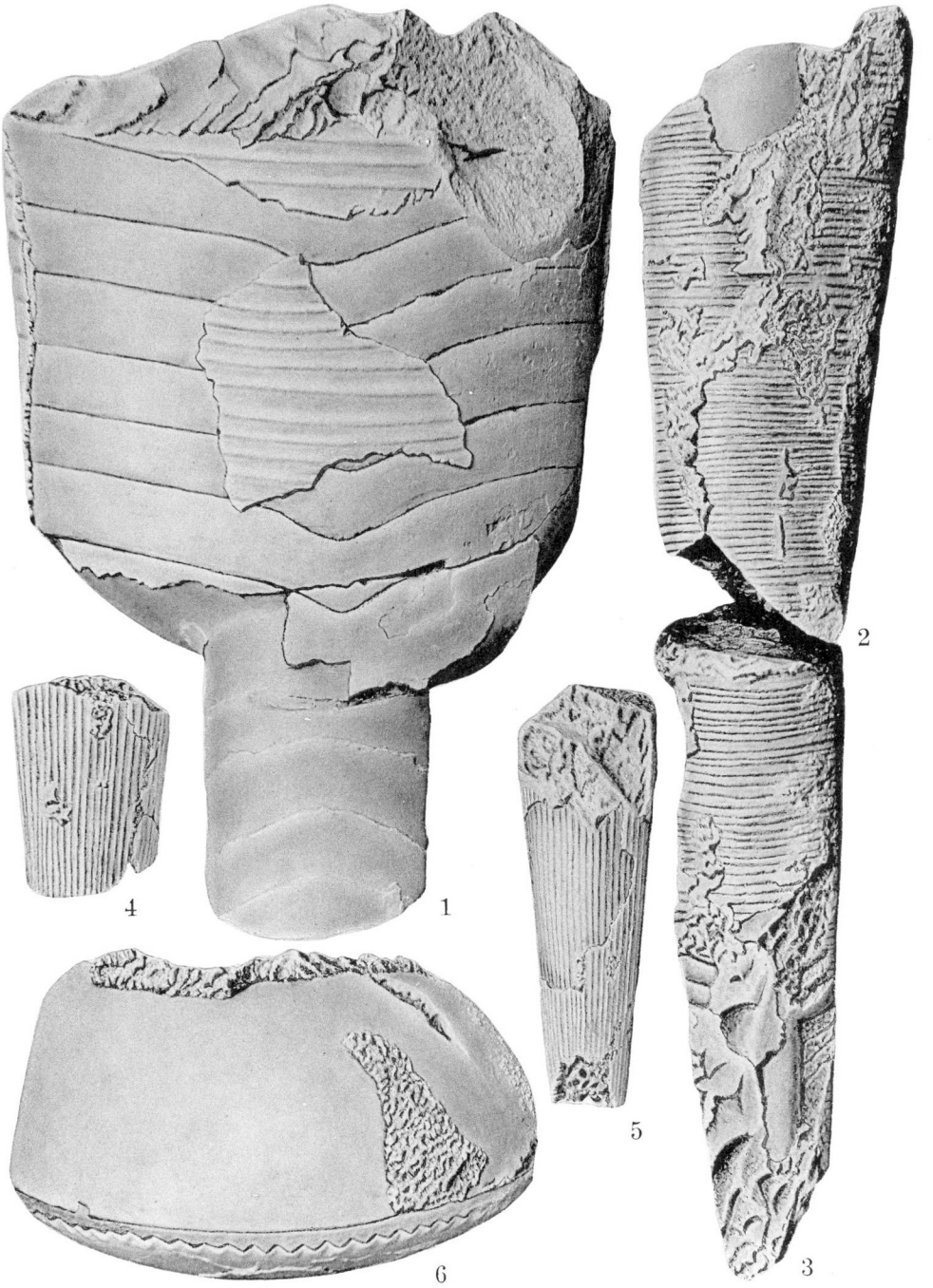

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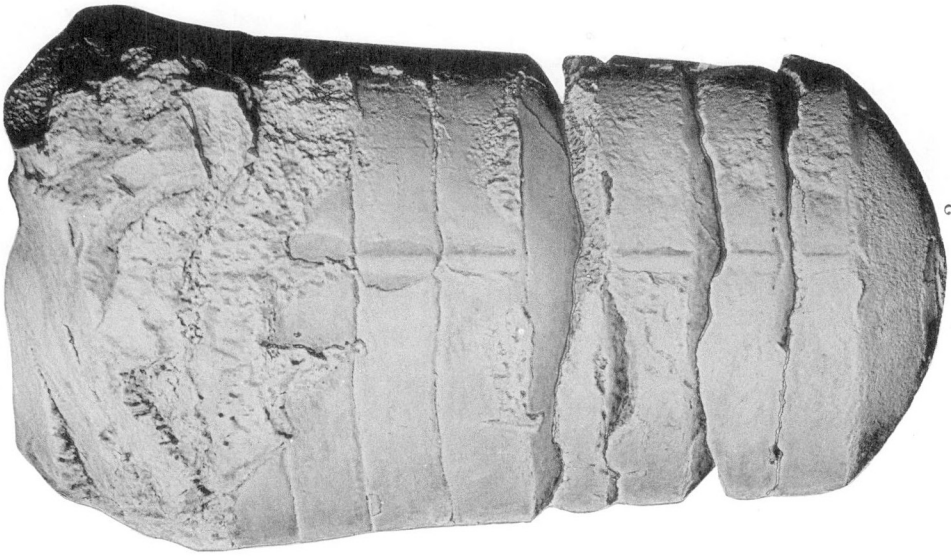

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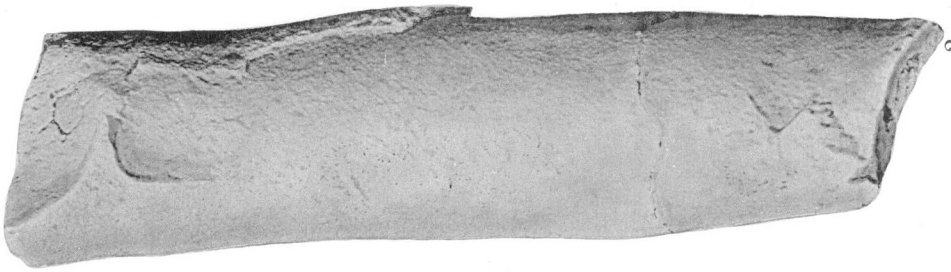

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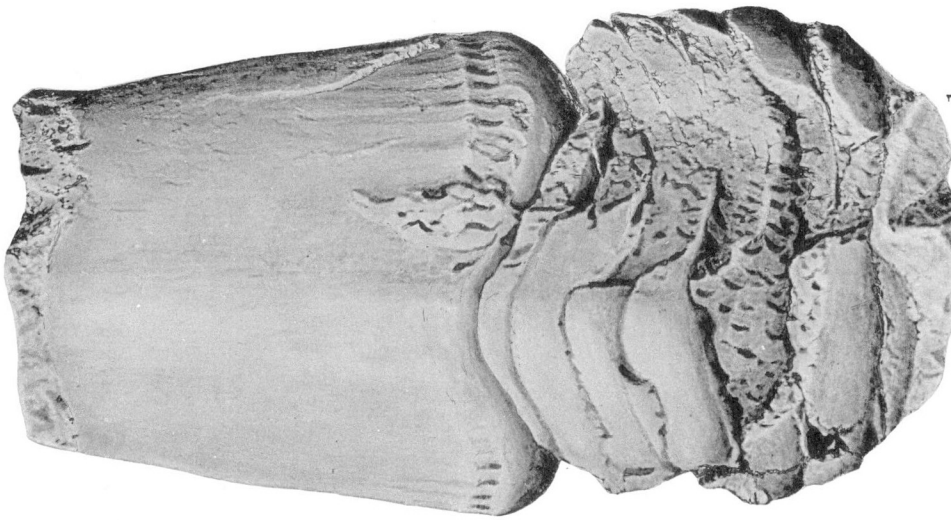

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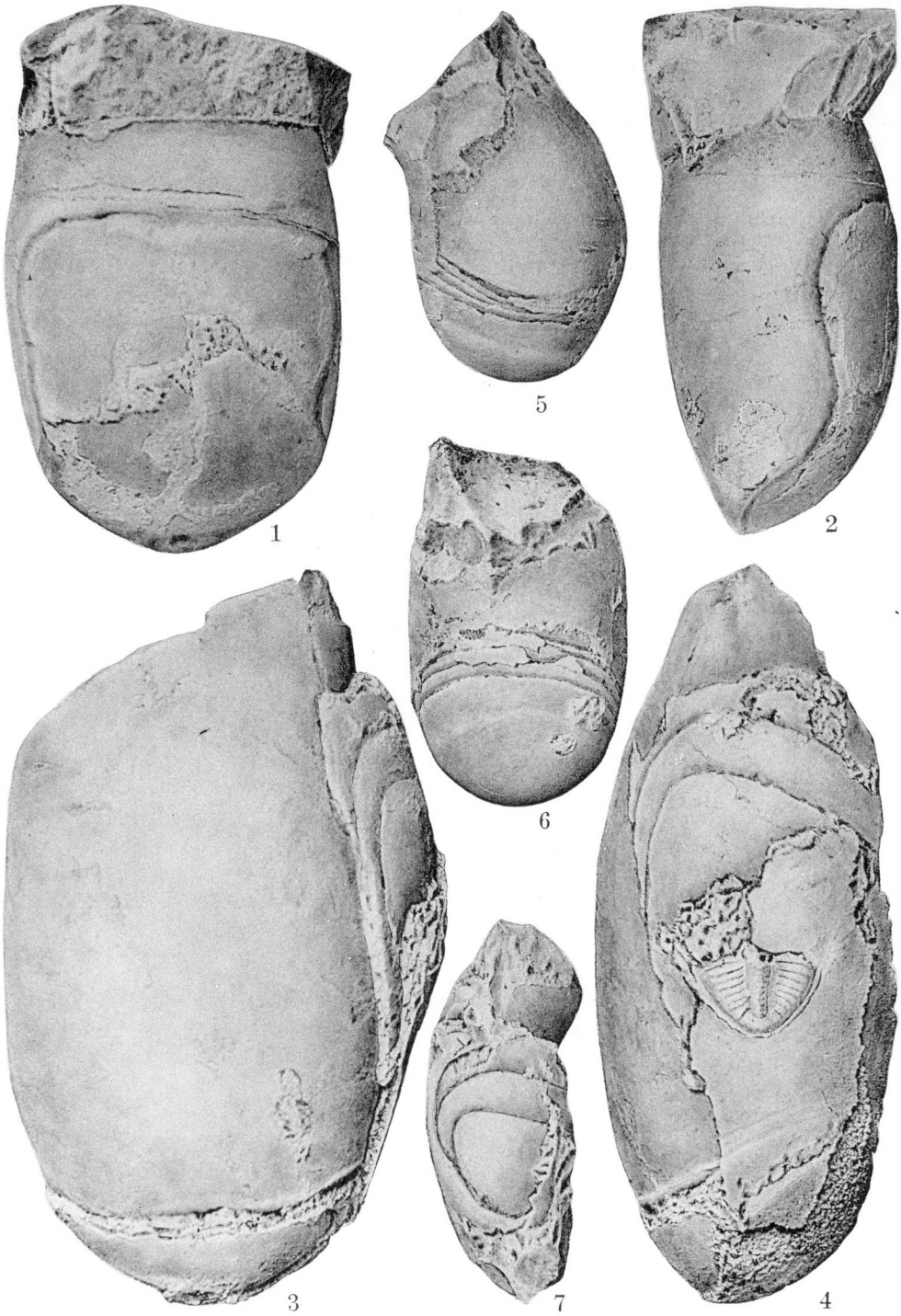

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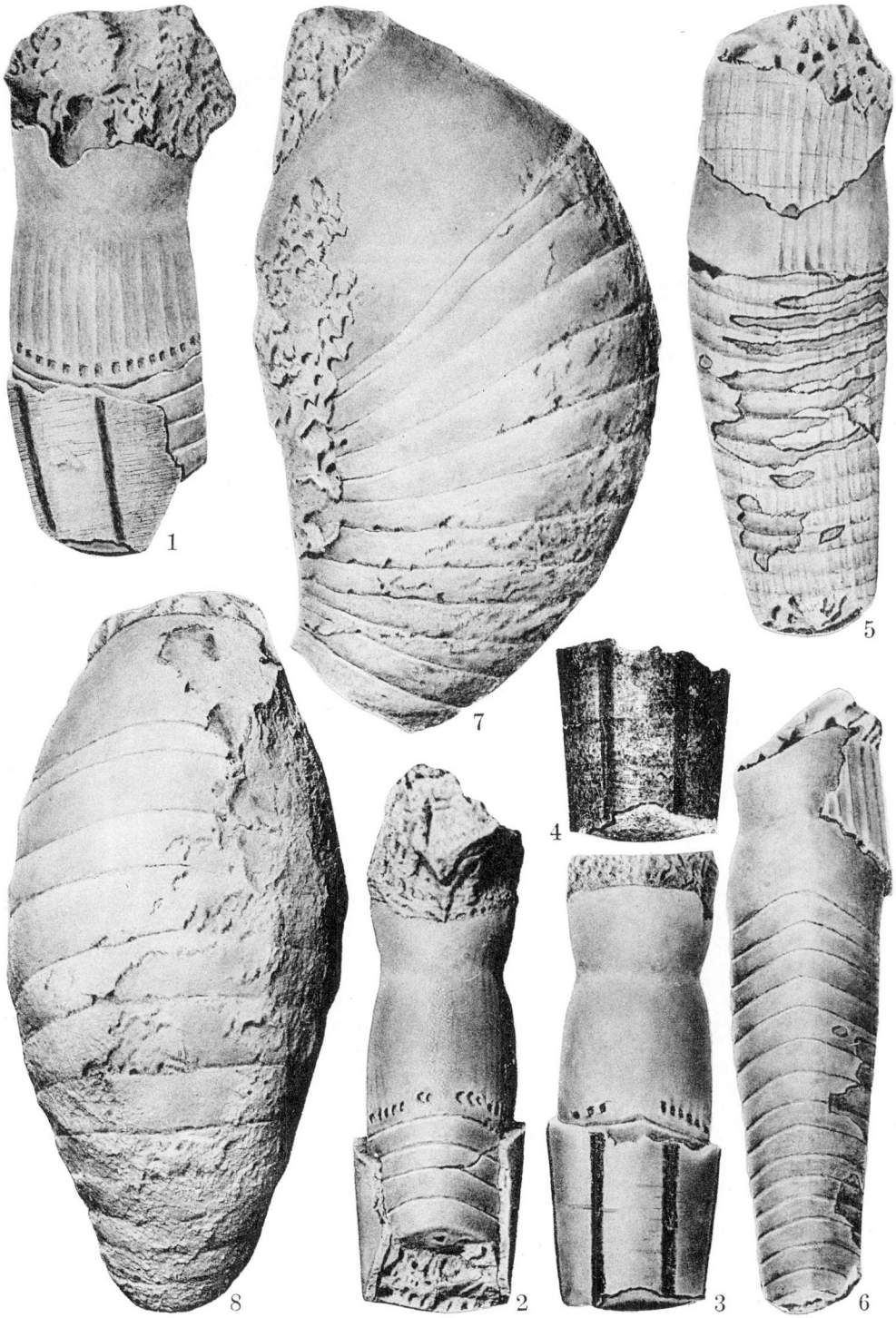

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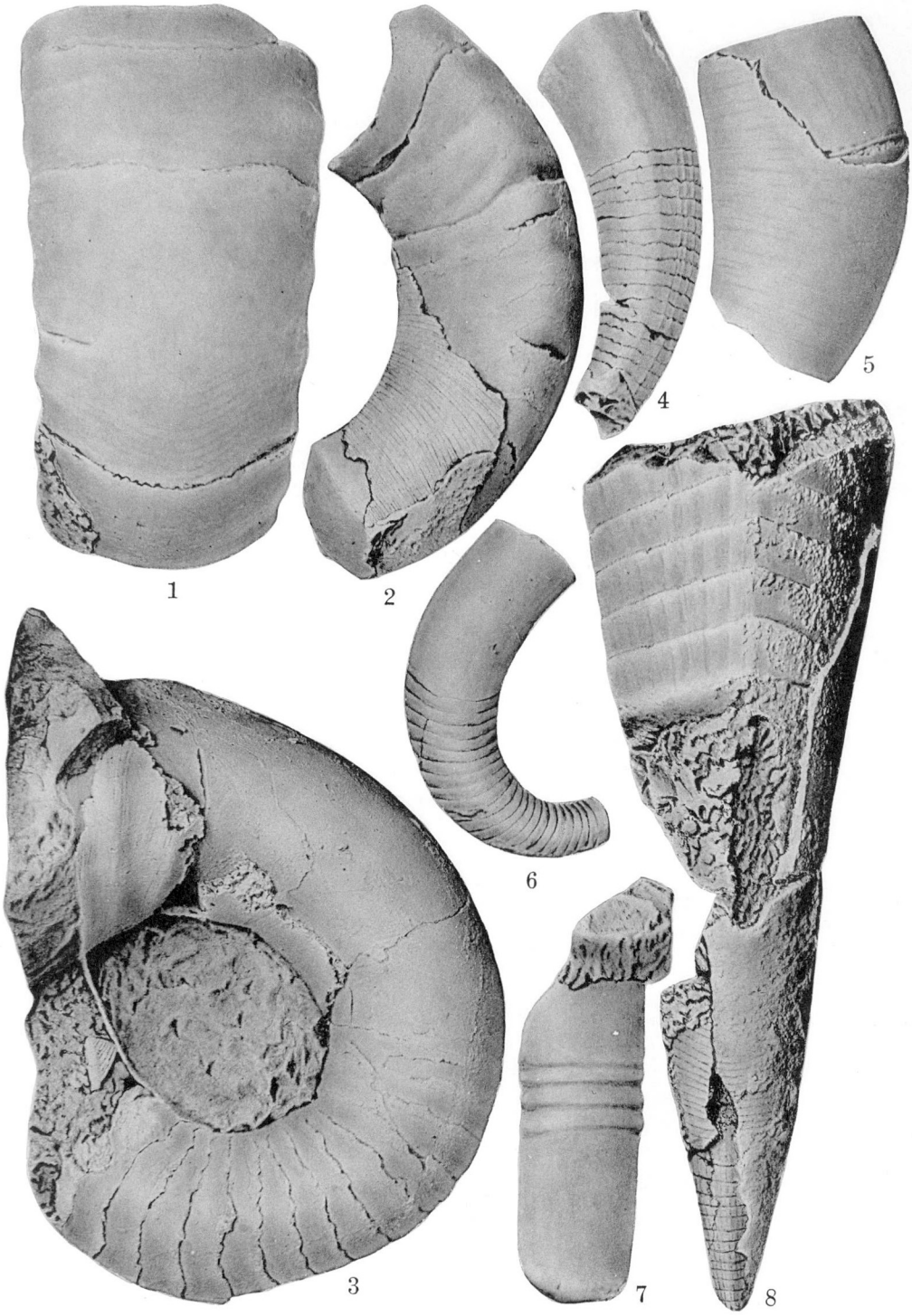

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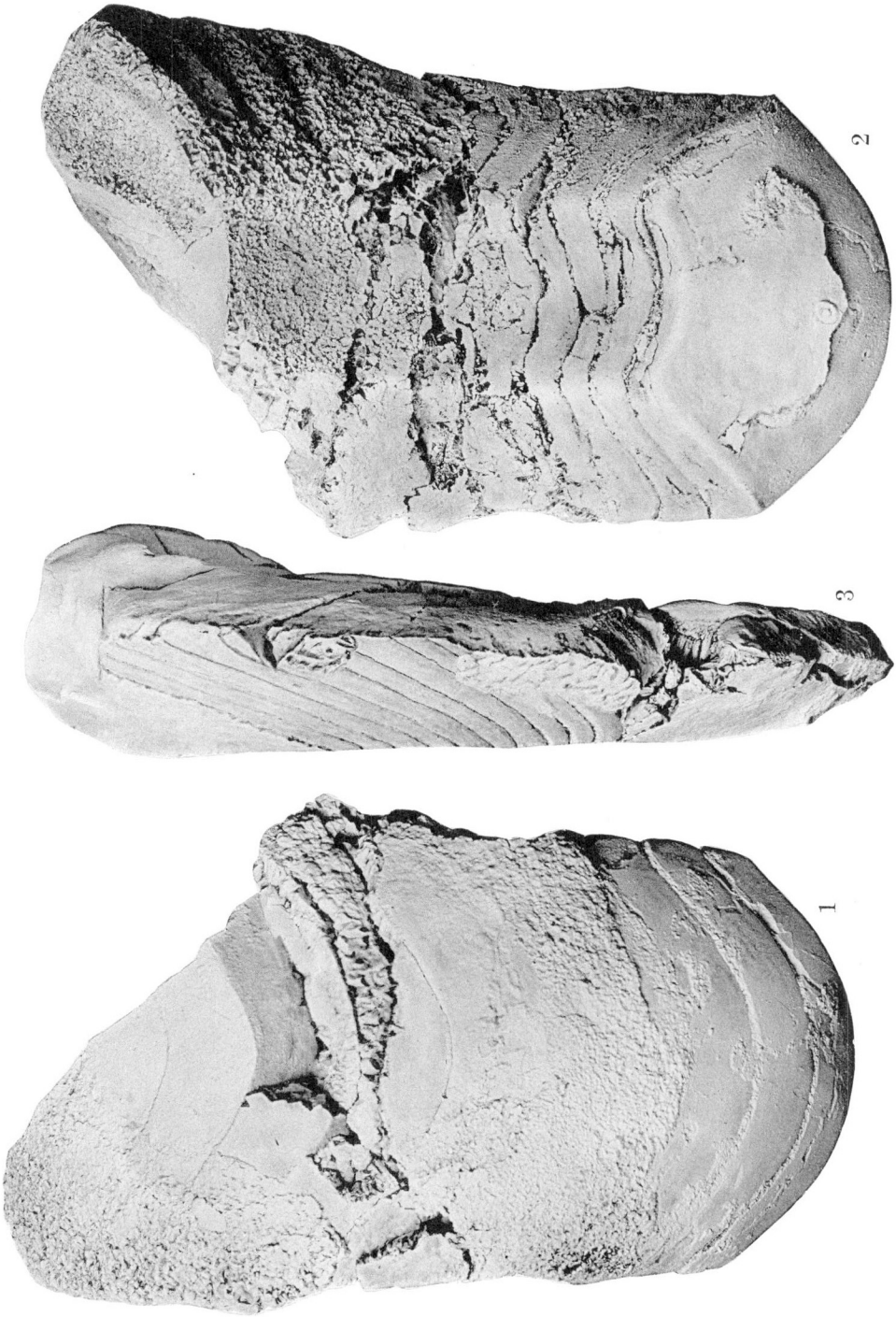

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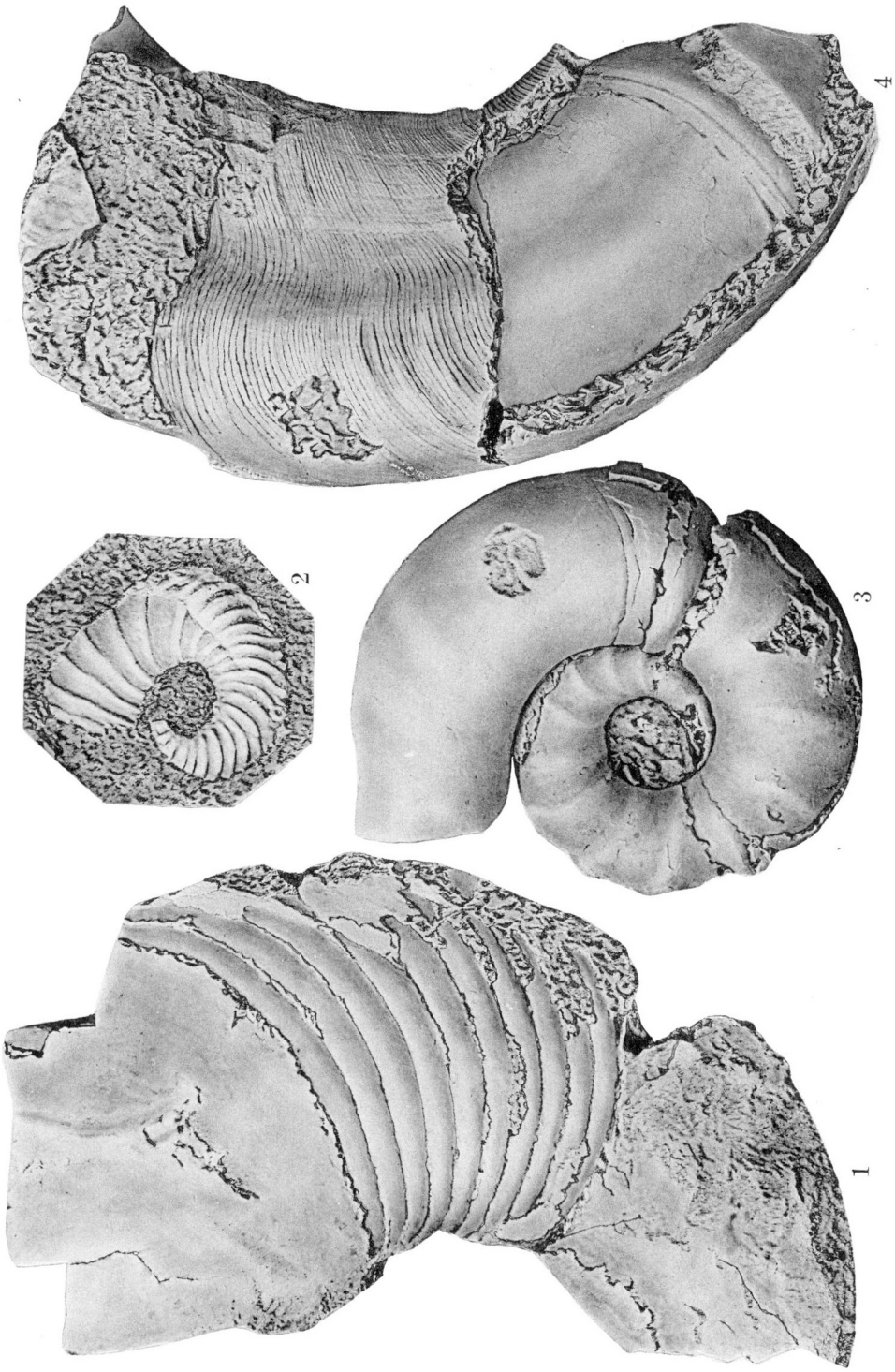

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