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SILURIAN CEPHALOPODS OF NORTHERN MICHIGAN

BY
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UNIVERSITY OF MICHIGAN
ANN ARBOR

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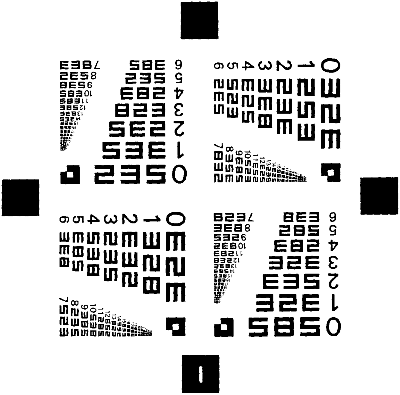

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UNIVERSITY OF MICHIGAN

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SILURIAN CEPHALOPODS OF NORTHERN MICHIGAN

AUG. F. FOERSTE

ACKNOWLEDGMENTS

THE following studies are based in large part on specimens belonging to the University of Michigan, collected by Professor George M. Ehlers and others, but it includes also all other available material. The specimens originally studied by Bigsby and Stokes, now deposited in the British Museum of Natural History, were made available to the writer by means of excellent casts of the original types provided by Dr. F. A. Bather, who also furnished such additional information as could not be ascertained with certainty from the casts alone. The specimens studied by Hall, and now deposited in the American Museum of Natural History, were loaned to the writer by Dr. Chester A. Reeds. The specimens of *Huronia canadense* and *Huronia persiphonatum* studied by Billings, and now in the Museum of the Geological Survey of Canada, were loaned by Dr. E. M. Kindle. The specimens of *Huronia septata, Huronia inflecta,* and *Actinoceras hearsti* described by Parks, belonging to the Royal Ontario Museum of Paleontology, at Toronto University, were loaned by Prof. W. A. Parks himself. It is evident that this report could not have been written without their kind assistance, for which the writer is extremely grateful.

INTRODUCTION

The Niagaran formations of the northern peninsula of Michigan and of the islands in the adjacent parts of Lake Huron, in descending order, are: the Racine, Manistique, Burnt Bluff, and

Mayville (abstract in *Bulletin of Geological Society of America*, 32, pt. 1, 1921, pp. 129–130). Cephalopods are known at present only from the Manistique and Burnt Bluff formations. Of these, twenty-three species and varieties are known only from the Manistique, four species are known only from the Burnt Bluff, and four additional species appear to be common to both.

The species common to both formations are *Discosorus ehlersi*, *Discosorus halli*, *Stokesoceras romingeri*, and *Stokesoceras engadinense*, all actinoceroids. In view of the fact that a distinct faunal break appears to exist between the Burnt Bluff and the overlying Manistique, it appears possible that future observations may result in the discovery of differences between the Burnt Bluff and Manistique representatives of the four species here in question.

The four species known only from the Burnt Bluff are *Protokionoceras* sp., *Ormoceras* sp., *Discosorus* sp., and *Cyrtoceras* (?) sp.

Stokesoceras romingeri is fairly common in the upper or Fiborn part of the Hendrick quarry; *Stokesoceras engadinense* is rare here; only a single specimen of *Ormoceras*, not identifiable, was found. A single specimen closely related to *Discosorus infelix* and a single specimen possibly related to *Discosorus halli* were found in the upper beds of the Burnt Bluff formation, in strata corresponding approximately to the Fiborn part, near Gould City. *Protokionoceras* and the specimen doubtfully identified as *Cyrtoceras* are represented by single specimens from Marblehead, at the eastern end of Drummond Island.

In general, the Burnt Bluff formation contains few cephalopods, and these chiefly from its upper strata. The Manistique formation, on the contrary, appears to contain a fairly rich cephalopod fauna, though it has not yet been ascertained whether this fauna is restricted to definite horizons.

It is assumed that the various species of cephalopods described from Drummond Island all belong to the Manistique formation. This assumption probably is correct for most species of *Actinoceras*, *Ormoceras*, and *Huronia*. Whether it is correct also for *Discosorus* and *Stokesoceras* remains to be seen.

The Niagaran formations of northern Michigan are rich in actinoceroids, but poor or entirely lacking in other groups of cephalopods. Among the orthoceracones they include only one specimen each of *Kionoceras* and *Protokionoceras*. The single specimen doubtfully referred to *Cyrtoceras* may be an orthoconic shell, but with the exception of these three species all others are actinoceroids. No cyrtoceraconic, gyroceraconic or nautiliconic shells are known, unless the doubtful specimen already mentioned is a cyrtoceraconic form. No species of the *Poterioceras*, *Gomphoceras*, or *Oncoceras* groups of cephalopods are present.

Among the actinoceroids the Niagaran fauna of northern Michigan includes a wealth of forms here referred to *Actinoceras*, *Huronia*, *Ormoceras*, *Discosorus*, and *Stokesoceras*, a total of twenty-nine species and varieties, evidently not exhausting the list.

It has not been found possible to identify from Castelnau's published figures and descriptions the forms described by him from the Niagaran of Drummond Island and other northern areas. These figured forms include *Actinoceras beaumonti*, *A. beudanti* and *A. dufresnoyi* from Drummond Island; *Actinoceras blainvillei* from Little Manitoulin or Cockburn Island; *Actinoceras cordieri* from Great Manitoulin Island; and *Actinoceras deschayesi* from Green Bay, Lake Michigan. Only an examination of the types of these species, if still in existence, will make it possible to determine their identity. The form called *Actinoceras beaudanti* appears to be a *Stokesoceras*, with a smaller apical angle than in *Stokesoceras romingeri*, and with a smaller number of segments as compared with the diameter of the siphuncle. *Actinoceras blainvillei* appears to have been an orthoceroid. The generic relations of *Actinoceras beaumonti* and *Actinoceras deschayesi* are unknown. *Actinoceras dufresnoyi* is undoubtedly a species of *Actinoceras*, and *Actinoceras cordieri* probably belongs to this genus. In our present state of knowledge of these species it is impossible to regard them either as described or as figured sufficiently for purposes of identification. This is unfortunate, since the work by Castelnau includes one of the earliest studies of the cephalopod fauna of northern Michigan.

No attempt is made in this paper to give special consideration to the taxonomic value of the various divisions of the genus *Actinoceras*, of subgeneric or generic rank. It is well known that the forms included under the terms *Huronia* and *Ormoceras* are both connected with typical forms of *Actinoceras* by intermediate species. Moreover, it is possible that *Stokesoceras* is connected in a similar manner with *Discosorus*. Such intermediate species, however, need not invalidate genera, since they are to be regarded as natural, if closely related genera were derived from the same parent stock.

Deiroceras Hyatt, founded on *Orthoceras python* Billings, from the Trenton at Ottawa, is known at present only from three segments of the siphuncle, in which the length of the segments equals their diameter, their general aspect being distinctly elongate, while in *Ormoceras* Stokes the length of the segments is distinctly smaller than their width, though in certain species their aspect is fairly globular. This appearance is due in part to the considerable width of the segments where they become free from contact with the septa.

Paractinoceras Hyatt, founded on *Sactoceras canadense* Whiteaves from the Black River or Richmond of Lake Winnipeg, has a siphuncle with large flat nummuloidal segments toward the apex, but narrowing toward the aperture until the length of the segments greatly exceeds their diameter.

The cephalopod fauna of northern Michigan finds its nearest relatives in the Niagaran of the Lake Timiskaming area, 200 miles northeast of Drummond Island. Here numerous relatives of the northern Michigan Niagaran cephalopod fauna occur, *Actinoceras gouldense* and a form very similar to No. 6 of the present paper, described from the Scott quarry, are found. Several species similar to, but not identical with *Actinoceras backi* and *A. rotulatum*, are present. *Huronia obliqua* and species similar to *Huronia annulata* Hall and *Huronia paulodilata* occur. *Discosorus* is represented by a form closely similar to *Discosorus ehlersi*, in addition to which there is an undescribed species. Species rather distantly related to *Discosorus remotus* are present. Several straight, narrow, elongate actinoceroids with small, flat, oblique,

nummuloidal segments may belong to *Stokesoceras*. As in northern Michigan, the cephalopod fauna is chiefly actinoceroid, with relatively few other species. The Silurian genus *Sactoceras* Hyatt, founded on *Orthoceras richteri* Barrande, and probably distinct from the Carboniferous genus *Loxoceras* M'Coy, is represented by several species.

The northern Michigan cephalopod fauna continues eastward into Cockburn Island and Manitoulin Island. Williams figures *Huronia* from Cockburn Island, and notes the presence of *Huronia vertebralis* at South Bay, in the eastern part of Manitoulin Island. *Discosorus gracilis* is noted from Sandfield, south of Manitou Lake, on Manitoulin Island. All of these localities are in the Lockport, and beneath the horizons referred to the Guelph.

Cephalopods related to the Niagaran forms in northern Michigan occur also in Anticosti, 900 miles northeast of Drummond Island. Several of the Anticosti species show a close relationship to Lake Timiskaming forms, rather than to any known at present from northern Michigan. The significant Anticosti species are given below.

There are several species belonging to the same group as *Actinoceras backi* and *Actinoceras rotulatum*. There are also several species of *Ormoceras*, one of which can not be distinguished from *Ormoceras bayfieldi*, while two or three are so closely similar to *Ormoceras whitei* that they are distinguished only by features usually regarded as of minor value. Of *Huronia* there are four forms. One of these is *Huronia obliqua*. The form described by Billings under *Orthoceras canadense* can not be distinguished from *Huronia vertebralis*. The form described by Billings as *Orthoceras persiphonatum* is closely related to *Huronia inflecta* Parks, which is a form intermediate between typical *Actinoceras* and *Huronia*. A fourth form is similar to *Huronia distincta*. The species described by Billings as *Orthoceras infelix* appears to be related to *Discosorus*, as noted long ago by Hyatt. Related species occur in the Lake Timiskaming area. An undescribed genus of cyrtoceroid actinoceroids, with coarse, large segments in the siphuncle, is represented on Anticosti by a species almost

identical with one found in the Lake Timiskaming area. There is also a long cyrtoceraconic form of *Discosorus* unknown at either Lake Timiskaming or in northern Michigan. No form strictly comparable with *Stokesoceras* is known. On the other hand, there are numerous specimens of *Sactoceras*, *Kionoceras*, and *Spyroceras*, several species of *Orthoceras*, and one of *Dawsonoceras*. One species of *Gomphoceras* and one of *Phragmoceras* are present. Finally, there are several nautiliconic or gyroceraconic forms. Evidently there is a greater variety of cephalopod forms in Anticosti than in the Lake Timiskaming area or in northern Michigan.

In a westerly direction from northern Michigan, the presence of *Huronia* in the Niagaran of Iowa should be noted.

The Attawapiskat River, in the area west of James Bay, is about 450 miles north of Drummond Island; the Ekwan River is about 35 miles farther north; and the Severn River is 300 miles beyond the Ekwan river, but in a northwest direction, on the southwestern side of Hudson Bay. Along these streams the Attawapiskat and Ekwan members of the Niagaran are exposed. A huge siphuncle of *Discosorus*, for which the term *Discosorus parksi*, sp. nov., is here proposed, was described by Parks (*Trans. Royal Canadian Inst.*, 11, 1915, p. 74, Pl. 2, Fig. 3) from the Ekwan River limestone at the Assina rapids, on the Severn River. The same species was collected by Professors Savage and Tuyl from the Ekwan River limestone on the Ekwan River. Parks described from the Limestone rapids on the Severn River *Huronia inflecta* (referred to *Actinoceras* in the present publication) and *Actinoceras hearsti*, presumably from the Ekwan River limestone. Professors Savage and Tuyl, however, cite only *Actinoceras hearsti* from the Ekwan River limestone on the Severn River, and in their collections they label a specimen of *Actinoceras inflectum* as coming from the Attawapiskat limestone on the Severn River. In addition they found a species closely resembling *Actinoceras rotulatum* in the Ekwan River limestone on the Severn River, and a species of *Stokesoceras* resembling *Stokesoceras romingeri*, but with a smaller apical angle, in the Ekwan River limestone on the Ekwan River.

In the Niagaran limestone exposed along the southern half of the western shore of Southampton Island, at the northern end of Hudson Bay, a species of *Actinoceras* appears to have been common. A second species resembles *Actinoceras keewatinense*, but has relatively shorter and more oblique segments of the siphuncle. One specimen may be a discosoroid, resembling the strongly curved forms described by Lee from the Prince Regent Inlet, farther north, but the apical angle is much smaller.

Two species of *Discosorus*, namely *Discosorus borealis* and *Discosorus regularis*, were described by Dr. G. W. Lee (*Proc. Royal Physical Soc. Edinburgh*, 18, No. 4, 1912, pp. 255–258, Figs. 1, 3, on page 259) from Prince Regent Inlet. This inlet is located in Arctic areas, directly north of Madison, Wisconsin, 90 degrees west of the meridian of Greenwich and from 73 to 74 degrees in north latitude. Here Parry collected Niagaran fossils in 1824–25 from Port Bowen, on the northwestern edge of Baffin Island, and also along the eastern shore of North Summerset Island. Both species of *Discosorus* found here are strongly curved lengthwise, the second much more than the one named first.

Typical actinoceroids are known much farther north, occurring as far north as Bessels Bay, on the northwest coast of Greenland, in 81° 6′ north latitude, and 63° 45′ west longitude. Here a form similar to *Actinoceras rotulatum* occurs.

Endoceroids appear to be represented in the Silurian of Great Britain only by *Actinoceras nummularium*. *Actinoceras cochleatum* is cited by Lindström from the Silurian of Gotland. Olaf Holtedahl makes the following statements on *Actinoceras* (*Notes on the Ordovician Fossils from Bear Island, Norsk Geologisk Tidsskrift*, 5, No. 1, 1918, p. 87):

"Ordovician representatives of *Actinoceras* may be said to be characteristic of the American faunal province, while in Silurian time the genus has spread also to Europe and is quite commonly found in England and the Scandinavian-Baltic regions. The *Orthoceras laeve* Schmidt is thought by Eichwald (*Lethaea Rossica*, p. 1254) to be near *Actinoceras bigsbyi*, and *Actinoceras bigsbyi* Bronn aff. is mentioned by the same author (*l.c.*, p. 1253) as occurring in the *Orthoceras* limestone in the vicinity of Wesenberg and Nyby in Estland. When looking through the fossil lists of the Baltic Ordovician, published in more recent time by Lamansky and Bassler, no *Actinoceras* species is mentioned, so the question of the occurrence of this genus

there seems a little uncertain. Of interest is the occurrence of a true *Actinoceras* (resembling somewhat the Silurian *A. imbricatum* Hisinger) found in the uppermost Ordovician (stage 5) of some districts at the western side of the Kristiania region, in Hadeland and Ringerike. The form is quite common. This may possibly indicate the approaching *Actinoceras* stock coming from the west or northwest, spreading in Silurian time all over southern Norway and Sweden."

In North America *Actinoceras* makes its first appearance in Black River strata. The earlier known forms occur chiefly in an area extending from Tennessee and Kentucky on the south to New York; southeastern Ontario and Newfoundland on the east; northern Greenland and Ellesmereland on the north; Prince William Land, Manitoba, Minnesota, and Missouri on the west. A single specimen, of unknown horizon, was found at the western end of Alaska, at Bering Strait. Recently Graubau described seven species of *Actinoceras* from the Machiakou limestone of Shantung and Chili provinces in eastern China (*Palaeontologia Sinica*, Ser. B, fol. 1, fascicle 1, 1922, pp. 70–89). The affinities of these forms evidently are with the Black River of North America.

The center of origin of the *Actinoceras* fauna appears to have been in the area extending from New York and southern Ontario westward to Minnesota, southward to Kentucky and Tennessee, and northward to Manitoba and the southern part of the Arctic Archipelago. *Huronia* appears to have originated along the belt extending from Iowa to Anticosti, with northern Michigan as its center. Typical *Discosorus* is known from southern Ohio eastward as far as New York, northward as far as northern Michigan and Lake Timiskaming, and westward as far as Wisconsin and Idaho, with closely related forms as far east as Anticosti, and as far north as Prince Regent Inlet. *Stokesoceras* is known chiefly from northern Michigan, though a form occurs also west of Hudson Bay. *Ormoceras* has a wide range, almost commensurate with that of *Actinoceras*. The *Actinoceras* fauna of North America appears to be indigenous, rather than derived from European or other sources.

The genesis of *Actinoceras* has not received much attention. Possibly this genus was derived from forms similar to those described by Ruedemann from the Chazyan of New York under

the terms *Cyrtactinoceras champlainense* and *Cyrtactinoceras boycii*. The primitive character of these Chazyan forms was recognized by Ruedemann (*New York State Museum, Bull.* 90, 1906, p. 488). The Chazyan forms referred to *Cyrtactinoceras* probably originated from still earlier forms with moderately developed annulations of the siphuncle, similar to the species described by Ruedemann as *Orthoceras vagum*. In these forms the septa curve downward at their contact with the siphuncle in the form of septal funnels or septal necks; successive septal necks are connected together by ring-like deposits presenting convex vertical outlines. The upper margin of each ring embraces the lower margin of the overlying septal neck and enters the upper margin of the neck beneath.

In cephalopods from Canadian strata, beneath the Chazyan, the septal necks appear prolonged sufficiently downward to enter the top of the neck beneath, without the assistance of a connecting ring. Between the septa, the intermediate walls of the siphuncle usually present concave vertical outlines. Where entering the top of the septal neck or funnel from above, the general concave outline of the wall of the siphuncle may change rapidly from concave to convex, to permit rigid contact with the underlying septal neck. Structure of this kind is characteristic of *Endoceras, Cameroceras, Protocycloceras, Orygoceras, Cyclostomiceras, Clarkoceras,* and the numerous species described by Billings from Canadian strata under the term *Orthoceras*. It is probable that the Canadian nautiloid genera show affinities with those in which the septal funnels are prolonged the entire length of the camera, instead of being short; the connection with the septal funnel next beneath is established without the use of connecting rings.

Species without connecting rings are represented in post-Canadian strata by *Endoceras* and *Cameroceras*, but in general almost all post-Canadian cephalopods have connecting rings.

NEW GENERA

Armenoceras; genotype, *Actinoceras hearsti* Parks
Huroniella; genotype, *Huronia inflecta* Parks

Elrodoceras; genotype, *Cyrtoceras indianense* Miller
Stokesoceras; genotype, *Stokesoceras romingeri* Foerste
Ephippiorthoceras; genotype, *Orthoceras formosum* Billings

(The preceding generic terms were introduced after the manuscript was in type. They are regarded as of generic rather than of subgeneric rank, though provisionally printed in the latter form in some cases, to avoid other and greater changes in the original manuscript.)

LIST OF SPECIES

1. Kionoceras loxias (Hall); Niagaran
2. Protokionoceras sp.; Burnt Bluff (Drummond Island)
3. Orthoceras: cf. alienum Hall; Manistique
4. Actinoceras (Armenoceras) sphaeroidale (Stokes); Manistique
5. **Actinoceras** (Armenoceras) **gouldense,** sp. nov.; Manistique
6. Actinoceras (Huroniella?) sp. (Scott quarry); Manistique
7. Actinoceras (Armenoceras) backi (Stokes); Manistique
8. Actinoceras (Armenoceras) rotulatum (Billings); Niagaran (Lake Timiskaming)
9. Huroniella inflecta (Parks); Niagaran (Hudson Bay)
10. **Huroniella ehlersi,** sp. nov.; Manistique
11. Huronia bigsbyi Stokes; Manistique
12. **Huronia bigsbyi intermedia,** var. nov.; Manistique
13. Huronia vertebralis Stokes; Manistique
14. **Huronia engadinensis,** sp. nov.; Manistique
15. Huronia annulata Hall; Manistique
16. Huronia minuens Barrande; Manistique
17. **Huronia paulodilatata,** sp. nov.; Manistique
18. Huronia obliqua Stokes; Manistique
19. Huronia portlocki Stokes; Manistique
20. Huronia distincta Barrande; Manistique
21. Huronia septata Parks; Hudson Bay (Richmond age)
22. Huronia turbinata Stokes; Manistique
23. Huronia romingeri Barrande; Manistique
24. Ormoceras bayfieldi Stokes; Manistique
25. Ormoceras ?(Elrodoceras?) whitei Stokes; Manistique
26. Ormoceras sp. (Gould City); Manistique
27. Ormoceras sp. (Hendrick quarry); Burnt Bluff
28. Discosorus conoideus Hall; New York (Clinton age)
29. **Discosorus ehlersi,** sp. nov.; Manistique, Burnt Bluff
30. Discosorus (?) infelix (Billings); Niagaran (Anticosti)
31. Discosorus (?) sp. (Gould City); Burnt Bluff
32. **Discosorus halli,** sp. nov.; Manistique, Burnt Bluff
33. Discosorus (?) remotus Foord; Manistique
    Discosorus parksi, sp. nov.; page 24.
34. **Stokesoceras romingeri,** sp. nov.; Manistique, Burnt Bluff
35. Stokesoceras gracile (Foord); Manistique
36. **Stokesoceras engadinense,** sp. nov.; Manistique, Burnt Bluff
37. Cyrtoceras (?) sp. (Drummond Island); Burnt Bluff

1. KIONOCERAS LOXIAS (Hall)

(Plate XIV, Fig. 1)

Orthoceras loxias Hall, 20th Rep. New York State Cab. Nat. Hist., 1868, p. 380, Pl. 19, Fig. 7.

Type Specimen. — Apical angle 5 degrees, the diameter enlarging 8 mm. in a length of 100 mm. Specimen 215 mm. in length. Since the top shows a cross-section of the siphuncle, the dimensions attained by a fully mature individual are unknown. Sutures are shown well only along the lower half of the specimen. Here there are four camerae in a length equal to the diameter of the conch at the uppermost camera counted. The siphuncle is cylindrical, as usual in *Kionoceras*. In its present condition the siphuncle is 5 mm. in diameter, at its smaller end, but this diameter includes a small deposit adhering to its exterior, because of silicification.

The exterior of the shell is marked by about eighteen vertical ribs, which are rather sharply angular. Transverse striae occur at the rate of eight in a length of 10 mm. These striae are low and broad and relatively indistinct. Along the lower half of the specimen the upper margin of the cast of the interior of each of the camerae is slightly enlarged, which results in a slightly annulated appearance, much less distinct than in *Kionoceras irregulare* McChesney.

Locality and Horizon. — Described from some unknown locality on the "Shores of the northern Lakes," according to the original label attached to the specimen. The matrix is dolomitic, and resembles that of the Racine. It is assumed to have come from some Niagaran exposure on the northwestern border of Lake Michigan, possibly in the Green Bay area.

Specimen No. 2105 in the American Museum of Natural History in New York City.

Remarks. — *Kionoceras loxias* apparently is closely related to *Kionoceras lineolatum* McChesney, from the Racine dolomite at Joliet, Illinois. It differs, as far as known, only in expanding more rapidly; the Joliet species is described as "tapering very gradually, nearly cylindrical."

2. PROTOKIONOCERAS SP.

A very small fragment, about 14 mm. in diameter, with thirty-two vertical ribs, and with fifteen low but distinct transverse striae. These striae are relatively broad. In each space between the vertical ribs there is a distinct vertical striation. In several of these intermediate spaces there are traces of one or two additional, though fainter, vertical striae. Three camerae occupy a total length of 4.5 mm. The fragment is too small for specific determination, but it appears to be the apical part of some *Protokionoceras*.

Locality and Horizon. — From Marblehead, easternmost point of Drummond Island, in the Burnt Bluff formation.

3. ORTHOCERAS (cf. *alienum* Hall)

(Plate VIII, Fig. 6)

Fragment 90 mm. in length, enlarging from 25 mm. at the lowest well-preserved camera to 31 mm. at the top of the uppermost well-preserved camera; there is an enlargement of 6 mm. in a length of 52 mm., including nine camerae. From these measurements the apical angle is calculated to equal nearly 7 degrees. There are about five camerae in a length equal to the diameter of the conch at the top of the series of camerae counted.

The sutures of the septa are directly transverse. The concavity of the septa equals at least the depth of one and a half camerae. The siphuncle is central in location. Its diameter is 7 mm. at a point where the diameter of the conch is 31 mm., thus equalling about 23 per cent of the length of the latter. The siphuncle is cylindrical.

Locality and Horizon. — From the southwest quarter of section 7, T 42 N, R 12 W, about a quarter of a mile north of Hunt Spur, in Mackinac County, Michigan, in the Manistique formation. Specimen No. 8752 in the University of Michigan collection.

Remarks. — No part of the surface of this specimen is preserved, but the relatively large size of the siphuncle should prove

diagnostic in case any other specimens of this species are found. It may be related to *Orthoceras alienum*, but in the absence of any knowledge of the surface ornamentation, it is impossible to determine this with accuracy.

ACTINOCERAS

The genotype of *Actinoceras* is *Actinoceras bigsbyi* Bronn (Plate I, Figs. 1 A, B; Plate XII, Figs. 7 A, B, C). This species was figured by Bigsby in 1824 (*Trans. Geol. Soc. London*, 1, 1824, p. 198, Figs. 1, 2), from Thessalon Island, as one of the *Orthocerae*. Bronn in 1837 (*Leth. Geogn.*, 1, 1837, p. 98, Pl. I, Fig. 8) reproduced one of Bigsby's figures, recognized the species as belonging to a new generic type, *Actinoceras*, and supplied the specific designation *bigsbyi*. Bigsby's figures are reproduced in the present publication on Plate I. Both specimens are preserved in the British Museum of Natural History, where the original of Figure 1 is numbered 33448, and the original of Figure 2 is numbered C.2664. Part of the infilling of the second specimen has been broken away since the specimen was figured.

Both specimens belong to that division of the genus *Actinoceras* in which the septal necks or funnels are strongly developed. The rings connecting successive necks are in contact with the septa beneath, but are separated from the septa above by the entire length of the septal necks. Species possessing these characteristics are common in Ordovician strata, especially in those of Black River (Plate XII, Fig. 4) and Trenton age. The original of Figure 1 is the type of both the genus and the species. It is not certain that the original of Figure 2 belongs to the same species as the type. This can be determined only by a direct examination of the original specimens. Moreover, it is not certain that the two specimens were obtained on Thessalon Island. The eastern half of this island consists of quartzite of pre-Ordovician age. The western half apparently consists of limestone. This was examined by the writer only on the east shore of a large bay indenting the northern side of the island. Here the rock consisted of a whitish fine-grained limestone, in

which the exposed surfaces of the fossils were more or less silicified. Lithologically this rock resembled the Plattin of Missouri. In the originals of the two specimens figured by Bigsby, however, it is chiefly the matrix filling the camerae and the various hollow spaces within the siphuncle which remain. This is the type of structure presented by the Beloit dolomite of Wisconsin, which is quite unlike anything seen by the writer on Thessalon or neighboring islands. Possibly the southwestern shore of Thessalon, which was not visited, may expose strata similar lithologically to those containing the type of *Actinoceras bigsbyi*, but, in view of the general character of the exposures found elsewhere in the northwestern part of Lake Huron, the prospect does not appear encouraging.

In a second division of species commonly referred to *Actinoceras* the septal necks are practically obsolete. The septa are in contact with the lower side of the segments of the siphuncle above, and form an acute angle with the segments beneath. Frequently the septa are in contact with the inner margins of the segments below. Species having these characteristics are common in the Silurian, where they include *Actinoceras rotulatum* (Billings), illustrated on Plate I of the present publication, and *Actinoceras hearsti* Parks (*Trans. Royal Canadian Inst.*, 11, 1915, Pl. 6, Fig. 5; see also Plate XIII, Fig. 4, in the present publication). Occasional representatives of this type occur on Lake Winnipeg, and west of Hudson Bay, in strata regarded as of Richmond age. These include *Actinoceras richardsoni* Stokes and *Actinoceras richardsoni magnum* Parks.

For this second group of species the name *Armenoceras* is proposed, with *Actinoceras hearsti* Parks as the genotype. *Armenoceras* probably includes the four following species, here described as *Actinoceras sphaeroidale*, *Actinoceras gouldense*, *Actinoceras backi* and *Actinoceras rotulatum*, but no sections have been made demonstrating the structure of their siphuncles.

A third group of species differs from the second only in having a tendency toward a more or less distinct concave vertical outline along that part of the segments of the siphuncle where the septa are adnate to the latter. A representative species of the latter

is *Actinoceras inflecta* Parks (Plate XIII, Fig. 3), from the Silurian of the Severn River, west of Hudson Bay (*Trans. Royal Canadian Inst.*, 11, 1915, Pl. 6, Fig. 4). It is evident that a lengthening of the segments of species of this type would give rise to forms such as those included in typical *Huronia*. The genus *Huronia*, however, includes species sufficiently diverse to have arisen possibly from more than one type of actinoceroids.

For the third group of species the name *Huroniella* is proposed, with *Huronia inflecta* as the genotype. This genus includes also *Orthoceras persiphonatum* Billings, from Anticosti, and probably also the species here described as *Huroniella ehlersi*.

4. **ACTINOCERAS (ARMENOCERAS) SPHAEROIDALE** (Stokes)

(Plate II, Figs. 1 A, B, C)

Huronia sphaeroidalis Stokes, *Trans. Geol. Soc. London*, 2d Ser., 1, pt. 2, 1824, p. 203, Pl. 28, Fig. 5.

Type specimen. — This consists of four segments of the siphuncle, with vague traces of adjoining parts of the septa. The segments are 37 mm. in diameter, and two and two-thirds segments occur in a length equal to their diameter. The sutures between successive segments of the siphuncle are almost at right angles to the vertical axis, and certainly do not deviate less than 85 degrees from the latter. The lateral outlines of the segments are evenly convex. The septa are adnate to the lower surface of the segments, becoming free near the base of their lateral margins. The upper surface of each segment curves downward within a circle whose diameter is 28 mm., as far as a second circle whose diameter is about 20 mm. Along this circular band the septa are in contact with the overlying segments and either touch or almost touch the segments beneath.

Locality and Horizon. — Drummond Island; presumably in the Manistique formation.

Specimen, type, numbered 33863, in the British Museum of Natural History.

5. ACTINOCERAS (ARMENOCERAS) GOULDENSE, sp. nov.

(Plate XIV, Figs. 2 A, B; Plate XV, Figs. 2 A, B; Plate X, Figs. 4 A, B)

Type specimen. — The specimen (Plate XIV, Figs. 2 A, B.) is 270 mm. in length and includes the siphuncle and part of the ventral half of the conch, exhibiting the transverse curvature of the shell, its rate of enlargement, and the character of the septa. Not all of these features are revealed with equal definiteness.

The rate of enlargement, for instance, is nothing but an estimate, based on two other estimates. The diameter of the conch at the lowest distinctly preserved segment of the siphuncle appears to be 64 mm., and 150 mm. farther up the corresponding diameter of the conch appears to be 74 mm. This suggests an apical angle of 4 degrees. The maximum diameter of the lowest segment of the siphuncle is about 32 mm.; 150 mm. farther up, this diameter is at least 38 mm., which indicates an apical angle, as far as the siphuncle is concerned, of 2.5 degrees. Since the rate of enlargement of the siphuncle may not keep pace with that of the conch, it is not known whether the estimate of the apical angle of the conch is too large or not.

Eleven segments of the siphuncle occupy a length of 152 mm. Two and three-fourths segments occupy a length equal to the maximum diameter of the conch at the top of the series of segments being counted. The sutures between the segments form an angle of about 80 degrees with the vertical axis of the siphuncle. The ventral side of the segments evidently is either in actual contact with the ventral wall of the conch or barely escapes contact. Where the diameter of the conch is estimated at 64 mm., that of the siphuncle is estimated at 32 mm.; and, in a similar manner, where the diameter of the conch is estimated at 74 mm., that of the siphuncle is estimated at 38 mm. From this it is assumed that the diameter of the siphuncle is about half that of the conch. At the sutures the siphuncle contracts to a diameter about 8 or 9 millimeters less than at the crest of the annulations formed by the segments; along the inner

margins of the involutions at the sutures this diameter is contracted about 6 mm. more. These involutions curve inward and downward, and their upper and lower halves are less than half a millimeter apart. Along the dorsal side of the siphuncle, facing the interior of the conch, the vertical outlines of the segments are evenly rounded; toward the ventral side the line of maximum convexity of the segments rises to slightly above mid-height, as in other actinoceroids. There is a slight tendency toward flattening of the lower side of the annulations formed by the segments, especially toward the ventral side of the siphuncle. This flattened area marks the height to which the septa are adnate to the annular segments. The distance from the innermost part of the involution to the point where the septum becomes free from the annular segment is from 9 to 11 mm. This includes only the lower side of the annulation.

The septa are exposed on both lateral sides of the siphuncle where the ventral part of the conch has weathered away. Here the septa are deeply concave, but it cannot be determined definitely how deep this concavity of the septa is along the center of the conch. It appears to have a depth equal to the height of two of the annular segments.

Along the upper part of the specimen a vertical section of the siphuncle through its center is presented. The interior of the siphuncle was apparently filled by a calcareous deposit, as is usual in actinoceroids; this filling, however, may not have reached the central, axial part of the upper portion of the siphuncle. The vacant space thus left was filled, subsequently to the death of the animal, by a quartz infiltration; the latter presents the appearance of an axial chord, with a tendency toward branching at mid-height of the annular segments.

Locality and Horizon. — From southwest quarter of section 7, T 42 N, R 12 W, about half a mile north of Hunt's Spur, in Mackinac County, Michigan. In the Manistique formation.

Specimen No. 7547 in the University of Michigan collection.

Gould City specimen (Plate XV, Figs. 2 A, B). — This second specimen consists of the siphuncle only. It is about ten segments in length, with these segments occupying a total length

of 125 mm. The maximum diameter of the siphuncle at its upper end is 34 mm. The suture between the segments makes an angle of 78 degrees with the vertical axis of the siphuncle. The specimen is of interest chiefly because it presents clearly the form of the segments of the siphuncle. The line at which the septum becomes free from contact with the lower surface of the annular segments rises distinctly on approaching the ventral side of the siphuncle, and here the annulation tends to be slightly more angular than anywhere along the dorsal side of the siphuncle, or that part of the siphuncle which faces the interior of the conch.

Locality and Horizon. — From half a mile south of Gould City, in Mackinac County, Michigan. In the southeast quarter-section 29, T 43 N, R 11 W. In the Manistique formation.

Specimen No. 7548, University of Michigan collection.

Remarks. — This species differs from *Actinoceras sphaeroidale* in the much more oblique inclination of the segments of the siphuncle as compared with a plane directly at right angles to the vertical axis of the siphuncle. The siphuncle probably was located much nearer the ventral wall of the conch.

6. ACTINOCERAS (HURONIELLA?) SP.

(Plate II, Fig. 3)

This specimen consists of a natural vertical section through the center of a siphuncle. It resembles *Actinoceras gouldense* closely in the size, prominence, and relative number of segments. The sutures, however, between the segments appear to be almost directly transverse, and there is a tendency toward oblique flattening of the lower surface of the annular segments, so that the maximum diameter of the siphuncle is distinctly above mid-height, in some cases about two-thirds of their length above the base. Along the obliquely flattened area, the lower side of the annulations tends to present a slightly concave vertical outline, as in *Actinoceras inflectum*.

The structure of the calcareous deposit in the interior of the siphuncle has been weathered in such a manner as to show

its radial lamellar arrangement, the lamellae being vertical. The axial portion at present resembles an irregular, vertically-fluted chord, sending off branches, near mid-height of each segment, toward the center of curvature of the exterior vertical outline of this segment. The axial chord is narrowest at the base of the specimen and largest in diameter at the top. It corresponds to the vacant space, filled with matrix, seen in some actinoceroids. It is that part of the interior of the siphuncle which is filled last. Apparently it indicates the form and structure of the tissues which secreted the calcareous deposits. In that case these tissues must have occupied successively smaller spaces with increasing age.

Locality and Horizon. — From Scott's quarry, in Chippewa County, Michigan, in section 29, T 44 N, R 4 W. In the Manistique formation.

Specimen No. 7542, University of Michigan collection.

Another specimen from the Scott quarry presents the same vertical outline in the case of the individual segments, but the siphuncle appears to enlarge at a more rapid rate, apparently presenting an apical angle of 8 degrees.

7. ACTINOCERAS (ARMENOCERAS) BACKI (Stokes)

(Plate III, Figs. 4 A, B, C)

Orthocerae ————, Bigsby, Trans. Geol. Soc. London, 1, pt. 2, 1824, p. 204, Pl. 30, Fig. 1.

Orthoceras backii Stokes, Proc. Geol. Soc. London, 2, 1838, p. 689.

Type specimen. — This consists of the ventral half of a conch, exposing the dorsal side of the siphuncle and traces of the septa. The diameter of the conch is estimated at 35 mm. The impression of the exterior of the lowest segment of the siphuncle is 20 mm. in diameter, and this segment is in contact with the ventral wall of the conch. Above this impression is the silicified filling of the interior of four segments of the siphuncle, with the lower half of a fifth segment at the top. The fourth segment of the series appears to be about 18 mm. in diameter, which indicates a decrease in size of the siphuncle in

an upward direction, as in the specimen of *Actinoceras rotulatum* figured by Barrande. Two and a half segments occur in a length equal to the diameter of the siphuncle. The segments form an angle of about 77 degrees with the vertical axis of the siphuncle. Their vertical outlines are evenly convex from septum to septum. The septa are deeply concave.

Locality and Horizon. — Drummond Island, presumably in the Manistique formation.

Specimen numbered 33429 in the British Museum of Natural History.

8. ACTINOCERAS (ARMENOCERAS) ROTULATUM (Billings)

(Plate I, Figs. 3 A, B, C)

Orthoceras rotulatum Billings, Geol. Surv. Canada, Rep. Progress for 1853–56, published in 1857, p. 334. Barrande, Syst. Sil. du Centre Boheme, 2, pt. 3, 1874, p. 732, Pl. 437, Figs. 1–5.

Three specimens were described by Billings in his original description of the species. All of these appear to be lost. No figures were ever published, so that only the description remains as a means of identification. The first specimen is described as having a conch 51 mm. in diameter, with a siphuncle nearly 30 mm. in diameter and located nearly 6.5 mm. from the ventral wall of the conch. The segments of the siphuncle form an angle of about 70 degrees with the vertical axis. Three and a half segments occur in a length equal to the diameter of the siphuncle. The vertical outlines of the segments are evenly convex from septum to septum. All three specimens are described as found at the head of Lake Timiskaming, in Niagaran strata.

The specimen figured by Barrande (Plate I, Figs. 3 A, B, C of the present publication) consists of a siphuncle only 22 mm. in diameter, narrowing gradually to 19 mm. in a length of 60 mm. toward the top of the specimen. This narrowing takes place both laterally and dorso-ventrally. The segments present evenly convex outlines and form an angle of about 73 degrees with the vertical axis of the siphuncle. This specimen also was

obtained in the Lake Timiskaming area. It agrees with the type apparently in every respect except its smaller size.

Remarks. — *Actinoceras rotulatum* appears closely related to *Actinoceras backi*, in the relative size of siphuncle and conch, and in the obliquity of its segments. In typical *Actinoceras rotulatum*, however, the siphuncle is distinctly removed from contact with the ventral wall of the conch, and the number of segments in a length equal to the diameter of the siphuncle is distinctly greater.

9. HURONIELLA INFLECTA (Parks)

(Plate XVI, Figs. 2 A, B)

Huronia inflecta Parks, Trans. Royal Canadian Inst., 9, 1915, p. 75, Pl. 6, Fig. 4.

Type specimen. — Siphuncle 45 mm. in diameter, with three and a half segments in a length equal to this diameter; the segments form an angle of about 83 degrees with the vertical axis of the conch. The septa are adnate to the lower side of the segments, and along the area of adnation the vertical outline tends to be slightly concave. The line along which the septa become free rises from the dorsal toward the ventral side of the conch, the upper, annular part of the segments being slightly more rapidly rounded on the ventral than on the dorsal side.

Found at the Limestone rapids, on the Severn River, west of Hudson Bay, presumably from the Ekwan River limestone member of the Niagaran.

Specimen No. 310S in the Royal Ontario Museum of Paleontology.

University of Michigan specimen. (Plate XVI, Fig. 2 A, B). — This specimen exposes fourteen segments of the siphuncle in a length of 207 mm., enlarging from a diameter of 51 mm. at the base to 57 mm. at the tenth segment farther up. On the average, about three and a half segments occupy a length equal to the maximum diameter of the segments at the annulations, but at one point this number equals almost four segments. In a segment 14 mm. in length, the diameter at its base is 46.5 mm.;

from this point it enlarges to a maximum diameter of 55 mm., the lower half of the segment being funnel-shaped in outline. Along the dorsal side of the segment the vertical outline of the lower half of the segment forms an angle of 40 degrees with the vertical axis; on the ventral side this angle is nearer 35 degrees. The line at which the septa become free from the lower part of the segments rises from about 3 mm. above the base along the dorsal side of the segment to 9 or 10 mm. above the base along its ventral side. Below this line the lower part of the segment has a slightly concave outline along its dorsal outline, of which practically no trace remains along its ventral side. As in other actinoceroids, the annulations are much more broadly curved along the dorsal than along the ventral side, in a vertical direction. The plane of separation between the segments forms an angle of 82 to 80 degrees with the vertical axis of the siphuncle.

The readiness with which actinoceroids lost the greater part of their shell — only the siphuncle remains — is shown by this specimen in which a considerable part of the siphuncle is well preserved, but no trace of the free part of the septa remains. Several colonies of *Aulopora* are attached to its upper part. While calcareous deposits fill the lower part of the siphuncle as far as its center, at the ninth segment from the base these deposits are confined to the exterior of the siphuncle and vary from 3 to 5 mm. in diameter, becoming even thinner toward the top of the specimen.

Specimen No. 3647 in the University of Michigan Museum.

From some unknown locality, in the Niagaran. There is a possibility that this specimen was obtained from the same source as the *Huronia septata* figured in the present publication, since it resembles the latter lithologically, both being silicified in the same manner. The specimens from the Hudson Bay area are not silicified.

Remarks. — *Actinoceras inflecta* is similar to *Actinoceras hearsti* Parks in the size of the siphuncle and in the number of segments in a length equal to the maximum diameter of the siphuncle; also in the obliquity of the segments and in the relative convexity of their vertical outlines followed from the dorsal toward the ventral

side of the siphuncle. It differs, however, in being distinctly concave along the lower half of the vertical outlines of the segments, where it is in contact with the septa, which results in a very different appearance in vertical sections.

10. HURONIELLA EHLERSI, sp. nov.

(Plate XV, Fig. 1; Plate X, Fig. 1)

Type specimen. — The specimen consists of a large siphuncle, including twelve segments, with the upper part of a thirteenth segment at its base. The total length of the twelve segments is 260 mm. The average length of the six lower segments is 21 mm., while that of the six upper segments is 22.5 mm. The lateral diameter of successive segments varies irregularly between 54 and 56 mm., with no appreciable increase in diameter of a permanent character within the length of the specimen. The most striking feature of this specimen is the strong obliquity of its segments; the plane of separation between the latter forms an angle of 76 degrees with the vertical axis of the siphuncle. The segments are large and prominent. Two and a half segments occur in a length equal to their maximum lateral diameter. Only the ventral and lateral sides of the siphuncle are well exposed, but sufficient is seen of the dorsal side also to indicate its characteristics. The segments expand quite evenly from their bases to the annulations. The latter are not distinctly demarcated along their lower margins from the underlying parts of the segments, as in typical *Huronia*. The maximum prominence of the annulations is conspicuously above mid-height of the segments. Along their ventral side it is about two-thirds of the length of the segment above its base, and from this point it declines on approaching the dorsal side of the siphuncle, while the annulations at the same time become more broadly rounded, as in other actinoceroids. Along the ventral side, the vertical outline of the lower part of the segments, as far up as the annulations, is nearly straight, and forms an angle of 28 degrees with the vertical axis. Along the lateral sides of the segments, the corresponding vertical outline is slightly concave, and the angle with the vertical axis is nearer 33 degrees. The amount of this

concave curvature along the lateral and dorsal sides is, however, much less than in typical *Huronia obliqua*, and there is no trace of a pestle-like structure.

The segments of the siphuncle enlarge from about 40 mm. at their bases to 54 or 56 mm. at the most prominent part of their annulations. At the sutures between the segments the narrowly involuted part of the siphuncle has a width of 6 mm.

Locality and Horizon. — From Scott quarry, in Chippewa County, Michigan; in section 29, T 44 N, R 4 W, in the Manistique formation. Specimen No. 7541 in the University of Michigan collection.

Remarks. — *Actinoceras ehlersi* apparently is related to the specimen figured on Plate XVI of this publication under the name *Actinoceras inflecta*, but the segments of the siphuncle are relatively taller, and the vertical outline of these segments is less concave along their lower halves.

HURONIA

The type of the genus *Huronia* is *Huronia bigsbyi*, described by Stokes from the Niagaran of Drummond Island. This species is characterized by having the annulated part of the segments of the siphuncle limited to their upper extremities; their remaining portions are extended into a broadly cylindrical form. The annulation and cylinder together resemble an inverted pestle in which the cylindrical part is very broad. Among other forms having the same type of structure are *Huronia vertebralis* Stokes and *Huronia minuens* Barrande.

Included in *Huronia* is a second group of species, typified by *Huronia obliqua*, also from the Niagaran of Drummond Island, which is characterized by having that part of the segments of the siphuncle which lies beneath the annulation contracted downward into a form approximately inversely conical, instead of cylindrical. This group of species includes also *Huronia turbinata* Stokes and *Huronia distincta* Barrande. In this second group the vertical outline along the lower half of the segments tends to be obliquely concave.

In this respect the second group is similar to that division of the genus *Actinoceras* in which the lower part of the segments likewise tends to be obliquely concave in vertical outline. This third group includes the species described originally as *Orthoceras persiphonatum* Billings and *Huronia inflecta* Parks. In this third group the septa are adnate to the lower part of the annulations forming the segments of the siphuncle. Along this adnate portion of the vertical section the outline is distinctly concave. If emphasis be placed on the concave vertical outline along the lower part of the segments of the siphuncle, the species forming this third group also could be included in the genus *Huronia*. If, however, emphasis be placed on the moderate vertical elongation of the lower part of these segments, beneath the annulation, these forms could be included in the second group of the genus *Actinoceras*, in which the septal necks are very short. In the present publication *Orthoceras persiphonatum* and *Huronia inflecta* are placed in *Huroniella*, with *Huronia inflecta* as the genotype.

In *Huronia* the septa are adnate to the lower portion of the segments of the siphuncle and the basal part of the annulations at their top, becoming free where the concave vertical outline along the basal part of the annulations reverses to convex on approaching the outer limits of these annulations. This type of structure, as noted above, is present in elementary form also in species of *Huroniella*, from which genus *Huronia* evidently evolved.

In both *Huronia* and *Actinoceras* the interior of the siphuncle was filled by organic calcareous deposits. These begin to form around the inner margin of the septal necks. Additional layers are added until vertical sections of the deposits resemble lunettes, with the convex sides facing the interior of the siphuncle. Eventually the lunettes of successive septal necks come in contact with one another. Since the lunettes grow more rapidly in an upward than in a downward direction, successive lunettes meet along a line distinctly above mid-height of the segments of the siphuncle. The coming in contact of the lunettes leaves triangular spaces between the outer margins of adjacent lunettes and

the inner surface of the more prominent part of the intermediate annulations. These triangular spaces eventually become filled with calcareous deposits similar to those forming the lunettes. Calcareous deposits are added also along the side of the lunettes facing the center of the siphuncle, until only a central space remains, which is often called the endosiphuncle. In vertical sections through the center of the siphuncle, this endosiphuncle appears connected with strands which curve downward and outward, until they are slightly below the level of the central part of the annulations, after which the apparent strands curve upward toward the center of the latter. These strands probably represent the shrunken remains of the organic membranes secreting the calcareous deposits. In some cases they appear to be strands, in other cases they appear to be curved membranes, and in still others they appear to be membranes thickened locally by radiating strands. The deposits appear to be more or less fibrous in character. The fibers appear to be arranged more or less at right angles to the successive areas of deposition. Frequently more or less distinct vertical lamellae, radiate in direction, are formed. Both the radiate vertical lamellae and the transverse lamellae outlining successive stages of growth of the lunettes are well shown by weathered specimens exposing the interior of the siphuncle.

11. **HURONIA BIGSBYI** Stokes

(Plate IV, Fig. 1; Plate XI, Fig. 1)

Huronia bigsbyi Stokes, Trans. Geol. Soc. London, 2d Ser., 1, 1824, explanation of Pl. 28, Fig. 1.

Type specimen. — In the type specimen figured by Stokes the segments of the siphuncle are in the form of an inverted pestle; nearly three-quarters of the length of each segment is approximately cylindrical, but the uppermost portion of each segment, for a distance equalling about 27 per cent of its length, is enlarged conspicuously so as to form a rather abrupt annulation. This annulation is nearly one-third larger in diameter than the basal part of the segment. The most characteristic feature of this species is the considerable length of its segments, which

equals the width of the segment at its base. According to Dr. F. A. Bather, who kindly examined the type, the suture between the segments forms an angle of about 83 degrees with the vertical axis of the siphuncle.

Locality and Horizon. — Drummond Island, presumably in the Manistique formation.

Specimen No. C. 2948 in the British Museum of Natural History.

University of Michigan specimens. — Among the various forms of *Huronia* from Drummond Island, belonging to the University of Michigan, typical *Huronia bigsbyi* is represented by specimens No. 2814 (Plate IV, Fig. 1) and 2812, in which the annulations are distinctly less in length than one-third of the total length of the segments. In the Manistique formation.

12. HURONIA BIGSBYI INTERMEDIA, var. nov.

(Plate IV, Figs. 4, 5; Plate XVI, Fig. 1; Plate XI, Fig. 4)

Huronia bigsbyi Barrande, Syst. Sil. du Centre Boheme, 2, pt. 3, 1874, p. 743, Pl. 436, Figs. 1–3.

Type specimen No. 7539, University of Michigan. — In the collections of the University of Michigan, specimens No. 7539 (Plate IV, Fig. 4), 3658 (Plate XVI, Fig. 1), 3649, from Drummond Island, and specimen No. 8753 (Plate IV, Fig. 5), from Scott quarry in Chippewa County, resemble typical *Huronia bigsbyi* in having the length of the segments of the siphuncle equal to the diameter of these segments at their bases, but the annulations are relatively longer, occupying approximately one-third of the total length of the segments, or even exceeding one-third. The first, second, and last of the specimens mentioned are figured here. All are from the Manistique formation.

Barrande specimen. — The specimen figured by Barrande agrees with typical *Huronia bigsbyi* in the cylindrical form of the lower two-thirds of each segment, and in the relatively abrupt enlargement of its upper third into an annulation, but this annulation forms a relatively greater part of the total length of the segment. Moreover, the length of the segments is distinctly less than their diameter at the base, equalling from 80 to 90 per

cent of the latter. In *Huronia vertebralis* the length of the segments, as compared with their maximum diameter at the annulations, is still less.

13. **HURONIA VERTEBRALIS** Stokes

(Plate V, Figs. 5, 1; Plate IV, Figs. 3, 2; Plate XI, Fig. 2)

Huronia vertebralis Stokes, Trans. Geol. Soc. London, 2d Ser., 1, 1824, explanation of Pl. 28, Figs. 2, 6.

Orthoceras canadense Billings, Geol. Surv. Canada, Rep. Progress for 1853–56, published in 1857, pp. 321–328.

Huronia vertebralis Barrande, Syst. Sil. du Centre Boheme, 2, pt. 3, 1874, Pl. 436, Figs. 5–7.

Huronia bigsbyi Barrande, Syst. Sil. du Centre Boheme, 2, Suppl. 1877, Pl. 474, Figs. 2–4.

Type specimen. — The specimen of *Huronia vertebralis* (Plate V, Fig. 5) figured by Stokes is similar to *Huronia bigsbyi* in the approximately cylindrical form of the lower half of the segments of the siphuncle, but the annulations at their top form a much larger part of the length of the segments, equalling almost or fully half of the total length of the latter. Moreover, the segments are relatively shorter, since the length of one and a third segments is necessary to equal the diameter of the lower part of these segments. According to Dr. F. A. Bather, who kindly made the necessary measurements, the plane of separation between successive segments makes an angle of 86 degrees with the vertical axis of the siphuncle.

No. 23460 in the British Museum of Natural History. From Drummond Island, Lake Huron. In the Manistique formation.

A copy of the figure of this type is presented by Fig. 5 on Plate V of the present publication, but in this copy the two lower segments of the original figure have been omitted.

Type of *Huronia canadense* Billings (Plate V, Fig. 1). — The specimen described by Billings is similar in all essential respects to the type of *Huronia vertebralis*, differing only in size. This suggests that it belongs to the apical end of a siphuncle. Barrande figured a vertical section through the center of the two middle segments of the siphuncle, of which the type originally had six. All of these segments are still at hand, but the speci-

men is broken into three parts of two segments each. The two lower segments probably were used by Barrande for his figure of the exterior of two of the segments of the siphuncle. The two upper segments were never figured.

Barrande specimen. — The specimen from Drummond Island, figured by Barrande on Plate 474, belongs to the University of Michigan, where it is numbered 2815. This specimen is re-figured in the present publication as Fig. 3 on Plate IV. Only the uppermost segment of this specimen has not been distorted by pressure. All the remaining segments are flattened more or less; the amount of this flattening increases in successive segments on approaching the lower end of the specimen. Originally the five segments probably were nearly of the same form and diameter, though this need not necessarily have been the case, since the siphuncle of actinoceroids often diminishes in diameter toward the top of the phragmacone. From the Manistique formation.

Engadine specimen. — This specimen (Plate IV, Fig. 2) possesses all the characteristics of *Huronia vertebralis* except that the segments are slightly shorter. The plane of separation between the successive segments forms an angle of 84 or 85 degrees with the vertical axis of the siphuncle. The specimen was found northeast of Engadine, in Mackinac County, Michigan, along a north and south road following the west line of section 34, T 44 N, R 10 W. It is numbered 7549 in the collections of the University of Michigan.

14. HURONIA ENGADINENSIS, sp. nov.

(Plate VI, Fig. 2; Plate XI, Fig. 3)

Type specimen. — Segments of the siphuncle strongly oblique, the plane of separation between successive segments forming an angle of about 80 degrees with the vertical axis of the siphuncle. The maximum width of the segment at its annulation is from one and a half to one and two-thirds of its length. The lower part of each segment, along five-ninths of its length, is approximately cylindrical; the upper part is strongly annulated.

From drift along the north and south road following the west line of section 3, T. 43 N, R 10 W, and section 34, T 44 N, R 10 W, northeast of Engadine, in Mackinac County, Michigan. From the Manistique formation.

Specimen No. 7562 in the University of Michigan collection.

Remarks. — *Huronia engadinensis* resembles *Huronia vertebralis* in the cylindrical character of the lower part of the segments and the relative length of the segment occupied by the annulation; moreover, the length of the segments, as compared with the maximum diameter of their annulations, is the same. But it differs in the much greater obliquity of the plane of separation between the segments.

Compared with *Huronia obliqua*, the obliquity of the segments is the same; but the segments are much longer, and their lower parts are much more cylindrical. Compared with *Huronia turbinata*, the annulations are almost equally prominent. But the siphuncle enlarges much more slowly, and the obliquity of the segments is greater.

A similar specimen, three segments in length, was found in the Scott quarry, in the Manistique formation.

15. HURONIA ANNULATA Hall

(Plate XI, Fig. 5; Plate VI, Figs. 3, 1; Plate XII, Fig. 6)

Huronia annulata Hall, Geol. Lake Superior Land District, Foster and Whitney's Report, 1851, p. 221, Pl. 34, Fig. 4.

Type specimen. — The specimen figured by Hall is not listed in the *Catalogue of the Types and Figured Specimens in the Palaeontological Collection of the American Museum of Natural History*, published in 1899, and probably is lost. According to the published figure the specimen was about 320 mm. in length, and included fourteen segments of the siphuncle in a length of 260 mm. About two segments occur in a length equal to the diameter of these segments at their annulations. Beneath these annulations, the lower two-thirds of the segments is cylindrical rather than inversely conical in outline. The annulations are relatively broad, in a vertical direction, as compared with the total length

of the segments. This specimen was obtained, associated with *Huronia vertebralis* and *Discosorus halli* at Orthoceras Point, 8 miles northeast of Point Detour, in Delta County, Michigan. An outline of part of the type, based on part of the figure published by Hall, is presented by Figure 5 in Plate XI of the present publication.

At Manistique, 21 miles northeast of Orthoceras Point, a similar specimen, No. 2806, University of Michigan Collections, was found. This presents sixteen segments in a length of 278 mm.; the five lower segments occupy a total length of 80 mm., while the upper five have a total length of 92 mm. The annulations are conspicuous, and occupy more than half of the total length of the segments. In the Manistique formation.

Similar specimens occur also on Drummond Island, in the Manistique formation. Specimen No. 2811, University of Michigan Collections (Plate VI, Fig. 3, and Plate XII, Fig. 6), has one and two-thirds segments in a length equal to the diameter of these segments at their bases, two of these segments being only slightly less in total length than the diameter of these segments at their annulations. The plane of separation between successive segments forms an angle of about 85 degrees with the vertical axis of the siphuncle. *Huronia minuens* differs from this type of siphuncle chiefly in the shorter length occupied by its annulations. In the specimen of *Huronia annulata*, No. 2810, University of Michigan collections (Plate VI, Fig. 1), the obliquity of the segments of the siphuncle is greater.

16. **HURONIA MINUENS** Barrande

(Plate V, Fig. 3)

Huronia minuens Barrande, Syst. Sil. du Centre Boheme, 2, pt. 3, 1874, p. 744, Pl. 435, Fig. 4.

Type specimen. — The specimen figured by Barrande resembles *Huronia vertebralis* in the relative length of its annulations; the latter occupy about half the length of the individual segments. It differs in the length of the segments as compared with the diameter at their base, the length of two segments being

required to equal this diameter. The diameter of five of the annulations in ascending order is 47, 47, 45.5, 44, and 44 mm. There appears to be no special significance in this diminution in diameter toward the top of the specimen. Similar contractions in diameter toward the top of siphuncles is observed in other actinoceroids, and usually is significant only of old age.

From Drummond Island, presumably in the Manistique formation.

Remarks. — *Huronia minuens* appears to differ from *Huronia annulata* chiefly in the relatively shorter length of the segments of the siphuncle as compared with the diameter of these segments at their annulations. The annulations also appear to be slightly shorter as compared with the total length of the segments. The differences evidently are slight and it will be difficult to distinguish *Huronia minuens* and *Huronia annulata* in the present state of our knowledge of these forms.

17. HURONIA PAULODILATATA, sp. nov.

(Plate XV, Fig. 3; Plate X, Fig. 2)

Type specimen. — This consists of a siphuncle with ten segments in a length of 234 mm.; very slowly enlarging, from a maximum lateral diameter of 46 to 47 mm. at the lowest segment to 48 or 48.5 mm. at the top segment. All of the segments are from 1 to 1.5 mm. narrower dorso-ventrally than laterally. There is also a slight increase in length of the segments, from a total length of 68 mm. for the three lower segments to one of 71 mm. for the three upper segments. The plane of separation between the segments forms an angle of 80 to 83 degrees with the vertical axis of the siphuncle.

The individual segments expand relatively slowly and quite evenly from their base toward the top. The second segment from the base expands from 39 mm. at its base to 46 mm. at the point of maximum expansion of the annulation. This annulation forms a little less than one-third of the total length of the segment along the ventral side of the siphuncle, and a little more than one-third along its dorsal side. The line along which the

septum became free from the lower part of the annulation descends from 3 to 4 mm. below the plane of separation between the segments on the ventral side to 9 or 10 mm. below on the dorsal side, the total length of the segments being about 22 mm. At the base of each segment the walls of the siphuncle are strongly and abruptly inflected, so that from a diameter of 39 mm. at the base of the segment the inflected part narrows to a diameter of 29 mm. transversely.

Locality and Horizon. — From Scott quarry, in Chippewa County, Michigan; in section 29, T 44 N, R 4 W. Specimen No. 7543 in the University of Michigan. In the Manistique formation.

Remarks. — *Huronia paulodilatata* is related most closely to *Huronia bigsbyi*, from which it differs in the more even rate of enlargement of the segments from their base to the maximum diameter of the annulation, and in the very inconspicuous enlargement of the segments along their annulations. Moreover, the segments are relatively much shorter, two segments occupying a length equal to their maximum diameter.

With *Huronia obliqua* it agrees in the obliquity of the segments and in their relative length, but the annulations form a much smaller part of the length of the segments and they are far less conspicuous.

18. **HURONIA OBLIQUA** Stokes

(Plate V, Fig. 4; Plate VI, Fig. 4; Plate XII, Figs. 1, 2; Plate XIII, Figs. 2 A, B; Plate XVII, Figs. 1 A, B)

Huronia obliqua Stokes, Trans. Geol. Soc. London, 2d Ser., 1, 1824, Pl. 28, Fig. 4.

Huronia obliqua Foord, Cat. Foss. Ceph. British Mus., 1, 1888, p. 200, Fig. 28.

Type specimen. — The figure of the type (Plate V, Fig. 4) presented by Stokes includes only six segments of the siphuncle, but Foord states that this type consists of about seven segments, varying but little in diameter, the rate of increase of the siphuncle being about 1 in 18. About two-thirds of the specimen is imbedded in the limestone matrix. The segment at the smaller end of the specimen has a length of 12 mm., and a maximum

diameter of 26 mm., so that two segments occupy a length equal to the maximum diameter of the annulation. This annulation forms approximately two-thirds of the length of the segment. The segments enlarge strongly, from 16 mm. at their base to 26 mm. at the maximum diameter of the annulation. According to Dr. F. A. Bather, who kindly examined the type, the plane of separation between successive segments forms an angle of 80 degrees with the vertical axis of the siphuncle. This is the angle presented by the figures published by Stokes and Foord, cited above. Foord states that in several specimens fragments of the septa are attached to the siphuncle, which enfold each segment up to the point where the most inflated part begins, from whence they arch upward to the shell-wall. It is unfortunate that he did not figure one of these specimens, in which the structure of the siphuncle and septa is correctly interpreted, instead of republishing the erroneous figure, based on a drawing by Dr. Bigsby, presented by S. P. Woodward in his *Manual of Mollusca* (3d ed., 1875, p. 192, ff. 56 a, b).

Foord also calls attention to the fact that, as in other actinoceroids, the vertical outlines of the annular enlargements are more rapidly rounded on the ventral side than on the dorsal side, producing here a more subturbinate appearance. This is due to the more rapid rise of the line at which the septa become free from the lower side of the annulations than of the upper margin of the annulations.

The type of *Huronia obliqua* is numbered 33433 in the British Museum of Natural History, and presumably is from the Manistique formation on Drummond Island.

University of Michigan specimens. — Several specimens in the collection of the University of Michigan resemble typical *Huronia obliqua* in the size and general shape of the segments of the siphuncle, but they differ considerably in the obliquity of these segments and in the abruptness with which they enlarge at the base of the annulations. In the type figured by Stokes, the obliquity of these segments, as compared with the vertical axis, is 80 degrees, and the segments enlarge so abruptly at the base of the annulations that a subturbinate form results.

In the collection of the University of Michigan, specimen No. 7546 (Plate VI, Fig. 4) has an obliquity of 81 degrees, but the enlargement of the segments at the base of the annulations is less abrupt.

Specimens No. 2810 (Plate VI, Fig. 1) and 7545 (Plate VI, Fig. 5), on the contrary, have obliquities of only 85 and 87 degrees respectively, and, although evidently closely related to typical *Huronia obliqua*, they more nearly resemble *Huronia distincta* in this respect. In specimen 2810 the segments enlarge strongly and abruptly at the base of the annulations. In specimen 7545 the rate of enlargement from the base of the segments to the maximum diameters of their annulations is even more regular than in typical *Huronia distincta*.

The specimens numbered 2810, 7545, and 7546 are from Drummond Island, Lake Huron, and were found in the Manistique formation.

Gould City specimen preserving septa. — In the collection of the University of Michigan there is a large specimen, No. 7540 (Plate XVII, Figs. 1 A, B; Plate XIII, Figs. 2 A, B), from the Manistique formation, a mile and a half south of Gould City, in Mackinac County, Michigan, which preserves traces of the septa. In this specimen the obliquity of the segments, as compared with the vertical axis of the siphuncle, is 80 degrees, and two segments occupy a length equal to the maximum diameter of their annulations. The enlargement of the segments at the base of the annulations is fully as abrupt as in the type of *Huronia obliqua*. On this account the Gould City specimen is identified with the latter species.

The length of the Gould City specimen is 435 mm. It exposes the ventral side of the conch. It is a cast of the interior which has been weathered sufficiently to expose the ventral side of the segments of the siphuncle. Twenty of these segments are exposed to varying degrees. The five lowest segments occupy a total length of 90 mm.; the next five, 90 mm.; the next five, 87 mm., and the last five, 97 mm.; above this length the segments of the siphuncle are not exposed distinctly. At the base of the specimen the maximum diameter of the annulations is

38 mm.; at the top of the specimen, this diameter appears to be 48 mm.; half-way between, this diameter is 49 mm., but here the siphuncle evidently is strongly depressed dorso-ventrally. The septa are fairly well indicated from the ninth segment above the base of the specimen to the nineteenth segment. They are visible only from the point where they become free from the annulations, a short distance below the maximum expansion of the latter. From this point they may be traced laterally across the ventral side of the specimen as far as the specimen is preserved. It is evident that the sutures of the septa curve strongly downward on this ventral side, forming deep lobes. At the eighteenth segment above the base of the specimen, the course of the septum within the shell is exposed for a considerable distance. From this it is evident that the septa are deeply concave, almost funnel-shaped, at least along the ventral side of the conch.

Engadine specimen. — Another specimen, belonging to the University of Michigan, resembles *Huronia obliqua* in the strong obliquity of its segments, and in their relative length as compared with their height. The plane of separation between the segments forms an angle of 80 degrees with the vertical axis of the siphuncle, and it requires a little more than the length of two segments to equal the maximum diameter of the annulations. This specimen, however, differs from typical *Huronia obliqua* in the absence of any abrupt enlargement of the segments at the base of the segments. These segments, on the contrary, enlarge quite evenly from their base to the maximum diameter of the annulations, with only a slight increase in this rate of enlargement at the base of the annulations.

From northeast of Engadine, in Mackinac County, Michigan, along the north and south road following the west line of section 34, T 44 N, R 10 W. Specimen numbered 7550 in the University of Michigan collection. From the Manistique formation.

19. HURONIA PORTLOCKI Stokes

(Plate IX, Fig. 9; Plate XII, Fig. 3)

Huronia portlockii Stokes, Proc. Geol. Soc. London, 2, 1838, p. 689; Trans. Geol. Soc. London, 2d Ser., 5, 1840, p. 710, Pl. 60, Fig. 5; Foord, Cat. Foss. Ceph. British Museum, 2, 1891, p. 383.

Type specimen. — This consists of two parts, of which only the lower part, including five annulations of the siphuncle, was figured by Stokes. Of the part figured by Stokes, the lowest annulation is omitted in the figure presented in the present publication. Two additional annulations occur on the second part of the specimen, not figured by Stokes, but recognized by Foord as belonging to the top of the same specimen. In its partially restored condition the specimen shows parts of eight camerae. The conch was at least 80 to 85 mm. in diameter. The segments of the siphuncle are about 35 mm. in diameter at the annulations. The septa are about 16 to 18 mm. apart. The septa become free from the lower side of the annulations where the concave curvature of the lower half of the segments of the siphuncle changes to the convex curvature of the annulations. About two segments occur in a length equal to the maximum diameter of these segments at their annulations. The siphuncle is close to the ventral wall of the conch, though apparently not in actual contact with the latter. In that location the annulations should incline in the same direction as the segments, though to a lesser degree, since the line at which the septa become free from the lower side of the annulations rises from the dorsal toward the ventral side of these annulations. According to Dr. F. A. Bather, who kindly examined the type, these annulations incline at an angle of 75 degrees with the vertical axis of the siphuncle.

Locality and Horizon. — Drummond Island, probably in the Manistique formation.

Specimen No. 33418 in the British Museum of Natural History.

Remarks. — Foord states that this species most nearly resembles *Huronia obliqua* Stokes, from which it differs in the per-

fect horizontality of its siphuncular segments, and in the greater distance of the septa from one another. As noted above, Dr. Bather indicates an obliquity of 75 degrees with the vertical axis of the siphuncle, while that of *Huronia obliqua* is 80 degrees. Moreover, if two segments of the siphuncle of *Huronia portlocki* occupy a length equal to the diameter of their annulations, this also agrees very well with *Huronia obliqua*. It will require a vertical section through the type of *Huronia portlocki* to determine definitely whether these species are distinguishable.

20. **HURONIA DISTINCTA** Barrande

(Plate VI, Figs. 6, 5; Plate XII, Fig. 5)

Huronia sp. Stokes, Trans. Geol. Soc. London, 2d Ser., 5, 1840, p. 710, Pl. 60, Fig. 2.

Huronia distincta Barrande, Syst. Sil. du Centre Boheme, 2, pt. 3, 1874, p. 745, Pl. 231, Fig. 2.

Huronia distincta Foord, Cat. Foss. Ceph. British Mus., 1, 1888, p. 204.

Type specimen. — The figure (Plate VI, Fig. 6) presented by Stokes formed the type of *Huronia distincta*. Two of the segments equal or slightly exceed in length the maximum diameter of their annulations. Those parts of the segments which are beneath the annulations are not cylindrical, but diverge from the base upward, with a moderate increase in divergence at the base of the annulations. According to Dr. F. A. Bather, who kindly measured the specimens, the plane of separation between the segments forms an angle of 85 degrees with the vertical axis of the siphuncle.

From Drummond Island, Lake Huron. In the Manistique formation.

Specimen No. 33417 in the British Museum of Natural History.

Remarks. — Foord states that "*Huronia distincta* differs from *Huronia vertebralis*, its nearest ally, in the greater breadth of the siphuncular segments in proportion to their height. Their inflated rims are also less prominent than those of *Huronia vertebralis*."

In my opinion the relationship is rather with *Huronia obliqua*,

from typical forms of which it differs chiefly in the smaller obliquity of its segments, and less prominence of its annulations.

Specimen 7545, University of Michigan collections (Plate VI, Fig. 5), from the Manistique formation of Drummond Island, has an obliquity of 87 degrees, in this respect resembling *Huronia distincta,* though evidently belonging to the *Huronia obliqua* group.

21. HURONIA SEPTATA Parks

(Plate VIII, Fig. 1; Plate X, Fig. 6)

Huronia septata Parks, Trans. Royal Canadian Inst., 11, 1915, p. 27, Pl. 5, Fig. 8.

Type specimen. — The type of *Huronia septata* consists of a specimen showing a vertical section through the central part of the siphuncle. Although part of the surrounding matrix is present, no trace of the septa is preserved. The specimen is 115 mm. in length and consists of six segments, varying from 19 to 20 mm. in length. Their diameter enlarges from 25 mm. at the base to 37 mm. at their point of greatest expansion. This point is located 5 or 6 mm. below the top of the segment. The upper two-thirds of each segment is quite evenly convex in vertical sections, while the lower third or even a half tends to be more or less concave in an oblique direction. The involuted part, between successive segments, is about 3 mm. in width and curves downward toward its inner margin. The total thickness of this involuted part, in a vertical direction, is only one-fourth of a millimeter. The interior of the siphuncle exposes the vertical radiating plate-like structure seen in other species of *Huronia.* Unfortunately it is impossible to determine from the type whether the segments were appreciably oblique to the vertical axis, or at what point the septa became free from the lower part of the annulations.

Locality and Horizon. — From the Lower Rapids on the Shammattawa River. Referred doubtfully to the Ordovician, by Parks; probably from the Shammattawa limestone member of the Richmond formation.

Savage and Tuyl specimen. — Professors Savage and Tuyl collected on the Shammattawa River in strata, apparently of Rich-

mond age, a well-preserved siphuncle, presumably identical specifically with *Huronia septata*. This specimen differs chiefly in having slightly shorter segments. The area along which the septa are adnate to the lower half of the segments is distinctly concave in vertical sections. The line at which the septa become free from the lower part of the annulations is distinctly defined, and rises strongly from the dorsal toward the ventral side of the siphuncle.

University of Michigan specimen (Plate VIII, Fig. 1.) — This specimen consists of five segments of the siphuncle in which the adnation of the septa to the lower part of the segments is indicated distinctly. These segments originally occupied a total length of 86 mm., and they increase in diameter from 37 mm. at the lowest segment to 39 mm. at the uppermost one, in a lateral direction. Dorso-ventrally their diameter is slightly smaller. Where the diameter of the segments is 38 or 39 mm., two segments occupy a length of 35 mm. At their base the lateral diameter of these segments is only 28 mm., and from this base the lateral walls of the siphuncle curve concavely upward and outward, as far as the line where the septa become free from the lower side of the annulations. Where the segments are 17 mm. in height, this line rises from a level of 4 or 5 mm. above the base, along the dorsal side of the siphuncle, to 8 or 9 mm., along its ventral side. The concave curvature is marked more strongly along the dorsal than on the ventral side of the segments. Above the line along which the septa become free the segments are broadly annulated; the annulations are broadly rounded in vertical outline along the dorsal side, and distinctly less broadly rounded along the opposite side. At the sutures between the successive segments the walls of the siphuncle are narrowly involuted, the width of the involution being about 3 mm. The plane of separation between the segments forms an angle of 87 to 90 degrees with the vertical axis of the siphuncle.

From the Nelson River, near the mouth of Limestone River, in the area west of Hudson Bay. In the Richmond (Shammattawa) limestone.

Specimen No. 2479, University of Michigan collection.

Remarks. — The Nelson River specimen appears to be iden-

tical with that obtained by Professors Savage and Tuyl from the Shammattawa River, and both probably are identical with the form described by Parks as *Huronia septata*. The relations of this species evidently are with the group typified by *Huronia obliqua*. From the latter species it differs in the much smaller obliquity of its segments. From *Huronia distincta* it differs in its more broadly rounded annulations.

The occurrence of a species of *Huronia* in Richmond strata indicates that this type of structure originated much earlier than was supposed previous to the investigations of Professor Parks.

A *Huronia*-like cephalopod, with the siphuncle flattened against the ventral wall of the conch is known from Richmond strata also from the Big Horn Mountains of Wyoming, at Medicine Mountain; a specimen is preserved in the collections of the U.S. National Museum. The internal structure of this specimen, however, has not yet been studied.

In all species of *Huronia* the walls of the siphuncle are narrowly involute in the space between successive septa; the vertical thickness of this involute portion is often less than half a millimeter. Frequently this involute portion forms a circular band 3 or 4 mm. in width, curving slightly or distinctly downward toward its inner margin. This narrowly involute portion is distinctly differentiated from the vertically concavely curved lower part of the segments in such species as *Huronia obliqua* and related forms. No differentiation of this type occurs in the forms of *Actinoceras* typified by *Actinoceras bigsbyi*, in which the concave vertical outline beneath the annulations belongs to the septal necks, and in which there is no additional narrow involution between the segments of the siphuncle.

22. **HURONIA TURBINATA** Stokes

(Plate VIII, Fig. 8; Plate X, Fig. 5)

Huronia turbinata Stokes, Trans. Geol. Soc. London, 2d Ser., 1, 1824, explanation of Pl. 28, Fig. 3.

Huronia turbinata Foord, Cat. Foss. Ceph. British Mus., 1, 1888, p. 206.

Type specimen. — The specimen figured by Stokes (Plate VIII, Fig. 8) consists of six segments of a siphuncle. This siphuncle

enlarges rapidly. According to Foord, the rate of enlargement can not be determined accurately, since the greater part of the specimen is imbedded in the rock, but it may be taken at about 1 in 8. Moreover, the annulations are remarkably prominent as contrasted with the diameter of the lower part of the segments. According to Dr. F. A. Bather, who kindly measured the type, the obliquity of the segments of the siphuncle compared with their vertical axis equals 85 degrees or less.

From Point Detour, Michigan, opposite Drummond Island, Lake Huron; presumably in the Manistique formation.

Specimen No. C.2954 in the British Museum of Natural History.

23. **HURONIA ROMINGERI** Barrande

(Plate VI, Figs. 7 A, B; Plate X, Fig. 3)

Huronia romingeri Barrande, Syst. Sil. du Centre Boheme, 2, pt. 3, 1874, p. 758; Suppl. 1877, Pl. 474, Figs. 5, 6.

Type specimen. — The type specimen, figured by Barrande, but belonging to the University of Michigan, consists of all of one segment and of the greater part of the segment next above. The complete segment is 11.5 mm. in diameter at the base, while the corresponding diameter of the next overlying segment is about 16 mm. Since the height of this segment is 14 mm., this suggests an enlargement of the siphuncle at the rate of 4.5 mm. in a length of 14 mm., or an apical angle of about 19 degrees. If, on the other hand, the maximum enlargements of the segments at their annulations be compared, then that of the complete segment is 21 mm., and that of the segment next above is estimated at 24 mm.; this suggests a rate of enlargement corresponding to 3 mm. in a length of 14 mm., or an apical angle of about 13 degrees. In either case the apical angle is large as compared with any other species of *Huronia*, larger even than in *Huronia turbinata*, for which the measurements recorded by Foord indicate an apical angle of about 7.5 degrees only.

The vertical outline of the segments is turbinate or funnel-shaped. The complete segment preserved in the type enlarges from 11.5 mm. at the base to 21 mm. at the annulation near its

top. This annulation rises from a level of 11 mm. above the base of the segment on its dorsal side to 13 mm. above this base along its ventral side; the entire height of the segment is 14 mm. The annulation occupies a length of 5 mm. along the dorsal side of the segment; here it is weakly delimited from the parts below; the immediately underlying part of the outline is faintly concave. Along the ventral side of the segment, however, the outline is gently convex from the base of the segment as far as the crest of the annulation; the latter is not delimited at all from the underlying part of the segment.

The obliquity of the sutures between the segments can not be determined with accuracy, but it appears to be somewhere between 85 and 83 degrees, as compared with the vertical axis. At the base of the specimen the abrupt narrow involution of the walls of the siphuncle has a width of 3 mm., so that the diameter of the siphuncle here is reduced to 5.5 mm.

The specimen consists of a siliceous replacement of the calcareous deposit which once filled the interior of the siphuncle. In actinoceroids, deposits of this character begin as annular layers enveloping the inner margins of the abruptly involute parts of the siphuncle at the sutures between the septa. Deposits from adjacent segments always meet along the annulations seen on the exterior of the segments, usually a little above the middle of these annulations. Here they meet along surfaces which curve from above the middle of the annulations, seen on the exterior of the segments, at first downward and then upward, rising toward the so-called endosiphuncle along the center of the siphuncle. Along these curved surfaces the deposits filling the upper part of the segments tend to separate from those filling the lower part. Such a separation has taken place in the type of *Huronia romingeri*, so that in the upper, or incomplete segment, it is only that part which underlies this plane of separation which remains.

Specimen No. 7561, University of Michigan. From Drummond Island, presumably in the Manistique formation.

Remarks. — From *Huronia turbinata* this species is distinguished readily by the extreme weakness of its annulations.

Apparently its rate of growth is more rapid, but that has not been determined with sufficient accuracy.

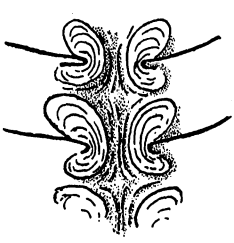
ORMOCERAS

The type of the genus *Ormoceras* is *Ormoceras bayfieldi* Stokes, a species usually referred to *Actinoceras*. This species is characterized by the moderate width of the segments of the siphuncle as compared with their length, the ratio being about 11 to 7. The involution of the walls of the siphuncle at the septal necks between the successive segments is very narrow in a vertical direction, equalling less than half a millimeter in most specimens. The siphuncle is less eccentric in position than in many species of *Actinoceras*.

The peculiar structure shown by the siphuncle of the genotype is that shown by most actinoceroids. No trace of the walls of the segments of the siphuncle is retained. On the contrary, the lunate organic calcareous deposits embracing the inner margin of the septa at the septal necks are well shown; the course of the septa also is indicated clearly. Apparently the specimen had reached that stage of growth when the lunate deposits were well developed; successive deposits were in contact with each other, but the remaining spaces within the interior of the siphuncle were still free of calcareous deposits. Indications of the radiate structure of these deposits are seen. Evidently only the more exterior parts of the lunate deposits are well preserved. The specimen probably is silicified. The deposits within the camerae apparently produce the appearance of pseudo-septa, a not uncommon feature in actinoceroids. The genus *Ormoceras* proposed by Stokes brings together a number of closely related species, which differ sufficiently from typical *Actinoceras* to warrant a distinct designation generically.

Ormoceras bayfieldi, the genotype, possesses short, but distinct septal necks. In the species described by Stokes as *Ormoceras whitei*, no such septal necks are present, as will be seen from the accompanying figures, drawn by Dr. F. A. Bather. The structure of the siphuncle of the latter species resembles

that of *Armenoceras*, as defined in this publication, but the width of the segments of the siphuncle is relatively less.



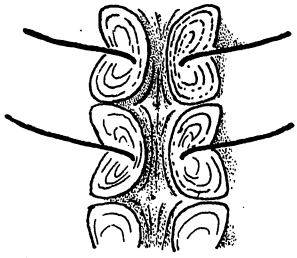


FIG. 1. ORMOCERAS BAYFIELDI Stokes FIG. 2. ORMOCERAS (?) WHITEI Stokes

Diagrams based on holotypes in the British Museum, Nos. 33416 and 33423, respectively. Reproduced from drawings by Dr. F. A. Bather. × 1.6 and 1.3.

24. **ORMOCERAS BAYFIELDI** Stokes

(Plate III, Figs. 1 A, B; Text Fig. 1)

Ormoceras bayfieldii Stokes, Proc. Geol. Soc. London, 2, 1838, p. 689 (Nom. nudum); Trans. Geol. Soc. London, 2d Ser., 5, 1840, p. 709, Pl. 60, Fig. 1.

Type specimen. — Specimen 60 mm. in length, about 35 mm. in diameter, enlarging very slowly. Eight segments of the siphuncle occur in a length of 57 mm.; single segments average about 7 mm. in length. Five camerae occur in a length equal to the diameter of the conch. The septa are deeply concave; their concavity equals or slightly exceeds the length of one and a half segments of the siphuncle. The location of the siphuncle is central or subcentral. The original diameter of the segments of this siphuncle is estimated at 11 mm. At present the walls of the siphuncle are absent, and only the silicified replacement of the organic calcareous deposits originally filling this siphuncle is preserved. These deposits take the form of lunettes embracing the inner margins of the septa. By following the general curvature of the exterior of two adjacent lunettes the former outline of the walls of the segments of the siphuncle may be determined.

According to the figure drawn by Dr. F. A. Bather, the septal necks are short but distinct. The lateral outline of the segments of the siphuncle may be determined from the lateral outlines of the calcareous deposits enveloping the septal necks. These deposits are in contact with the inner wall of the segments for the greater part of their length.

Locality and Horizon. — Drummond Island, presumably from the Manistique formation.

Specimen No. 33416 in the British Museum of Natural History.

25. ORMOCERAS ? (ELRODOCERAS?) WHITEI Stokes

(Plate III, Fig. 5; Text Fig. 2)

Orthocerae ———— Bigsby, Trans. Geol. Soc. London, 1, pt. 2, 1824, p. 204, Pl. 30, Fig. 2.

Ormoceras whitei Stokes, Proc. Geol. Soc. London, 2, 1838, p. 689; Trans. Geol. Soc. London, 2d Ser., 5, 1840, p. 709.

Type specimen. — Conch estimated to be approximately 36 mm. in diameter. Siphuncle subcentral in position. Four segments of the siphuncle occupy a combined length of 37 mm., averaging slightly more than 9 mm. for the length of a single segment. Apparently four camerae occupy a length equal to the diameter of the conch. The septa are deeply concave; their concavity equals the length of about one and a half segments of the siphuncle. The diameter of these segments is nearly 14 mm.; at their contact with the septa this diameter is contracted to about 11 mm. The convexity of the lateral walls of the segments is about one-fourth of the circumference of a circle of equal diameter. The uppermost segment of the siphuncle exposes the central vertical chord or "endosiphuncle," and the lateral "radii" at the plane of separation between the deposits embrace successive septal necks.

According to the figure drawn by Dr. F. A. Bather, there are no distinct septal necks. The calcareous deposits enveloping the inner margin of the septa are in contact with both the upper and lower surface of the latter, as in *Armenoceras*. However,

the lateral walls of the segments of the siphuncle evidently were much less convex than in *Ormoceras bayfieldi*. As a matter of fact, they are much narrower and less curved also than in typical *Armenoceras*. The relationship of *Ormoceras whitei* may be not with *Armenoceras hearsti*, but with the species originally described as *Cyrtoceras indianense* Miller, later described also as *Rhynchorthoceras dubium* Hyatt. To this species *Orthoceras abnorme* Hall is closely related. For the latter group the term *Elrodoceras* here is proposed, in honor of Dr. Moses N. Elrod, long an indefatigable collector at Hartsville, Indiana.

The genus *Elrodoceras*, of which the genotype is *Cyrtoceras indianense*, is characterized by sharply defined transverse striae of the banded type and by a relatively narrow siphuncle; the segments of the siphuncle expand moderately within the camerae and the base of the conch is curved in a distinctly cyrtoceraconic form.

Locality and Horizon. — Drummond Island, presumably in the Manistique formation.

Specimen No. 33423 in the British Museum of Natural History.

Remarks. — *Ormoceras whitei* agrees with *Ormoceras bayfieldi* in the ratio between the length and lateral diameter of the segments of its siphuncle; however, the diameter of the siphuncle is larger as compared with the diameter of the conch, and the number of camerae within a length equal to the diameter of the conch is less.

Barrande specimen (Plate III, Figs. 2 A, B). — The specimen figured by Barrande (Syst. Sil. du Centre Boheme, 2, pt. 3, 1874, p. 731, Pl. 437, Figs. 17, 18) under the name *Orthoceras backi* is not identical either with *Ormoceras whitei* or with *Ormoceras bayfieldi*. The number of camerae in a length equal to the diameter of the conch equals four and a half. The ratio of the diameter of the siphuncle to that of the conch is about the same as in *Ormoceras whitei*, but the ratio of the length of its segments to their diameter is distinctly less.

26. ORMOCERAS SP.

(Plate III, Fig. 3)

Figured specimen. — This consists of three segments of a siphuncle. Two of these segments occupy a length equal to the maximum diameter of the siphuncle at the point where the segments are counted. The siphuncle appears to be in contact with the ventral wall of the conch. The sutures between the segments form an angle of about 82 degrees with the vertical axis of the siphuncle. The vertical outline of the segments tends to be evenly convex. Three segments occupy a length of 27 mm., and are 19 mm. in diameter. From this maximum diameter the segments contract to about 15 mm. at the sutures, and to about 11.5 mm. at the inner margin of the inflections at these sutures. The upper and lower halves of these inflections appear to be less than half a millimeter apart, and there appears to be no evidence of downward curvature of the inner part of the inflections.

Locality and Horizon. — From piles of rock along fences, half a mile south of Gould City, in Mackinac County, Michigan. In the Manistique formation.

Specimen No. 8754 in the University of Michigan collection.

Remarks. — This specimen most closely resembles the specimen of *Actinoceras* figured by Barrande (*Syst. Sil. du Centre Boheme*, Pl. 437, Figs. 17, 18) under *Actinoceras backi* Stokes. Compared with the latter species the segments of the siphuncle are distinctly less numerous; there are three segments in a length equal to the diameter of the siphuncle in the latter species.

27. ORMOCERAS SP.

(Plate II, Fig. 2)

Figured specimen. — Small fragment of a conch, presenting a vertical section through the siphuncle, exhibiting four camerae, with traces of an additional camera at the top and another at the base. The conch, at the level of the fragment, is estimated to have had a diameter of 23 mm. The diameter of the siphuncle is 7 mm. Four segments of the siphuncle occupy a length of 15 mm. The vertical outlines of the segments of the siphun-

cle are evenly convex. From a maximum of 7 mm. the segments contract to 5 mm. at the sutures, and to 3 mm. at the inner margin of the involution at the suture. The inner part of this involution curves slightly downward, and the upper and lower halves of the involution are half a millimeter apart. The septa are deeply concave, possibly to an extent equal to the length of one and a half segments of the siphuncle.

The calcareous deposit on the interior of the siphuncle lines the inner wall of the latter for a thickness of 1 to 2 mm., leaving a relatively wide open space along the center. This calcareous deposit begins around the inner edge of the involutions at the sutures, or at the septal necks. From this point it spreads upward and downward, and also increases in thickness, but at a less rapid rate than it spreads up and down. The deposits spreading from adjacent necks meet near mid-height of the annular segments along convex margins which leave small triangular spaces between these margins and the inner walls of the annular segments. These triangular spaces pass entirely around the annular segments, at mid-height of the latter, or at a point slightly above mid-height. In the course of time these annular spaces also are filled up. After that, growth continues toward the axial part of the siphuncle, but still in such a manner as to leave the growths from adjacent septal necks clearly distinguishable. The axial part is filled up last. In the specimen at hand this axial part is still vacant.

Locality and Horizon. — From Hendrick's quarry, in Mackinac County, Michigan. In the Burnt Bluff member of the Niagaran.

Specimen No. 7555 in the University of Michigan collection.

Remarks. — Compared with *Stokesoceras romingeri*, from the same quarry, the segments of the siphuncle appear taller, and the siphuncle appears to enlarge less rapidly.

DISCOSORUS

The type of the genus *Discosorus* is *Discosorus conoideus*, described by Hall (*Pal. New York*, 2, 1852, p. 99, Pl. 28, Figs. 13

a–c) from the lower part of the Clinton. Since the matrix surrounding the type encloses also two pedicel valves of *Pentamerus*, it is probable that its exact horizon was in the Renayles limestone member of the Clinton.

One year earlier, in 1851, Hall had described under the name *Discosorus conoideus* a very different specimen (*Geol. Lake Superior Land Dist., Foster and Whitney's Rept.*, 1851, p. 222, Pl. 34, Figs. 2, 3) from Orthoceras Point, 8 miles northeast of Point Detour and 22 miles southwest of Manistique. That the latter is not, however, to be regarded as the type is shown by the citation of the New York specimen at the top of the description of the Wisconsin one. The publication of the New York specimen had merely been delayed.

The New York specimen of *Discosorus conoideus* consists of a siphuncle characterized by its strong obliquity and its rapid rate of expansion. It evidently belonged to a distinctly breviconic cyrtoceracone.

To *Discosorus* it is customary to refer also a distinct group of actinoceroids, with distinctly more elongated siphuncles, belonging to relatively straight conchs. For this second group the name *Stokesoceras* is selected, in commemoration of the work of Stokes on the cephalopods of northern Michigan in the early stages of paleontological work in this area.

28. **DISCOSORUS CONOIDEUS** Hall

(Plate VII, Figs. 1 A, B, C)

Discosorus conoideus Hall, Pal. New York, 2, 1852, p. 99, Pl. 28, Figs. 13 a–c.

Type specimen. — Siphuncle enlarging rapidly from 5 mm. at its smaller end to 30 mm. at the top; the vertical distance between these ends, measured at right angles to the plane of the upper segments, is 28 mm., which indicates an apical angle of about 50 degrees. Along their dorsal side the segments tend to be at right angles with the vertical outline of the siphuncle, but along their ventral side they form very oblique angles with the vertical outline. There are eight segments, and the vertical height of the uppermost segment is 6.5 mm.

The siphuncle is curved lengthwise. Along the lower part of the ventral side, the radius of lengthwise curvature is 80 mm., the curvature practically disappearing along its upper part. Along the lower part of the dorsal side the lengthwise curvature is distinct, but only for a short distance. From this it may be concluded that the conch was a rapidly expanding shell, oblique in growth, but moderately curved, with most of the curvature taking place at its apical end. The number of segments in a length equal to the diameter of the conch is about seven.

Locality and Horizon. — From Lockport, New York, in the lower part of the Clinton. The matrix surrounding the type specimen encloses also two pedicel valves of *Pentamerus*. This suggests the horizon of the type to have been the Renayles limestone member of the Clinton.

Specimen numbered 1580 in the American Museum of Natural History.

29. DISCOSORUS EHLERSI, sp. nov.

(Plate VIII, Figs. 7, 5; Plate VII, Figs. 5 A, B; Plate XIII, Figs. 1 A, B)

Columns of circular discs, etc., Bigsby, Trans. Geol. Soc. London, 2d Ser., 2, pt. 1, 1824, p. 204, Pl. 30, Fig. 6.

Orthoceras (?) (*Discosorus*) *conoideus* Barrande, Syst. Sil. du Centre Boheme, 2, Suppl. 1877, Pl. 437, Figs. 19–22.

Discosorus conoideus Foord, Catalogue Foss. Ceph. British Museum, pt. 1, p. 194, Figs. 25 A, B.

Type specimen No. C.2726 in the British Museum of Natural History. This is the specimen described by Foord.

Foord specimen (Plate VIII, Fig. 7). — The specimen figured by Foord presents a dorso-ventral apical angle of 30 degrees. The ventral outline is slightly convex. The segments of the siphuncle form right angles with the dorsal outline of the siphuncle, and angles varying from 67 to 75 degrees with the ventral outline. The septa evidently rose to a higher level on the ventral side of each of the segments than on the dorsal side. The number of these segments in a length equal to their dorso-ventral diameter is about five. The conch was cyrtoceraconic and apparently was breviconic.

Locality and Horizon. — Drummond Island, presumably in the Manistique formation.

Remarks. — Compared with *Discosorus conoideus* from the Clinton of New York, the siphuncle of *Discosorus ehlersi* is much less oblique, has a smaller apical angle, and probably was more elongate.

Barrande specimen. — The specimen figured by Barrande presents a dorso-ventral apical angle of about 38 degrees. Along the dorsal side of the siphuncle the segments form right angles with the vertical outline; along the ventral side the corresponding angle approaches 60 degrees. Drummond Island.

Bigsby specimen. — The specimen figured by Bigsby (Plate VIII, Fig. 5) appears more strongly curved than usual in typical specimens of this species. Within a length of nine segments of the siphuncle the obliquity of these segments changes at least 25 degrees. The number of segments in a length equal to the dorso-ventral diameter of the siphuncle is six. This dorso-ventral diameter increases from 13 to 30 mm. in an axial length of 45 mm. Specimen No. C.2724 in the British Museum of Natural History. Drummond Island.

Point aux Barques specimen. — This specimen closely resembles that figured by Foord. It has six segments in a length equal to the dorso-ventral diameter. Numbered 2438 in the University of Michigan collections; presumably from the Manistique formation.

Cordell specimen (Plate VII, Figs. 5 A, B). — This specimen exposes a siphuncle which is outlined distinctly for a length of seventeen segments, with three additional segments indicated very indistinctly at the top. For a length of eleven or twelve segments from the base it retains approximately the vertical ventral outline of both the siphuncle and conch. The siphuncle evidently is almost in contact with the ventral wall of the conch. The ventral outline is convex, though the amount of this convexity does not exceed 1 mm. within a length of ten segments from the base. About the same convexity of outline may have been shown by the upper part of the specimen, but here only a part of the lateral side of the specimen is retained; the ventral outline remains uncertain.

The lowest septum of the conch which is still preserved occurs at the top of the fourteenth segment from the base of the siphuncle. Altogether nine septa may be detected. These occur at intervals varying from 5.5 to 6 mm.

At the twelfth segment above the base the dorso-ventral diameter of the siphuncle appears to have been 26 mm. Its distance from the ventral wall of the conch is 1 mm. or slightly less. The dorso-ventral diameter of the conch at this level is estimated at 48 or 50 mm. No estimate can be made of the lateral diameter.

The segments of the siphuncle are nearly at right angles to its dorsal outline, but they form an angle of about 60 degrees with the ventral outline. The dorso-ventral apical angle of the siphuncle is about 30 degrees. There are six segments in a length equal to the dorso-ventral diameter of the siphuncle, if this diameter be measured at the top of the series being counted. The septa rise distinctly from the ventral toward the dorsal side of the conch; the amount equals about the height of two camerae. Along the ventral side successive segments of the siphuncle project back beyond the vertical limits of that segment which lies immediately beneath.

From near Cordell, in Chippewa County, Michigan, in the northeast quarter of section 29, T 44 N, R 4 W. Specimen No. 7563 in the University of Michigan collections. From the Burnt Bluff formation.

Orthoceras Point specimen. — The specimen figured by Hall (*Geol. Lake Superior Land District, Foster and Whitney's Rep.*, 1851, p. 222, Pl. 34, Fig. 3) from Orthoceras Point, 8 miles northeast of Point Detour, in Delta County, Michigan, appears to be a specimen of *Discosorus ehlersi*, in which the two upper segments of the siphuncle have been "crushed, giving them apparently an abruptly increased diameter," according to Hall's description.

30. DISCOSORUS (?) INFELIX (Billings)

Orthoceras infelix Billings, Cat. Silurian Foss. Anticosti, Geol. Surv. Canada, 1866, p. 57.

Type specimens. — The larger specimen, described first, is 60 mm. long and consists of ten segments, the uppermost of

which is represented only by a small part of its ventral side. The siphuncle enlarges rapidly in a dorso-ventral direction near the base, from 18 mm. at the lowest segment to 30 mm. at the fifth, 31 mm. at the sixth, and practically 31 mm. also at the ninth segment, which shows that the upper part of the siphuncle either does not enlarge at all or enlarges only slightly. The lateral enlargement of the lower part of the specimen is less conspicuous than the dorso-ventral one. At the sixth segment from the base the lateral diameter is 27 mm., showing distinct lateral compression of the siphuncle. The lowest segment forms an angle of 75 degrees with the vertical axis of the siphuncle; at the fifth segment from the base this angle is 86 degrees, and the seventh segment forms a right angle.

The second specimen, including seven segments of the siphuncle, shows a similar dorso-ventral enlargement along its lower part, and a similar change in the amount of obliquity of the lower segments. It is of interest chiefly on account of showing the line at which the septa become free from the lower side of the segments of the siphuncle. This line rises from the dorsal toward the ventral side of the segments.

Locality and Horizon. — From South West Point, Anticosti. According to Twenhofel it occurs in the Jupiter member of the Niagaran.

Specimens numbered 2545 in the museum of the Geological Survey of Canada.

31. DISCOSORUS (?) SP.

(Plate V, Fig. 2; Plate XIII, Figs. 1 A, B)

Figured specimen. — The specimen consists of part of a siphuncle and part of one side of the conch. Of the siphuncle nine segments are exposed. Of these the lowest is estimated to have had a dorso-ventral diameter of 22 mm. Along the four lower segments the ventral outline of the siphuncle is distinctly convex lengthwise, but farther up this outline appears to have been straight or nearly so. In this respect the siphuncle appears similar to that of *Discosorus infelix* (Billings), but it differs in not having the lower segments obliquely inclined from the ven-

tral side downward toward the dorsal side of the siphuncle. Whether such a difference is sufficient to indicate a distinct species is not known in our present state of knowledge of these forms.

Along the lower part of the specimen the dorso-ventral diameter of the siphuncle enlarges from 23 to 28 mm. in a length of 15 mm., indicating an apical angle of 16 degrees here. Nothing definite is known about the upper part of the siphuncle.

At the base of the specimen the contour of the lateral parts of the conch indicates that the ventral wall of the conch either was in contact with the siphuncle or almost so. In either case it is estimated that the siphuncle occupied between one-half and five-eighths of the dorso-ventral diameter of the conch. The conch apparently was compressed laterally, and the siphuncle appears to have been compressed in the same direction. At the base of the specimen the dorso-ventral diameter of the conch is estimated at 42 mm., and the lateral diameter at 37 mm. The dorso-ventral diameter of the siphuncle here is 25 mm., and the lateral diameter is estimated at 22 mm.

The course of three of the sutures of the septa can be traced from 18 to 25 mm. around the circumference of the conch; this is sufficient to indicate that the sutures rise from the ventral toward the dorsal side of the conch, at least beginning with a vertical line opposite the middle of the lateral side of the siphuncle. The amount of this rise of the sutures is estimated at approximately the height of two camerae.

The septa are moderately concave, to judge from that part of the lowest septum which is exposed. The radius of concave curvature is estimated at 50 mm. The number of segments of the siphuncle in a length equal to the diameter of the uppermost one being counted is estimated at six. The vertical outline of these segments is more evenly rounded along their dorsal than along their ventral side. The line at which the septa become free from the lower side of the segments probably rises from the dorsal toward the ventral side.

Locality and Horizon. — From the vicinity of Gould City, in Mackinac County, Michigan; in the southwestern corner

of section 20, T 43 N, R 11 W. From the Burnt Bluff formation.

Specimen No. 8755 in the University of Michigan collections.

32. DISCOSORUS HALLI, sp. nov.

(Plate VII, Figs. 3, 4; Plate VIII, Fig. 4)

Discosorus conoideus Hall, Geol. Lake Superior Land Dist., Foster and Whitney's Rept., 1851, p. 222, Pl. 34, Figs. 2, 3.

Columns of circular discs, etc., Bigsby, Trans. Geol. Soc. London, 2d Ser., 1, 1824, p. 204, Pl. 30, Fig. 4.

Type specimen No. 2115 in the American Museum of Natural History.

Hall specimen (Plate VII, Fig. 3). — This specimen consists of ten segments, with a trace of an eleventh segment at the smaller end. The specimen is imbedded in the rock in such a manner that little definite information can be secured from it. The second segment below the top of the specimen exposes a width of at least 40 mm. Eight segments occur immediately below this segment in a length equalling its apparent width. The lowest distinct segment exposes a width of 16 mm. Apparently the apical angle of this specimen is somewhere near 36 degrees.

Locality and Horizon. — Found at Orthoceras Point, 8 miles northeast of Point Detour, and 22 miles southwest of Manistique, in Delta County, Michigan. Associated with *Huronia vertebralis* and *Huronia annulata*, presumably in the Manistique formation.

Remarks. — The validity of this species rests on the belief that the siphuncle of the type has a large apical angle, that its upper segments attain a large size, and that the number of segments in a length equal to the diameter of the uppermost segment being counted is relatively large. Because of the imperfect exposure of the specimen, the first of these statements is chiefly an assumption.

Bigsby specimen (Plate VIII, Fig. 4). — Bigsby figured a rapidly expanding siphuncle of some actinoceroid, from Drummond Island. The original of this specimen has been lost. The rate of enlargement of the lower six segments of the published

figure appears to be comparable with that of *Discosorus halli*, described above, but the sudden enlargement of the next two segments suggests that the siphuncle figured was more or less imperfectly exposed. The abnormality, however, is not confined to the unnatural enlargement of the two upper segments in diameter; there is also a more rapid increase in vertical length of these segments than occurs in typical *Discosorus halli*.

Gould specimen. — A small specimen (Plate VII, Fig. 4), with segments comparable in length to those along the lower part of the Bigsby specimen, but enlarging at a more rapid rate than indicated by this part of Bigsby's figure. From locality along the east and west road about three-quarters of a mile west of the southeast corner of section 20, T 43 N, R 11 W, in the vicinity of Gould, in Mackinac County, Michigan. Specimen No. 7556 in the University of Michigan collection. From the Burnt Bluff formation.

Remarks. — The significance of the specimens here described is that they indicate the presence of a breviconic shell, expanding much more rapidly than in any species of *Discosorus* so far named.

33. DISCOSORUS (?) REMOTUS Foord

(Plate IV, Figs. 6 A, B)

Columns of circular discs, etc., Bigsby, Trans. Geol. Soc. 2d Ser., 1, 1824, p. 204, Pl. 30, Fig. 7.

Discosorus remotus Foord, Cat. Foss. Ceph. British Museum, 1, 1888, p. 197.

Type specimen. — The specimen consists of the apical end of a siphuncle including six segments. The lengthwise convex curvature of the ventral side of this specimen has a radius of 60 mm. along an axial length of 30 mm. In this length the lateral diameter of the segments increases from 8.5 mm. at the base to 17 mm. at the top. If we assume that the dorso-ventral diameter is only slightly greater than the lateral one, the segments are approximately at right angles to the dorsal outline of the siphuncle, but form an angle of about 70 degrees with the ventral outline. Along this ventral side the vertical outline of the segments is flattened in a direction parallel to the general outline,

which indicates that the siphuncle was in contact with the ventral wall of the conch. The line along which the septa became free from the lower side of the segments apparently rose on approaching the ventral side of the siphuncle. The vertical outline of the segments along their lateral sides is only moderately curved. Compared with other species referred to *Discosorus*, the convexity of the vertical outline of the segments is small. The number of segments in a length equal to the lateral diameter of the siphuncle at the top of the series being counted is about three and a third. This is a small number as compared with other species known from Drummond Island, and may be regarded as one of the chief characteristics of the species here described.

Locality and Horizon. — Drummond Island, Lake Huron, presumably in the Manistique formation.

Specimen No. 33427 in the British Museum of Natural History.

Remarks. — The oblique flattening of the ventral outline and the small incurvature of the vertical outline of the siphuncle at the sutures between the segments are characteristic features.

Discosorus remotus is not a typical species of *Discosorus*. It appears to belong to an undescribed genus of breviconic actinoceroids of a cyrtoceraconic form. In this genus the segments are much larger, longer, and present less rapidly curved vertical outlines. Moreover, there is a tendency on the part of the siphuncle to contract toward the top in old age. Species of this type are not uncommon in the Lake Timiskaming area, and are known as far east as Anticosti Island, from which a single specimen of this type is at hand. Since the reference of *Discosorus remotus* to this undescribed genus is not firmly established, it is allowed to remain provisionally in the genus *Discosorus*, to which it was referred by Foord, but with which it has no close relationship.

STOKESOCERAS

Typical *Discosorus* is founded on a breviconic species of a distinctly cyrtoceroid character. *Stokesoceras* is intended to include

those species which resemble *Discosorus romingeri* Foerste in being longiconic and relatively straight. To what extent *Stokesoceras* represents a line of descent distinct from that of *Discosorus*, even though from a common ancestor, can not be determined in our present meager knowledge of the structure of the conchs in these two groups. The species described by Foord as *Discosorus gracilis* is a typical *Stokesoceras*. The species described by Whitfield from the *Trimerella* horizon beneath the Pentamerus zone in the Byron beds at Ashford, Wisconsin, under the name *Discosorus conoideus*, appears to belong to *Stokesoceras* rather than to typical *Discosorus*. The species here described as *Stokesoceras engadinense* appears to occupy an intermediate position, but it is distinctly elongate and relatively straight. Such intermediate species are to be expected, according to the laws of evolution. Not all of the species are to be expected to fall definitely into one or the other of two gradually diverging groups. *Stokesoceras romingeri* is the genotype.

Actinoceras beudanti Castelnau (*Essai Syst. Sil. l'Amerique Septent.*, 1843, p. 34, Pl. 6, Fig. 2), described from Drummond Island, probably is a typical species of *Stokesoceras*, but it differs from any species here described in its relatively few segments in a length equal to the diameter of the siphuncle.

34. STOKESOCERAS ROMINGERI, sp. nov.

(Plate IX, Figs. 6, 7, 4, 2, 3; Plate VIII, Figs. 3 A, B)

(?) *Discosorus* ——— Barrande, Syst. Sil. du Centre Boheme, 2, Suppl. 1877, Pl. 474, Figs. 9, 10.

(?) *Discosorus gracilis* Foord, Cat. Foss. Ceph. British Museum, 1, 1888, p. 198, Fig. 26 B.

Type specimen. — Siphuncle 72 mm. in length (Plate IX, Fig. 6), consisting of twenty-one segments; slender, enlarging from a width of 4.5 mm. at the base to 18.5 mm. at the top, indicating an apical angle of 11 degrees. Slightly curved lengthwise; the radius of convex curvature along the ventral side is 240 mm. There are four and a half segments in a length equal to the lateral diameter of the siphuncle at the top of the specimen, diminishing to four near the middle of the specimen, and

to two and a half segments at its base. The cross-sections of the siphuncle are circular or nearly so. The segments form an angle of 85 degrees with the vertical axis of the siphuncle. In its present condition the segments of the siphuncle are half a millimeter apart along their lateral sides on the upper part of the specimen, and still farther apart along their ventral side, where the septa rose on approaching the ventral wall of the conch. This relatively large distance between the segments is due, however, chiefly to the fact that the walls of the siphuncle are not preserved, since only the calcareous deposit within the siphuncle is present. Originally, when the walls of the siphuncle were present, the distance between the segments must have been considerably less.

Locality and Horizon. — From the Hendrick quarry, in Mackinac County, Michigan, in the Burnt Bluff formation.

Specimen 7557 in the collections of the University of Michigan.

Several specimens from the same quarry differ from the type chiefly in being straight. One of these (Plate IX, Fig. 7) is 50 mm. in length. In a distance of 35 mm. its dorso-ventral diameter enlarges from 9 to 15 mm.; the corresponding lateral diameters are 8.5 and 14 mm. The segments form angles of 85 to 80 degrees with the vertical axis of the siphuncle. The number of segments in a length equal to their diameter is four. Specimen No. 7559 in the University of Michigan collection.

A third specimen, No. 7558 in the University of Michigan collection (Plate IX, Fig. 4), differs from the type in its more slender proportions. The specimen is 60 mm. long, and enlarges from 1.7 mm. at its base to 7.6 mm. at its top, thus indicating an apical angle of 6 degrees. The plane of the segments forms an angle of about 75 degrees with the vertical axis. There are two and a half segments in a length equal to the diameter of the siphuncle. In other aciculate specimens from the same quarry the number of segments in this length is nearer three. Compared with more typical specimens of *Stokesoceras romingeri*, the apical angle is smaller and the relative number of segments in a length equal to the diameter is also smaller. Compared with typical *Stokesoceras gracile*, the segments are much more oblique, and

their relative number in a length equal to the diameter of the siphuncle is somewhat greater. Provisionally, at least, these more aciculate specimens are regarded as the apical ends of *Stokesoceras romingeri*, since they are found associated with the latter. The fact that in the type of *Stokesoceras romingeri* the number of segments in a length equal to the diameter of the siphuncle is only two and a half at the base, while equalling four and four and a half nearer the top, favors this view, though the apical angle of these aciculate specimens is much smaller. Compared with *Stokesoceras gracile* the segments of the aciculate specimens appear distinctly more numerous at corresponding diameters. From the point at which the lateral diameter equals 7 mm., there are ten segments in a length of 24 mm. in the aciculate specimens, while in the type of *Stokesoceras gracile* the corresponding ten segments occupy a length of 32 mm. The chief difference from *Stokesoceras gracile* consists, however, in the more oblique direction of the segments of the siphuncle.

The preceding specimens are from the Hendrick quarry, occurring in the Burnt Bluff formation.

Specimens from Drummond Island. — Specimens similar to *Stokesoceras romingeri* occur on Drummond Island, presumably in the Manistique formation. Two specimens, one numbered 2437 and the other 7560, belong to the collections of the University of Michigan. Of these, the one numbered 2437 (Plate IX, Fig. 2) is the original of Figures 9 and 10 on Plate 474 published by Barrande. This specimen has weathered so as to expose the funnel-like cavity left at the top of the specimen by the calcareous deposits lining the inner walls of the siphuncle. Only the exterior parts of these deposits have silicified, so that these parts are preserved, while the interior parts of the deposits have weathered away, giving the false appearance of a camerated siphuncle. The specimen is slightly curved lengthwise at its base. The other specimen, numbered 7560 (Plate IX, Fig. 3), has weathered so as to reveal the more or less radiating structure shown by the calcareous deposits filling the interior of the siphuncle. Neither specimen shows any conspicuous obliquity of the segments as compared with the vertical axis of the siphuncle.

Foord specimen. — The second one of the Drummond Island specimens figured by Foord under the name *Discosorus gracilis* (Plate VIII, Figs. 3 A, B) is a siphuncle which expands more rapidly, especially in a dorso-ventral direction; and its segments, within a length equal to the dorso-ventral diameter, are more numerous. Among known forms, it approaches *Stokesoceras romingeri*, but its apical angle is much larger, equalling 15 degrees. It may be a distinct form, but it presents enough points of similarity to be referred to *Stokesoceras romingeri* provisionally. Since it is a figured specimen, the following more detailed description is presented.

The figure presented by Foord suggests that this specimen was curved lengthwise. To judge, however, from the cast presented to the writer by the British Museum of Natural History, this curvature is due chiefly to a crack crossing the specimen 35 mm. below its top; the vertical axes of the two parts, above and below the crack, form an angle of about 160 degrees with each other. Originally, the specimen may have been straight, although that part of the specimen corresponding to the right side of Foord's figure (Figure 3 B, on Plate VIII, of the present publication) appears to be slightly convex lengthwise. Possibly the radius of this curvature is not less than 200 mm. The specimen enlarges from 5 mm. at its base to 18 mm. at its top, in a length of 50 mm. There are four segments in a length equal to the dorso-ventral diameter of the siphuncle. As far as known, this siphuncle may be circular in cross-section. The specimen has been cut lengthwise, in order to secure details of its inner structure, and, in the casts of the two halves (as represented by the casts presented to the writer by the British Museum of Natural History), the segments of the siphuncle form an angle of about 80 degrees with the vertical axis of the siphuncle. This specimen is numbered 33424 in the British Museum of Natural History. Presumably it is from the Manistique formation.

Specimens similar to *Stokesoceras romingeri* occur in the Niagaran of the Lake Timiskaming area.

35. STOKESOCERAS GRACILE (Foord)

(Plate VIII, Fig. 2)

Discosorus gracilis Foord, Cat. Foss. Ceph. British Museum, 1, 1888, p. 198, Fig. 26 A.

Type specimen. — This consists of a slender conch, weathered along its ventral side so as to show the entire length of the siphuncle (Plate VIII, Fig. 2). To judge from the transverse curvature of that part of the shell which remains, the siphuncle probably was in contact with the ventral wall of the conch, although a very slight distance may have intervened. In either case, the conch must have been compressed laterally. It is estimated that at the top of the specimen the dorso-ventral diameter was 18 or 19 mm. and that the lateral diameter was 16 mm. While there is a possibility that the siphuncle also was slightly compressed laterally, this can not be determined definitely. In its present condition the conch is curved distinctly lengthwise, but this appearance of lengthwise curvature is produced chiefly by a bend at the base of the tenth segment of the siphuncle below the top of the specimen. Here there must have been a crack. The vertical axes of the parts above and below this crack at present form an angle of about 160 degrees with each other. Another bend, much slighter, may have taken place four segments farther down. If not, the lower part of the specimen is slightly convex lengthwise along its ventral side, while its upper part is essentially straight. Possibly the entire length of the specimen was essentially straight. The shell enlarges from a dorso-ventral diameter of 8 mm. at its base to 18 or 19 mm. at its top, in a length of 63 mm., which indicates an apical angle of 9.5 degrees in this direction. In the cast of the type presented to the writer by Dr. F. A. Bather of the British Museum, the lateral diameter of the specimen widens from 3.8 mm. at its base to 9 mm. at its top, which indicates an apical angle of 5 degrees in this direction.

The most striking features shown by this specimen, however, remain to be presented. One is the distinct rise of the sutures of the septa from the ventral toward the dorsal side of the

conch; the curvature of these sutures along the lateral sides of the conch is slight. The other feature is the small number of segments in a length equal to the diameter of the conch, this number being only two. The rise of the sutures from the ventral toward the dorsal side of the conch is shared by this species with *Stokesoceras ehlersi*, from the Burnt Bluff formation.

Locality and Horizon. — From Drummond Island, Lake Huron, presumably from the Manistique formation.

Specimen No. 33562, British Museum of Natural History.

Remarks. — This is the only specimen known presenting the combination of characteristics here noted. The second specimen figured by Foord (Fig. 26 B) under the name *Discosorus gracilis* has little in common with the type of that species except the slender outline of the shipuncle, and even that is considerably greater than in typical *Discosorus gracilis*. Moreover, the number of its segments in a length equal to the diameter of the siphuncle is greater.

36. STOKESOCERAS ENGADINENSE, sp. nov.

(Plate IX, Figs. 1, 5; Plate VII, Fig. 2)

(?) Columns of circular discs, etc., Bigsby, Trans. Geol. Soc. London, 2d Ser., pt. 1, 1824, p. 204, Pl. 30, Fig. 3.

Orthoceras (?) (*Discosorus*) *conoideus* Barrande, Syst. Sil. du Center Boheme, 2, Suppl., 1877, Pl. 474, Figs. 7, 8.

Type specimen. — The Engadine specimen (Plate IX, Fig. 1) consists of a siphuncle 95 mm. long, enlarging from a diameter of 7 mm. at the base to diameters of 41 and 33 mm. at the top, according to the direction in which these measurements are made; the specimen is flattened in an oblique direction which lies between the dorso-ventral and lateral diameters. The lengthwise curvature is small. In its present condition the radius of lengthwise curvature along the ventral side varies from 250 mm. along the lower half of the specimen to 350 mm. along its upper half. Along the dorsal side the radius of concave lengthwise curvature along the lower half of the specimen is 150 mm., the upper half being straight. The number of segments in a length equal to the diameter of the siphuncle varies from five to six,

according as the shorter or the longer diameter is chosen as a standard. The segments are only moderately oblique, forming an angle of 85 degrees with the vertical axis of the siphuncle. The vertical outline of the dorsal side of the segments of the siphuncle is evenly rounded, while the lower part of the outline on their ventral side is obliquely flattened; the line at which the septum becomes free from the lower part of the segments rises toward the ventral side, as in other actinoceroids. Specimen from a locality about 3 miles northeast of Engadine, in Mackinac County, Michigan. This locality is on the north and south road following the west line of section 3 in T 43 N, R 10 W, in the Manistique formation. Specimen No. 7551 in the collections of the University of Michigan.

Hendrick's quarry specimen. — A typical specimen of *Stokesoceras engadinense* was found at the Hendrick's quarry, in Mackinac County.

Point aux Barques specimens. — Another fairly straight specimen, No. 2431, 63 mm. in length, has five segments in a length equal to the diameter of the siphuncle. The obliquity of the segments to the vertical axis of the siphuncle appears to be small. Another specimen, No. 7552 (Plate VII, Fig. 2), has been sectioned vertically so as to show the calcareous deposit filling the interior of the siphuncle. Both the calcareous deposits and the matrix enclosing the specimen and filling the vacant space left in its interior are of a very light-brown tint, but are distinctly outlined by the darker color of the intervening shell. At the base of the specimen the matrix filling the interior of the siphuncle extends downward in a funnel-like manner, and the space between this funnel-like extension and the light-brown calcareous deposit lining the interior of the siphuncle is occupied by translucent calcite of a darker appearance, representing a later deposit of calcareous matter within the siphuncle. Extending downward from the tip of the funnel is a light-brown deposit resembling, on a minute scale, an actinoceroid siphuncle with nummulitic members 2.5 to 3 mm. in width and with a central axis less than 1 mm. in diameter. This structure is interpreted as an endosiphuncle, the nummulitic extensions representing suc-

cessive stages of the base of the funnel-like cavity found in the upper part of the interior of all specimens of *Discosorus*. In this particular specimen the deposits filling the funnel-like cavity appear to have taken place in a succession of rhythmically deposited layers. Both specimens were obtained at Point aux Barques, 15 miles southwest of the town of Manistique, in Michigan. The locality is near the line separating Schoolcraft and Delta counties. The specimens are numbered 2431 and 7552 in the collections of the University of Michigan. They are presumably from the Manistique formation.

Drummond Island specimens. — Barrande figured a specimen from Drummond Island (*Syst. Sil. du Centre Boheme*, 2, *Suppl.* 1877, Pl. 474, Fig. 7) in which the segments of the siphuncle are much more strongly oblique to the vertical axis of the siphuncle; the specimen evidently was strongly flattened toward its top. A closely similar specimen, No. 7554, both as regards the obliquity of the segments and the compression of the siphuncle toward the top, occurs in the collections of the University of Michigan. It is labelled as coming from the southwest shore of Drummond Island, opposite Detour, in the northwest quarter of section 30, T 42 N, R 5 E, in Chippewa County, Michigan. It is not known to what extent the obliquity of the segments of the siphuncle was accentuated by the compression of the siphuncle, but provisionally, at least, both the Barrande specimen and the one here described from the University of Michigan collections are associated with typical *Stokesoceras engadinense*. In the Manistique formation.

Gould specimen. — Specimen 70 mm. long, enlarging from a diameter of 3.5 mm. at the base to 25 mm. at the top, which indicates a smaller apical angle than in the type of *Stokesoceras engadinense*. The siphuncle appears to be straight. The number of segments in a length equal to the diameter of the siphuncle is slightly over four. The segments are either at a right angle to the vertical axis of the siphuncle or nearly so. This specimen is characterized by the straightness of the siphuncle and the relatively smaller number of its segments. It may belong to a distinct species, but this can not be determined from the single

specimen at hand. Specimen No. 7553, University of Michigan collections, from locality along the east and west road about three quarters of a mile west of the southeast corner of section 20, T 43 N, R 11 W, northwest of Gould City in Mackinac County, Michigan; from the upper beds of the Burnt Bluff formation.

Bigsby specimen. — The specimen figured by Bigsby (Plate IX, Fig. 5) on his Plate 30 (Fig. 3) has been lost. According to the published figure it presented an apical angle of 18 degrees, which is distinctly smaller than that of typical *Stokesoceras engadinense.* Five segments occupy a length equal to the diameter of the siphuncle. To judge from the figure, the segments may have been rather strongly oblique to the vertical axis. From Drummond Island, presumably from the Manistique formation.

37. CYRTOCERAS (?) SP.

(Plate IX, Fig. 8)

Figured specimen. — This consists of the upper part of a phragmacone to which an uncertain length of the living chamber is attached. Within the limits of the short length of the part of the phragmacone which is at hand, no lengthwise curvature is noted. The walls of the living chamber are too poorly indicated to serve to determine whether the conch was essentially straight or cyrtoceraconic. The figure presented on Plate IX represents the conch as straight, but the siphuncle is strongly eccentric in location, and the form of its segments suggests cyrtoceroid rather than orthoceroid affinities. For the present the relationship of this specimen must be regarded as doubtful.

The specimen is compressed laterally, the dorso-ventral diameter being 29 mm., and the lateral one being estimated at 20 mm. Five camerae are present. Of these, the three lower have a total length of 13 mm., while the fourth is 3 mm. long, and the fifth has a length of only 1.5 mm. The specimen evidently had reached full maturity. The number of camerae in a length equal to the dorso-ventral diameter is about six and two-thirds.

The sutures of the septa are curved downward strongly along

the lateral sides of the conch, forming lateral lobes almost as deep as the distance between the sutures. The dorsal and ventral saddles are conspicuous. The septa are only slightly concave in a lateral direction. The siphuncle is about 1 mm. distant from the ventral wall of the conch. It is 5 mm. in diameter, contracting to 4 mm. where reaching contact with the septa, and to 3 mm. at its passage through these septa. The general contour of the segments of the siphuncle is similar to that of some cyrtoceroids in which the septal neck indents the upper side of the segments.

Locality and Horizon. — From Marblehead, the easternmost point of Drummond Island, in the Burnt Bluff formation.

Remarks. — Conchs with downward curving lateral sutures of the septa are common among cyrtoceroids. Lateral sutures curving downward are known also among gomphoceroids and orthoceroids. The species *Orthoceras formosum* Billings has been selected as the genotype of those orthoceroids in which the lateral lobes are conspicuously developed, the generic term *Ephippiorthoceras* being selected for the group.

Orthoceroids with conspicuous lateral lobes are known from as low as the Black River to the upper part of the Niagaran formations. If the specimen here described from Marblehead were known to be an orthoceroid form, it would fall under *Ephippiorthoceras*. Some of the cyrtoceroid forms are, however, but moderately curved, especially toward the living chamber, and the specimen in question is not sufficiently preserved to exclude the possibility of its belonging to one of the cyrtoceroid genera. Hence little can be done with it at present beyond calling attention to its doubtful relationship.

PLATES AND DESCRIPTIONS

PLATE I

FIG. 1. *Actinoceras bigsbyi* Bronn. — *A*, upper half of specimen, with vertical section through the siphuncle, showing traces of the septa. The calcareous deposits lining the inner walls of the siphuncle have weathered away, and the matrix filling the central cavity left between these deposits remains. Between this central pillar of matrix and the inner walls of the annular segments of the siphuncle are radiating chords which locate the lines of contact between lunate deposits embracing the successive septal necks. *B*, lower half of specimen, showing the sutures of the septa. Described as coming from Thessalon Island, in Lake Huron. Black River formation. Copied from *Trans. Geol. Soc. London*, 2d Ser., 1, 1824, Pl. 25, Fig. 1. Specimen No. 33448 in British Museum of Natural History. Selected type of genus and species. See also Plate XII, Figs. 7 A, B, C.

FIG. 2. Cf. *Actinoceras bigsbyi* Bronn. — Vertical section through the siphuncle, with calcareous deposits lining the inner walls of the siphuncle weathered away. Matrix occupies the central cavity left among these deposits, and there are traces of the so-called chords radiating between this central deposit of matrix and the inner walls of the siphuncle a little above mid-height of the annular segments. There are traces also of some of the septa. Described as coming from Thessalon Island, in Lake Huron. Black River formation. Copied from *Trans. Geol. Soc. London*, 2d Ser., 1, 1824, Pl. 25, Fig. 2, which was printed in an inverted position. Specimen No. C.2664 in British Museum of Natural History.

FIG. 3. *Armenoceras rotulatum* (Billings). — *A*, lateral view of siphuncle. *B*, dorsal view. *C*, vertical section through siphuncle, showing lunate deposits embracing the inner margin of the septa, at the septal necks; *a*, inner ends of the septa; *b*, lines of contact between successive lunate deposits. Along these lines of contact appear the so-called radiating chords. From Lake Timiskaming, in the Niagaran. Copied from Barrande, *Syst. Sil. du Centre Boheme*, 2, pt. 3, 1874, Pl. 437, Figs. 1, 2, 4. Topotype.

PLATE I

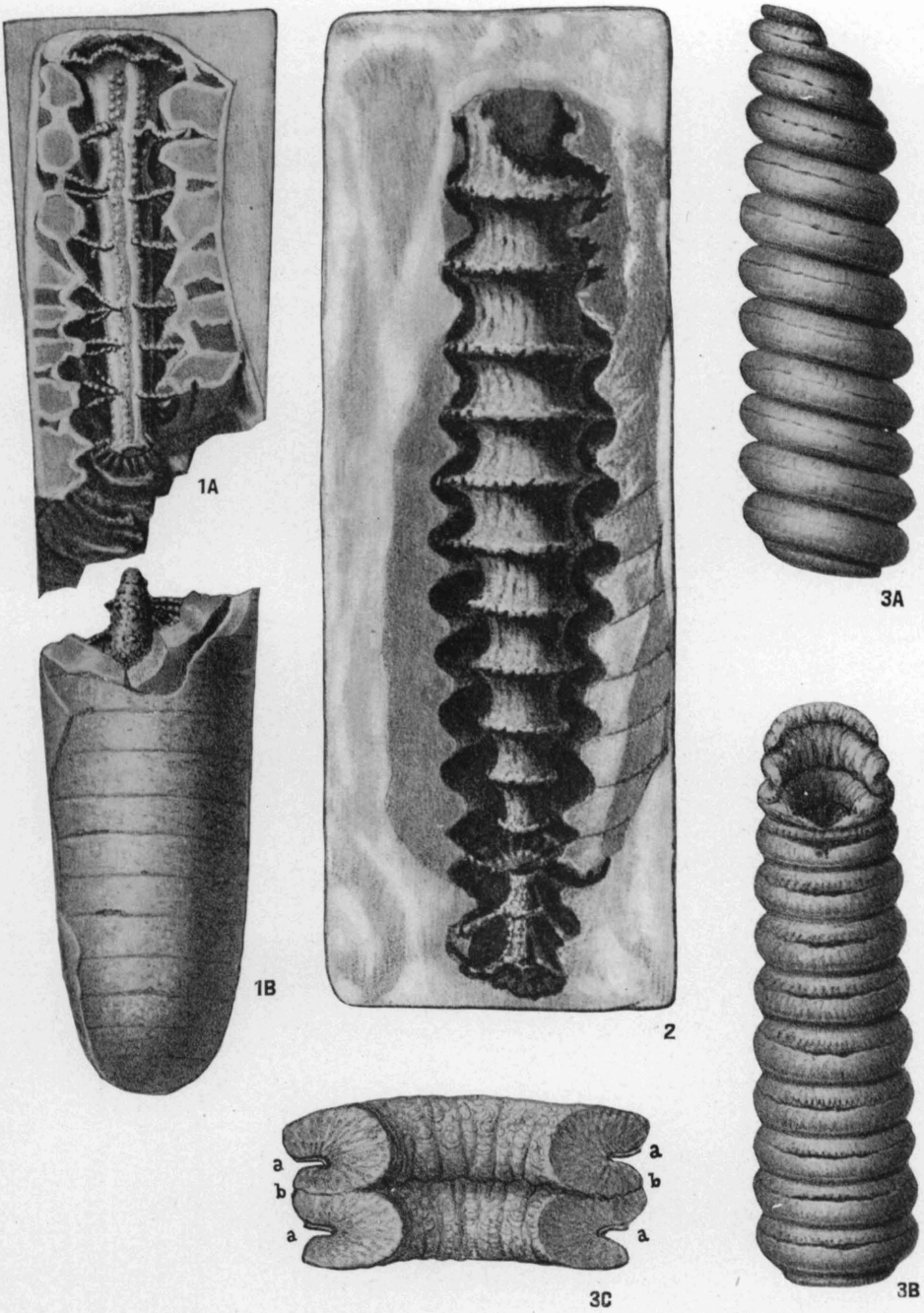


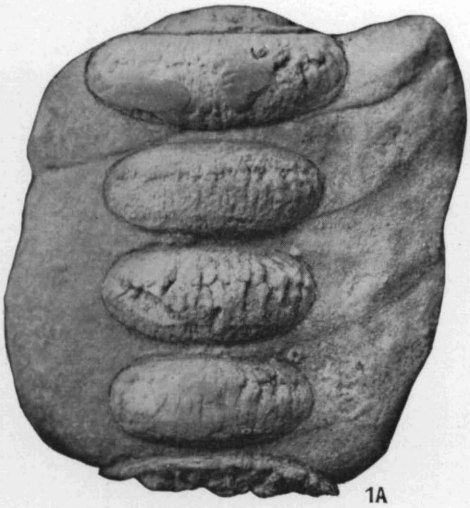
PLATE II

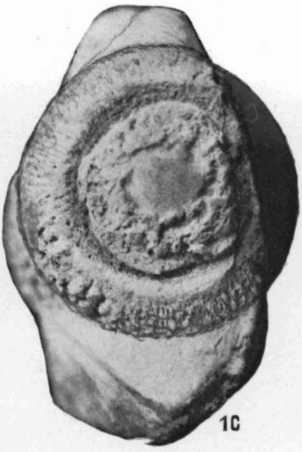
FIG. 1. *Armenoceras sphaeroidale* (Stokes). — *A*, lateral view of siphuncle embedded in the matrix, showing traces of the septa. *B*, view at right angle to the preceding. *C*, view of top, showing outline of uppermost segment, and the annular band along which that part of the septum which intervenes between two successive segments slopes inward and downward. From Drummond Island, presumably in the Manistique formation. Same specimen as that figured by Stokes (*Trans. Geol. Soc. London,* 2d Ser., 1, pt. 2, 1824, Pl. 28, Fig. 5, printed in inverted position). Specimen No. 33863, in British Museum of Natural History. Holotype. Plastoholotype No. 8840, University of Michigan collections.

FIG. 2. *Ormoceras* sp. — Vertical section through the siphuncle, with the lateral outlines of the conch exposed obliquely. From Hendrick's quarry, in Mackinac County, Michigan; in the Burnt Bluff formation. Specimen No. 7555 in the University of Michigan collections.

FIG. 3. *Huroniella* sp. — Vertical section through the siphuncle, showing the central strand and the curving radiating chords produced by matrix filling the hollow spaces left toward the center of the calcareous deposits and between the successive lunate deposits embracing the septal necks. From Scott's quarry, in Chippewa County, Michigan. In the Manistique formation. Specimen No. 7542 in the University of Michigan collections.

PLATE II


1A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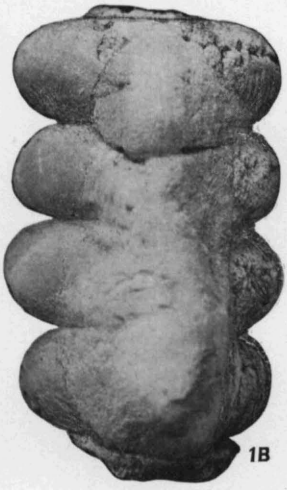
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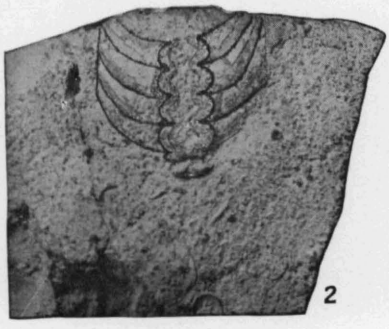
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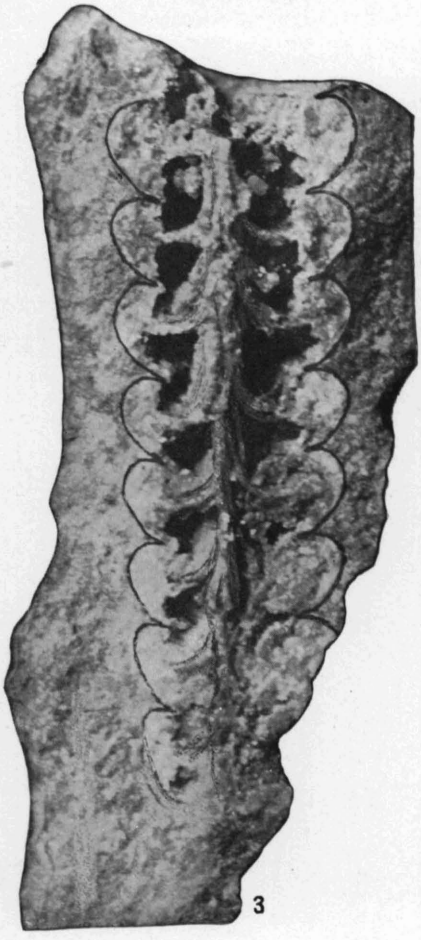

3

PLATE III

FIG. 1. *Ormoceras bayfieldi* Stokes. — *A*, vertical section through the siphuncle, not retaining the walls of the segments, but showing the lunate calcareous deposits embracing the septal necks. These deposits leave a central passage, and distinctly show traces of radiating structure. *B*, the same specimen drawn so as to show the probable vertical outline of the segments of the siphuncle. From Drummond Island, presumably in the Manistique formation. Copied from *Trans. Geol. Soc. London*, 2d Ser., 5, 1840, Pl. 60, Fig. 1. Specimen No. 33416 in the British Museum of Natural History. Holotype.

FIG. 2. *Ormoceras* sp. — *A*, vertical section, exposing the siphuncle along its lower part; *o*, earlier deposits within the camerae, separated by so-called pseudo-septa from *d*, the later deposits. *B*, vertical section through several of the segments of the siphuncle, exhibiting the inner margin of the septa, at the septal necks, the embracing lunate deposits, the so-called endosiphuncle and radiating chords. From Niagaran rocks of Drummond Island, Michigan. Copied from Barrande, *Syst. Sil. du Centre Boheme*, 2, pt. 3, 1874, Pl. 437, Figs. 17, 18.

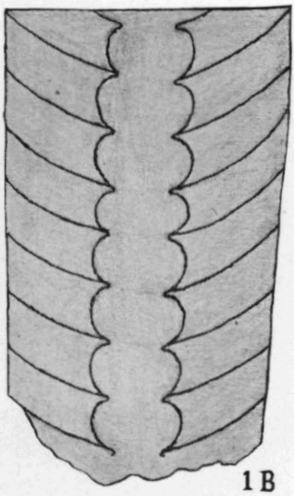
FIG. 3. *Ormoceras* sp. — Lateral view of several segments of a siphuncle. From loose material, south of Gould City, in Mackinac County, Michigan. In the Manistique formation. Specimen 8754 in the University of Michigan collections.

FIG. 4. *Armenoceras backi* (Stokes). — *A*, lateral view of the specimen, showing the siphuncle. *B*, view from beneath, showing the outline of the conch and of the siphuncle. The lower part of the figure exposes the outline of the exterior of the siphuncle; the upper part shows the calcareous deposit filling its interior. *C*, dorsal side of the specimen, showing the siphuncle and traces of the septa. From Drummond Island, presumably in the Manistique formation. Specimen No. 33429 in the British Museum of Natural History. Same specimen as that figured by Stokes (*Trans. Geol. Soc. London*, 1, pt. 2, 1824, Pl. 30, Fig. 1. Holotype. Plastoholotype No. 8837, University of Michigan collections.

FIG. 5. *Elrodoceras* (?) *whitei* Stokes. — View of a natural vertical section of the conch, showing the dorsal side of the siphuncle and traces of the septa. The upper segment of the siphuncle has weathered so as to show the so-called endosiphuncle and the curved radiating chords. From Drummond Island, presumably in the Manistique formation. Same specimen as that figured by Bigsby in *Trans. Geol. Soc. London*, 1, pt. 2, 1824, Pl. 30, Fig. 2. Bigsby's figure presents a fifth segment of the siphuncle, at the base of the series here figured, but this fifth segment has been lost. Holotype. Plastoholotype No. 8841, University of Michigan collections.

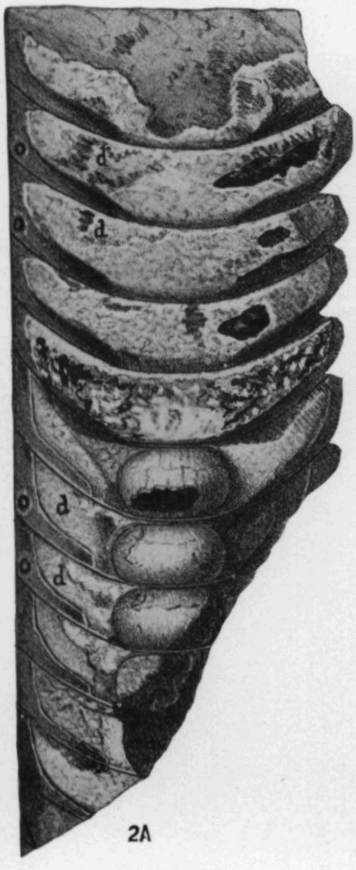
PLATE III

1A



1B

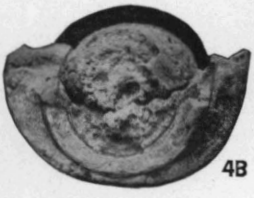
4A



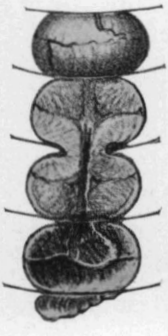
2A

3

5



4B



2B

4C

PLATE IV

FIG. 1. *Huronia bigsbyi* Stokes. — Fragment of a siphuncle. From Drummond Island, presumably in the Manistique formation. Specimen No. 2814 in the University of Michigan collections.

FIG. 2. *Huronia:* cf. *vertebralis* Stokes. — Lateral view of siphuncle. From northeast of Engadine, in Mackinac County, Michigan; in the Manistique formation. Specimen No. 7549 in the University of Michigan collection.

FIG. 3. *Huronia vertebralis* Stokes. — View of a specimen of which only the upper segment is not distorted, while the others are successively more flattened by crushing. From Drummond Island, presumably in the Manistique formation. Specimen No. 2815 in the University of Michigan collections. Same specimen as that figured by Barrande in *Syst. Sil. du Centre Boheme*, 2, Suppl. 1877, Pl. 474, Figs. 2–4.

FIG. 4. *Huronia bigsbyi intermedia* Foerste. — Several segments of a siphuncle. From Drummond Island, presumably in the Manistique formation. Specimen No. 7539 in the University of Michigan collections. Holotype.

FIG. 5. *Huronia bigsbyi intermedia* Foerste. — Several segments of the siphuncle. From Scott's quarry, from the Manistique formation. Specimen No. 8753 in the University of Michigan collections.

FIG. 6. *Discosorus* (?) *remotus* Foord. — *A*, ventral view of a siphuncle. *B*, lateral view of the same. From Drummond Island, presumably in the Manistique formation. Specimen No. 33427, in the British Museum of Natural History. Same specimen as that figured by Bigsby, in *Trans. Geol. Soc. London*, 2d Ser. 1, 1824, Pl. 30, Fig. 7. Holotype. Plastoholotype No. 8842, University of Michigan collections.

PLATE IV

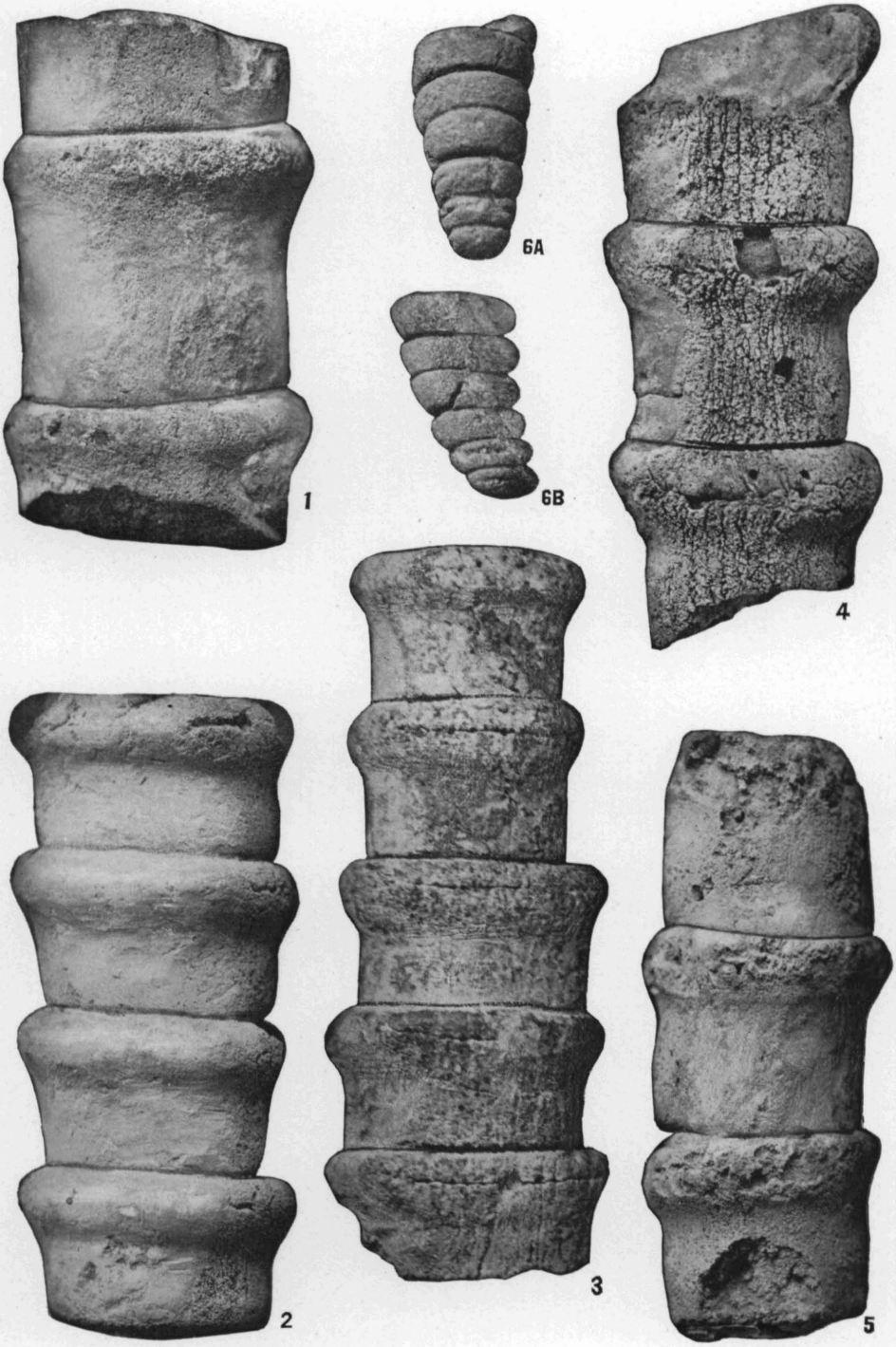


PLATE V

FIG. 1. *Huronia vertebralis* Stokes. — Vertical section through the two middle segments of the type of *Orthoceras canadense* Billings; the entire specimen consists of six segments. Lunate calcareous deposits embrace the inner margins of the septa, at the septal necks. These lunate deposits grew more rapidly upward than downward, meeting above mid-height of the segments. The surface of contact between successive lunate deposits is concave in an upward direction, in radial sections through the siphuncle. Along these concave areas of contact the radiating chords developed, which appear to have been the last stages of the membranous tissue secreting the calcareous deposits. The calcareous spaces left, in vertical sections, between the annular parts of the segments of the siphuncle and the adjacent parts of the lunate deposits, in the course of time are filled also by calcareous deposits. Drummond Island, from the Manistique formation. Copied from Barrande, *Syst. Sil. du Centre Boheme*, 2, Pl. 436, Fig. 6; on the same plate Fig. 5 probably represents the two lower segments of this specimen; the two upper segments never were figured. Specimen No. 2544 in the Museum of the Geological Survey of Canada.

FIG. 2. *Discosorus* sp. (cf. *Discosorus infelix* Billings). — Lateral view, exposing the siphuncle. The path of the sutures of the septa is shown along the lower part of the conch. From Gould City, Michigan; in the Burnt Bluff formation. Specimen No. 8755 in the University of Michigan collections.

FIG. 3. *Huronia minuens* Barrande. — Vertical section of a siphuncle, showing the involuted part of the walls at the sutures between successive segments, also a part of the so-called endosiphuncle. From Drummond Island, presumably from the Manistique formation. Figure copied from Barrande, in *Syst. Sil. du Centre Boheme*, 2, pt. 3, 1874, Pl. 435, Fig. 4. Holotype.

FIG. 4. *Huronia obliqua* Stokes. — Lateral view of a siphuncle. From Drummond Island, presumably in the Manistique formation. Figure copied from Stokes in *Trans. Geol. Soc. London*, 2d Ser., 1, 1824, Pl. 28, Fig. 4. Specimen No. 33433 in the British Museum of Natural History. Holotype. See also Plate XII, Fig. 1.

FIG. 5. *Huronia vertebralis* Stokes. — Part of a siphuncle, the two lower segments of the specimen being omitted in the figure. From Drummond Island, presumably in the Manistique formation. Figure copied from Stokes in *Trans. Geol. Soc. London*, 2d Ser., 1, 1824, explanation of Pl. 28, Fig. 2. Holotype.

PLATE V

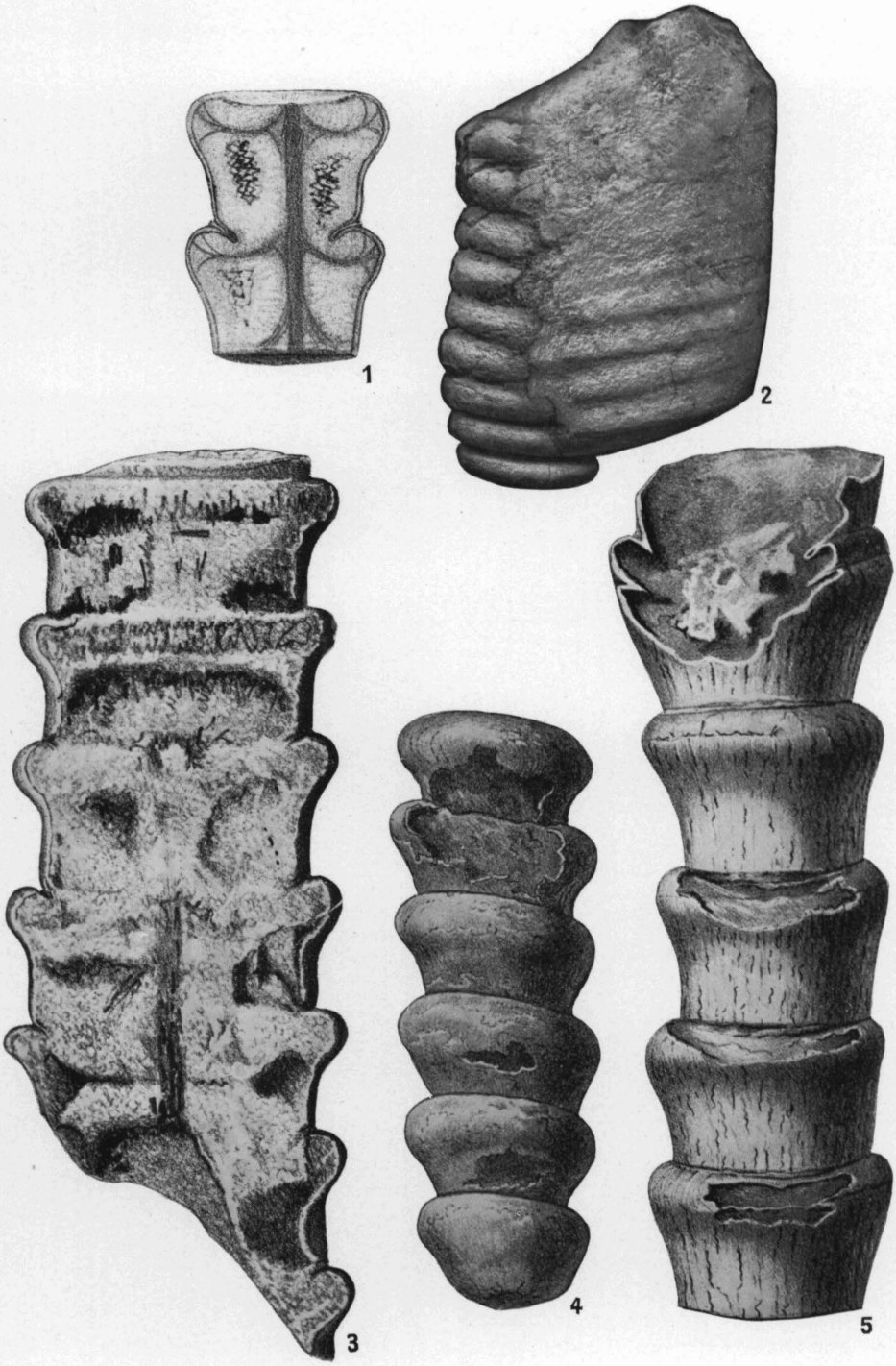


PLATE VI

FIG. 1. *Huronia annulata* Hall. — Lateral view of siphuncle. From Drummond Island, in the Manistique formation. Specimen No. 2810 in the University of Michigan collections.

FIG. 2. *Huronia engadinensis* Foerste. — Lateral view of a siphuncle. From drift northeast of Engadine, in the Manistique formation. Specimen No. 7562 in the University of Michigan collections. Holotype.

FIG. 3. *Huronia annulata* Hall. — Part of a siphuncle. From Drummond Island, in the Manistique formation. Specimen No. 2811 in the University of Michigan collections. Holotype. See also Plate XII, Fig. 6.

FIG. 4. *Huronia obliqua* Stokes. — Lateral view of a siphuncle. From Drummond Island, in the Manistique formation. Specimen No. 7546 in the University of Michigan collections.

FIG. 5. *Huronia:* cf. *distincta* Barrande. — Lateral view of siphuncle. From Drummond Island, in the Manistique formation. Specimen No. 7545 in the University of Michigan collections.

FIG. 6. *Huronia distincta* Barrande. — Vertical section through the siphuncle, showing involution of the walls at the sutures between the segments of the siphuncle, the so-called central endosiphuncle, the curved radiating chords, and the location of the latter along the base of the lunate calcareous deposits embracing the septal necks; the upper outline of these lunate deposits is not indicated. From Drummond Island, in the Manistique formation. Specimen No. 33417 in the British Museum of Natural History. Figure copied from Stokes, in *Trans. Geol. Soc. London*, 2d Ser., 5, 1840, Pl. 60, Fig. 2. Holotype. See also Plate XII, Fig. 5.

FIG. 7. *Huronia romingeri* Barrande. — *A*, lateral view of fragment of siphuncle. *B*, view of the top, showing top of lunate calcareous deposit embracing the septal neck at the top of the lower segment figured. The so-called radiating chords apparently are the thickened radiating lines traversing the last remnants of the membrane producing the calcareous deposits. Holotype. Specimen No. 7561 in the University of Michigan collections.

PLATE VI


1


2


3


7A


7B


4


5


6

PLATE VII

FIG. 1. *Discosorus conoideus* Hall. — *A*, lateral view of siphuncle. *B*, ventral view of same. *C*, dorsal view of same. From Lockport, New York, in the lower Clinton limestone, presumably in the Renayles limestone member. Specimen No. 1580 in the American Museum of Natural History in New York City. Same specimen as that figured by Hall in *Pal. New York*, 2, 1852, Pl. 28, Fig. 13 a. Holotype.

FIG. 2. *Stokesoceras engadinense* Foerste. — Vertical section through siphuncle, showing intermittent growth at base of the calcareous organic deposits lining the central part of the interior of the siphuncle, at the base of the fragment preserved. This deposit was formed subsequent to the lunate deposits embracing the septal necks. From Point aux Barques, in the Manistique formation. Specimen 7552 in the University of Michigan collections.

FIG. 3. *Discosorus halli* Foerste. — Strongly weathered siphuncle, still enclosed in the matrix. Lateral outlines not satisfactorily exposed, so that the rate of expansion is not known definitely. From Orthoceras Point, in the southeastern corner of Delta County, Michigan, presumably in the Manistique formation. Same specimen as that figured by Hall in *Geol. Lake Superior Land Dist., Foster and Whitney's Rept.*, 1851, Pl. 34, Figs. 2, 3. Specimen No. 2115 in American Museum of Natural History in New York City. Holotype.

FIG. 4. *Discosorus halli* Foerste. — A small apical fragment of some siphuncle, exposing a vertical section retaining a small part of the calcareous deposit occupying the center of the siphuncle. From the vicinity of Gould City, in Mackinac County, in the Burnt Bluff formation. Specimen No. 7556 in the University of Michigan collections.

FIG. 5. *Discosorus ehlersi* Foerste. — *A*, specimen imbedded in the rock, weathered so as to expose the lower part of the siphuncle and part of the septa. *B*, an attempt to indicate the rate of enlargement of the siphuncle. From vicinity of Cordell, in Chippewa County, Michigan. Specimen No. 7563 in the University of Michigan collections.

PLATE VII

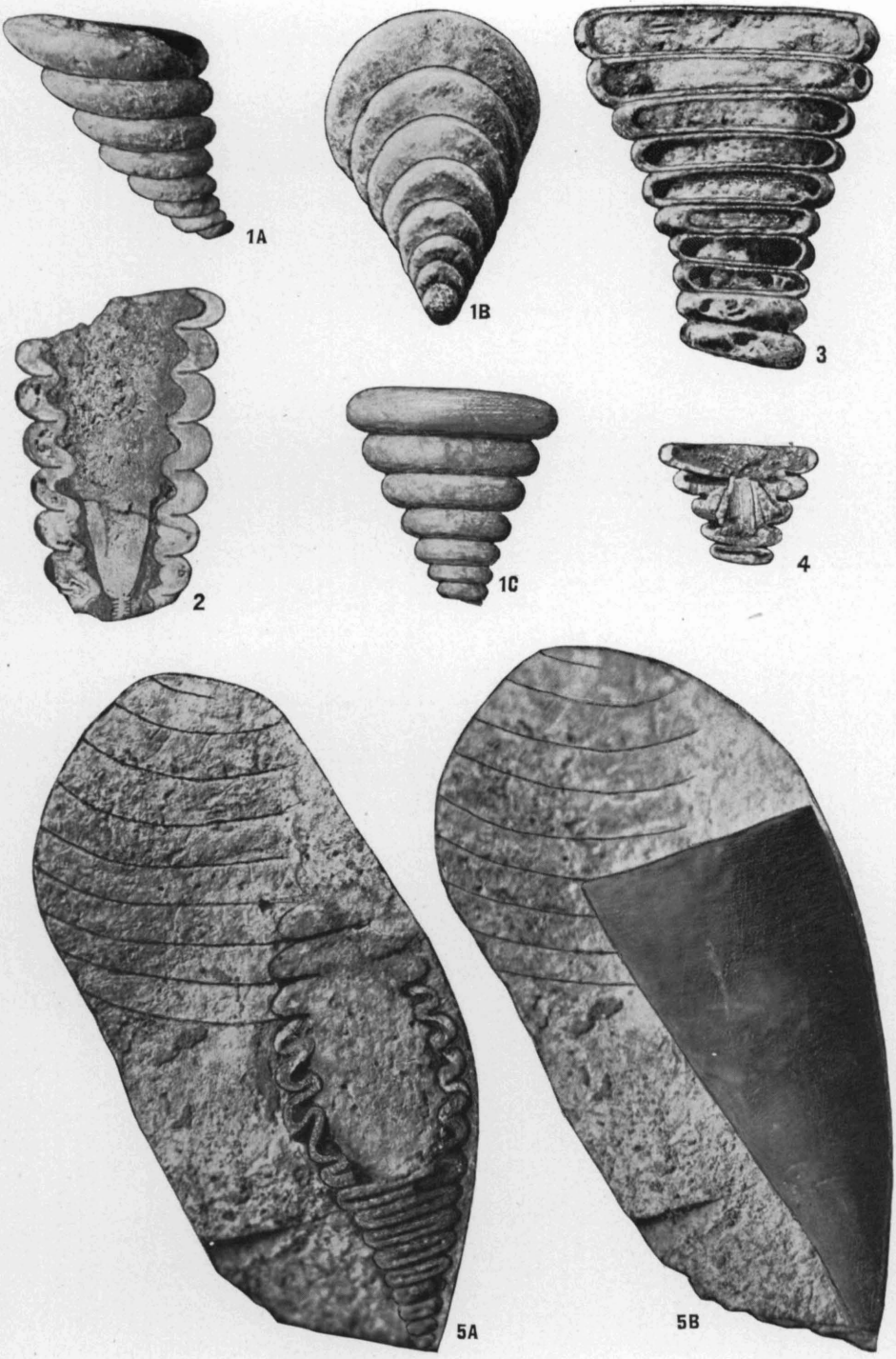


PLATE VIII

FIG. 1. *Huronia septata* Parks. — Lateral view of a siphuncle. From the Nelson River, near the mouth of Limestone River, west of Hudson Bay. From the Shammattawa limestone, a member of the Richmond formation. Specimen No. 2479 in the University of Michigan collections.

FIG. 2. *Stokesoceras gracile* (Foord). — Lateral view of conch, exposing the ventral side of the siphuncle. The specimen is bent at the base of the tenth segment below the top of the siphuncle, and also four segments lower down. This has produced the lengthwise curved appearance of the conch. From Drummond Island, presumably in the Manistique formation. Specimen No. 33562 in the British Museum of Natural History. Same specimen as that figured by Foord, in *Cat. Foss. Cephaloda in British Museum*, 1, 1888, Fig. 26 A. Lectotype. Plastolectotype No. 8843, University of Michigan collections.

FIG. 3. *Stokesoceras:* cf. *romingeri* Foerste. — *A*, *B*, opposite sides of same vertical section of the siphuncle. The specimen was cracked and bent at the base of the tenth segment from the top, best seen in figure *B*. From Drummond Island, presumably in the Manistique formation. Specimen No. 33424, in the British Museum of Natural History. Same specimen as that figured by Foord in *Cat. Foss. Cephalopoda in British Museum*, 1, 1888, Fig. 26 B. Plaster cast of specimen, No. 8844, University of Michigan collections.

FIG. 4. *Discosorus:* cf. *halli* Foerste. — Lateral view of siphuncle, with abnormal rate of enlargement, probably due to imperfect exposure of the specimen in the matrix. From Drummond Island, presumably in the Manistique formation. Same specimen as that figured by Bigsby in *Trans. Geol. Soc. London*, 1, pt. 2, 1824, Pl. 30, Fig. 4.

FIG. 5. *Discosorus:* cf. *ehlersi* Foerste. — Lateral view of siphuncle. From Drummond Island, presumably from the Manistique formation. Specimen No. C.2724, in the British Museum of Natural History. From Drummond Island, presumably in the Manistique formation. Same specimen as that figured by Bigsby in *Trans. Geol. Soc. London*, 2d Ser., 1, pt. 2, 1824, Pl. 30, Fig. 6. Plaster cast of specimen, No. 8846, University of Michigan collections.

FIG. 6. *Orthoceras:* cf. *alienum* Hall. — Vertical section exposing the siphuncle. From a quarter of a mile north of Hunt's Spur, in Mackinac County, Michigan. Specimen No. 8752 in the University of Michigan collections.

FIG. 7. *Discosorus ehlersi* Foerste. — Lateral view of siphuncle. From Drummond Island, presumably in the Manistique formation. Specimen No. C.2726 in the British Museum of Natural History. Same specimen as that figured by Foord in *Cat. Foss. Cephalopoda in British Museum*, 1, 1888, p. 194, Fig. 25 A. Holotype. Plastoholotype No. 8845, University of Michigan collections.

FIG. 8. *Huronia turbinata* Stokes. — View of siphuncle. From Drummond Island, presumably in the Manistique formation. Specimen No. C.2954 in the British Museum of Natural History. Copied from Stokes in *Trans. Geol. Soc. London*, 2d Ser., 1, 1824, explanation of Plate 28, Fig. 3. Holotype.

PLATE VIII

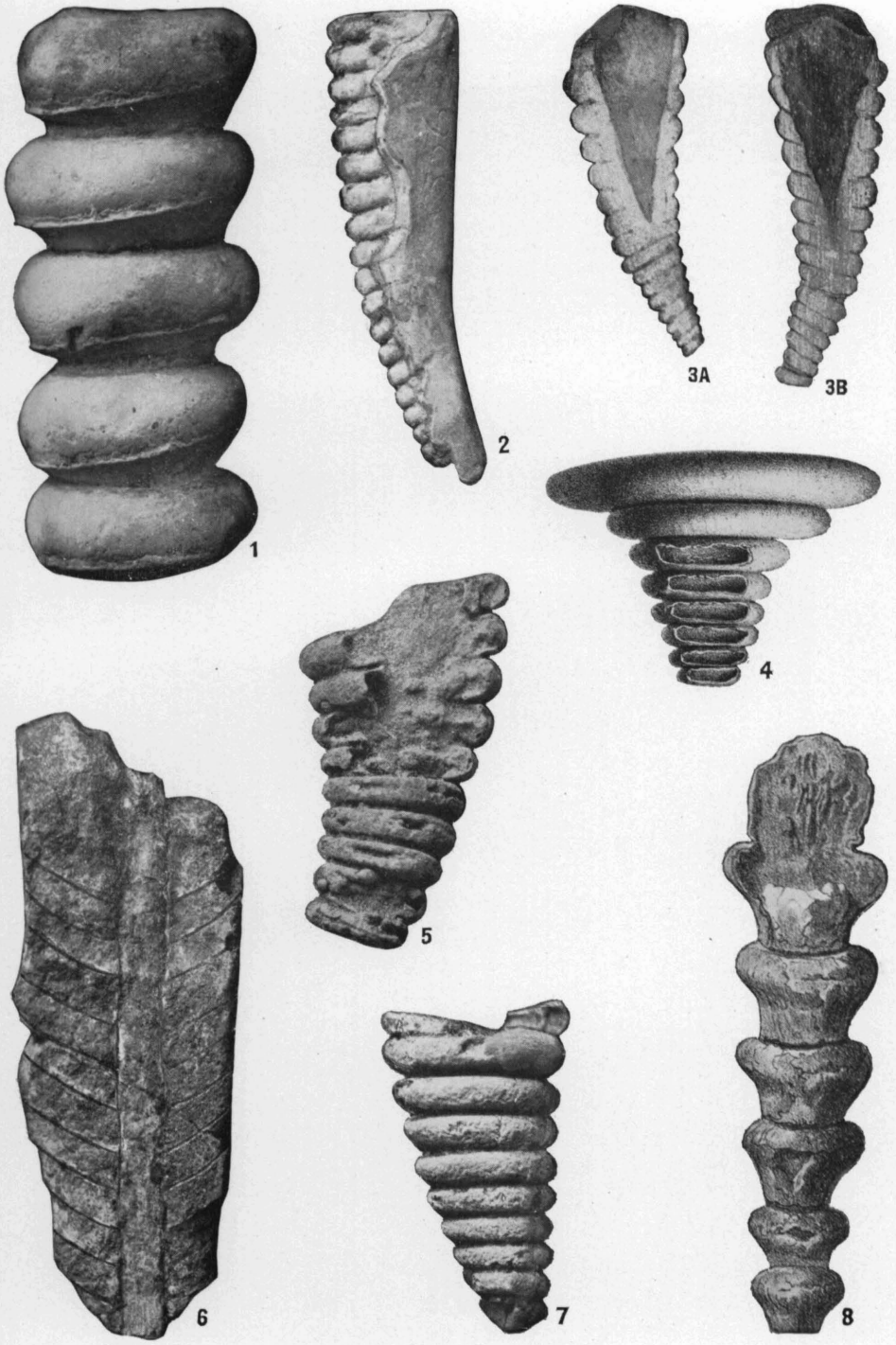


PLATE IX

FIG. 1. *Stokesoceras engadinense* Foerste. — Lateral view of siphuncle. From northeast of Engadine, in Mackinac County, Michigan, in the Manistique formation. Specimen No. 7551 in the University of Michigan collections. Holotype.

FIG. 2. *Stokesoceras romingeri* Foerste. — Lateral view of siphuncle, with only the more exterior parts of the calcareous deposits within its interior preserved, the central cavity being well exposed toward the top. The weathering away of part of these deposits has resulted in a pseudo-camerate appearance. From Drummond Island, presumably in the Manistique formation. Specimen No. 2437 in the University of Michigan collection. Same specimen as that figured by Barrande in *Syst. Sil. du Centre Boheme*, 2, Suppl. 1877, Pl. 474, Figs. 9, 10.

FIG. 3. *Stokesoceras romingeri* Foerste. — Siphuncle weathered so as to show radiate structure in the calcareous deposit within its interior. From Drummond Island, presumably in the Manistique formation. Specimen No. 7560 in the University of Michigan collections.

FIG. 4. *Stokesoceras romingeri* Foerste. — Aciculate apical end of some siphuncle, considerably weathered along the exposed surface. From Hendrick's quarry, in Mackinac County, Michigan, in the Burnt Bluff formation. Specimen No. 7558 in the University of Michigan collections.

FIG. 5. *Stokesoceras:* cf. *engadinense* Foerste. — Dorsal view of siphuncle. From Drummond Island, presumably in the Manistique formation. Specimen lost. Figure copied from Bigsby, in *Trans. Geol. Soc. London*, 2d Ser., 1, 1824, Pl. 30, Fig. 3.

FIG. 6. *Stokesoceras romingeri* Foerste. — View of siphuncle, weathered toward the top. From Hendrick's quarry, in the Burnt Bluff formation. Specimen No. 7557 in the University of Michigan collections. Holotype.

FIG. 7. *Stokesoceras:* cf. *romingeri* Foerste. — Lateral view of siphuncle. From Hendrick's quarry, in Mackinac County, in the Burnt Bluff formation. Specimen No. 7559 in the University of Michigan collections.

FIG. 8. *Cyrtoceras* (?) sp. — Only the upper part of the phragmacone is outlined distinctly. The living chamber, more or less imbedded in the matrix, is limited indistinctly. The siphuncle appears cyrtoceroid, but the conch may be orthoceroid. Not enough is present to determine its form longitudinally. From Marblehead, the easternmost point of Drummond Island, in the Burnt Bluff formation. Specimen No. 8839 in the University of Michigan collections.

FIG. 9. *Huronia portlocki* Stokes. — Ventral side of the specimen weathered so as to show the ventral side of the annular part of the segments of the siphuncle, the contracted lower portion of the segments remaining covered by the matrix. The septa become free from adnation to the segments along the lower part of these annulations. From Drummond Island, presumably in the Manistique formation. Specimen No. 33418 in the British Museum of Natural History. Same specimen as that figured by Stokes in *Trans. Geol. Soc. London*, 2d Ser., 5, 1840, Pl. 60, Fig. 5. Holotype. See also Plate XII, Fig. 3. Plastoholotype No. 8847, University of Michigan collections.

PLATE IX

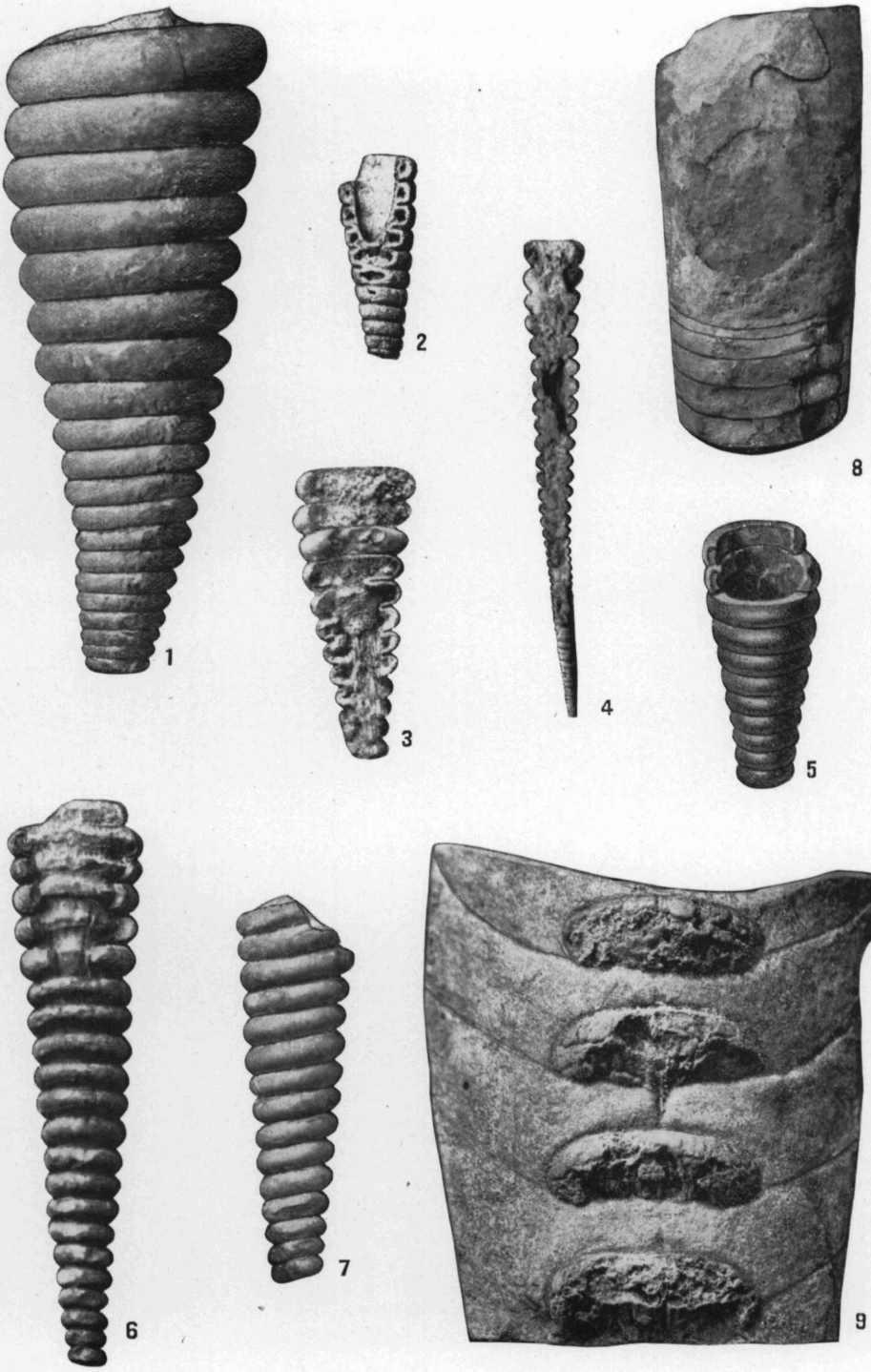


PLATE X

FIG. 1. *Huroniella ehlersi* Foerste. — Lateral outline of same specimen as Pl. XV, Fig. 1.

FIG. 2. *Huronia paulodilatata* Foerste. — Lateral outline of same specimen as Pl. XV, Fig. 3.

FIG. 3. *Huronia romingeri* Barrande. — Lateral outline of same specimen as Pl. VI, Fig. 7.

FIG. 4. *Armenoceras gouldense* Foerste. — *A*, cross-section of specimen; *B*, lateral outline of same. Same specimen as Pl. XIV, Fig. 2.

FIG. 5. *Huronia turbinata* Stokes. — Lateral outline of specimen, founded on Pl. VIII, Fig. 8.

FIG. 6. *Huronia septata* Parks. — Lateral outline of same specimen as Pl. VIII, Fig. 1.

PLATE X

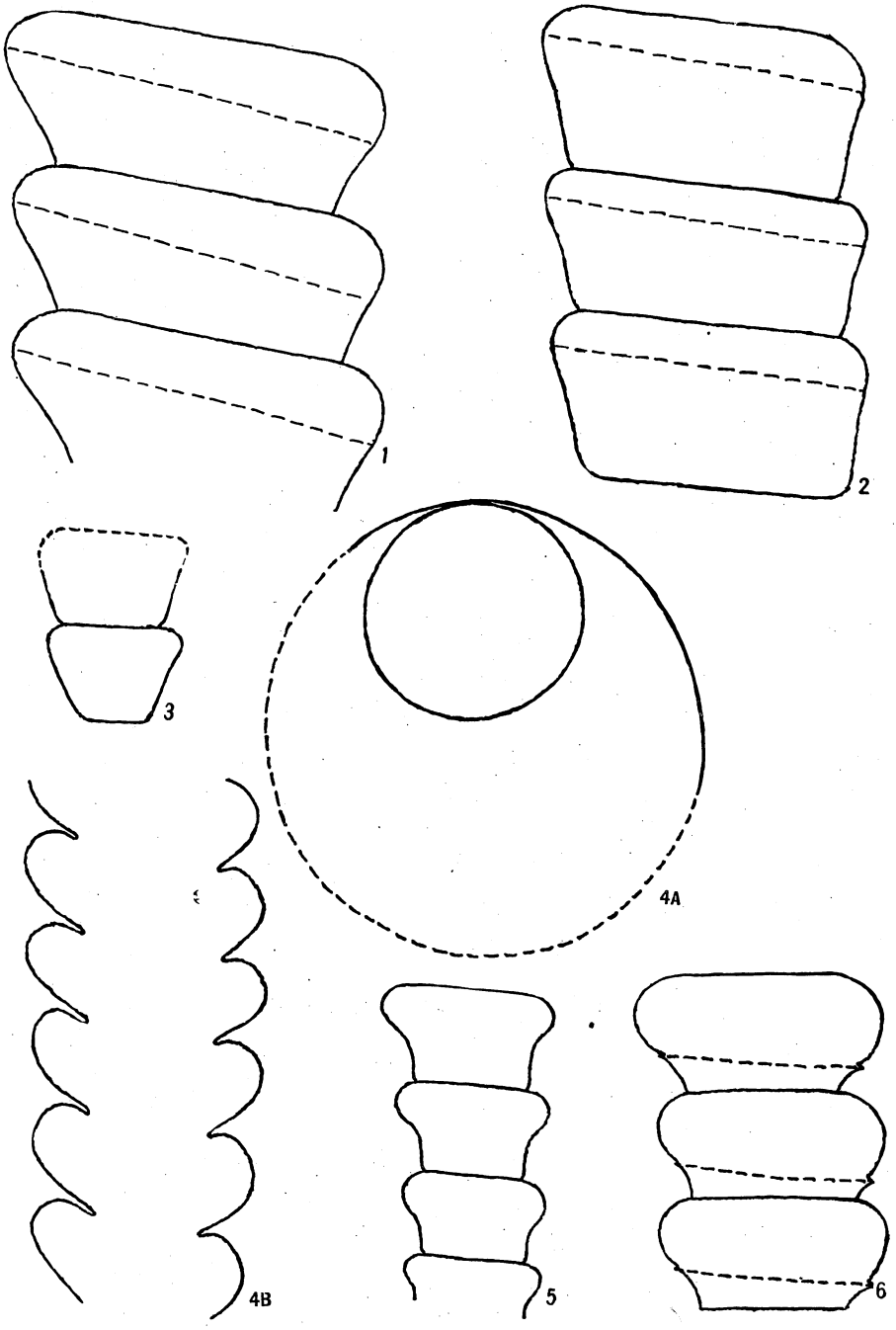


PLATE XI

FIG. 1. *Huronia bigsbyi* Stokes. — Lateral outline of type, based on an obliquity of 83 degrees in the annulations of the segments. Compare Pl. IV, Fig. 1.

FIG. 2. *Huronia vertebralis* Stokes. — Lateral outline of type, based on an obliquity of 86 degrees in the annulations of the segments. Compare Pl. V, Fig. 5.

FIG. 3. *Huronia engadinensis* Foerste. — Lateral outline, annulations having an obliquity of 80 degrees. Same specimen as Pl. VI, Fig. 2.

FIG. 4. *Huronia bigsbyi intermedia* Foerste. — Lateral outline with annulations having an obliquity of 85 degrees. Based on same specimen as Pl. IV, Fig. 4.

FIG. 5. *Huronia annulata* Hall. — Lateral outline based on the type.

PLATE XI

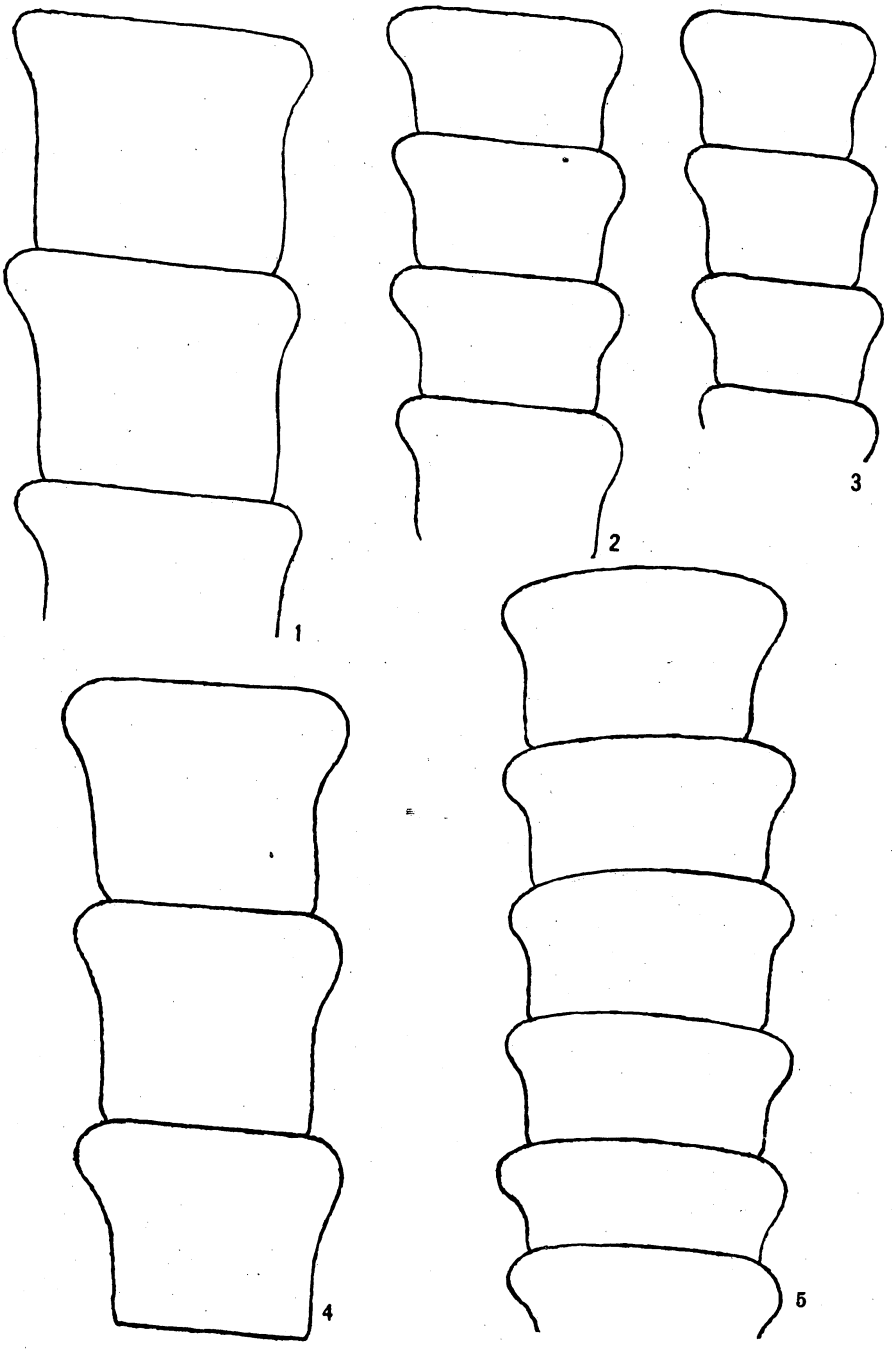


PLATE XII

FIG. 1. *Huronia obliqua* Stokes. — Lateral view with annulations having an obliquity of 80 degrees. Based on the type, Pl. V, Fig. 4.

FIG. 2. *Huronia obliqua* Stokes. — Lateral view, based on Pl. XVII, lower part of Fig. 1 B.

FIG. 3. *Huronia portlocki* Stokes. — An attempt at a lateral view of the type, Pl. IX, Fig. 9, based on Foord's statement that the species most nearly resembles *Huronia obliqua*, and based also on the obliquity of 75 degrees as estimated by Dr. Bather.

FIG. 4. *Actinoceras tenuifilum* (Hall). — Vertical section through the conch, showing the long septal necks in the siphuncle. From Watertown, New York, in the Black River limestone. Same specimen as *Bull. Sci. Lab. Denison Univ.*, 19, 1921, Pl. 28, Fig. 2.

FIG. 5. *Huronia distincta* Barrande. — An attempt at a lateral view of the outline, based on an obliquity of 85 degrees. See Plate 6, Fig. 6.

FIG. 6. *Huronia annulata* Hall. — Lateral view of outline of the same specimen as Plate 6, Fig. 3.

FIG. 7. *Actinoceras bigsbyi* Bronn. — *A*, vertical section through part of the type, showing the right margin of the siphuncle with part of two of the septa; the lunate calcareous deposits embrace the septal necks, and the intervening radiating chords are indicated; the central space filled by matrix is outlined. *B*, cross-section of the conch, indicating the relative size and position of the siphuncle; the outline of the central space filled by matrix, and the radiating chords also are shown. *C*, lateral view of the conch, showing a few of the sutures of the septa. Same specimen as Plate 1, Fig. 1 A, the type of the species. Figures drawn by Dr. F. A. Bather, of the British Museum of Natural History.

PLATE XII

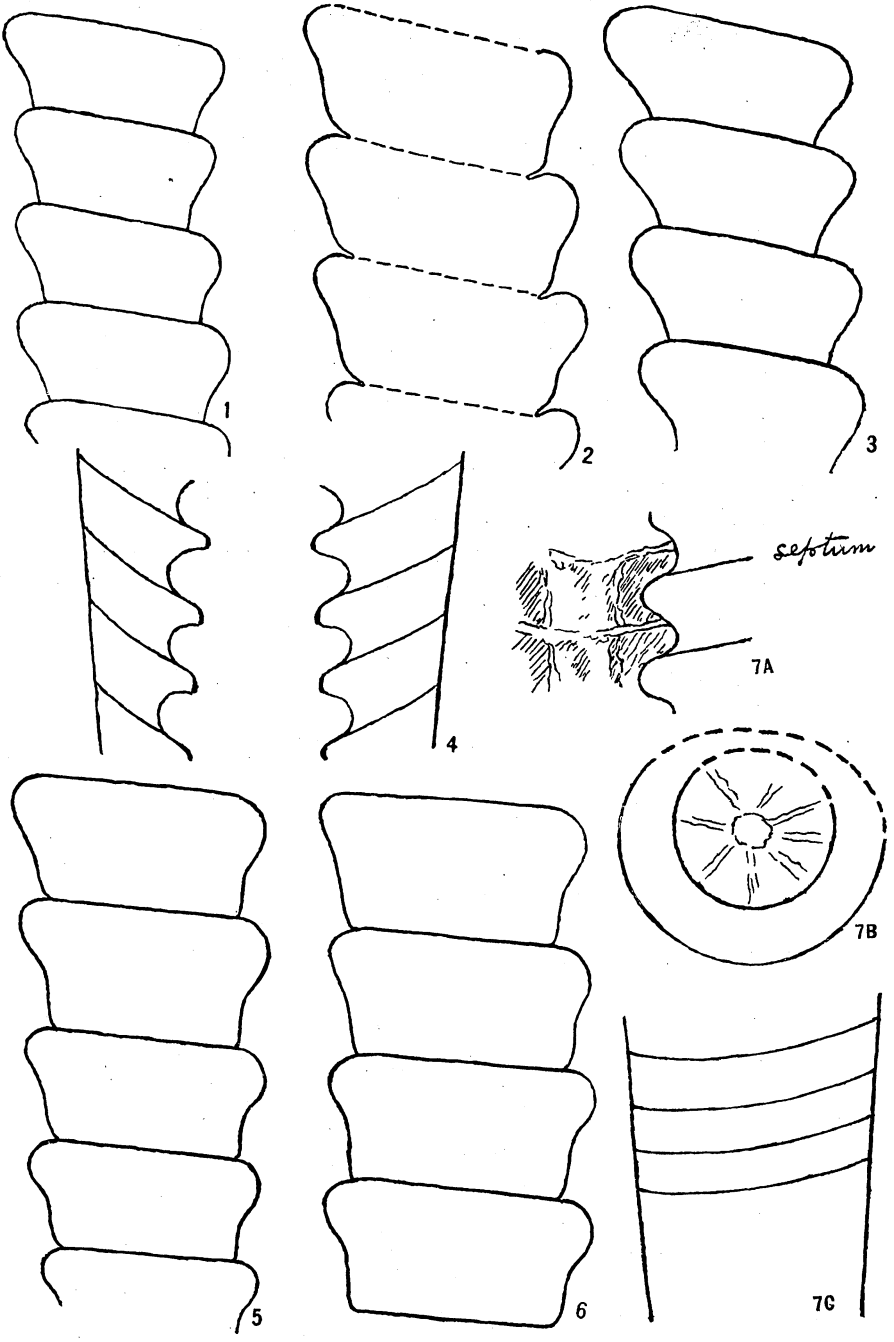


PLATE XIII

FIG. 1. *Discosorus* sp. — *A*, an attempt at a vertical section dorso-ventrally through the conch; only the lower part of the specimen and the ventral side of the siphuncle along its upper part are well exposed. *B*, cross-section of the same. Same specimen as Plate V, Fig. 2.

FIG. 2. *Huronia obliqua* Stokes. — *A*, an attempt at a vertical section dorso-ventrally through the conch. *B*, cross-section through the same.

FIG. 3. *Huroniella inflecta* (Parks). — Vertical section through the siphuncle of the type showing the concave vertical outline along the lower side of the annulations, and the point at which the septa become free from the segments of the siphuncle. Same specimen as *Trans. Royal Canadian Inst.*, 11, 1915, Pl. 6, Fig. 4. From the Limestone Rapids on Severn River, west of Hudson Bay.

FIG. 4. *Armenoceras hearsti* (Parks). — Vertical section through the siphuncle of the type, showing the extremely short length of the septal neck, and the virtual absence of any concavity of outline of the segments of the siphuncle along the lower side of the annulations; the proximal parts of the septa also are shown. Same specimen as *Trans. Royal Canadian Inst.*, 11, 1915, Pl. 6, Fig. 5. From the Limestone Rapids on Severn River, west of Hudson Bay.

PLATE XIII

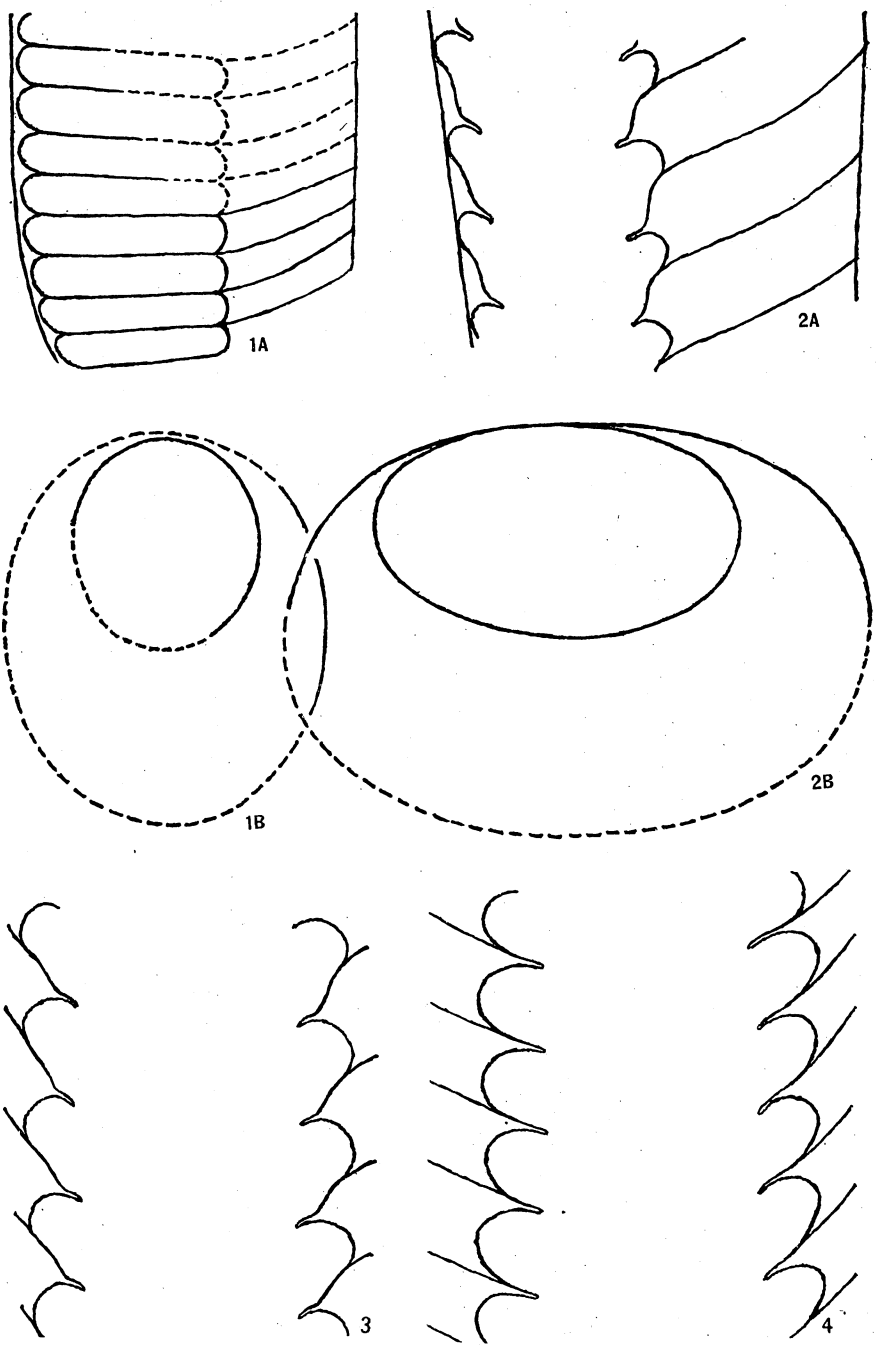
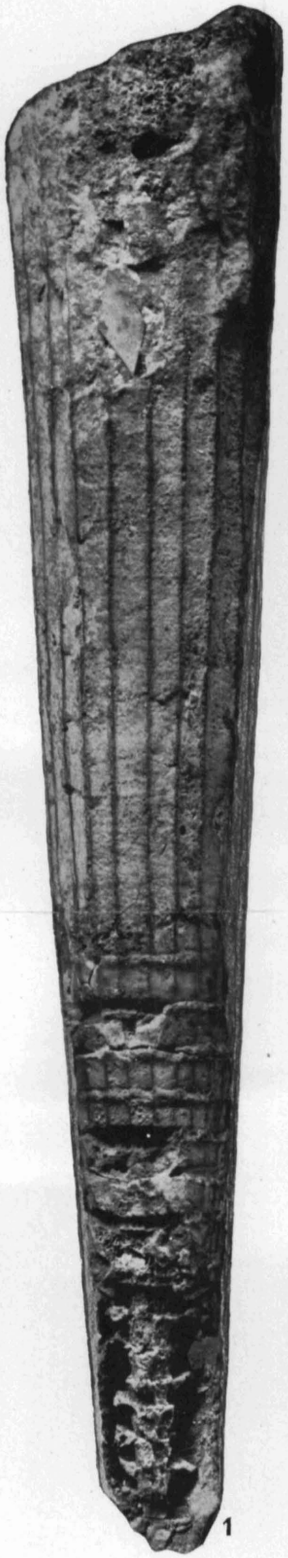


PLATE XIV

FIG. 1. *Kionoceras loxias* (Hall). — Lateral view of specimen, showing surface of shell above, a camerate portion below the middle, and traces of the septa and of the siphuncle at the base. The siphuncle is encrusted by silicified deposits. From some exposure on the northwestern shore of Lake Michigan, presumably in the Manistique formation. Specimen No. 2105 in the American Museum of Natural History. Same specimen as that figured by Hall in *20th Rep. New York State Cab. Nat. Hist.*, 1868, Pl. 19, Fig. 7. Holotype.

FIG. 2. *Armenoceras gouldense* Foerste. — *A*, ventral view of specimen, weathered so as to show the siphuncle and the septa. *B*, lateral view, with ventral outline on right, showing the dorsal outline of the siphuncle. From north of Hunt's Spur, in Mackinac County, Michigan. Specimen No. 7547 in the University of Michigan collections. Holotype.

PLATE XIV



1

2A

2B

PLATE XV

FIG. 1. *Huroniella ehlersi* Foerste. — Ventral view of siphuncle. From Scott's quarry, in Chippewa County, Michigan, in the Manistique formation. Specimen No. 7541 in the University of Michigan collections. Holotype.

FIG. 2. *Armenoceras gouldense* Foerste. — *A*, lateral view of siphuncle. *B*, lower part of specimen represented by figure 2 B on Plate XIV, modelled in clay so as to show the general outline of the siphuncle. *A*, from north of Hunt's Spur, in Mackinac County. *B*, from south of Gould City, in Mackinac County, Michigan. Both in the Manistique formation. Specimen *A*, numbered 7548; specimen *B*, numbered 7547 in the University of Michigan collections.

FIG. 3. *Huronia paulodilatata* Foerste. — Lateral view of siphuncle. From Scott's quarry, in Chippewa County, Michigan, in the Manistique formation. Specimen No. 7543 in the University of Michigan collections. Holotype.

PLATE XV

1

2A

2B

3

PLATE XVI

FIG. 1. *Huronia bigsbyi intermedia* Foerste. — View of siphuncle. From Drummond Island, presumably in the Manistique formation. Specimen No. 3658 in the University of Michigan collections.

FIG. 2. *Huroniella inflecta* (Parks). — *A*, lateral view of siphuncle. *B*, ventral view of same. From some unknown locality in the Niagaran formation. Specimen No. 3647 in the University of Michigan collections.

PLATE XVI

1

2A

2B

PLATE XVII

FIG. 1. *Huronia obliqua* Stokes. — *A*, ventral view of upper part of specimen, exposing the ventral side of the annulations at the top of the segments of the siphuncle, and the septa which become free from adnation with these segments at the lower part of the annulations. *B*, same specimen, reduced in size, showing also the lower part of this specimen. In this lower part of the specimen the contracted part of the siphuncle is exposed. See also Plate XII, Fig. 2; Plate XIII, Figs. 2 A, B. Specimen No. 7540 in the University of Michigan collections.

PLATE XVII

1A

1B