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Edw. A. BIRGE, Director. **Wm. O. HOTCHKISS, State Geologist.**

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The Fossils and Stratigraphy

OF THE

Middle Devonic of Wisconsin

BY

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PREFACE AND ACKNOWLEDGMENTS

One of the greatest needs in Palaeontology at the present time in North America is faunal lists of the various geological formations throughout the United States and Canada with careful descriptions of the fossils. Until these lists are published the solution of many important faunal problems is impossible. It was with this need in mind that the writer began work on the Devonic beds of Wisconsin, since this field seemed to be of especial importance because of the mixture of eastern and western species. The results have shown the correctness of this view. The value of the work has, however, been greatly lessened by the meager knowledge of the faunas of Michigan, Iowa, Missouri and States to the west. As the palaeontologic work in these States progresses the material in this bulletin will be of increasing interest. More than forty new species and varieties are described herein as a result of this work.

The field work upon which this bulletin is based was done during the summers of 1904 and 1907. Together with the fossils collected during this work the writer has had free access to the excellent private collection of Mr. Edgar E. Teller of Milwaukee and to those donated by Mr. Charles E. Monroe to the Public Museum, Milwaukee. With out these collections the fauna, as given in this bulletin, would have been very incomplete, since they represent the work of many years of careful and intelligent collecting and contain a large number of rare and exceptionally well preserved specimens. The fauna herein described is fairly complete but much is yet to be done, especially on the corals of the Lake Church section.

The writer wishes, at this time, to express his obligation to Professor Charles Schuchert of Yale University who has read the brachiopod chapter and who, because of his wide experience and thorough knowledge of Devonic fossils, has been helpful in many ways during the progress of the work. To Messrs. Charles E. Monroe and Edgar E. Teller my thanks are especially due for pointing out to me the Devonic outcrops, for the loan of their excellent collections, and for many personal courtesies shown the writer during his stay in Wisconsin.

It gives me pleasure to express my thanks to the following gentlemen who have been consulted concerning the identification of certain fossils: Dr. J. M. Clarke, Dr. E. M. Kindle, Dr. R. Ruedemann, Dr. C. R. Eastman, Dr. H. W. Shimer, and to other gentlemen to whom I have written for information.

The entire work of the identification and description of the Bryozoa and Ostracoda was done by Mr. R. S. Bassler of the United States National Museum.

The excellent drawings of fossils illustrating this report is the work of Mr. G. S. Barkentin of the New York State Geological Survey, and the writer wishes at this time to thank him for his painstaking and artistic work.

Williams College, Williamstown, Mass., February 7, 1908.

THE FOSSILS AND STRATIGRAPHY OF THE MIDDLE DEVONIC OF WISCONSIN.

CHAPTER I.

GEOLOGICAL STRUCTURE

The State of Wisconsin possesses a great variety of geological formations from the most ancient—the Archean—to and including that of the Middle Devonic. In this bulletin only the last mentioned, the Middle Devonic, is considered. With the exception of the stratum immediately underlying this formation, each of the formations of the State has been correlated with those in the eastern part of North America with considerable certainty. The formation in doubt was provisionally referred by Professor T. C. Chamberlin[1] to the Lower Helderberg but has recently been placed in the Cayugan (Siluric) group and given the local name Waubakee formation.[2] (See text figure 1.)

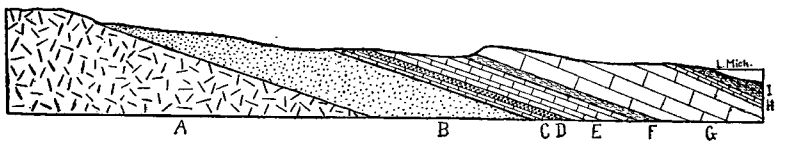

Fig. 1.—Generalized Northeast-Southwest section across Wisconsin from the Pre-Cambrian to the Devonic. A, Pre-Cambrian; B, Potsdam; C, Lower Magnesian; D, St. Peters; E, Galena and Trenton; F, Cincinnati; G, Niagara; H. Waubakee; I, Hamilton.

Between the Waubakee and the overlying Middle Devonic (Milwaukee) formation is an unconformity representing a long period of time (some of the late Siluric, all of the Lower Devonic and a part of the Middle Devonic being absent). During the time represented by this unconformity the older deposits were subjected to weathering

[1] Geology of Wisconsin, vol. 2, pp. 390–394.

[2] G. D. Alden, Prof. Paper 34, U. S. G. S. pp. 13–14; Folio U. S. G. S. 140.

and erosion or solution. This unconformity is shown in the Lake Church exposures but in every case the Middle Devonic beds are parallel with the Lower and no erosion channels are apparent. The evidence in some exposures points to solution rather than to erosion.

The strata of the Middle Devonic outcrop in but a few places in Wisconsin, the most distant exposures—those in Milwaukee, at the Humboldt Street bridge, and those at Lake Church—being but 30 miles apart. There are two reasons for the scarcity of exposures: (1) the country is covered with drift except in a few places and (2) preglacial and glacial erosion had probably carried away the greater part of the formation which formerly appeared on the surface leaving isolated patches here and there. That this is true is shown by the presence of the Niagara limestone and the thin-bedded Waubakee limestone only a short distance to the west and south and even between the Devonic outcrops.

An examination of the geologic maps of Michigan and Wisconsin will show that the main body of the Devonic rocks even before erosion took place probably did not cover a great area in Wisconsin. Exception must be made to the hypothetical strait (see map, page 4), which the fauna shows must have existed to furnish a passage for the migration of the animals of that time to and from the eastern and western seas.

THE GEOGRAPHY OF THE MIDDLE DEVONIC

A study of the fossils of the Wisconsin Devonic with reference to their relationship to fossils of the same age in other parts of North America brings out some interesting facts concerning the relative position of land and water at the time at which they were deposited.

That a great inland sea existed during the Middle Devonic which was narrowed to a broad strait in what is now Northern Illinois and Southern Michigan, by a tongue of land that stretched diagonally across the State of Illinois and well into the lower peninsula of Michigan, there seems to be little doubt. It was through this strait that migration took place between the east and west. An analysis of the Wisconsin Middle Devonic fauna brings out the following facts. Out of 25 species of Bryozoa, 10 species have been described from the east only, 10 species from the west only, and 3 species are common to both east and west. The general assemblage is, however, more western than eastern. The brachiopods show a somewhat similar distribution; out of 35 well marked species and varieties, 6 are restricted to the west, one is found only in the east, and 14 are common to both sections.

A comparison of the Wisconsin Middle Devonic fauna with the following list that Williams[1] has given as the "Standard list of dominant species for the New York-Ontario Province" (eastern Middle Devonic) shows that a marked difference exists between the faunas of the east and Wisconsin:

1. *Spirifer mucronatus*
2. *Phacops rana*
3. *Tropidoleptus carinatus*
4. *Ambocoelia umbonata*
5. *Athyris spiriferoides*
6. *Palaeoneilo constricta*
7. *Spirifer granulosus*
8. *Chonetes coronatus*
9. *Nuculites triqueter*
10. *Nucula corbuliformis*
11. *Nuclites oblongatus*
12. *Nucula bellistriata*

The only brachiopod of the above list common to both regions is *Spirifer mucronatus;* of the pelecypods only *Palaeoneilo constricta.* The wide-spread *Phacops rana* is common to both. In other words, out of twelve dominant species of the eastern provinces only three are also found in the Middle Devonic of Wisconsin. Besides the species included in the above list we miss in the Milwaukee formation *Spirifer marcyi, Spirifer divaricatus, Spirifer consobrinus, Spirifer medialis, Rhipidomella vanuxemi, Stropheodonta concava, Stropheodonta demissa, Stropheodonta inaequistriata* and other common species of New York and Ontario.

On the other hand, of the western fauna we have several typical species such as *Spirifer iowensis, Spirifer subvaricosus, Atrypa hystryx,* (at Milwaukee earlier than elsewhere) and *Cranaena iowensis.*

The crustaceans are all eastern forms with the exception of the widespread species *Phacops rana.*

Fish are especially likely to be widespread because of their means of locomotion and we find, consequently, 1 eastern species, 4 western species and 5 species common to both sections. That is, of 12 well marked species of fish (18 species including doubtful forms) which occur in Wisconsin over 40 per cent are known to have lived throughout the Middle Devonic seas in North America.

The distribution of the pelecypods is rather puzzling in that although 11 (out of 24 well marked species and varieties) have been described from the east, none are reported from Iowa. This is remarkable when the distribution of other classes of organisms is considered.

The cephalopods seem to have found the conditions at certain times especially favorable for their development and growth as is seen from the fact that in certain parts of the Milwaukee section, zone B, they

[1] H. S. Williams, American Journal of Science, Vol. 14, 4th series, 1902,

are very numerous and of several new species of the genus *Gomphoceras*. It should be noted, however, that all the species of *Gomphoceras* are closely related.

The foregoing analysis shows, then, that Southern Wisconsin was in the path of migration for the animals living in the Middle Devonic both to and from the eastern and western seas; that this waterway was quite narrow as is indicated by the marked difference between the eastern and western faunas of that period. The deposits which were laid down in this strait have been eroded away to such an extent that only a few patches are left here and there leaving the position of the shore line a matter of speculation.

These conclusions are well shown in Professor Charles Schuchert's[1] map of the Middle Devonic which presents the best that our knowledge of the Middle Devonic faunas has to offer as to the geography of the time.

It should be remembered in studying these faunal tables that little has yet been done on the Middle Devonic faunas in the States west of the Mississippi river and that, consequently, one can not, at the present time, make definite statements as to the western limits of any of these species.

(For further discussion as to the age of these beds see the following paragraphs.)

AGE OF BEDS

The beds under discussion are Devonic and were probably deposited during the later portion of the Middle Devonic. They should be correlated with the Hamilton formation of New York, although some species which occur only in the Upper Devonic of the east occur in these deposits. They correspond in part at least to the Traverse group of Michigan. Schuchert[2] states as his opinion that "the Milwaukee Devonic includes not only a part of the Hamilton but also a part of the Portage of New York" and that "the former region has probably received migrants from the east." "The higher beds of the Upper Devonic have been removed in the Milwaukee-Chicago area but in Michigan are present as the Atrium (Genesee, Portage, and Chemung) formation." Dr. C. R. Eastman[3] from the evidence of fish remains,

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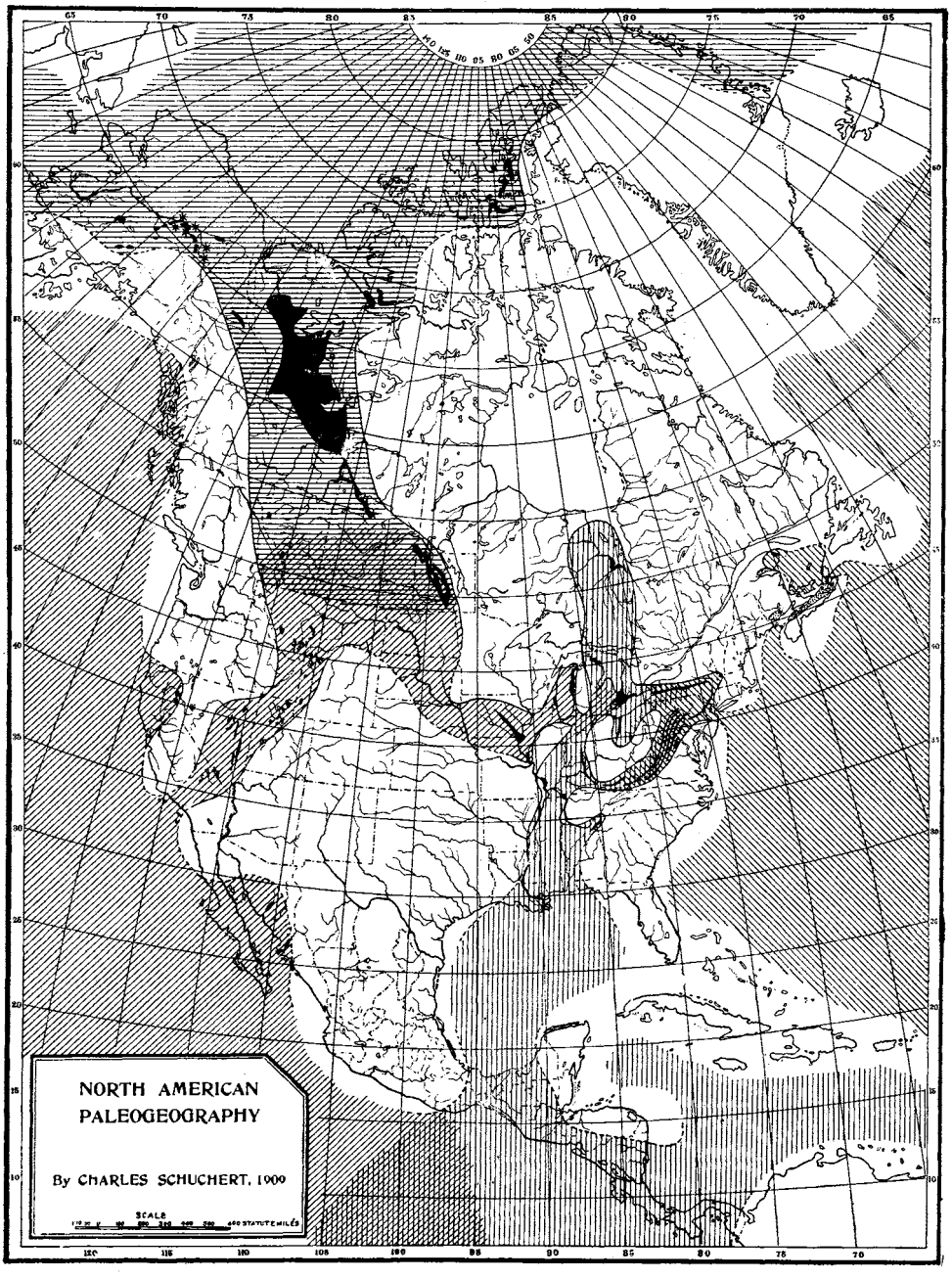
1 Paleogeography of North America, pl. 76, vol. 20, Geological Society of America Bulletin, 1910.

2 Schuchert, Am. Geol. Sept. 1903, vol. 32, pp. 145–6.

3 Eastman, Letter to the writer Jan. 28, 1908.

MIDDLE DEVONIC (LATE HAMILTON)



believes that the "Corniferous" clearly has no representative west of the Mississippi valley, and there are no forms of fish-life in the Cedar Valley limestone of Iowa which appear to be derivatives of an eastern Corniferous fish-fauna. Hence the origin of the Iowan forms is to be sought from the northwest, as a Eurasian dispersal. Some time before the close of the Hamilton, communication was established between the Wisconsin and Iowan areas, in consequence of which we find at Milwaukee a mingling of Cedar Valley forms from the south-west and a modified post-Corniferous fauna from the Ohioan region. As compared with foreign horizons, the Milwaukee beds would correspond to the Upper Middle Devonic, that is, in France, etc. the Givetien rather than the Eifelien and in Rhineland the Stringocephalus rather than the Calceola beds.

A study of the faunal lists, pages 12–20 leaves no doubt that these beds are Middle Devonic and should be correlated with the later part of the Hamilton formation of New York. It is possible that the "Lingula shales" of Teller and Monroe (of the New Intake Tunnel, Milwaukee) should not be included in this formation. The name Milwaukee formation[4] has recently been given to these beds to conform with the present custom of applying local names in each State in which a formation occurs, when the exact correlation is thought to be in doubt.

LOCALITIES

Milwaukee Cement Quarry, Berthelet (Humboldt Street Bridge), Milwaukee.

The rock of the Hamilton (Milwaukee) formation in Wisconsin has long been known as "Cement Rock" because of the fact that the impure dolomite which constitutes this formation is a hydraulic limestone and has for many years been quarried and burnt for cement.

The most important exposure near Milwaukee is in the cement quarries of the Milwaukee Cement Company on the Milwaukee river at Berthelet (Humboldt street bridge), a northern suburb of Milwaukee, where the river flows over this rock for some distance above the quarries. The lithologic character of this exposure varies in different layers as described below. In general, however, it may be said that the rock of the quarry is of a blue gray color which weathers to a buff in certain layers, due to the oxidation of the marcasite which occurs

[4] Alden, Folio U. S. G. S., No. 140, 1906.

commonly throughout the section. The average analysis of the rock at Milwaukee as given by Chamberlin[1] and quoted by Teller[2] is:

Carbonate of Lime	45.11
Carbonate of Magnesia	30.89
Silica	16.61
Alumina	4.09
Oxide of Iron	3.25
Total	99.95

A number of minerals occur in the rocks of this quarry among which the following are the most common:

(1) *Calcite.* This mineral occurs in cavities varying in diameter to two or more inches, the crystals of which are scalenohedrons with rhombohedral terminations. Common.

(2) *Pyrite* or *Marcasite* (FeS_2) in the form of small concretions, and replacing shells, occurs throughout the section and occasionally forms the lining of small cavities. Common.

(3) *Sphalerite* (ZnS) in small crystals is occasionally found.

(4 *Millerite* (NiS) in beautiful long, needle-like crystals with the characteristic radiating habit occurs in cavities free from the matrix. This mineral is very rarely found.

(5) *Asphaltum* occurs in small globules.

(6) *Barite* in some abundance occurs in the underlying formation.

A careful search will doubtless bring other minerals to light.

The rock of the Milwaukee quarry is seen to be in a number of distinct layers separated from one another by well defined bedding planes as is shown in the accompanying figures. (Plates A and B.)

PLATE A.

Figure 1

North bank of the Milwaukee river north of the Milwaukee cement quarry. At this place the weathered specimens of zone C are quite common in the drift immediately overlying the shaly layers (zone C) which are here in place. The whole is overlaid by a thick mantel of drift.

Figure 2

North side of the Milwaukee cement quarry south of the Milwaukee river. The lower part of the section is zone A, the upper darker layers, the "hard layer," zone B.

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[1] Geology of Wisconsin Vol. 2, pp. 396.

[2] Bull. of Wis. Nat. His. Soc. Vol. 1, No. 1, pp. 47–56.

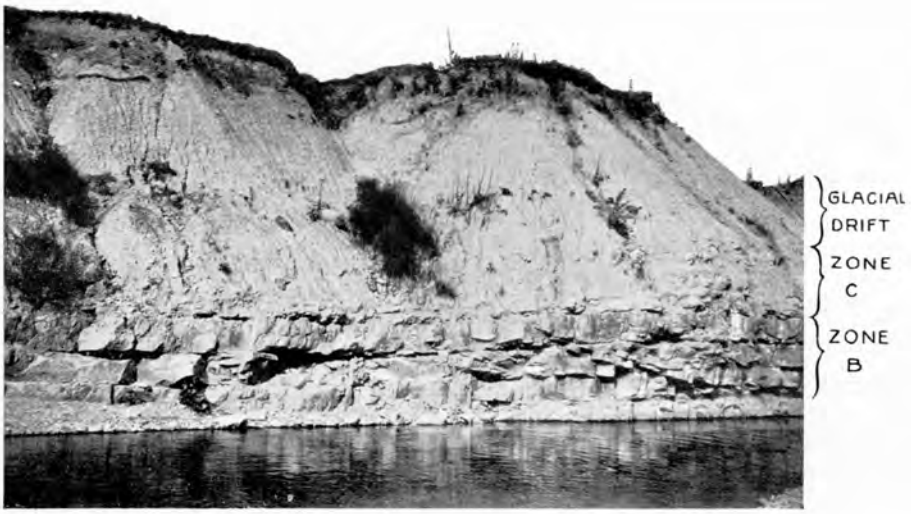

FIG. 1

FIG. 2

The separation of the Milwaukee section into zones is based upon three characters: (1) lithologic differences, (2) preservation of the fossils, and (3) the fauna. These characters are discussed under the description of each zone.

Zone A, 15 ft.—From the floor of the quarry which is the brown arenaceous Waubakee formation to the "hard layer," zone B (Pl. B, fig. 2).

In this portion of the section the layers are all very similar in composition, the whole being a fairly heavy-bedded, light-gray, hydraulic dolomite in which the layers are separated from one another by shaly partings varying in thickness from a fraction of an inch to three inches.

Some of the layers of this division are more arenaceous than others, but not noticeably so except in hand specimens. The layers vary greatly in the abundance of fossils but the species are quite constant although the relative abundance varies. The fossils are almost entirely in the form of casts of the exterior, and stand out in high relief because of a black deposit with which they are often coated. E. E. Teller[1] has described this division with great care and has noted the fossils contained in each layer but as certain layers are found to merge into others when traced to distant parts of the quarry and because of the constancy of the fauna it is thought best for the purpose of this paper to include all in one division. Zone A is especially rich in fish remains, *Spirifer iowensis* and *Stropheodonta perplana.*

Zone B, 6 ft.—This layer (Pl. B, figs. 1 and 2), called the "hard layer," is one which is readily distinguishable because of its lithologic and other characters. It is of a yellower color than the beds above and below, and, because of its hardness and resistant character, does not readily break down. When the rock of zone A was quarried by tunnelling this layer was left by the quarrymen to form the roof of the tunnels. A faunal character which is quite distinctive is the abundance of cephalopods. The greater abundance of calcite and marcasite lined cavities and marcasite concretions should be mentioned. Fossils are in the form of casts of the exterior and interior, many of which are lined with calcite crystals.

Zone C, 4 ft. exposed.—The rock above the "hard layer" (Zone B) is softer than that below because of its shaly character, but thin layers of purer and harder limestone also occasionally occur. In zone C (Pl. B, fig. 1) the fossils seldom occur in the form of casts; in this respect differing from zones A and B. In one species, *Cranaena iowensis*, even the color markings are preserved. It is difficult to obtain a fauna from

[1] Bull. Wis. Nat. Hist. Soc. Vol. 1, No. 1, pp. 47–56.

this bed except where the fossils are weathered out, but as the rock disintegrates easily the best fossils of the section are obtained from it. The most noticeable difference between this zone and zones A and B is the abundance of Bryozoa in certain layers. In the debris of the Intake tunnel C. E. Monroe obtained many excellent silicified specimens.

The strata are practically horizontal but are slightly undulating in some places with a slight dip to the southwest.

Lake Shore Stone Quarry Near Lake Church, Ozaukee County

A richly fossiliferous exposure occurs on the shores of Lake Michigan about one and one-half miles south of east of the village of Lake Church. The rock is exposed for a few hundred yards along the shore of the lake but the best section is in the quarry of the Lake Shore Stone Company (Pl. B, fig. 4). Beginning with the bottom of the quarry the section is as follows:

Niagaran, 40 ft.—The Niagaran is a bluish-white coarsely crystalline limestone, heavy bedded and characterized by innumerable small, oblong pores which are arranged parallel to the bedding planes. A layer 28 inches thick near the base of the Waubakee is often weathered to a soft bluish-brown clay. This layer, however, does not weather in this way in all parts of the quarry.

No fossils were found in this limestone which, judging from its lithologic characters and stratigraphic position, is probably Niagaran.

The rock of this and the overlying beds is used as a flux in the blast furnaces at Milwaukee and for concrete and road material.

PLATE B.

Figure 3

East side of the quarry at Dreuckers. The Hamilton formation (6 feet thick) is weathered to a dark yellow and broken into angular fragments by the frost and is easily distinguished from the thin-bedded Waubakee (2 feet) which underlies it unconformably and the light colored Niagara limestone which constitutes the greater part of the quarry and which is unconformable with the overlying Waubakee.

Figure 4

Lake Shore Stone Co., one and one half miles east and south of the village of Lake Church on the shore of Lake Michigan. A fault with a small throw is shown in the Hamilton beds. Underlying these unconformably and overlying the Niagara unconformably is the Waubakee formation (2 feet 8 inches). The surface is smoothed and polished by glacial action.

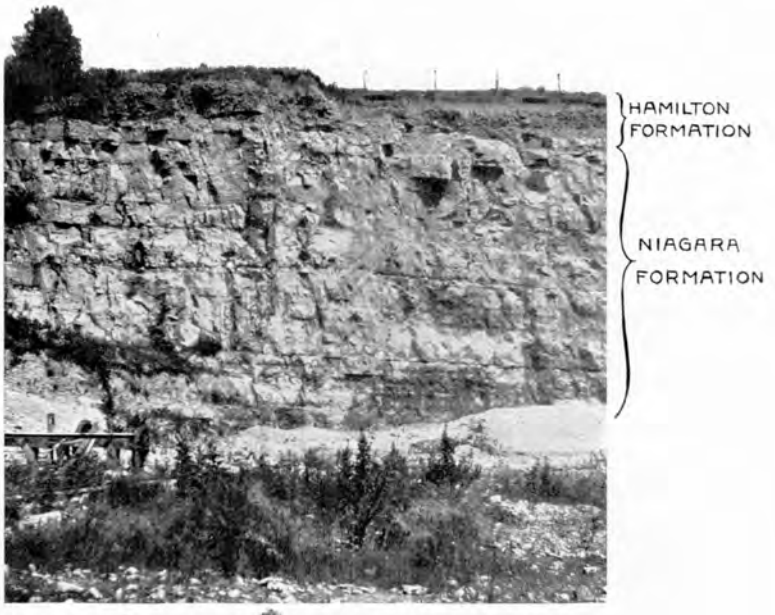
HAMILTON
FORMATION
NIAGARA
FORMATION

FIG. 3

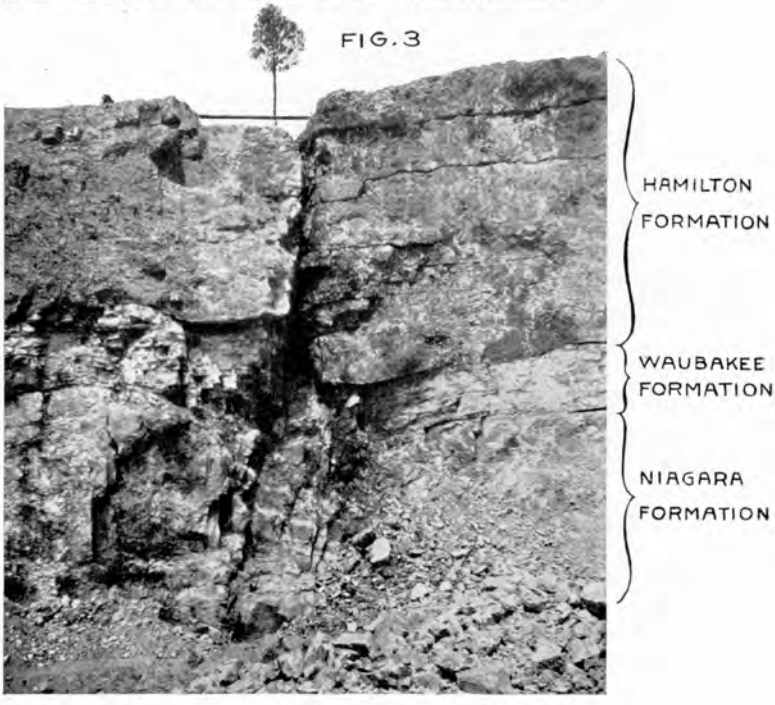
HAMILTON
FORMATION
WAUBAKEE
FORMATION
NIAGARA
FORMATION

FIG. 4

Waubakee formation, 2 feet 5 inches to 2 feet 7 inches.—This formation is unconformable with both the overlying and underlying formations. The relation between the formations is shown in text figure 2. This stratum is composed of a wavy, thin-bedded, nodular limestone in which the layers are separated from one another by well marked shaly partings. In the Lake Church quarry it is of a light-gray color and is usually easily distinguished from the darker and browner Devonic above and the lighter Niagaran below. In the Milwaukee quarry this rock is darker and harder than at Lake Church and Dreuckers or at Waubakee. No fossils were found.*

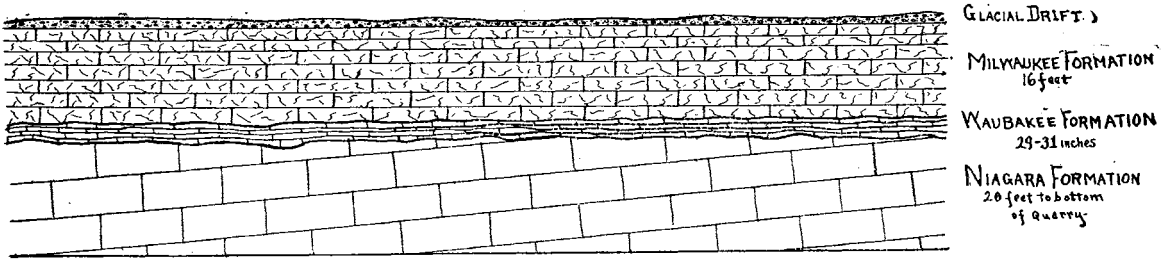

Fig. 2.—A generalized section in the Lake Shore Stone Quarry near Lake Church, Ozaukee County.

Middle Devonic, (Hamilton formation) 10 feet.—The stratum immediately overlying the Waubakee formation contains the fossiliferous rock of the quarry. It is an impure dolomite that breaks up readily into irregular, more or less angular fragments. Its color is a light brown or buff and is readily distinguished in the quarry and in hand specimens. It is a comparatively thin-bedded dolomite although occasional layers are as much as two feet in thickness. The upper members of the formation are absent, having been eroded away by glacial action and the usual processes of erosion. The upper surface is finely smoothed and scratched by glacial action.

The fossils of the formation occur as casts which often beautifully preserve the fine markings of the exterior and interior. Some layers are practically barren while others are extremely rich in fossils. The chief difference between the fauna of this and the Milwaukee section—29 miles southwest—is the greater abundance of corals and gastropods (see faunal lists, pages 12–20).

Several small faults occur in the quarry which are of especial interest to the student in a region where faults are rare or at least inaccessible (see text fig. 3).

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* For a discussion of the fossils from this formation see Whitfield, Bull. Am. Mus. Nat. His., vol. VIII, pls. XII, XIII, XIV.

Whitefish Bay

The Hamilton formation outcrops about two miles north of Whitefish Bay station on the lake shore. It was here that Whitfield[3] obtained some of his specimens for volume IV of the Geology of Wisconsin. The rock here was formerly mined by tunnelling by the Consolidated Cement Company but in 1907 no work was being done and the rock was inaccessible except on the shore of the lake.

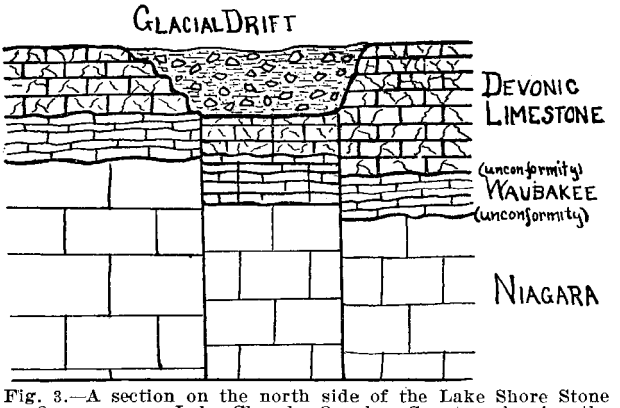

Fig. 3.—A section on the north side of the Lake Shore Stone Quarry, near Lake Church, Ozaukee County, showing the unconformities between the Devonic (Hamilton) and the Waubakee and between the Waubakee and the Niagara.

The New Intake Tunnel, Milwaukee

One of the most important sections is that furnished by borings made for the New Intake tunnel for the city of Milwaukee, on the shore of Lake Michigan north of North avenue, between 1885 and 1900. "At a depth of 42 feet below the water level, as shown by the records in the engineer's office, the short shaft penetrated 15 feet of black shale. Below this in succession were 40 feet of soft, blue shale rock, 10 feet of cement rock and 31 feet of blue shaly rock. At a depth of 138 feet brown stone and lime rock [Waubakee] was reached."

The following is the section of the Intake tunnel as given by Teller and Monroe*:

"Lingula bearing shales."

"That portion of the soapstone carrying shells of *S. euryteines* [var. *milwaukeensis*], *S. asper ect.* . . . being the upper "soapstone" of the City Engineer's section." [Includes zones A, B and C of this bulletin.]

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* Teller and Monroe, Jour. of Geol. vol. 7, p. 272–283, 1899.

"Thin white seams, whose relations are not definitely known" [probably a portion of zone C of this paper].

Brown Deer

At the village of Brown Deer the rocks of this formation are to be seen in a railroad cut but they are so badly broken up by weathering that the collecting is very poor.

Granville Center.

Professor T. C. Chamberlin speaks in the Geology of Wisconsin, vol. 2, page 391, of an exposure of the Devonic in this township which has since been covered and which at that time was the most northwesterly exposure.

Dreuckers Quarry, Port Washington.

In this exposure there is a maximum of six feet of the Milwaukee formation on the east side; on the north and south portions of the quarry it is absent, having been eroded away (see Pl. C, fig. 3). The fossils collected in a few minutes yielded the following species:

Spirifer euryteines var. milwaukeensis
Spirifer (of *divaricatus* characters)
Spirifer subvaricosus
Atrypa reticularis
Stropheodonta halli
Bellerophon pelops
Platyceras sp.
Chonetes vicinus

The lithologic characters and fauna are identical with those of the Lake Church exposures.

The Milwaukee formation is underlaid by about two feet of the Waubakee formation, which is similar to that at Lake Church.

The Niagaran is the important rock of the quarry and is burnt for lime.

THE FAUNA OF THE WISCONSIN MIDDLE DEVONIC SHOWING (1) THE VERTICAL DISTRIBUTION IN THE MILWAUKEE QUARRY, (2) THE DISTRIBUTION IN WISCONSIN, AND (3) THE GEOGRAPHICAL DISTRIBUTION.

CORALS.	MILWAUKEE.			LAKE CHURCH.	GEOGRAPHICAL DISTRIBUTION.		
	Zone A.	Zone B.	Zone C.		East of Wisconsin.	Wisconsin.	West of Wisconsin.
Acervularia davidsoni E. and H.	.....	.....	.....	c	.....	.....	.....
Aulopora annectens Clarke	.....	.....	x	.....	x	x	x
" *serpens* Goldfuss	.....	.....	x	.....	x	x	.....
Alveolites? monroei nov	x	.....	.....	.....	.....	x	.....
Aulacophyllum convergens Hall	x	.....	.....	.....	x	.....	.....
Ceratopora agglomerata Grabau var	.....	.....	x	.....	x	x	.....
" *flabellata* Greene	.....	.....	x	.....	x	x	.....
" *intermedia* Nich	.....	.....	x	.....	x	x	.....
" *jacksoni* ? Grabau	.....	.....	x	.....	x	x	.....
" *rugosa* nov	.....	.....	x	.....	.....	x	.....
" sp. nov	.....	.....	.....	x	.....	x	.....
Cystiphyllum cf. *americanum* E. and H	.....	.....	.....	x	x	x	.....
Favosites alpenensis ? Winchell	.....	.....	x	.....	x	q	.....
" *radiatus* ? Rominger	.....	.....	x	x	x	x	.....
" sp	.....	.....	.....	x	.....	x	.....
Heliophyllum halli E. and M	.....	.....	.....	x	x	x	.....
" " *corniculum*	.....	.....	x	.....	.....	x	.....
Striatopora iowensis (Owen)	.....	.....	x	.....	.....	x	x

CRINOIDS AND BLASTOIDS.	MILWAUKEE. Zone A.	Zone B.	Zone C.	LAKE CHURCH.	GEOGRAPHICAL DISTRIBUTION. East of Wisconsin.	Wisconsin.	West of Wisconsin.
Melocrinus nodosus Hall						x	
" " var. *spinosus* Weller						x	
" *subglobosus* Weller						x	
" *milwaukeensis* Weller						x	
" " var. *rotundatus* Weller						x	
" *petangularis* nov						x	
Taxocrinus interscapularis Hall						x	x
Pentremitidea filosa Whiteaves					x	x	
" *milwaukeensis* Weller						x	
Nucleocrinus obovatus (Barris)						x	x

VERMES.	MILWAUKEE. Zone A.	Zone B.	Zone C.	LAKE CHURCH.	GEOGRAPHICAL DISTRIBUTION. East of Wisconsin.	Wisconsin.	West of Wisconsin.
Arabellites crescentum nov			R			x	
Cornulites sp			R			x	
Spirorbis omphalodes Whiteaves			R		Ontario	x	
Autodetus apicatus nov							
Tentaculites bellulus Hall	R	R	C	R	New York		

BRYOZOA.	MILWAUKEE.			LAKE CHURCH.	GEOGRAPHICAL DISTRIBUTION.		
	Zone A.	Zone B.	Zone C.		East of Wisconsin.	Wisconsin.	West of Wisconsin.
Allonema fusiforme N. and E.	....	....	x	.....	Ontario. New York	x	.....
Ascodictyon floreale U. and B	....	....	x	.....	New York Ontario.	x	.....
" *stellatum* N. and E	....	....	x	.....	New York Ontario.	x	.....
Cyclotrypa collina (Ulrich)	....	....	?	.....	.....	x	Iowa.
Cystodictya hamiltonensis Ulrich	....	....	x	.....	.....	x	Illinois. Iowa.
Eridotrypa appressa Ulrich	....	?	.....	.....	.....	x	Iowa. Illinois.
Fenestella vera Ulrich	....	....	x	.....	.....	x	Iowa. Illinois.
Fistulipora monticulata Ulrich	....	?	.....	.....	.....	x	Iowa.
" *romingeri* N. and F.	....	x	.....	.....	New York	x	Iowa.
" *utriculus* Rominger	....	....	x	.....	Ontario.	x	.....
Hedcrella magna Hall	....	....	x	.....	Ontario. New York	x	.....
" *filiformis* (Billings)	....	....	x	.....	New York	x	.....
" *cirrhosa* Hall	....	....	x	.....	New York Ontario.	x	.....
Hemitrypa tenera Ulrich	....	....	x	.....	.....	x	Illinois. Iowa.
Hernodia humifusa Hall	....	x	.....	.....	New York	x	.....
Heteronema monroei (Bassler) nov	....	....	x	.....	.....	x	.....
Lioclema minutissimum (Nicholson)	....	....	x	.....	New York Ontario.	x	Illinois. Iowa.
Orbignyella monticula (White)	....	x	.....	.....	.....	x	Iowa.
" *tenera* (Bassler) nov	....	....	x	.....	.....	x	.....
Petalotrypa compressa Ulrich	....	....	x	.....	.....	x	Illinois. Iowa.
Reptaria stolonifera Rolle	....	x	.....	.....	New York	x	.....
Reteporina hamiltonensis (Prout)	....	x	?	?	.....	x	Illinois. Iowa.
Rhopalonaria tenuis U. and R	....	....	x	.....	Ontario. New York	x	.....
Semicoscinium rhombicum Ulrich	....	....	?	.....	.....	x	Iowa.
Vinella devonica (Bassler) nov	....	....	x	.....	....	x	.....

BRACHIOPODA.	MILWAUKEE.			LAKE CHURCH.	GEOGRAPHICAL DISTRIBUTION.		
	Zone A.	Zone B.	Zone C.		East of Wisconsin.	Wisconsin.	West of Wisconsin.
Athyris fultonensis (Swallow.)	R	R	A	C	Michigan.	x	Manitoba. Missouri.
Atrypa hystrix Hall	CR	....	.....	C	New York.	x	Iowa.
" *sinuata* nov.	.....	....	.....	C	.....	x	.....
" *reticularis* (Linnaeus)	C	C	A	A	Europe.	x	Asia.
Camarotoechia scitula nov.	R	....	R	.....	.....	x	.....
" *contracta* var. *saxatilis* Hall.	R	....	CR	.....	.....	x	Iowa.
Chonetes schucherti nov.	CR	R	A	.. ..	.....	x	.....
" *vicinus* Castelnau	.....	....	?	C	New York.	x	Nevada (?)
Crania iowensis (Calvin)	.....	R	C	.....	.....	x	Iowa. Missouri.
Craniella hamiltoniæ Hall	.....	R	R	.....	New York.	x	Atabasca, Canada.
Cyrtina hamiltonensis Hall	R	R	CR	R	New York. Maryland.	x	Nevada. Atabasca.
Eunella lincklaeni (Hall)	.....	....	?	.....	.....	.....	.....
Glossina truncata nov.	.....	...	R	.....	.....	x	.....
Gypidula comis ? Owen	.....	....	.....	C	....	x	Nevada. Manitoba.
Liorhynchus greeni nov.	R	R	.....	.....	.....	x	.....
Lingula milwaukeensis nov.	.....	....	R	.....	.....	x	.....
" *delia* ? Hall	.....	....	R	....	New York.	x	.....
Lingula sp. undet.	.....	....	.....	.....	.....	.....	.....
Lingulodiscina marginalis Whitfield	R	R	R	.....	.....	x	.....
Orbiculoidea telleri nov	CR	R	R	.....	.....	x	.....
" *wardi* nov	CR	R	R	.....	.....	x	.....
Pentamerella multicostata nov.	?	R	.....	.....	.....	x	.....
" sp	?	R	... ..	.....	.....	.....	.....
Pholidostrophia iowensis Owen.	R	R	A	A	New York. Ontario.	x	x Iowa.
Productella spinulicosta Hall	.....	....	R	C	New York. Ontario.	x	Mackenzie R Iowa.
Reticularia fimbriata Hall	.....	....	R	C	New York.	x	Iowa. Mackenzie R
Schizophoria striatula (Schlotheim)	C	A	C	.....	New York.	x	Iowa. Mackenzie R
Schuchertella chemungensis var. *arctistriata* Hall	.....	....	R	?	New York.	x	Nevada.
Spirifer asper Hall	?	C	C	.....	New York.	x	Iowa.
" *euryteines* var. *milwaukeensis* var. nov.	R	C	A	C	.....	x	.....

BRACHIOPODA—Continued.	MILWAUKEE.			LAKE CHURCH.	GEOGRAPHICAL DISTRIBUTION.		
	Zone A.	Zone B.	Zone C.		East of Wisconsin.	Wisconsin.	West of Wisconsin.
Spirifer iowensis Owen	A	R	?	.....	Indiana.	x	Iowa.
" *mucronatus* Conrad	.....	....	R	R	New York. Ontario.	x	.....
" *subvaricosus* Hall & Whitfield	R	C	A	.....	.....	x	Iowa.
" sp. (similar to *divaricatus*)	.....	....	.....	R	.....	x	.....
Strophеodonta cf. *costata* Owen	.....	....	.....	R	.....	x	Iowa.
" *halli* nov	C	A	A	C	.....	x	Iowa.
" *halli* var. *musculosa* var. nov.	.....	....	.....	C	.....	x	.....
" *perplana* (Conrad)	A	C	CR	?	New York. Maryland.	x	Nevada. Brazil.

PELECYPODA.	MILWAUKEE.			LAKE CHURCH.	GEOGRAPHICAL DISTRIBUTION.		
	Zone A.	Zone B.	Zone C.		East of Wisconsin.	Wisconsin.	West of Wisconsin.
Actinopteria boydi Conrad	R	R	R	.....	New York	x	.....
Conocardium ohioensis Meek	....	....	.....	R	Ohio	x	.....
" *ornatum* nov	....	....	R	.....	.....	x	.....
Cimitaria recurva Conrad	R	R	.....	.....	New York	x	.....
Cypricardinia cf. *indenta* Conrad	....	....	R	.....	New York	x	.....
Edmondia fragilis nov	R	....	.....	.....	.....	x	.....
Goniophora obtusiloba nov	R	....	.....	.....	.....	x	.....
Grammysia nodocostata Hall	R	....	.....	.....	New York	x	.....
Glyptodesma ? sp	....	....	.....	R	.....	x	.....
Liopteria cf. *conradi* Hall	....	R	.....	.....	New York	x	.....
" cf. *rafinesquii* Hall	....	R	.....	.....	New York	x	.....
Megambonia ? sp	R	....	.....	.....	.....	x	.....
Modiomorpha concentrica Conrad	R	CR	R	.....	New York Ohio.	x	.....
" *mytiloides* Conrad	R	R	R	.....	New York	x	.....
" *obliqua* nov	R	....	.....	.....	.....	x	.....
" *schucherti* nov	....	CR	.....	.....	.....	x	.....
" *clarkei* nov	R	....	.....	.....	.....	x	.....

PELECYPODA—Continued.	MILWAUKEE.			LAKE CHURCH.	GEOGRAPHICAL DISTRIBUTION.		
	Zone A.	Zone B.	Zone C.		East of Wisconsin.	Wisconsin.	West of Wisconsin.
Mytilarca trigonale nov	....	....	.....	CR	.....	x	.....
" *oviformis* ? Conrad	R	....	.....	.....	New York	.....	.....
" sp	R	....	.....	.....	.....	x	.....
Nucula lirata var	....	R	.....	.....	.....	x	.....
Nuculites milwaukeensis nov	R	....	R	.....	.....	x	.....
" *laphami* nov	....	....	R	.....	.....	x	.....
Nyassa elongata nov	R	....	?	.....	.....	x	.....
Palæoneilo brevis Hall	R	R	R	.....	New York	x	.....
" sp	....	....	R	.....	.....	x	.....
" sp	....	....	R	.....	.....	x	.....
" *constricta* Conrad	CR	CR	CR	.....	New York	x	.....
" cf. "	....	....	R	.....	.....	x	.....
" *emarginata* Conrad	C	CR	CR	.....	Maryland New York	x	.....
" *fecunda* Hall	R	R	R	.....	New York	x	.....
" cf. *plana* Hall	R	....	.....	.....	New York	x	.....
" cf. *maxima* Conrad	R?	....	.....	.....	New York	x	.....
Paracyclas elliptica Hall	....	....	R?	CR	New York Ontario	x	.....
" *lirata* var	....	R	.....	.....	.....	x	.....
" *ohioensis tenuistriata* var. nov	....	....	.....	R	.....	x	.....
" sp	R	....	.....	.....	.....	x	.....
Pterinea paucicostata nov	....	....	.....	R	.....	x	.....
Pterinopecten tellerí nov	R	...	R	.....	.....	x	.....
Schizodus cf. *appressus* Conrad	....	....	.....	R	New York	x	.....

GASTROPODA.	MILWAUKEE.			LAKE CHURCH.	GEOGRAPHICAL DISTRIBUTION.		
	Zone A.	Zone B.	Zone C.		East of Wisconsin.	Wisconsin.	West of Wisconsin.
Bellerophon pelops Hall	....	....	CR	A	New York Ohio.	x	.....
" *patulus* Hall	....	....	R	.....	New York. Maryland.	x	.....
Cyclonema ? *subglobosa* nov	....	....	R	CR	.....	x	.....
Cyclonema sp	....	....	.....	R	.....	x	.....
Euomphalus (*Straparollus*) *exiguus* ?	....	....	.....	.....	Indiana.		.....
" sp	....	....	.....	R	.....	x	.....
" sp	....	....	.....	R	.....	x	.....
" cf. *planodiscus* Hall	....	....	.....	R	New York.	x	.....
Loxonema cancellata nov	....	....	.....	CR	.....	x	.....
" *hamiltoniae* Hall	R	R	R	R	New York. Indiana.	x	.....
Murchisonia cf. *dowlingii* Whiteaves	....	....	.....	R	.....	x	Manitoba.
Phanerotinus exiguus Kindle	....	....	.....	R	.....	x	.....
Platyceras hornefferi nov	....	....	R	.....	.....	x	.....
" *bertheletensis* nov	....	....	R	.....	.....	x	.....
" " *unsymetricum*, var. nov	....	....	R	.....	.....	x	.....
" sp	....	....	R	.....	.....	x	.....
Pleuronotus sp	....	....	.....	R	.....	.....	.....
Pleurotomaria sp	....	R	.....	.....	.....	x	.....
Porcellia kindlei nov	R ?	....	.....	.....	.....	x	.....
Trochonema monroei nov	....	....	.....	C	.....	x	.....

CONULARIDA.	MILWAUKEE.			LAKE CHURCH.	GEOGRAPHICAL DISTRIBUTION.		
	Zone A.	Zone B.	Zone C.		East of Wisconsin.	Wisconsin.	West of Wisconsin.
Coleolus ? *tenuis* nov	....	....	.....	R	.....	x	.....
Coleolus ? sp	....	....	.....	.....	.....	x	.....
Conularia congregata milwaukeensis var. nov	R	R?	R	.....	.....	x	.....
Hyolithes cf. *aclis* Hall	R	R	R	R	New York	x	.....
" *alatus* ? Whiteaves	....	....	.....	R	.....	x	Manitoba

CEPHALOPODA.	MILWAUKEE.			LAKE CHURCH.	GEOGRAPHICAL DISTRIBUTION.		
	Zone A.	Zone B.	Zone C.		East of Wisconsin.	Wisconsin.	West of Wisconsin.
Gomphoceras sp.	....	x	.....	.....	.....	x	.....
" *brevipositicum* Whitfield	....	A	.....	.....	.....	x	.....
" *calvini* Cleland.	....	A	.....	.....	.....	x	.....
" *fusiforme* Whitfield.	....	A	.....	.....	.....	x	.....
" *whitfieldi* Cleland.	....	C	.....	.....	.....	x	.....
" *wisconsinense* Cleland.	....	R	.....	.....	.....	x	.....
Goniatites sp.	R?	....	.....	.....	.....	x	.....
Gyroceras sp.	....	R	.....	.....	.....	x	.....
" *eryx* Hall.	....	R	.....	.....	.....	x	.....
Nautilus	?	....	.....	.....	.....	x	.....
Orthoceras cf. *bebryx* Hall.	R	R	.....	.....	New York	x	.....
" sp.	?	R	.....	.....	.....	x	.....
" *clarkei* nov.	....	....	R	.....	.....	x	.....

CRUSTACEA.	MILWAUKEE.			LAKE CHURCH.	GEOGRAPHICAL DISTRIBUTION.		
	Zone A.	Zone B.	Zone C.		East of Wisconsin.	Wisconsin.	West of Wisconsin.
Barychilina walcotti (Jones)	....	....	R	.....	x	x	.....
Bollia ungula Jones.	....	....	R	.....	x	x	.....
Kirkbya subquadrata Ulrich	....	....	R	.....	x	x	.....
Ulrichia conradi Jones	....	....	R	.....	x	x	.....
Echinocaris punctata Hall.	R ?	....	I	.....	x	x	.....
Phacops rana Green.	R	R	C	.....	New York. Ontario.	x	Iowa. ? Illinois.
Proëtus cf. *crassimarginatus* Hall.	....	?	.....	.....	.....	?	.....
" *rowi* Green.	R	R	R	.....	New York.	x	.....
Tropidocaris sp.	....	....	R	.....	.....	x	.....

PISCES.	MILWAUKEE.			LAKE CHURCH.	GEOGRAPHICAL DISTRIBUTION.		
	Zone A.	Zone B.	Zone C.		East of Wisconsin.	Wisconsin.	West of Wisconsin.
Cladodus monroei Eastman	R	?	.....	.....	.....	x	.....
Dinichthys pustulosus Eastman	R	?	.....	.....	New York. Kentucky.	x	Iowa.
" *tuberculatus* Newb	R	?	.....	.....	Penn. Ohio.	x	Iowa.
Acantholepis fragilis Newb	R	?	.....	.....	New York. Ohio.	x	.....
Gamphacanthus (*Heteracanthus*) *politus* Newb	R	?	.....	.....	New York.	x	Iowa.
" " *uddeni* Lindahl	R	?	.....	.....	.....	x	Iowa.
Holoptychius sp	R	?	.....	.....	.....	x	.....
Oestophorus sp	R	?	.....	.....	.....	x	.....
Onychodus cf. *sigmoides* Newb	R	?	.....	.....	New York. Ohio.	x	Iowa.
Machaeracanthus sp	R	?	.....	.....	.....	x	.....
Myriacanthus-like dermal plates Eastman	R	?	.....	.....	.....	x	.....
Palaeomylus greenei (Newb)	R	?	.....	.....	.....	x	.....
Phlyctaenacanthus telleri Eastman	R	?	.....	.....	.....	x	.....
Ptyctodus calceolus N. & W	R	?	.....	.....	Ontario.	x	Manitoba. Missouri.
" *compressus* Eastman	R	?	.....	.....	.....	x	Iowa.
" *ferox* Eastman	R	?	.....	.....	.....	x	Iowa.
Rhynchodus excavatus Newb	R	?	.....	.....	.....	x	Iowa.
" sp	R	....	.....	.....	.....	.....	.....
Titanichthys sp	R	?	.....	.....	.....	x	.....

PLANTS.	MILWAUKEE.			LAKE CHURCH.	GEOGRAPHICAL DISTRIBUTION.		
	Zone A.	Zone B.	Zone C.		East of Wisconsin.	Wisconsin.	West of Wisconsin.
Fusus bertheletensis Penh	R	....	R	.....	.....	.....	.....
Nematophycus milwaukeensis Penh	....	....	.....	.....	.....	.....	.....

A comparison of the Lake Church and Milwaukee sections.—The differences between the faunas of the Milwaukee and Lake Church sections are unusual when one considers that the lithologic character of the rock (with the exception of zone C of the Milwaukee section) is very similar and the distance between the outcrops only about 30 miles. This difference is shown clearly by a comparison of the faunal lists (pages 12–20) which bring out the following facts*: Out of 41 species and varieties collected from Lake Church 21 have been found at Milwaukee, i. e., less than 50 per cent are common to both sections. Out of 160 species known to occur at Milwaukee only, 20 (12½ per cent) have been collected from the Lake Church exposures. Theoretically one would expect the Lake Church species and those of zones A and B of the Milwaukee quarry to be nearly identical since both immediately overlie the Waubakee formation and also because the lithologic character is similar though not identical in the two sections. Out of 95 species collected from zones A and B at Milwaukee only 12 species, or about 12½ per cent, are common to these zones and Lake Church.

It should be remembered in this connection, that the fauna of the Milwaukee section is very much more complete than that of Lake Church but, on the other hand, there is no reason to suppose that the proportion of species common to both would be materially changed were the fauna more complete.

No perfectly satisfactory explanation is offered for the differences shown above. It is possible that in a strait joining two large seas constant currents carrying food, or of a slightly different temperature, due to the place of origin of the water supplying the currents, may have existed. As a result in a comparatively short distance from the shore of the strait a very different fauna might have lived. It is possible, though hardly probable, that the Lake Church deposits are slightly younger or older than those at Milwaukee. It is interesting to compare these two sections with the Onondaga limestone formation which, for hundreds of miles, does not differ greatly in its fauna, whereas in a distance of only 30 miles in Wisconsin the faunas have but 12½ per cent of species in common.

History and Bibliography of the Devonic Rocks, (Milwaukee), Hamilton Formation of Wisconsin

Because of their limited extent in the state of Wisconsin rocks of Devonic age were not reported until 1860, at which time Increase A. Lapham announced at a meeting of the Milwaukee Geological Club

* The coral species are omitted in these figures.

or Association "the discovery of rocks near Milwaukee, equivalent to the Devonian (Old Red Sandstone) containing remains . . . of characteristic fishes." "These remains consist of fragments of bone, teeth, a paddle with portions of the tuberculated skin or osseous covering."

Two years later James Hall in the Geology of Wisconsin described the lithologic character of the rock and correlated the formation with the Hamilton of New York.

After a study of the fossils of Wisconsin for the Geological Survey of 1873–79 Prof. R. P. Whitfield published figures and descriptions of 19 species from the Hamilton in volume IV of that series. The type specimens of this report are said to have been destroyed by fire.

Increase A. Lapham in 1874 first called attention to the possibility of using the rock of this formation for hydraulic cement. This suggestion and that of Mr. O. W. Wight a little later caused considerable excitement in the vicinity. Shortly after this the State Geological Survey and a private company demonstrated that the rock possessed this property and a company was formed which is at the present writing engaged in the manufacture of this rock into cement.

The most striking fossils of the Wisconsin Devonic are the fish plates, teeth and scales which are occasionally found at Berthelet (Humboldt street bridge), near Milwaukee.

Newberry in 1889 described a number of species of this class of remains that occur here and recently Dr. Chas. R. Eastman has written several papers in which he describes and figures certain of the Wisconsin fish fossils.

Messers. Teller and Monroe, after years of careful collecting and a thorough knowledge of the fauna, have in recent years added much to the knowledge of the fauna of the Milwaukee formation.

Dr. Wm. C. Alden in Folio 140 and in Professional paper 34 of the United States Geological Survey treats briefly of the rocks underlying the glacial drift along the Lake Shore north of Milwaukee and discusses their age.

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CHAPTER II

COELENTERATES: CORALS

Among the most unsatisfactory fossils of the Milwaukee formation, as far as ease and certainty of identification is concerned, are the corals. This is due largely to the fact that these fossils occur either in the form of casts or, when the external form is preserved, the internal structure is either indistinct or obliterated. As a consequence of this, thin sections for examination with the microscope seldom show the features that are essential for accurate specific determination. In the Milwaukee section all species of coral are rare: of these some occur as casts and some preserve the external form. At Lake Church and Dreuckers the fossils are all in the form of casts but are not uncommon: Acervularia, Heliophyllum, Cystiphyllum, Blothrophyllum and certain branching and hemispherical Favosites are often collected. It is evident that the conditions during the Middle Devonic about Lake Church were very favorable for the growth of corals. In fact, if solution had not removed the soluble portions of the animals this would have been a notable collecting place for corals, both in species and individuals.

Class **ANTHOZOA.** Corals.

Sub-Class **TETRACORALLA** Haeckel.

Family ZAPHRENTIDAE M–E. and H.

Genus **Aulacophyllum** M–E. and H.

Aulacophyllum cf. *convergens* Hall

Plate I, Fig. 1

Aulacophyllum convergens Hall, Thirty fifth Annual Report of the New York State Museum of Natural History, p. 426, August, 1882. (Printed 1884.)

12th Ann. Rept. Ind. Geol. & Nat. His. Survey, 1882, pl. 17, figs. 1, 2, p. 281.

Description: "Corallum simple, broadly sub-turbinate, regularly curved; exterior comparatively smooth with concentric wrinkles and

striations; longitudinal striae fine, distinct; specimens of the same height have a diameter at the calyx varying from twenty-five to forty-five millimeters; in one example the height is ten millimeters; length of posterior side, twelve millimeters; of anterior side, twenty-five millimeters; diameter of calyx, twenty millimeters, for a distance of five millimeters, from the margin nearly flat, then the posterior portion is nearly vertical, the anterior portion concave; fossette narrow, deep, extending from the bottom of the calyx to the anterior margin; lamellae varying from 80 to 120 in number according to the diameter of the calyx, alternating in size, thin, denticulated; convergence of the lamellae to the fossette very distinct." Hall, 1882.

From the illustration it will be seen that the position of the septa are not well shown but are sufficiently well marked to place it under this genus. The external shape, its externally smooth surface, flatness of the calyx near the anterior margin and very steep posterior slope point strongly to *A. convergens.* Only one specimen has as yet been collected.

Collection: E. E. Teller.

Locality: Milwaukee Quarry, Humboldt st. bridge, Milwaukee.

Family CYATHOPHYLLIDAE M–E. and H.

Genus **Heliophyllum** Hall.

Heliophyllum halli Milne-Edw.

Plate I, fig. 5.

Heliophyllum halli Hall, Ill. Dev. Fossils, 1876, pl. XXIII.

Cyathophyllum hallii, Geol. Sur. Michigan, Vol. III, 1873–76, p. 99, pl. XXXV.

C. halli Davis, Kentucky Fossil Corals, 1885, pl. 92.

H. halli Cleland, U. S. G. S., Bulletin No. 206, p. 36.

Description: "Simple turbinate polyp cells, attached by the small basal apex, and frequently by additional root-like prolongations from a part of the side-walls. The conical shape of the cells varies considerably in different specimens, and changes during the progress of growth. A specimen may begin with a narrow cylindrical base, and then suddenly spread its end cell into an expanded dish form, or another may very regularly and gradually dilate into curved, horn-shaped cells, or the conical calyces of the base, after attaining a certain diameter, may stop to dilate and continue to grow on, maintaining the same size, into long, cylindrical stems, straight, or curved, or geniculated by interruptions in the growth, with constrictions and deflexions. In regularly formed specimens the calyces are shallow, bell-shaped,

with broadly spread margins; other specimens have deeper calyces, with nearly erect margins. The radial lamellae are alternately shorter and longer, but equal in size near the calyx margins, forming a uniform, uninterrupted cycle, with exception always of a faintly indicated apertural gap and septal fovea. The longer lamellae extend as somewhat flexuose crests to the centre. Often a lamella continues across the calyx from the centre of the apertural gap to the opposite side, and the other lamellae abut against it from both sides in symmetrical order. The bottoms of the end cells are usually raised into obtusely rounded, monticulose protrusions, on which the lamellae unite with interlaced, twisted ends; or sometimes the lamellar crests fade away before reaching the centre, which then is formed by a smooth, naked spot of narrow extent. The most obvious characters of this species are the arched carinae extending across the lateral faces of the lamellae from the outer peripheral side and below, to the upper and inner edges of the lamellae; the carinations correspond on both faces and project on the edges of the lamellae as obtuse, transverse bars or as acute dentations. The carinae of different specimens vary considerably in degree of approximation; in some about eight carinae are in the space of one centimeter, while others may have as many as fifteen within the same space." Rominger, 1876.

Remarks: The casts of the calices of a Heliophyllum, which are probably of this species, are rather common in the Lake Church and Dreucker sections. The diameter of the calices varies from 2 cm. to more than 3 cm. The casts of the interior are, however, of a somewhat different shape from the typical *H. halli.*

Collections: H. F. Cleland, C. E. Monroe and E. E. Teller.

Locality: Lake Church, and Milwaukee cement quarry.

Heliophyllum cf. *corniculum* M–E.

Plate I, fig. 2.

cf. *Cyathophyllum corniculum,* Geol. Sur. Mich., Lower Penin., Vol. III, 1873–76, p. 102. plate XXXV.

A nearly complete specimen from the Milwaukee Quarry in the collection of E. E. Teller has the characters of this genus but is not of the common species *H. halli.* The calice is so filled with crinoid joints and other calcareous objects that the characters of the septa are not well shown.

It agrees with *H. corniculum* in its external shape and depth of calice as far as can be seen from the specimen and is referred to it provisionally.

Locality: Milwaukee cement quarry, Humboldt street bridge.

Genus **Acervularia** Schweigg.

Acervularia davidsoni Milne-Edward and Haime

Plate I, figs. 3, 4.

Acervularia profunda Hall, Geol. Sur., Iowa, Vol. I, pt 2, 1858, p. 477, pl. 1, fig. 7, a, b, c.

Acervularia davidsoni Hall, Geol. Sur., Iowa, Vol. 1, pt 2, 1858, p. 476, pl. 1, figs. 8, a, b.

Cyathophyllum davidsoni Rominger, Geol. Sur., Michigan, Vol. III, 1873–76, p. 107, pl. XXXVII, fig. 4.

Description: "Coral astraeiform, subhemispheric; cells irregularly polygonal, unequal in size, often somewhat circular in the young and half grown conditions; walls thin, scarcely undulating; inner wall undefined, cup abruptly and deeply depressed from a little within the outer wall; centre marked by a papilliform mode." Hall, 1858, *A. profunda.*

Remarks: The specimens which have been referred to this species occur only as casts of the exterior. They appear to be identical with *A. profunda* Hall of the Iowa Devonic which has been identified by Rominger as *A. davidsoni.* Our specimens are of the variety described by Hall as *A. profunda* rather than the coarser form which he identified as *A. davidsoni.*

This species has a wide range, if the identifications are correct, occurring in the Devonic strata of Canada, Ohio, Iowa, Michigan and Wisconsin.

Locality: Lake Church, Wis.

Collection: H. F. Cleland and C. E. Monroe.

Family CYSTIPHYLLIDAE M– E. and H.

Genus **Cystiphyllum** Lonsdale.

Cystiphyllum cf. *americanum* M–E and H.

Description: Casts of the interior of several specimens from Lake Church preserve, in some degree, the vesicular tissue which is characteristic of the genus. The specimens are all so fragmentary that no specific determination is possible.

Collection: H. F. Cleland.

Sub-Order TABULATA M–E. and H.

Family FAVOSITIDAE M–E. and H.

Genus **Favosites** Lam.

Favosites radiatus ? Rominger

Plate I, fig. 10.

Favosites radiatus Rominger, Geol. Sur. Lower Peninsula of Michigan, Vol. III, pt II, 1876, p. 33, pl. X, fig. 1.

Description: "Tubes unequal, rounded-polygonal, one and a half to two and a half millimeters in width, radiated by twelve prominent rows of lateral squamae with intervening deep linear furrows. Diaphrams simple, straight, or warped by marginal, siphon-like depressions; the pores are numerous, forming from one to three rows on a side. A small pit surrounds each of them, as in *Favosites tuberosus.* The tubes of some specimens exhibit the lateral rows of squamae only in rudimentary development, and are nearly smooth on the inside, with flat, moderately distant diaphrams. In other specimens the squamae project with their elongated linguiform apices nearly to the centre of the tubes." Rominger, 1876.

Remarks: A number of casts of the interior of specimens which are probably of this species were collected from the Lake Church section. The corallites have a diameter varying from 1½ to 3 mm. and radiate in such a way as to form the sector of a circle. The mural pores are large, distant and in a single irregular row on each side. The corallite is smaller than normal for the species and only one row of pores seem to be present.

Collection: H. F. Cleland.

Locality: Lake Church, Wisconsin.

Favosites alpenensis ? Winchell

Plate I, fig. 8.

Favosites hamiltonensis Rominger, Geol. Surv. Michigan Lower Peninsula, Vol. III, 1876, p. 28, pl. VII, fig. 3.

Favosites alpenensis Winchell, Rept. of the Lower Peninsula of Michigan, p. 88, 1866.

Description: "Tubes rounded-polygonal, unequal in the same specimens and in different specimens, variable from one and a half to two and a half millimeters. Walls stout. Diaphragms regular, simple, but frequently with lateral squamae interposed, which occasionally become anchylosed with them and disturb their regularity, but never to the

same degree as in the former species. Connecting pores large, forming a single row on each side. Rows of lateral squamae, in some specimens very well developed. Other specimens or portions of specimens have smooth tube channels. Mode of growth globular, or tuberose, or in coarse ramifications, often incrusting other bodies with the basal portion." Rominger 1876.

Remarks: A single rather imperfect specimen of a coral from the Teller collection possesses some of the characters of *F. alpenensis* of the Michigan Hamilton. The tubes are angular, unequal, varying from 1 mm. to 25 mm. in diameter. The diameter of the colony is about 7 cm. It differs from the above in the shape of the colony which is flat as in *F. nitella* Winchell.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee.

Favosites sp.

Description: Certain branching favosite corals occur as casts in the Lake Church section. Some of the smaller branches have a diameter of 8 to 10 mm. The material is too imperfect to warrant a description.

Collection: H. F. Cleland.

Genus **Striatopora** Hall.

Striatopora iowensis (Owen)

Plate II, fig. 5.

Cyathopora iowensis Owen, Rept. on Mineral Lands of Iowa etc., 1839, p. 69.

Striatopora rugosa Hall, Geol. Sur. Iowa, Vol. I, Part 2, 1858, p. 479, pl. I, fig. 6.

Description: "Coral ramose, frequently bifurcating; branches very gradually tapering, cells somewhat distant, arranged in alternating series, subcylindrical below and gradually expanding toward the aperture, with the walls much elevated on the basal and lateral margins." Hall 1858. Although somewhat smaller than the Iowa specimens they appear to be of this species.

Remarks: This species differs from *S. linnaena* Billings in the uniform size of the corallites as well as in other particulars.

Collection: H. F. Cleland.

Locality: Shaly limestone, zone C, Milwaukee quarry, Humboldt street bridge, Milwaukee, Wis.

Genus **Alveolites** Lam.

Alveolites ? monroei nov.

Plate II, figs. 1, 2.

Description: Incrusting expansions. In the only specimen collected the corallum surrounds what appears to be the fragment of a large Gomphoceras. On one side the growth of the edge of the colony has caused it to overlap a portion of the earlier growth. Corallites very oblique and large for the genus varying in greatest diameter from 1½ to 3 mm.; in some of the corallites the transverse diameter is considerably greater than the hight but in others the two diameters are nearly equal. In general appearance the corallum looks like a carpenter's coarse wood file.

Remarks: This species somewhat resembles *Alveolites goldfussi* Billings but differs from it in the larger size of the corallites and their less elongate form. Since neither the tabulae nor mural pores have been seen the generic determination is in doubt, but unless a new genus should be made it should be included in the above. Named for Mr. Charles E. Monroe of Milwaukee whose careful collecting has so greatly advanced our knowledge of the Middle Devonic of Wisconsin.

Collection: The only specimen collected is a fine one and is in the collection of E. E. Teller.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee.

Family AULOPORIDAE Nich.

Genus **Aulopora** Goldfuss.

Aulopora annectens Clarke

Plate II, fig 3.

Aulopora annectens Clarke, on the higher Devonian Faunas of Ontario Co. New York, U. S. G. S., Bull. 16, 1885, p. 63, plate III.

Description: "Polyp-cells scattered at nearly equal intervals along it. The sclerenchyma is flattened and the polyp-cells evenly sessile, opening directly from the base of the polyzoarium. Polyp-cells shallow, and with a number of deep striations on the inner surface, making pseudosepta." Clarke 1885.

Remarks: In the specimen at hand the pseudosepta are not seen. When the "polyp cells" were freed of their filling of shale they were found to reach to the brachiopod upon which they were parasitic with-

out an intervening wall. A separating calcareous wall may, however, have been removed by the caustic potash used in the cleaning.

Collection: E. E. Teller.

Locality: The shaly limestone, zone C, of the Milwaukee quarry, Humboldt street bridge, Milwaukee.

Aulopora serpens Goldfuss

Plate II, fig. 4.

Aulopora serpens ? Rominger, Geol. Sur. Michigan, Lower Peninsula, 1876, p. 87, pl. XXXIII, fig. 2.

Description: "Prostrate expansions of conical tubules, one sprouting in a linear row from the basal part of the orificial end of the other; or at times two of them fork off, and meeting others in the course of their growth, unite laterally with them and inclose irregular loops. All the tube ends, after the departure of a branch tube, bend into an erect position and usually grow no farther. The width of the tube of different specimens varies from one to two millimeters." Rominger 1876.

Remarks: A number of specimens of this species have been found parasitic on *Stropheodonta halli, Atrypa reticularis, Heliophyllum* sp. and other fossils. They seem typical of the species.

Collections: H. F. Cleland, E. E. Teller, Public Museum, Milwaukee.

Locality: Zone C, Milwaukee cement quarry, Humboldt street bridge, Milwaukee.

Family MONILOPORIDAE Grabau.

Genus **Ceratopora** Grabau.

Ceratopora flabellata Greene

Plate II, fig. 7.

Ceratopora flabellata Greene, Cont. to Indiana Palaeontology, pt. IX, 1902, p. 75, pl. 25, figs. 2, 3, 4.

Description: "Corallum rapidly increasing by lateral gemmation, with closely aggregated tubules, spreading in fan-like expansions in more than one direction. Corallites closely connected more or less throughout the entire length, gradually enlarging in diameter to the margin of the calyx. Diameter of tubes varies in the same corallum from two to four millimeters, and occasionally there is a tube much larger. When the walls are in contact with each other large rounded pores may be observed. The spines in the tubes are not well defined,

but the bases can be seen in all well preserved tubes. Exterior with numerous annular lines of growth, more strongly pronounced near the margin of the tube." Greene 1902.

Remarks: Two or more species of Ceratopora occur commonly in the shaly limestone of zone C and of these the above seems to be the most abundant. All the specimens collected are in a fragmentary condition but there seems to be little doubt as to the correctness of the identification.

This species also occurs in the Hamilton formation of Indiana but is not reported from any other State.

Collection: H. F. Cleland.

Locality: Zone C of the Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Ceratopora intermedia Nicholson

Syringopora intermedia Lambe, Canadian Geological Survey, Cont. to Canadian Palaeontology, Vol. IV, pt I, 1899.

Remarks: A number of fragmentary specimens of the genus *Ceratopora* were referred to Professor A. W. Grabau who identified them as probably of this species. It did not seem wise, because of their fragmentary condition, to have figures made of them.

Locality: Zone C of the Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Collection: H. F. Cleland.

Ceratopora agglomerata Grabau var. nov.

Plate I, fig. 9.

cf. *Ceratopora agglomerata Grabau,* Greene's Cont. to Indiana Palaeontology, Part VII, 1901, p. 51, plate 19, figs. 22–25.

Description: "Corallum compound, consisting of agglomerate masses, unattached except basally. Corallites auloporoid, slightly curved, and gradually enlarging towards the aperture which is circular. A short distance below the termination of the corallite, one or two buds are given off, diverging at various angles, sometimes extending acutely upward; frequently at right angles to the parent, or occasionally extending downward. The buds themselves give off other buds which may extend in all directions. Corallites frequently joined by epithecal prolongations. Interior with circumferential cysts. Cysts rather sparingly developed, but usually of fair size. Septal spines small, short and comparatively stout; in numerous vertical rows." Description of *C. agglomerata* Grabau, 1901.

Remarks: Among the specimens of Ceratopora from the Milwaukee quarry are a number that were identified by Professor A. W. Grabau, to whom they were referred, as *C. agglomerata* var. nov. The specimens are all in a fragmentary condition and are difficult to determine because the internal structure is so obliterated that a thin section does not show the diagnostic characters.

The species *C. agglomerata* is from the Warsaw division of the St. Louis group of the Lower Carboniferous, from Indiana.

Collection: H. F. Cleland.

Locality: Zone C of the Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Ceratopora jacksoni ? Grabau

Plate I, fig. 7.

C. jacksoni Grabau, Boston Society Natural History Proceedings, vol. 28, 1899, p. 415, Pl. 1, figs. 1, 2, 3, Pl. 2, fig. 6–10.

Remarks: Two specimens of this large aulopora-like coral attached to the shells of *Atrypa reticularis* have a diameter of 5 or 6 mm. in the larger portion. It resembles the above in its size, coarsely wrinkled epitheca and costal ridges.

Collections: H. F. Cleland and E. E. Teller.

Locality: Shaly limestones, zone C, Milwaukee cement quarry, Humboldt street bridge, Milwaukee.

Ceratopora sp.

Plate II, fig. 6.

Description: Corallum straight with lateral branches. Corallites alternate and apparently in three rows, in each row the corallites are about 7 mm. apart and are about 1½ mm. in diameter at the calice. They arise diagonally from the main stem and extend about 5 mm. from the axis. The total length of a fragment is 7 cm. but this is a small part of the entire length of a specimen.

All the specimens at hand are casts of the interior, a condition that makes an accurate description impossible.

Collection: H. F. Cleland.

Locality: Not uncommon in the Lake Church section.

Ceratopora rugosa nov.

Plate I, fig. 6.

Description: Corallum increasing by lateral gemmation with closely aggregated corallites which, in the specimen studied, is columnar. Corallites in contact for almost the entire length. Orfices oblique.

The epitheca of the walls is strongly wrinkled and gives off very short, more or less definite, prolongations which bind the adjoining corallites together.

This species resembles *C. agglomerata* Grabau but differs from it in the definite direction and compactness of the corallum as contrasted with the loosely consolidated corallites of that species.

Only a few specimens have been found and they are usually poorly preserved.

Collection: H. F. Cleland.

Locality: Zone C of the Milwaukee quarry, Humboldt street bridge, Milwaukee, Wis.

CHAPTER III

CRINOIDEA AND BLASTOIDEA

Fossils of this group of invertebrates are extremely rare in the Devonic rocks of Wisconsin. Occasionally plates of *Melocrinus nodosus* are found but only a very few good specimens have been collected. The Lake Church section has, up to this time, yielded no calyxes, and only a few poorly preserved crinoid joints.

Class **CRINOIDEA** Miller.

Order CAMERATA W. and S.

Family MELOCRINIDAE Zittel.

Genus **Melocrinus** Goldfuss.

Melocrinus nodosus Hall

Plate III, fig. 4.

Melocrinus nodosus Hall, Rep. Prog. Geol. Surv. Wis. p. 19, 1861.

Melocrinus nodosus Whitfield, Mem. Am. Mus. Nat. His., vol. I, p. 48, pl. V, fig. 14, 1895.

Melocrinus nodosus Weller, N. Y. Acad. Sci. vol. XI, No. 7, 1898, p. 118, pl. XIV, fig. 16.

"Calyx pyriform, truncate at the base, sides straight or slightly convex from the tops of the basals to the arm openings; cross-section, as seen from above, exclusive of the nodes, obscurely subpentagonal, greatest diameter at the base of the arms. The plates of the dorsal cup ornamented with conspicuous nodes.

"Basals four, projecting laterally into more or less prominent nodes, columnar facet large, often somewhat depressed between the nodes of the plates. Radials large, heptagonal and hexagonal, strongly nodose. First costals hexagonal, smaller than the radials, strongly nodose; second costals pentagonal or heptagonal, smaller than the first and less strongly nodose. Distichals smaller than the last costals, higher than wide, free beyond the first pair. First interdistichals hexagonal, as large as the first costals and bearing similar nodes followed by two smaller nodose plates in the second row, one of which often bears a larger node than the other; in the third row there are two or

three smaller plates and above these numerous small plates which lead up to those of the vault. The posterior interradius is not differentiated from the other four.

Ventral disk depressed convex or nearly flat, composed of small polygonal nodose plates of nearly equal size; marked by more or less prominent rounded ambulacral ridges which extend from the arm bases toward the center; and surmounted by the base of a subcentral proboscis whose height cannot be determined." Weller, 1898.

Locality: In the shaly layers, zone C, of the Milwaukee cement quarry.

Collections: E. E. Teller and C. E. Monroe in the Public Museum, Milwaukee.

Melocrinus nodosus var. *spinosus* Weller

Plate III, fig. 5.

Melocrinus nodosus spinosus Weller, N. Y. Acad. Sci. vol. XI, No. 7, 1898, p. 119, pl. XIV, fig. 2.

"This variety differs from the typical form of the species in its higher and narrower calyx, and in its more pointed spinelike nodes." Weller, 1898.

The variation in the shape of the nodes of one specimen from the Teller collection is interesting. The ends of the nodes of the lower two rows are strongly wedge-shaped with the nodes characteristic of *M. nodosus spinosus*. It is possible that this specimen should be considered a new variety but it has been included in this species and variety for the present.

Collections: E. E. Teller and Public Museum, Milwaukee.

Locality: In the shaly layers, zone C, of the Milwaukee cement quarry.

Melocrinus subglobosus Weller

Plate III, fig. 6 and 7.

Melocrinus subglobosus Weller, N. Y. Acad. Sci., Vol. XI, No. 7, 1898, p. 120, pl. XIV, fig. 1.

"Calyx sub-globular, sides convex from the tops of the basals to the arm openings. Cross-section, as seen from above, exclusive of the nodes, circular, greatest diameter at about the top of the first costals. The plates of the dorsal cup ornamented with remarkably large nodes, the radials, first costals and first and second interbrachials often bearing nodes whose diameter is nearly equal to the width of the plates. The larger nodes rise abruptly from the general surface of the plates, with subparallel sides and with an elevation equal to their diameter.

"Basals four, projecting laterally into more or less prominent nodes, columnar facet large, often somewhat depressed between the nodes of the plates. Radials large, heptagonal and hexagonal, strongly nodose. First costals hexagonal, smaller than the radials, strongly nodose; second costals pentagonal or heptagonal, smaller than the first, bearing a much smaller and lower node. Distichals smaller than the last costals, the second pair free and attached to the first by a conspicuous sub-circular facet with numerous fine radiating ridges. First interbrachials hexagonal in the four regular interradial areas, as large as the first costals, and bearing similar nodes, followed by two smaller plates in the second row, one of which often bears a conspicuous node similar to those of the lower plates and the other with a much lower and smaller inconspicuous node similar to those upon the second costals; above the second row the interradial spaces are filled with numerous smaller plates which lead up to those of the dome. The posterior interradius with a heptagonal nodose anal plate in the first row, similar, except in outline, to the first regular interbrachials, followed by three plates in the second row.

"Ventral disk sub-hemispherical, composed of small, polygonal, nodose plates of nearly equal size, and surmounted by the base of a subcentral proboscis whose height cannot be determined." Weller.

Remarks: There is considerable doubt as to the propriety of retaining *M. subglobosus* as a distinct species, the difference between it and *M. nodosus* being so slight that it seems to be of varietal rather than of specific rank.

Collections: E. E. Teller and Public Museum, Milwaukee.

Locality: In the shaly layers, zone C, of the Milwaukee cement quarry.

Melocrinus milwaukeensis Weller

Plate III, fig. 9.

Melocrinus milwaukeensis Weller, N. Y. Acad. Sci. vol. XI, No. 7, 1898, p. 121, pl. XIV, fig. 7.

"Calyx pyriform, truncated at the base, sides slightly convex from the tops of the basals to the arm openings. Cross-section, as seen from above, obscurely pentagonal. Greatest diameter at the arm bases. All the plates of the dorsal cup convex or ornamented with low, broad, central nodes.

"Basals four, moderately nodose, not projecting far beyond the column. Radials large, heptagonal and hexagonal. First costals hexagonal, smaller than the radials, second costals pentagonal or heptagonal, smaller than the first. Distichals much smaller than the last

costals, the second or third pair becoming free. First interbrachials in the four regular interradial areas, hexagonal, as large as the first costals, followed by two smaller plates in the second and three still smaller ones in third row, these being followed by small plates which lead up to the interradial plates of the vault. In the posterior interradius the first or anal plate is similar in size to the first interbrachials of the other sides, but is heptagonal in form, being followed by three plates in the second row.

"Ventral disk depressed convex or nearly flat, composed of small polygonal nodose plates of nearly equal size; marked by more or less prominent ambulacral ridges extending from the arm openings towards the center; and surmounted by a sub-central proboscis whose height cannot be determined." Weller, 1898.

Collections: E. E. Teller; Public Museum, Milwaukee.

Locality: In the shaly layers, zone C, of the Milwaukee cement quarry.

Melocrinus milwaukeensis rotundatus Weller

Plate III, fig. 8

Description: "This variety differs from the typical form in being shorter, with more convex plates, in the basals being more strongly nodose, and in the more convex subhemispherical vault." Weller, 1898

Melocrinus pentangularis nov.

Plate III, fig. 10.

Description: Calyx elongate-obovate, strongly pentagonal in cross-section with each of the faces of the pentagon nearly flat. Plates of the dorsal cup ornamented with large, prominent nodes; columnar facet of medium size, depressed between the nodes of the basals. Radials large elongate-hexagonal, with prominent nodes. First and second costals much smaller than the radials, round-hexagonal. The nodes of the plates of the dorsal cup become rapidly smaller as the ventral disk is approached. Ventral disk convex, composed of small polygonal (usually hexagonal) plates ornamented with small nodes.

Remarks: This species because of its elongate form and pentagonal outline is one of the most easily distinguished of the nodose crinoids from Milwaukee.

Collection: A single specimen of this species was collected by E. E. Teller and is now in his collection.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wis.

Order FLEXIBILIA Zittel.

Family ICHTHYOCRINIDAE W. and S.

Genus **Taxocrinus** Phillips.

Taxocrinus interscapularis Hall

Plate III, figs. 11, 12

Taxocrinus interscapularis Hall, Geol. Surv. of Iowa, 1858, Vol. I, Part II, p. 482, plate I, fig. 3.

Description: "Body narrow, turbinate below the first bifurcation of the arms; basal plates five, short, with the angular summit much pointed upwards between the lower radial plates; radial plates three in each series, much wider than high, the two lower series quadrangular; upper radial broad pentagonal, with the two upper sloping sides supporting a double series of arm plates; interbrachial plate narrow, resting the base slightly on the second radial plates, with its upper extremity lying between the second arm plates.

"Arms ten; those on the exposed side bifurcating on the fifth plate above the base, and the adjacent parts again bifurcating upon the eighth and tenth plates respectively [in the Milwaukee specimen the bifurcation is upon the eighth and thirteenth plates respectively], while the outer divisions of the same arms continue simple to the fifteenth or seventeenth plate. . . . A small axillary plate is intercalated between the arms at the first, and sometimes in the second bifurcation." Hall, 1858.

Concerning the specimen figured, Mr. Springer writes: "I am inclined to think it may be Hall's *T. interscapularis* of the Iowa Report of which the type specimen is poor, and the figures very misleading, and of which no other specimen has been reported before." Judging from the figure alone one would identify the Milwaukee specimens as of a different species. The only specimens collected are in the Teller collection.

A small specimen (fig. 12) may possibly be of the same species.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee.

Class **BLASTOIDEA** Say.

Order REGULARES E. and C.

Family NUCLEOBLASTIDAE E. and C.

Genus **Nucleocrinus** Conrad.

Nucleocrinus obovatus (Barris)

Plate III, fig. 2.

Elæacrinus obovatus, Geol. Sur. Ill., Vol. VII, 1883, p. 358, fig. 3.

Description: "Body obovate or elongate-balloon shaped, more than once and a half as long as wide; upper half wider than the lower, semi-ovoid; greatest width at about two-thirds from the base; lower half gradually increasing in width to the distal end of the ambulacra; base truncate with a deep concavity which is filled by the column. Cross-section pentangular, with straight or very slightly convex sides, except along the basals, where the sides are somewhat concave, and the section more stellate, etc." Barris 1883.

Collection: Public Museum, Milwaukee.

Locality: A single specimen from the Milwaukee cement quarry preserves the characters of the species.

Family PENTREMITIDAE d'Orbigny.

Genus **Pentremitidea** d'Orb.

Pentremitidea milwaukeensis Weller

Plate III, fig. 1

Pentremitidea milwaukeensis Weller, N. Y. Acad. Sci. Vol. XI, 1898, No. 7, p. 123, pl. XIV, fig. 5.

"Body of medium size, lateral outline subovate, maximum breadth a little below the middle of the radial sinuses. Cross-section at the point of maximum width decagonal, the sides of the decagon represented by the ambulacral areas, short and concave, the other sides longer, nearly straight or slightly concave." Weller, 1898.

Collections: E. E. Teller; Public Museum, Milwaukee.

Locality: In shaly layers, zone C, of the Milwaukee cement quarry.

Pentremitidea filosa Whiteaves

Plate III, fig. 3.

Pentremitidea filosa Whiteaves, Cont. Can. Pal. Vol. I, p. 104, pl. 149, figs. 1–1b.

Pentremitidea filosa Weller, N. Y. Acad. Sci. XI, 1898, No. 7, p. 122, pl. XIV, fig. 3.

"Body small, proportion of width to height as 3 to 5. Maximum breadth at or near the base of the radial sinus. Lateral outline subovate, but conical at the base and truncated at the apex; cross-section at part of maximum width, decagonal, the sides of the decagon represented by the ambulacral areas, short and concave, the other sides straight or slightly concave.

"Basal plates three, two pentagonal and larger than the third, which is quadrangular; about one-fourth as high as the radials. Basal cup strongly trihedral, about as high as wide, and reaching more than half way to the bases of the radial sinuses. Radial plates lanceolate in outline, nearly three times as high as wide; the bodies or undivided portions spread outward more rapidly than the basals, and occupy one-fourth of the total length of the plates. The apices of each of the two adjacent radials are united to form an acute point which projects a little above the summit. Radial sinuses deep, the sides elevated and forming sharp edges, bounding the base of the sinus more highly elevated into a conspicuous node-like projection. Deltoid plates, with the exception of the posterior one, apical, not visible in a side view. Posterior deltoid small, rhomboidal, not well preserved in the specimen.

"Ambulacra linear, narrow, narrowly rounded at the base and about one-half as wide at that point as at the summit. Surface transversely convex, forming a longitudinal depression along each side, the central portion raised not quite to the general level of the radials. The food groove in the center of each ambulacrum deepens and broadens near the summit.

"Spiracles five, rather large, the posterior one confluent with the anal opening. The remaining characters of the summit not well preserved.

"Surface of the radials ornamented with fine concentric lines which are only visible with a lens." Weller, 1898.

Collections: E. E. Teller and Public Museum, Milwaukee.

Locality: In the shaly layers, zone C, of the Milwaukee cement quarry.

CHAPTER IV

VERMES (WORMS)

The only specimens of this class that have been collected from the Devonic of Wisconsin are the genera *Spirorbis, Cornulites, Arabellites, Autodetus* and *Tentaculites.* The *Tentaculites* have been included in accordance with the recent custom of the New York Geological Survey. Dr. J. M. Clarke in a letter to the writer concerning the classification of the *Tentaculites* says: " . . . the *Tentaculites* can not be regarded as pteropods in accordance with the old ideas on account of the thick cellular structure of the walls of the shell, and their very frequent irregularity of growth. There is nothing comparable to this structure among living forms. On the other hand, the creatures have many similarities to the worm tubes which pass under the name of *Ortonia, Cornulites,* etc."

Certain marks on the rocks and fossils may have been made by worms as they crawled over the soft mud of the ocean bottom but the evidence is so poor that it does not seem worth while to attach any importance to them.

Class **VERMES.**

Sub-Order ERRANTIA.

Genus **Arabellites** Hinde.

Arabellites crescentum nov.

Plate IV, fig. 1

See also *Arabellites similis* var. *arcuata* Hinde, Quar. Jour. Geol. Soc. Lon. Vol. XXXV, p. 385, pl. 20, fig. 20.

Description: Jaw crescentic-triangular in shape; the posterior concave with the horns projecting to blunt points. The jaw is comparatively flat with five or six teeth-like projections; the three posterior are equal and in the same plane; the next in front is larger; the fifth is slender and on a lower plane. There also appears to have been a tooth-like projection on the extremity of the jaw. Total length of jaw 1½ mm.

This species resembles *Arabellites similis* var. *arcuata*, Hinde of the Hamilton group of Riveriere au Sable, Ontario but differs from it in the number, shape and position of the teeth.

Collection and Locality: A single specimen was collected from the shaly layer, zone C, of the Milwaukee quarry. H. F. Cleland.

Sub-Order TUBICOLA.

Genus **Cornulites** Schlotheim.

Cornulites sp.

Plate IV, fig. 2

Description: Tube slightly sinuous with round, irregularly disposed annulations; enlarging rapidly. Length of one specimen attached to *Spirifer subvaricosus* is 3 mm, and is probably new. This species resembles *C. sublaevis* Whiteaves but differs from it in its more prominent annulations.

Collection: E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Genus **Spirorbis** Lamarck.

Spirorbis omphalodes Goldfuss

Plate IV, figs. 3, 3a

Spirorbis omphalodes Whiteaves, Contributions to Canadian Palaeontology, Vol. I, part III, No. 5, p. 209, plate 28, figs. 3, 4, 4a, 5, 5a, 1891.

Description: "In small specimens the outer volution is rounded and somewhat depressed and the umbilicus usually, though not always, comparatively wide. In large individuals the outer volution is elevated and subangular and the umbilicus narrow. The surface is usually smooth or nearly so, but in some specimens which seem to be nearly intermediate between this species and the next, the umbilical margin is seen to be distinctly plicated, when examined under a lens." Whiteaves, 1891.

Remarks: The Wisconsin specimens appear to be of this species but none show the subangular form described above.

Collection: E. E. Teller.

Locality: The shaly layers, zone C, of the Milwaukee quarry, Humboldt street bridge, Milwaukee.

Genus **Autodetus** Lindstrom.

Autodetus apicatus nov.

Plate IV, figs. 4, 4A

Description: Discoid and forming a low cone. Only one volution is visible, others, if they exist, being covered by the outer volution. Aperture extending from the apex to near the periphery which it follows for a third or a half of the circumference forming a low ridge. This ridge is well shown in the enlargement (figure 4A).

Remarks: *Autodetus apicatus* is found parasitic on *Atrypa reticularis* and *Spirifer euryteines milwaukeensis.*

This genus has very much the appearance of a Spirorbis because of its parasitic habit and is often identified as such. No sections were made of the shells to determine whether or not a spire exists but it probably does.

Collection: E. E. Teller.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee.

Family TENTACULITIDAE Walcott.

Genus **Tentaculites** Schlotheim.

Tentaculites bellulus Hall

Plate IV, figs. 5, 6, 7, 8

Tentaculites bellulus Hall, Palaeontology of New York, Vol. V, part II, 1879, p. 169, plates XXXI, XXXIV.

Description: "Form extremely elongate-conical, slender, becoming more nearly cylindrical on approaching the mouth. The apical portion is extremely attenuate, with regular and closely arranged acute annulations, which near the apex are visible only under a strong lens, and the extreme portion is apparently smooth. . . .

"As the annulations increase in distance, fine transverse lamellose striae become developed in the interspaces; at first a single one, then two, three, etc., till toward the aperture there are eight or ten striae in the depression and upon the sides of the annulations. The latter are abruptly elevated and acute, sloping a little more on the apertural side, very abrupt, and nearly rectangular on the apical side, with the periphery quite smooth and free from striae." Hall, 1879.

Remarks: Tentaculites occur throughout the Milwaukee section and more commonly in the upper shaly layers, zone C. They have been

collected from the debris of the New Intake tunnel, Milwaukee, and rarely at Lake Church. The annulations are usually rounded and, except in well preserved specimens, do not show the fine transverse striae.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

CHAPTER V

BRYOZOA

By R. S. Bassler

The following species of bryozoa from the Devonian rocks at Milwaukee, Wisconsin, were determined from specimens in the paleontological collection of the U. S. National Museum, and from collections made by Prof. H. F. Cleland and Mr. C. E. Monroe. In abundance of material and preservation, Mr. Monroe's collection is especially fine, and without his specimens at hand, a number of the species could not have been identified with certainty. The Milwaukee bryozoa usually occur as molds in the arenaceous dolomitic limestone, and consequently seldom preserve enough of their specific characters for certain identification. Fortunately, gutta-percha squeezes of some of these molds give results which will admit of an accurate determination. Some of these dolomitic limestones, however, are thin bedded and the specimens occuring upon the upper or lower surface of such layers are usually in an excellent state of preservation, as far as external features are concerned. The internal characters, although showing fairly well under a hand lens, are unfortunately greatly obscured by the dolomitization when viewed under a higher power of magnification. At first glance, these thin bedded limestones seem to contain but a single bryozoan species, *Cystodictya hamiltonensis,* but more careful search and the use of caustic potash in cleaning away the adhering clay, brought a number of other forms to light. The most interesting of these were the various species of Ctenostomata noted on the following pages.

The study of the Milwaukee collection has brought out some interesting facts in regard to the distribution of American Middle Devonic bryozoa in general, and the relation of the different faunas to each other. The bryozoan fauna of the Marcellus and Hamilton of New York and Canada is well known on account of the work of Nicholson and Hall. The bryozoa of the more western Devonic, *i. e.,* of Iowa and western Illinois, are likewise well known from Ulrich's work in Volume VIII of the Illinois Geological Survey. Comparing these two faunas alone, very few species are found occuring in both areas. Further comparisons of each with the Wisconsin fauna shows the latter

to be made up of about an equal number of the strictly eastern and western species. This fauna, therefore, is apparently an intermediate one and its occurrence at Wisconsin is indicative of the path of migration of these ancient faunas. In the following table of Wisconsin Devonic bryozoa, the intermediate nature of this fauna is apparent.

Table Showing Geographic Distribution of Wisconsin Devonic Bryozoa.

	New York and Michigan.	Wisconsin.	Iowa and Illinois.
CTENOSTOMATA.			
Vinella devonica		x	
Heteronema monroei		x	
Rhopalonaria tenuis	x	x	
Allonema fusiforme	x	x	
Ascodictyon floreale	x	x	
" *stellatum*	x	x	
CYCLOSTOMATA.			
Hederella magna	x	x	
" *filiformis*	x	x	
" *cirrhosa*	x	x	
Reptaria stolonifera	x	x	
Hernodia humifusa	x	x	
Fistulipora monticulata		x	x
" *romingeri*	x	x	x
" *utriculus*	x	x	
Cyclotrypa collina		x	x
TREPOSTOMATA.			
Orbignyella monticula		x	x
" *tenera*	x	x	x
Lioclema minutissimum	x	x	x
Eridotrypa appressa		x	x
Petalotrypa compressa		x	x
CRYPTOSTOMATA.			
Fenestella vera		x	x
Reteporina hamiltonensis		x	x
Semicoscinium rhombicum		x	x
Hemitrypa tenera		x	x
Cystodictya hamiltonensis		x	x

Class **BRYOZOA**

Order CTENOSTOMATA Busk.

Family VINELLIDÆ Ulrich and Bassler.

Genus **Vinella** Ulrich.

Vinella ? devonica, new species

Plate V. figs. 5–7

This interesting species is based upon three well preserved specimens, which in each case are attached to brachiopods. Two of these specimens consist of a single cluster of radiating threads, while a third colony is made up of several well defined clusters. The number of radiating threads seems to vary considerably, 18 being observed in one cluster and traces of 36 or more in a more crowded cluster. The central subcircular depression from which the threads radiate seems, however, to maintain a uniform diameter of about 0.15 mm.

Two apparently similar species have been described, one, *Vinella? multiradiata* Ulrich and Bassler, from the Niagaran of Western New York, and *V.? radians* Nicholson and Etheridge Jr., from the Lower Carboniferous of Scotland. Both of these are described and illustrated by Mr. Ulrich and the writer in their revision of Paleozoic Bryozoa (Ctenostomata)*, to which the reader is referred for comparisons with the present species.

The discovery of this new species in Devonic strata completes the range of this doubtful section of *Vinella* and seems to indicate that it is a constant generic type. In the course of time it may, therefore, be found advisable to distinguish these doubtful species of *Vinella* under a separate generic name.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wis.

Genus **Heteronema** Ulrich and Bassler

Heteronema monroei, new species

Plate V, figs. 1, 2

The remains of this species consist of irregularly meandering, black corneous threads which, in the two type specimens, incrust examples of *Cystodictya hamiltonensis.* These threads, under a low power of magnification appear simply as black lines, but when highly magnified, their tubular nature is apparent and sometimes, although rather infrequently, small pores arranged in a single row may be indistinctly ob-

* Smithsonian Misc. Coll., Quart. Issue, XLV, 1904.

served. Threads of a rather uniform diameter of about 0.04 mm. and often intertwining so much that an irregular network results.

The delicate incrusting zoarium composed of narrow, intertwining corneous black threads, is so different from the associated Ctenostomatous bryozoa that there should be no difficulty in the identification of the species. The discovery of these specimens is interesting since it shows that this type of structure existed in the Devonic as well as in the Ordovicic, Siluric and Coal Measures, species from the latter three only having hitherto been described.

The specific name is in honor of Mr. C. E. Monroe of Milwaukee in recognition of his work upon the palaeontology of the Devonic rocks of Wisconsin.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wis.

Genus **Allonema** Ulrich and Bassler

Allonema fusiforme (Nicholson and Etheridge, Jr.)

Plate V, figs. 8, 9

Ascodictyon fusiforme Nicholson and Etheridge, Jr., Ann. and Mag. Nat. Hist. (4), XIX, 1877, p. 463, pl. 19, figs. 7, 8.

Ascodictyon fusiforme Vine, Proc. Yorkshire Geol. and Polyt. Soc., XII, 1892, p. 89.

Allonema fusiforme Ulrich and Bassler, Smithsonian Misc. Coll. (Quart. Issue), XLV. 1904, p. 284, pl. 67, fig. 8.

This well marked species is represented in the Wisconsin material by several finely preserved and rather complete examples. One of these incrusts a stipe of the common *Cystodictya hamiltonensis* and is the original of figure 9 on plate V. A large, more complete but less regularly arranged example covers a portion of the smooth surface of the bryozoan, *Lioclema minutissimum.* The former specimen indicates that in the more normal colonies, especially in young stages, the vesicles arrange themselves in more or less radiate series. The surface as usual is distinctly punctate and the same variation in the size and shape of the vesicles is observed as in other species of the genus.

Allonema fusiforme may be readily distinguished from all associated bryozoans by the corneous, incrusting zoarium composed of ovate to fusiform vesicles ranging from 0.35 to 1.30 mm. in length, and 0.30 to 0.60 mm. in width, and joined by rather long necks. Under a magnifying glass the punctate character of the vesicles is apparent and characteristic.

Occurrence: Middle Devonic; New York and Michigan, Falls of the Ohio, Thedford, Ontario, and Milwaukee, Wisconsin.

Family RHOPALONARIIDÆ Nickles and Bassler.

Genus **Rhopalonaria** Ulrich

Rhopalonaria tenuis Ulrich and Bassler

Plate V, figs. 3, 4

Rhopalonaria tenuis Ulrich and Bassler, Smithsonian Misc. Coll. (Quart. Issue), XLV, 1904, p. 270, pl. 66, figs. 7–9.

Original description: "Fusiform cells attenuate, averaging about 3 in 2.0 mm., occasionally only 4 in 3.0 mm.; greatest diameter of same about 0.5 mm. On the best specimen many of the cells preserve remains of the pores. Of these there is usually only one situated near the center of the cell, but in others there appear to be two pores. The connecting stolons rarely equal the fusiform swellings in length, the average, however, is considerably less.

The general aspect of the colony is greatly like that of *R. venosa,* but when critically compared the fusiform cells of the Devonian species prove to be both narrower and longer, and the connecting stolons generally shorter than the Ordovician type of the genus. In the Silurian species, *R. attenuata,* the fusiform swellings, though about equally narrow, are considerably shorter and enlarge more abruptly, while the connecting stolons are much longer."

The recogition of this species at Milwaukee is based upon a single specimen incrusting a brachiopod, and although this specimen is represented by the excavations only, the latter agree so closely with similar examples from the type locality that there is little if any doubt of the identification.

Occurrence: The figured type is from the lower shales of the Hamilton formation at Thedford, Ontario. Alpena, Michigan, Eighteen Mile Creek, New York, and Milwaukee, Wisconsin, are additional localities.

Family ASCODICTYONIDÆ Ulrich.

Genus **Ascodictyon** Nicholson and Etheridge

Ascodictyon floreale Ulrich and Bassler

Plate V, figs. 10, 11

Ascodictyon floreale Ulrich and Bassler, Smithsonian Misc. Coll. (Quart. Issue), XLV, 1904, p. 288, pl. 68, fig. 13.

The type specimens of this small but typical *Ascodictyon* were found in the Hamilton (Traverse) formation near Alpena, Michigan, but a single specimen from the Milwaukee material agrees in every respect

with the types. This specimen, like many of the other species of Ctenostomata noted here, occurs on the flat branches of *Cystodictya hamiltonensis* which seems to be especially favored by these delicate organisms.

The small, flower-like clusters of *Ascodictyon floreale* are so different from any associated bryozoan except *A. stellatum* that there should be no difficulty in recognizing the species. Compared with *Ascodictyon stellatum,* the present species is distinguished especially by its smaller size, the average width of the clusters in *A. floreale* being about 0.5 mm. while in *A. stellatum* the clusters are 1.0 mm. in diameter.

Localities: Common near Alpena, Michigan, and at several localities in New York and Canada; rare in the Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Ascodictyon stellatum Nicholson and Etheridge, Jr.

Plate V, figs. 12, 13

Ascodictyon stellatum Nicholson and Etheridge, Jr., Ann. and Mag. Nat. Hist. (4), XIX, 1877, p. 464, pl. 19, figs. 1–6.

Ascodictyon stellatum Whiteaves, Contr. Canadian Pal., I, 1891, p. 213.

Ascodictyon stellatum Vine, Proc. Yorkshire Geol. and Polyt. Soc., XIX, 1892, p. 89.

Ascodictyon stellatum Ulrich, Geol. Nat. Hist. Surv. Minnesota, Final Rept., III, Pt. I, 1893, p. 113, fig. 8a.

Ascodictyon stellatum Simpson, Fourteenth Ann. Rept. State Geol. New York for 1894, 1897, p. 603, fig. 220.

Ascodictyon stellatum Ulrich and Bassler, Smithsonian Misc. Coll. (Quart. Issue), XLV, 1904, p. 287, pl. 68, figs. 9, 10.

Not *Ascodictyon stellatum* Vine, 1881 (=*Ascodictyon siluriense* Vine).

Original description: "Colony composed of ovoid or pyriform calcareous vesicles, varying in length from one fifth to one third of a line, and usually disposed in stellate clusters, each containing from three to six cells, or sometimes more. The walls of the vesicles are perforated by microscopic foramina, usually showing a distinctly linear arrangement. The clusters are connected together by creeping filamentous tubes, the free surfaces of which are perforated by a single row of minute foramina, and which generally anastomose so as to form a network."

The geographic distribution of this characteristic Middle Devonic form is extended by the discovery of several examples at Milwaukee,

the species hitherto having been found only as far west as eastern Michigan. The closely related *Ascodictyon floreale* is distinguished under the remarks on that species.

Occurrence: Several specimens were found at Milwaukee, Wisconsin. Not uncommon in the Middle Devonic of Canada, New York, Michigan, Indiana. etc.

Sub-Order CYCLOSTOMATA Busk.

Family DIASTOPORIDÆ Busk.

Genus **Hederella** Hall

Hederella magna Hall

Plate VI, fig. 6

Hederella magna Hall, Trans. Albany Inst., X, 1883, p. 195 (abstract, 1881, p. 195).

Hederella magna Hall, Rept. State Geol. New York for 1883, 1884, p. 55.

Hederella magna Hall and Simpson, Nat. Hist. New York, Pal., VI, 1887, p. 280, pl. 65, fig. 15.

Hederella magna Whiteaves, Contr. Canadian Pal., I, Pt. V, 1898, p. 382.

This species, which seems to be not uncommon in the Milwaukee area, may be distinguished by its large size. The zoarium consists of an axial tube from which proceed simple tubular cells having a length of 2 to 3 mm. and a diameter of about 1 mm. The surface markings and other features of the species are well brought out in the figure. Comparisons with the associated species of *Hederella* are given under the description of *H. filiformis.*

Occurrence: Not uncommon in the Middle Devonic at various localities in New York, Canada, Michigan, and at Milwaukee, Wisconsin.

Hederella filiformis (Billings)

Plate VI, figs. 1–3

Aulopora filiformis Billings, Canadian Journal, new ser., IV, 1859, p. 119.

Aulopora filiformis Nicholson, Pal. Prov. Ontario, 1874, p. 42, figs. 11a, b.

Hederella filiformis Hall, Trans. Albany Inst., X, 1883, p. 194 (abstract, 1881, p. 194).

Hederella filiformis Hall, Rept. State Geol. New York for 1883, 1884, p. 54.

Hederella filiformis Hall and Simpson, Nat. Hist. New York, Pal., VI, 1887, p. 278, pl. 65, figs. 9–11.

Hederella filiformis Whiteaves, Contr. Canadian Pal.. I, 1897, p. 211, pl. 29, fig. 1.

Hederella filiformis Grabau, Bull. Buffalo Soc. Nat. Sci., VI, 1899, p. 179, fig. 77a.

Hall and Simpson describe this species as follows:

"Zoarium parasitic, procumbent, attached for its entire length, consisting of an elongated, sub-cylindrical primary axis, from which proceed, laterally, simple tubular cells, and occasionally tubular extensions having the same manner of growth as the primary axis. Fronds comparatively large, some specimens entirely cover the exterior of Cyathophylloid corals, which have a length of 75 mm., and a diameter at the calix of 45 mm. Axial tube and lateral cells sinuous or tortuous, diameter a little more than .50 mm.; length of cells generally from 1 to 1.25 mm.; just before ceasing growth the cell tubes turn abruptly outward, the apertures being parallel with the axis of the branch and constricted, the width a little more than one-half the length. Cell tubes sometimes alternating, at other times occurring opposite to each other, rapidly expanding for a short distance, but for the greater portion of their length essentially of the same size; those on the same side of the axial tube are quite regularly distant from each other 1.50 mm. One side of the cell for its entire length is very frequently in contact with the axial tube and the base of the succeeding cell tube, the frond presenting a compact appearance, but others diverge at an angle of forty-five degrees. The axial tubes and lateral cells are sharply striated and wrinkled transversely, and when well preserved have numerous, very fine, longitudinal striations; on some cells there are evidences of a line of nodes along the middle."

Several specimens in the Milwaukee collection are identical with typical examples of this species which occurs abundantly in Michigan, Ontario, and New York. The more slender and less compact zoarium of *H. filiformis* will distinguish it from the associated *H. magna,* while still another associated species, *H. cirrhosa,* may be separated from both by its much smaller and less closely arranged tubes.

Occurrence: A characteristic Middle Devonic form in New York and westward to Wisconsin, Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Hederella cirrhosa Hall

Plate VI, figs. 4, 5

Hederella cirrhosa Hall, Trans. Albany Inst., X, 1883, p. 194 (abstract, 1881, p. 194).

Hederella cirrhosa Hall, Rept. State Geol. New York for 1883, 1884, p. 53.

Hederella cirrhosa Hall and Simpson, Nat. Hist. New York, Pal. VI, 1887, p. 277, pl. 65, figs. 12, 13.

Hederella cirrhosa Simpson, Fourteenth Ann. Rept. State Geol. New York for 1894, 1897, pl. 25, figs. 10, 11.

Hederella cirrhosa Whiteaves, Contr. Canad. Pal., I, Pt. V, 1898, p. 381.

Hall and Simpson describe this species as follows:

"Zoarium consisting of a filiform, tubular axis, from which proceed laterally simple tubular cells, and at irregular intervals other tubules having the same manner of growth as the main axis; parasitic, procumbent attached for its entire length, occurring on cyathophylloid corals, brachiopods and crinoid columns. Cells about 1 mm. in length; diameter .20 mm.; transverse section nearly circular, turning abruptly outward at the extremity, the aperture being parallel with the axis of the branch and circular, generally alternating, distant on the same side of the branch from 2 to 2.50 mm., though sometimes occurring at irregular intervals. Surface marked by transverse striae and angular annulations."

A single specimen parasitic upon a stipe of *Cystodictya hamiltonensis* was the only example of this well marked species obtained at Milwaukee, but it agrees in all essential respects with the eastern types. The slender filiform tubes of *H. cirrhosa* will distinguish it from other species of the genus.

Occurrence: Abundant in the Middle Devonic of New York and Canada; less common in Indiana, Michigan, and Milwaukee cement quarry, Wisconsin.

Genus **Reptaria** Rolle

Reptaria stolonifera Rolle

Plate VI, figs. 7, 8

Reptaria stolonifera Rolle, Neues Jahrb., 1851, p. 810, pl. 9, figs. 5, 6.

Reptaria stolonifera Hall and Simpson, Nat. Hist. New York, Pal., VI, 1887, p. 274, pl. 65, figs. 17–19.

Reptaria stolonifera Simpson, Fourteenth Ann. Rept. State Geol. New York for 1894, 1897, pl. 25, figs. 8, 9.

Reptaria stolonifera Grabau, Bull. Buffalo Soc. Nat. Sci., VI, 1899, p. 178, fig. 76.

Ptilionella penniformis Hall, Trans. Albany Inst., X, 1883, p. 195 (abstract, 1881, p. 195).

Ptilionella penniformis Hall, Rept. State Geol. New York for 1883, 1884, p. 56.

The form and mode of growth of this species are so striking that there is no difficulty in identifying even the poorest of molds. A single specimen growing upon what was probably an *Orthoceras* occurred in the Milwaukee material. The distinctive features of the species are well brought out in Hall's figure, reproduced on plate VI.

Occurrence: This species is usually rare but specimens have been found in most of the well known Middle Devonic localities from New York to Wisconsin. Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Genus **Hernodia** Hall

Hernodia humifusa Hall

Plate VI, figs. 9, 10

Hernodia humifusa Hall, Trans. Albany Institute, X, 1883, p. 196 (abstract, 1881, p. 196).

Hernodia humifusa Hall, Rept. State Geol. New York for 1883, 1884, p. 58.

Hernodia humifusa Hall and Simpson, Nat. Hist. New York, Pal., VI, 1887, p. 281, pl. 65, figs. 20, 21.

Hernodia humifusa Simpson, Fourteenth Ann. Rept. State Geol. New York for 1894, 1897, pl. 25, figs. 1, 2.

Hall and Simpson's description of this species follows:

"Zoarium parasitic, procumbent, consisting of tubular cells; increasing by lateral gemmation; from one to three buds from each cell. The cells have a length of 5 mm., gradually enlarging to the aperture, diameter at the smaller end .35 mm., the greatest diameter of 1 mm., is at .50 mm. from the aperture. Apertures slightly constricted, not elevated, rectangular to the axis of the cell on the specimens observed; transverse section sub-circular; attached surface flattened, upper surface convex. After budding the parent cell continues its growth frequently for the extent of 1.50 mm. or even more. Surface marked by

comparatively strong annulations, concentric and fine longitudinal striæ."

Occurrence: Rare at Cazenovia, New York, Falls of the Ohio, and Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Family FISTULIPORIDÆ Ulrich.

Genus **Fistulipora** McCoy

Fistulipora monticulata Ulrich

Plate VII, figs. 7–10

Fistulipora monticulata Ulrich, Geol. Surv. Illinois, VIII, 1890, p. 477, pl. 47, figs. 3–3b; pl. 48, figs. 2, 2a.

Zoarium of compressed hollow branches, 10 to 30 mm. wide and 2 to 5mm. thick, the actual thickness of an individual layer being less than 2 mm. Surface with sub-solid, rather low, broad rounded monticules 4 or 5 mm. apart. Zooecial apertures with thick rounded peristomes 0.2 to 0.3 mm. in diameter, with a distinct lunarium whose ends project but little in the zooecial cavity.

A single mold in the Milwaukee dolomite shows all the characters of this species and there seems to be little doubt of its identity with the above form which occurs not infrequently at Buffalo, Iowa.

Occurrence: Hitherto unknown in any other fauna than the Middle Devonic of Iowa. Rare at Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Fistulipora utriculus Rominger

Plate VII, figs. 1–6

Fistulipora utriculus Rominger, Proc. Acad. Nat. Sci. Phila., 1866, p. 121.

Fistulipora utriculus Nicholson and Foord, Ann. and Mag. Nat. Hist. (5), XVI, 1885, p. 508, pl. 17, figs. 1–1e; pl. 17, figs. 1, 1a.

Fistulipora utriculus Whiteaves, Contr. Canadian Pal., I, 1898, p. 380.

Zoarium of irregular, subramose, hollow, clay filled stems varying from 5 mm. to 10 or more mm. in width, and 20 or more mm. in height. The zoœcial layer making up these hollow stes is 1 mm. or more in thickness. Surface often smooth but occasionally with low monticules composed of mesopores. Zoœcia comparatively small, about 6 in 2 mm., seldom less than their own diameter distant from each other. Lunarium well marked and occupying about a third of the zoœcial orifice. Interzoœcial space closed and granulose at the surface.

The habit of growth, small zoœcia, well marked lunarium, and granulose interspaces, are particularly diagnostic of this species.

Occurrence: Very abundant at Thedford and neighboring localities in Canada; rare at Milwaukee cement quarry, Milwaukee, Wisconsin.

Fistulipora romingeri Nicholson and Foord

Plate IX, figs. 1, 2

Fistulipora crassa Rominger, Proc. Acad. Nat. Sci. Phila., 1866, p. 121.

Fistulipora Romingeri Nicholson and Foord, Ann. and Mag. Nat. Hist. (5), XVI, 1885, p. 506 (proposed for *crassa* preoccupied).

Fistulipora Romingeri Whiteaves, Contr. Canadian Pal., I, 1898, p. 380.

The discovery of undoubted specimens of this well marked species in Wisconsin completes the geographic distribution, the form having hitherto been recorded from New York, Michigan, and Iowa.

The thick, solid ramose branches and large rounded zoœcia with well marked lunaria are characters which will readily distinguish *F. romingeri* from associated forms.

Occurrence: In Wisconsin not uncommon at Lake Church and Humboldt street bridge, Milwaukee.

Genus **Cyclotrypa** Ulrich

Cyclotrypa collina (Ulrich)

Plate VII, figs. 11, 12; plate XI, figs. 4, 5

Fistulipora collina Ulrich, Geol. Surv. Illinois, VIII, 1890, p. 478, pl. 47, figs. 6–6b; pl. 48, figs. 5, 5a.

Cyclotrypa collina Ulrich, Zittel's Textb. Pal. (Eng. ed.), 1896, p. 269.

A large portion of a circular expansion 50 or more mm. in diameter, preserved as a mold, exhibits all of the characters of the above species with the exception that the distribution of the vesicles and diaphragms cannot be determined with exactness. There seems little doubt, however, of the above identification. *C. collina* is readily distinguished from associated fistuliporoids at the type locality, Buffalo, Iowa, by the shape of the zoarium, the small zoœcia (8 in 3 mm.) and the absence of lunaria.

Occurrence: Common at Buffalo and other Middle Devonic localities in Iowa; rare at Milwaukee, Wisconsin.

Sub-Order TREPOSTOMATA Ulrich.

Family MONTICULIPORIDÆ Nicholson (emend. Ulrich).

Genus **Orbignyella** Ulrich and Bassler

Orbignyella monticula (White)

Plate IX, figs. 8–10; plate XI, figs. 1, 2

Monticulipora? monticula White, Proc. Acad. Nat. Sci. Phila., 1876, p. 27.

Zoarium usually petasiform in shape but varying from these flat expansions to hemispherical masses. Maculæ usually inconspicuous but sometimes forming low, rounded monticules. Zoœcial apertures thin walled, comparatively small, 8 to 9 in 2 mm., measuring from the center of a macula. Acanthopores small, few, and often wanting. Mesopores wanting. Diaphragms curved or oblique, a tube diameter apart in the immature zone and twice as numerous in the mature region.

The form of zoarium, thin walled zoœcia, few acanthopores, absence of mesopores, and numerous curved diaphragms, are characteristic of this species. The associated *Orbignyella tenera* has a different mode of growth, slightly smaller zoœcia, and thicker walls, and more numerous acanthopores and mesopores.

The Iowa examples of *O. monticula* occur abundantly and in an excellent state of preservation, but those from Wisconsin are usually represented by cavities in the dolomite. A few of the latter, however, preserved enough of the zoœcial structure to make an accurate identification.

Occurrence: The original types, here figured for the first time, are from the Devonic at Iowa City, Iowa. Other localities are Buffalo, Iowa, and Milwaukee, Wisconsin.

Orbignyella tenera, new species

Plate VIII, figs. 1–3; plate XI, fig. 3

This new species, although quite similar to the preceding in general structure, may be easily distinguished by its incrusting habit of growth. The zoarium is usually a thin incrustation upon crinoid columns or other foreign objects, but by the superposition of layer after layer, a considerable mass may result. Further compared with *O. monticula,* the slightly smaller zoœcia—9 to 9.5 in 2 mm.—and the thicker walls of the form under discussion, are to be noted, while a more obvious

distinction, both at the surface and in thin sections, is the presence of numerous acanthopores.

Occurrence: Common in the Devonic at Petosky, Michigan, and at the Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Family BATOSTOMELLIDÆ Ulrich.

Genus **Eridotrypa** Ulrich.

Eridotrypa appressa (Ulrich)

Plate VIII, figs. 10–14

Monotrypella appressa Ulrich, Geol. Surv. Illinois, VIII, 1890, p. 458, pl. 46, figs. 1–1e (on plate as *M. simplex* in error).

Eridotrypa appressa Nickles and Bassler, Bull. U. S. Geol. Surv., No. 173, 1900, p. 237.

Most of the specimens referred to this species occur as molds at Milwaukee and thus the absolute identity of the form could not have been ascertained, had not a single specimen been found which preserved the internal structure. The latter specimen showed all the characters of the type examples which were obtained at Rock Island, Illinois.

The subcylindrical or flattened ramose branches, smooth surface, and thin walled polygonal zoœcia are external characters which will separate *E. appressa* from all associated bryozoans. Illustrations of the internal features, copied from Ulrich, are given on plate VIII.

Occurrence: Rather common in the Devonic rocks of Illinois and Iowa, and at Milwaukee, Wisconsin.

Genus **Lioclema** Ulrich.

Lioclema minutissimum (Nicholson)

Plate IX, figs. 3–7

Callopora minutissima Nicholson, Pal. Province Ontario, 1875, p. 77, fig. 43.

Leioclema minutissimum Whiteaves, Contr. Canadian Pal., I, 1898, p. 380.

Fistulipora minute? Hall and Simpson, Nat. Hist. New York, Pal., VI, 1887, p. 223, pl. 59, figs. 5–8.

Leioclema minutum? Ulrich, Geol. Surv. Illinois, VIII, 1890, p. 427.

Fistulipora minuta Grabau, Bull. Buffalo Soc. Nat. Sci., VI, 1899, p. 169, fig. 64.

Not *Fistulipora minuta* Rominger, Proc. Acad. Nat. Sci. Phila., 1866, p. 120.

Zoarium of thin incrusting layers averaging 1 mm. in thickness and forming by the superposition of successive layers more or less irregular undulating masses sometimes 10 cm. in width and 1.0 cm. or more thick. Often when the incrustation is about ramose bryozoa or organisms having a similar growth, irregular, branching masses may result, but a fracture will always determine the lamellate method of growth of the *Lioclema*. Such irregular branching or lamellate masses are common in the Milwaukee and other western occurrences of the species, but occur less in the Michigan and New York localities.

Surface smooth. Zoœcia polygonal, thin walled, separated from each other by one to two rows of angular mesopores with walls still thinner than those of the zoœcia. Acanthopores few and inconspicuous, averaging one to a zoœcium. Diaphragms few in the zoœcial tubes, often absent altogether; numerous in the mesopores where they occur at intervals of their own diameter.

The method of growth and thin walled angular zoœcia separated by numerous mesopores will distinguish *L. minutissimum* from all associated bryozoa.

This very abundant bryozoan has been most often cited and identified as *Lioclema minutum* (Rominger), but an examination of Rominger's types of *Fistulipora minutum*, recently acquired by the National Museum, shows that this author's original reference of his species to *Fistulipora* was correct. In 1890, Ulrich, basing his observations upon an "authentic" specimen, described this common Middle Devonic *Lioclema as L. minutum*, but suggested that "should an examination of Rominger's original types prove his species distinct, then Nicholson's name will stand."

Occurrence: Abundant in New York, Canada, Michigan, Indiana. Iowa, Illinois, and Wisconsin.

Family AMPLEXOPORIDÆ Ulrich.

Genus **Petalotrypa** Ulrich.

Petalotrypa compressa Ulrich

Plate VIII, figs. 4–9

Petalotrypa compressa Ulrich, Geol. Surv. Illinois, VIII, 1890, p. 454, pl. 46, figs. 4–4f.

Petalotrypa compressa Simpson, Fourteenth Ann. Rept. State Geol. New York for 1894, 1897, p. 582, figs. 157–159.

Zoarium of compressed bifoliate branches averaging 10 mm. in width and 20 mm. or more in height. Surface smooth but exhibiting

maculæ composed of zoœcial apertures slightly larger than the average. Zoœcial walls of moderate thickness; zoœcial apertures polygonal, sometimes regularly hexagonal, about eight in 2 mm. Mesopores usually limited to the maculae. Diaphragms abundant in both zoœcia and mesopores.

The bifoliate zoarium, and size and shape of the zoœcia make this an easily recognized species. The Wisconsin specimens agree in every respect with the types which were found in corresponding strata at Rock Island, Illinois.

Occurrences: Not uncommon in the Devonic at Davenport, Iowa, Rock Island, Illinois, and Milwaukee, Wisconsin.

Sub-Order CRYPTOSTOMATA Vine.

Family FENESTELLIDÆ King.

Genus **Fenestella** Lonsdale.

Fenestella vera Ulrich

Plate X, figs. 8–10

Fenestella vera Ulrich, Geol. Surv. Illinois, VIII, 1890, p. 535, pl. 44, figs. 1, 1a; pl. 54, fig. 3.

Fenestella vera Whiteaves, Contr. Canadian Pal., I, 1892, p. 279, pl. 36, figs. 3, 3a.

Ulrich's description of *Fenestella vera* is as follows:

"Zoarium a somewhat undulating flabellate expansion; largest fragment seen over 6 cms. in length. Obverse with branches rather straight, slender, ridge-shaped, bifurcating at distant intervals, about 0.35 mm. in width, and twenty-four in 1 cm. Dissepiments short, subcarinate, varying in width from about two-thirds to almost the width of the branches. Fenestrules elliptical or sub-quadrangular, about 0.5 by 0.2 mm.; fourteen in 1 cm. Carina prominent, not sharp, bearing small nodes about twice their diameter apart, and six or seven in 2 mm. Zoœcia in two ranges. Apertures small, circular, opening obliquely into the fenestrules, generally four to each fenestrule, and twenty-three in 5 mm. On the reverse the branches are usually zigzag, on the same level and scarcely stronger than the dissepiments, the fenestrules have a somewhat hexagonal shape, less marked in the older portion of the zoarium, and form quite regular diagonal series. Surface of both branches and dissepiments very minutely granulose."

Occurrence: Some of the layers at Milwaukee, as indicated from specimens in Mr. Monroe's collection, are crowded with this form. The species is also very abundant in the Devonic of Illinois and Iowa.

Genus **Semicoscinium** Prout.

Semicoscinium rhombicum Ulrich

Plate X, figs. 5–7

Semicoscinium rhombicum Ulrich, Geol. Surv. Illinois, VIII, 1890, p. 556, pl. 44, figs. 4, 4a; pl. 54, fig. 8.

Two molds in the magnesian limestone show all the characters of this species that one could expect to find in specimens so preserved. However, since these characters include agreement in size and shape of the fenestrules and the presence of the characteristic carina, the discovery of better material will probably confirm this identification. The following points in the description of *S. rhombicum* are brought out in the Milwaukee specimens. Zoarium of large, undulated, infundibuliform branches with dissepiments so short that the branches appear to inosculate. Fenestrules oval, 8 in 10.00 mm., averaging about 0.6 mm. by 0.2 mm. Carina strongly elevated, flexuous, and but little thickened at the summit. Apertures circular, 0.09 mm. in diameter, about 22 in 5 mm. The fenestrules on the reverse are oval or subrhomboidal and arranged in regular diagonally intersecting series, eleven or twelve in 10 mm.

Occurrence: Not uncommon at Buffalo, Iowa; rarer at Milwaukee, Wisconsin.

Genus **Reteporina** D'Orbigny.

Reteporina hamiltonensis (Prout)

Plate XI, figs. 6, 7

Retepora hamiltonensis Prout, Trans. Acad. Sci. St. Louis, II, 1866, p. 412.

Polypora Hamiltonensis Prout, Geol. Surv. Illinois, II, 1866, p. 423, pl. 21, figs. 6, 6a.

Protoretepora (Polypora) hamiltonina DeKonninck, Rech. sur les Foss. Paleoz. de la Nouv. Galles des Sud, III, 1876–7, p. 179; Eng. translation, Mem. Geol. Surv. New South Wales, Pal., No. 6, 1898, p. 137.

Reteporina hamiltonensis Miller, North American Geol. and Pal., 1889, p. 320.

The most abundant fenestellid in the Milwaukee material is a species of *Reteporina* which agrees in all essential respects with the form from Buffalo, Iowa, described by Prout as *Polypora hamiltonensis.*

The sinuous branches with the zoœcial apertures rather large and

disposed in two to three ranges, distinguish the celluliferous face of the flabellate zoarium while the non-celluliferous side often exhibits rhomboidal fenestrules.

The sinuosity of the branches is caused by the slight development of the dissepiments, this bringing the branches almost into contact at the point of connection.

Occurrence: Abundant in the Devonic localities of Illinois and Iowa; common also at Milwaukee, Wisconsin.

Genus **Hemitrypa** Phillips.

Hemitrypa tenera Ulrich

Plate X, figs. 1–4

Hemitrypa tenera Ulrich, Geol. Surv. Illinois, VIII, 1890, p. 559, pl. 44, figs. 7, 7a; pl. 54, figs. 10–10c.

A specimen in the National Museum collection from Milwaukee, Wisconsin, shows all of the characters of this well marked species which is described by Ulrich as follows:

"Zoarium infundibuliform, only known from fragments. The obverse is very delicate net-work in which the principal and secondary bars are indistinguishable, being equal in width and both zigzag; connected by lateral bars or scalæ of the same width, they form equal hexagonal interstices, arranged in very regular vertical and diagonally intersecting series, twelve in 3 mm. measuring along the rows. Their openings correspond in number to the zoœcia in the branches beneath them. Zoœcia observed only in thin sections. On the reverse the branches are straight or slightly zigzag, slender, thirteen or fourteen in 5 mm., rounded, somewhat variable in width, smooth when old, granular and striated longitudinally when young. Dissepiments short, in the middle about as wide as the branches, spreading at their junction with them; on some portions of the zoarium, opposite in adjoining rows, on others alternate. Fenestrules oval or subquadrate, about 0.5 by 0.2 mm., with fourteen in 1 cm.

"The delicacy of the zoarium is its distinguishing feature."

Occurrence: Not uncommon in the Devonic strata at Rock Island, Illinois, and Davenport and Buffalo, Iowa; apparently rare at Milwaukee, Wisconsin.

Family CYSTODICTYONIDÆ Ulrich.

Genus **Cystodictya** Ulrich.

Cystodictya hamiltonensis Ulrich

Plate X, figs. 11, 12; plate XI, fig. 8

Cystodictya hamiltonensis Ulrich, Geol. Surv. Illinois, VIII, 1890, p. 493, pl. 42, fig. 4; pl. 43, fig. 1.

Cystodictya Hamiltonensis Whiteaves, Contr. Canadian Pal., I, 1892, p. 279, pl. 36, figs. 2–2b.

Zoarium a bifoliate, parallel edged, bifurcating stipe with narrow, non-poriferous margins, sharply elliptical in cross section, 2.5 to 3.0 mm. wide and 0.5 mm. at the greatest thickness. Zoœcial aperture arranged normally in 7 or 8 longitudinal parallel rows separated by well developed, elevated ridges; measuring lengthwise 6 zoœcia in 3 mm., the apertures being about 0.2 mm. in diameter and separated from each other longitudinally by spaces equalling 1½ times their own diameter. Lunarium inconspicuous in young specimens, strong only in old examples.

This is the most abundant bryozoan of the Wisconsin Devonic, the thin bedded limestone often being covered with more or less broken zoœcia while the rock itself is often made up of fragments as shown by thin cross sections along the broken edges. *C. hamiltonensis* is closely related to *C. incisurata* Hall and indeed may be considered the western representative of that species.

Occurrence: Devonic; Iowa, Illinois, and Milwaukee, Wisconsin.

CHAPTER VI

BRACHIOPODA

The brachiopods are represented by at least 37 species and varieties in the rocks of the Hamilton formation in Wisconsin. This class is especially interesting, and the large number of species peculiarly valuable, because it furnishes, as a whole, perhaps, the most definite evidence of the age of the rocks in which they occur. This is due to two facts; (1) the specific characters of brachiopods as a class are rather more easily and definitely recognizable than those of other classes of invertebrates and, (2) because the geological range is, generally speaking, not great.

No specimens have been examined which show the brachial supports; this apparatus having been destroyed during fossilization.

The brachiopods occur in the form of casts in all of the exposures except in the uppermost shaly layers, zone C, of the Milwaukee cement quarries. The completeness of the fauna is not a fair criterion of the abundance of fossils of this and the other classes represented. Many of the specimens illustrated and described here are from the collections of men who have repeatedly searched the exposures for fossils in the course of twenty years. The relationships of this fauna with that of others east and west is discussed on pages 2 and 3.

For a more complete account of the anatomy and classification of the Brachiopoda the student is referred to Eastman-Zittel *"Text Book of Palaeontology"*; Hall and Clarke *"Handbook of Brachiopoda"*; Grabau and Shimer *"North American Index Fossils"*.

Class **BRACHIOPODA** Cuvier.

Order ATREMATA Beecher.

Family LINGULIDAE Gray.

Genus **Glossina** Phillips.

Glossina truncata nov.

Plate XII, fig. 6

Equals *Lingula palaeformis* Whitfield, Geol. Wis. Vol. IV, 1882, p. 324, pl. 25, fig. 10.

Description: "Shell rather larger than medium size; broadly triangular in general form, being widest near the front and pointed at

the beak, with the cardinal slopes nearly straight [or even slightly concave] . . . to below the middle of the length, and diverging at an angle of [50 to 60 degrees]. Front margin broadly rounded or flattened, and the lateral angles abruptly rounded from the extremity of the cardinal slopes to the basal border. Body of the shell, as indicated by the specimen, flattened in the central portions or very depressed convex. The surface of the shell has been distinctly and very regularly marked by even, closely arranged, elevated, concentric ridges parallel to the margins, marking stages of growth, and with regularly increasing distances from the apex outward." Whitfield, 1882.

The specimen figured, a ventral valve, differs from the New York *Lingulella palaeformis* in the truncated appearance of the front of the shell, and the more sharply elevated and widely spaced concentric striae. It bears a strong resemblance to *Glossina waverlyensis* but differs from that species in the straighter lateral margin. A comparison of the published figures of the species mentioned above indicates that *Lingulella palaeformis* and *Glossina waverlyensis* are both Glossinas and are more closely related to each other than to *Glossina truncata.*

Collection: E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Genus **Lingula** Bruguiere.

Lingula milwaukeensis nov.

Plate XII, figs. 3, 4

Description: Shell, subelliptical; anterior margin regularly rounded, the posterior margin curving to the apex which is rather blunt. Shell substance apparently very thin. Surface marked by growth lines and wide concentric undulations. On certain specimens concentric color lines are preserved. The average size is 7 mm. in length and 4 mm. in breadth.

This species closely resembles *Lingula melie* of the Ohio Waverly group but differs from it in its greater relative length, rounder posterior margin, more convex valves and tumid umbos.

There is a strong resemblance to *L. nuda* of the New York Hamilton but this species, as shown by the illustrations and descriptions in the text of Palaeontology of New York, Vol. IV, is truncated posteriorly; *L. spatulata* of the Genesee is a smaller shell and more pointed posteriorly. It is possible that the shale of the New Intake tunnel should be correlated with the Genesee.

Collections: Milwaukee Museum, H. F. Cleland, E. E. Teller.

Locality: Collected by C. E. Monroe from the debris of the New

Intake tunnel, Milwaukee where it occurs in a fine, soft shale. One specimen was also found in the limestone of the Milwaukee cement quarry, Berthelet, Wis.

Lingula sp. undet.

Plate XII, fig. 5

A specimen from the debris of the New Intake tunnel identified by Teller and Monroe as *L. complanata* may prove to be a new species. It has the flat valves and general form of that species but the shell is rather more drawn out posteriorly than in specimens of *L. complanata* from Ithaca, N. Y. Until more material is available it seems best to attempt no description.

Collection: Milwaukee Museum.

Location: New intake tunnel, Milwaukee, Wis.

Lingula cf. *delia* Hall

Plate XII, figs. 1, 2

Lingula delia Hall, Pal. New York, Vol. IV, 1867, p. 12, pl. 2, fig. 9; Hall and Clarke, New York, Vol. VIII, pt. I, 1892, p. 15, pl. I, fig. 29.

Description: Large Lingulas with "sharply elevated, equally spaced, concentric lines" are the characters that are most conspicuous in the few specimens collected. They resemble the New York species *Lingula delia* Hall more closely than any other species.

The difficulty in determining species of *Lingula* even with perfect material is well known and it seems best consequently to refer these large *Lingulas* provisionally to the above species.

Collections: E. E. Teller and H. F. Cleland.

Locality: Humboldt street bridge, Milwaukee.

Order TELOTREMATA Beecher.

Family RHYNCHONELLIDAE Gray.

Genus **Camarotoechia** Hall and Clarke.

Camarotoechia contracta saxatilis Hall

Plate XIII, figs. 3, 4, 5

Rhynchonella contracta saxatilis Hall, Pal. New York, Vol. IV, 1867, p. 417, plate 54a., figs. 44–51.

There are at least two species of Camarotoechia in the collections from Milwaukee, the majority of which seem to be of this species. These are smaller and have a greater number of plications than the

larger and rarer form *C. scitulus* nov. The surface is marked by from twenty to more than twenty-six plications of which four or five are in the mesial sinus and three to five on the fold. Toward the cardinal extremities the plications are much crowded. The Milwaukee specimens resemble figs. 50–51 of Hall.

Collections: Public Museum, Milwaukee; H. F. Cleland; E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Camarotoechia scitulus nov.

Plate XIII, figs. 6, 7

Description: Shells medium to large. Plications about 24 with 4 in the fold and an equal number in the sinus. This species is of about the same size and has other characters in common with *C. sappho* Hall, but differs from it in general outline and the greater relative strength of the fold and sinus.

It has been the custom to refer all large Middle and Upper Devonic Camarotoechias to the species *C. sappho;* as a result *C. sappho* now probably includes a number of distinct species. The Milwaukee specimens are not the same as Hall's type specimens as figured in his reports and are consequently regarded as new.

Collections: E. E. Teller and Public Museum, Milwaukee.

Genus **Liorhynchus** Hall.

Liorhynchus greeni nov.

Plate XIII, figs. 1, 2

Equals *Leiorhynchus kelloggi,* Whitfield, Geol. of Wisconsin, Vol. IV, 1882, p. 334, plate 26.

Description: The casts of the interior of a few specimens of *Liorhychus* have been found in the Milwaukee cement quarry. These show five plications in the sinus and four or five on the fold. That portion of the shell between the fold or sinus and the cardinal extremities is occasionally ornamented with a few low rounded plications. The brachial valve preserves the impression of a thin median septum.

Compared with *L. laura* this species is more gibbous, the medial plications are far more prominent and the shell is less elongate in outline. Compared with *L. kelloggi* the plications are stronger and the shell more gibbous. It differs from the variable and poorly defined *L. globuliformis* Vanuxem in the strength of the plications and the depth of the sinus but closely resembles some of the variations of that species.

Collections: H. F. Cleland; E. E. Teller; Public Museum, Milwaukee.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Family TEREBRATULIDAE Gray.

Genus **Eunella** Hall and Clarke.

Eunella lincklaeni ? Hall

For bibliography cf. Schuchert, U. S. G. S., Bull. 87, p. 223.

Certain somewhat distorted terebratuloid shells in the Teller collection have narrow valves and the outlines of *Eunella lincklaeni* Hall but are probably poorly preserved specimens of *Cranaena iowensis,* It is possible, however, that they are of the above species since *Eunella lincklaeni* occurs in Devonic beds both east and west of Wisconsin.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Locality: Zone C of the Milwaukee quarry, Humboldt street bridge, Milwaukee.

Genus **Cranaena** Hall and Clarke.

Cranaena iowensis (Calvin)

Plate XIII, figs. 8, 9, 10, 11

Terebratula (Cryptonella) iowensis Calvin, Bull. Lab. Nat. Hist. Univ. Iowa, 1, 1890, p. 174, pl. 3, fig. 4.

Cranaena iowensis Hall and Clarke, Pal. New York, vol. VIII, part 2, 1893, p. 297, plates 80 and 83.

Description: "Shell large, ovate, widest at or below the middle, adult specimens very convex, greatest convexity a short distance in front of the umbo; front margin regularly rounded, truncate or slightly sinuate. Dorsal valve convex, curving gradually in all directions from a point situated at a variable distance behind the middle of the valve. Ventral valve, like the dorsal, sloping from a point behind the middle line, the curvature increasing most rapidly toward the beak; beak only moderately incurved, perforated by a relatively small foramen; cardino-lateral slopes rounding gradually, without the usual subangular ridge toward the deltidial plate; deltidial plate wide, its sides meeting beneath the foramen in an obtuse angle; muscular scars of ventral valve elongated and bounded by sharp ridges that leave three grooves extending beyond the middle of the shell in the exfoliated cast, middle groove deeper than the other two and extending in some instances almost to the front margin; sometimes the middle groove widens from the beak to about the middle of the valve, then narrows abruptly and is continued toward the front as a slender furrow. Muscular markings on the dorsal valve very variable; in general, the scars were long and separated by a narrow carina. The other details, however, are far

from being constant. Dental laminae forming two short septa in the umbonal cavity of ventral valve, nearly parallel or slightly diverging where their lower margins join the shell, but curving at their upper margins so as to conform nearly in direction to the lateral margins of the deltidial plate. Surface smooth, marked only by obscure lines of growth. Shell very finely punctate. Internal loop unknown.

"Large specimens are an inch and a quarter in length, more than an inch in width, and three-fourths of an inch in thickness. Immature forms are very common." Calvin, 1890.

Remarks: The surface characters of *Cranaena, Dielasma,* and *Eunella* are so similar that it is difficult, in many cases impossible, to distinguish one from the other without a knowledge of the brachial apparatus. Specimens which were identified under the three mentioned genera have all been included in the above species. It is possible that the three genera are represented but since the brachial apparatus is not preserved it does not seem advisable at present to make the separation. Specimens in the Teller collection which, judging from external form alone, might be placed under the three genera mentioned above, preserve faintly the color markings shown in figs. 8 and 9; a fact which is further evidence that all are varieties of the same species.

Cranaena iowensis from Iowa is larger than the Wisconsin shells but of the same general shape; *C. romingeri* Hall is more gibbous; *Cranaena transversa* Winchell in the Schuchert collection from Petosky, Michigan is similar. Both the larger and smaller specimens occasionally preserve distinct radial color bands on one or both valves (figs. 8 and 9). Such a degree of preservation is remarkable when the age and condition of the shell is considered.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Family ATRYPIDAE Gill.

Genus **Atrypa** Dalman.

Atrypa hystrix Hall

Plate XIII, figs. 14, 15, 16

Atrypa hystrix Hall, Pal. New York, Vol. IV, 1867, p. 326, pl. 53a; Whitfield, Geol. Wisconsin, IV, 1882, p. 333, pl. 26; Hall and Clarke, Pal. New York, Vol. VIII, part II, 1895, pl. 55, fig. 23.

Description: "Shell suboval, ovate or subcircular, usually flattened; surface acutely costate." Hall, 1867.

Remarks: The specimens of this species are not common in the Wis-

consin Devonic and the characters are poorly preserved. The shells from Lake Church are smaller than normal, varying in width from 17 mm. to less than 12 mm. Both at Milwaukee and Lake Church the specimens agree very closely with examples from the Upper Devonic of Iowa. The effect of environment is well shown in the dwarfing of the Lake Church specimens.

Collections: Public Museum, Milwaukee; H. F. Cleland; E. E. Teller.

Localities: The "hard layer", zone B, and below in the Milwaukee cement quarry, Berthelet, Wis.; and in the Lake Church section.

Atrypa reticularis Linnaeus

Plate XIII, figs. 12, 13

Atrypa reticularis Kindle, 25th Ann. Rept. Dept. Geol. and Nat. Res. Indiana, 1900, p. 598.

For complete bibliography see Schuchert, U. S. G. S., Bull. 87.

Description: "Shell depressed suborbicular in its young state, becoming gibbous and sinuate in its mature condition; hinge line often nearly straight, and almost equalling the width of the shell; valves nearly equally convex in the young state, the dorsal valve becoming more gibbous as the shell advances in age, and sometimes acquiring an undefined mesial lobe down the centre. The ventral valve, in the young state, has the beak nearly straight and perforate at the apex, becoming incurved and finally closely bent over the beak of the opposite valve: a narrow false area is sometimes observable. Shell broadly and deeply sinuate in front." Hall, 1858.

Remarks: This species is represented by two widely different varieties, one with few, coarse plications, the other with many fine plications. In the Milwaukee section the coarse ribbed type in which there are from 10–12 plications to one centimeter prevails; but in the Lake Church outcrops the shells are very fine ribbed with as many as 22 plications within the space of one centimeter. Here as elsewhere it is not advisable to separate the shells into varieties since the characters are not constant. Whitfield identifies the coarse ribbed form as *A. spinosa.*

Atrypa reticularis is an abundant species in all of the outcrops. At Milwaukee it is found in all parts of the section.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Localities: Milwaukee cement quarry, Berthelet; debris of Intake tunnel, Milwaukee; Lake Shore quarry, Lake Church; Dreuckers; Brown Deer, Wis.

Atrypa sinuata nov.

Plate XIII, figs. 17, 18, 19

Description: Shell becoming gibbous and decidedly sinuate in mature condition. Brachial valve much more gibbous than the pedicle; width to length of brachial valve as 26:22 mm.

Pedicle valve depressed-convex, beak slightly projecting. Sinus shallow in the middle of the shell becoming very deep and strongly extended into a ligulate extension in front.

Brachial valve convex, becoming very gibbous in old age. Mesial fold becoming prominent a little below the middle of the shell and highly elevated anteriorly. A wide shallow groove extends along the center of the fold from the beak to the front of the shell in which there is an incipient plication.

Surface marked by strong, rounded, radiating costae, which in the brachial valve bifurcate about ⅓ the distance of the shell from the front. Spiniferous lamellae as in *A. hystrix* and *A. hystrix occidentalis*. This species differs from *A. hystrix* in the tumid dorsal valve and the conspicuous ventral sinus and from the variety *occidentalis* by the great sinus.

Collections: C. E. Monroe and H. F. Cleland.

Locality: Lake Church; Dreuckers, Wis.

Family SPIRIFERIDAE King (emend. Davidson).

Genus **Cyrtina** Davidson.

Cyrtina hamiltonensis Hall

Plate XV, figs. 7, 8, 9, 10

Cyrtina hamiltonensis Hall, Pal. N. Y. Vol. IV, 1867, p. 268, pl. 27, figs. 1–4 and pl. 44, figs. 26–33, 38–52.

Cyrtina hamiltonensis Kindle, 25th Ann. Rept. Dept. Geol. and Nat. Res. of Indiana 1900, p. 591.

For more complete bibliography see Schuchert U. S. G. S., Bull. 87.

Description: "Shell more or less triangular-subpyramidal; hingeline equal to the greatest width of the shell; proportions of length, breadth and height variable, but frequently the width is equal to the length of the ventral valve; and the height of area is equal to the length of the dorsal valve: surface plicate.

"Ventral valve quadrilateral in outline, obliquely subpyramidal, most prominent at the beak, which is very variable in elevation and straight or a little arched over the area, and not unfrequently attenu-

ate and distorted or turned to one side; mesial sinus wide and strongly defined, rounded or subangular in the bottom: area variable, large and elevated, plane or arcuate in different degrees with the lateral margins angular, distinctly striate in both directions; fissure narrow, closed by a convex pseudo-deltidium, which is perforated above by an oval or narrowly ovate foramen.

Dorsal valve depressed-convex, with a broad more or less prominent mesial fold, which is bounded by broader furrows than those between the plications, and is sometimes extremely elevated in front; beak scarcely rising above the hinge-line; area narrow, but quite distinct.

Surface marked by about six to eight (rarely one or two more) simple rounded plications on either side of the mesial fold and sinus, and these are crossed by very fine concentric lines of growth, which at intervals become crowded and subimbricate, especially towards the margins of older shells. The finer surface-marking is minutely granulose or papillose, and the shell-structure distinctly punctate. In some of the larger individuals there is an obscure elevation on each slope of the sinus, resembling an obsolete plication." Hall, 1867.

Remarks: The Wisconsin specimens have, as a rule, from one to three plications more on each side of the fold and sinus than the New York and Michigan specimens.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Localities: Perfect specimens are very common in the uppermost bed, zone C, of the Milwaukee cement quarry, Berthelet, where they occur weathered out. They are also occasionally found as casts in the lower beds. Rare at Lake Church where they occur only as casts.

Genus **Spirifer** Sowerby.

Spirifer asper Hall

Plate XVI, figs. 1, 2, 3, 4, 5

Spirifer aspera Hall, Geol. Sur. Iowa Vol. I, pt II, 1858, p. 508, pl. 4 fig. 7.

Spirifera (Cyrtina) aspera Whitfield, Geol. Wisconsin, Vol. IV, 1882, p. 331, plate 26, figs. 1 and 2.

Spirifer asper Hall & Clarke, Pal. N. Y. Vol. VIII, pt II, 1893, pp. 29, 31, 32, 39, plate 25, figs. 20–25.

Description: "Shell semielliptical, width about twice the length; hinge-line equalling the greatest width of the shell, and abruptly angular at the extremities. Ventral valve triangular pyramidal, extremely elevated at the umbo, and sloping abruptly to the lateral and anterior margins; mesial sinus shallow, strongly defined at the edges, sides

straight, flattened within, sometimes curvilinear: area straight and flat, abruptly defined at its margins, equal or less in height than the length of the valve, transversely and vertically striate; foramen proportionally narrow, extending to the beak, and partially closed within by a pseudodeltidium; beak not incurved. Dorsal valve nearly flat or moderately convex; mesial fold strongly defined at the margins, and rounded above.

"Surface, in full-grown specimens, marked by twenty or more simple rounded and moderately elevated plications on each side of the mesial fold and sinus. Plications often fifteen to eighteen in ordinary specimens, four or five only of which reach the beak, the others running out along the hinge-line and margins of the area; concentrically marked by fine imbricating lines of growth, which are sometimes very conspicuous. Entire surface granulose; granules closely arranged, sometimes visibly following the concentric striae, and in other parts apparently scattered without order." Hall, 1858.

Remarks: The specimens figured and described in Geology of Wisconsin, Vol. IV, are all casts of the interior and were collected from the rocks of the Devonic at the Humboldt street bridge, Milwaukee. Specimens from the upper portion of the section in the Milwaukee cement quarries and from the debris of the New Intake tunnel at Milwaukee retain the granulose surface markings which readily distinguish this from all associated Spirifers.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Localities: Milwaukee cement quarry, Berthelet, Wis.; New Intake tunnel, Milwaukee.

Spirifer euryteines var. *milwaukeensis* var. nov.

Plate XV, figs. 1, 2, 3, 4, 5, 6

cf. *Spirifer euruteines* Owen, Geological Survey of Wisconsin, Iowa and Minnesota, 1852, p. 586, pl. 3, figs. 2, 6.

cf. *Spirifer fornacula* Hall, Meek and Worthen, Pal. Illinois, Vol. III, 1868, p. 433, pl. 13, fig. 8 a, b, c.

cf. *Spirifer euruteines* var. *fornacula* Whitfield, Geol. of Wisconsin, Vol. IV, 1882, p. 330, plate 25, fig. 22.

For more complete bibliography see Schuchert U. S. G. S., Bull. 87.

Description: Shell subelliptical to submucronate, length and breadth about as 20:10 to 34:19; hinge-line equal to the greatest width of the shell. Surface plicate. Pedicle valve subpyramidal curving rapidly to the front and lateral margins. Apex usually projecting slightly over the area. Mesial sinus rounded, well defined and reaching to the apex.

Area very high, concave above; delthyrium large and open to the apex, the length of the sides being about once and one-half the width of the base.

Brachial valve more moderately and evenly convex than the ventral except near the cardinal area where the incurving is more rapid. The mesial fold is well marked. In young specimens a groove extends the entire length of the fold but in older specimens the groove is distinct for but one third the distance or rarely entirely wanting. Surface marked by 12–18 plications on either side of the mesial fold and sinus. These plications are rounded and well defined, about half of them reach the apex and the remainder coalesce with the border of the cardinal area. In perfect specimens the entire surface is seen to be covered by fine radiating lines which are crossed by equally fine concentric lines. When both are well developed a granulose appearance results. The shell is also crossed by a few strong imbricating lines of growth.

The length of full grown individuals is a little more than two inches but in the Lake Church quarries the length is seldom more than one and three fourths inches.

Remarks: The group of Spirifers of which *S. eurytheines* is a member is very difficult to determine. Schuchert has grouped *S. eurytheines* Owen, *S. parryana, S. capax* and *S. fornacula* under the one species *S. eurytheines.*

It seems to the writer that the presence of the well marked groove in the mesial fold of the Wisconsin species is a specific character which necessitates a separation, but until more and better material is at hand from the western localities it seems best to include our species, temporarily, in *S. eurytheines* as a well marked variety.

This species is the commonest of the Spirifers both in the Milwaukee and the Lake Church sections.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Localities: Milwaukee cement quarry at Berthelet, and in the Lake Church and Dreuckers quarries. Specimens in which the exterior is preserved are found in the shaly layers above the hard layer in the Milwaukee cement quarry at Berthelet and were also collected by C. E. Monroe from the debris of the New Intake Tunnel on the lake shore in Milwaukee; elsewhere the specimens are in the form of casts.

Spirifer iowensis Owen

Plate XVII, figs. 3, 4, 5

Spirifer pennata Owen, Geol. of Wisconsin, 1882, Vol. IV, page 330, pl. 26, fig. 4.

Spirifer pennatus Owen, Geol. Survey, Iowa, Vol. I, pt. II, 1858; p. 510, pl. 5, figs. 1a, b, c, d, e, f, g, h, i.

Spirifer angusta Whitfield, Geol. Wisconsin Vol. IV, 1882, p. 329, pl. 26, fig. 3.

For more complete bibliography see Schuchert U. S. G. S., Bull. 87.

Description: "Shell variable in form from subglobose to transverse and broadly triangular, often inequilateral; hinge-line extremely extended into wing-like expansions; valves often nearly equally convex. Ventral valve very gibbous in the middle and on the umbo; beak much elevated above the hinge-line, more or less pointed and slightly incurved; mesial sinus strongly defined at the margins, widely spreading towards the base, and produced in an angular extension in front: area concave and very large, extending to the extremities of the hinge-line, striated vertically and longitudinally; foramen large, open to the apex, and forming an equilateral triangle. Dorsal valve very gibbous in the middle and upon the umbo, which is abruptly incurved, regularly curved towards the baso-lateral margins, and more or less compressed towards the lateral extremities; mesial fold strongly elevated, sometimes a little flattened on the top, and often subangular towards the front and slightly depressed on each side.

"Surface marked by about fourteen to twenty-six or more rounded plications on each side of the mesial fold and sinus; those near the center, to the number of ten or twelve, being much stronger than those upon the extremities, which become finally very slender. Plications crossed by closely arranged concentric undulating laminae of growth; and the entire surface, in perfect specimens, ornamented by slender radiating striae, which become granulose at their junction with the concentric striae." Hall, 1858.

Remarks: One incomplete specimen in the Teller collection must have originally been fully 7 inches in width. This species is very abundant in certain layers below the "hard layer" zone B in the cement quarry, Milwaukee. Figure 4 in Volume IV of the Geology of Wisconsin is from a specimen collected at the Humboldt street bridge, Milwaukee. No specimens were found at Lake Church.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Spirifer mucronatus Conrad

Plate XVI, figs. 12, 13, 14

Spirifer mucronata Hall, Pal. N. Y. Vol. 4, 1867, p. 216, pl. 34, figs. 1–23.

Spirifer mucronata Whitfield, Geology of Wisconsin, Vol. 4, 1882, p. 328, pl. 25, figs. 27–28.

Teller and Monroe, Jour. Geol. Vol. 7, April, May, 1899, p. 272–81.

Spirifer pennatus Kindle, 25th Ann. Rept. Geol. and Nat. Res. Indiana, 1900, p. 649, pl. 8, figs. 1, 2, 2a.

For more complete bibliography see Schuchert, U. S. G. S., Bull. 87.

Description: "Shell more or less gibbous, semicircular, semi-oval, or triangular in outline; cardinal angles sometimes truncate but usually extended, and often extremely prolonged into mucronate points, giving a length of hinge-line two, three or four times as great as the shell; sides straight or curving, the front straight or concave.

"Ventral valve often scarcely more convex than the dorsal, but in very gibbous forms becoming more unequal, gently curving to the lateral margins. The beak is small, and incurved over the narrow linear area, the mesial sinus is sharply defined quite to the apex, and limited by angular plications which are stronger than the adjacent ones. The prevailing form of the sinus is shallow and rounded in the bottom: it is sometimes flat and sometimes with a fold in the center and again it is angular.

"Dorsal valve moderately convex, sometimes becoming gibbous. The sides are gently curving, and usually flattened towards the cardinal margin: the mesial fold prominent and well defined, flat or rounded above, sometimes with a median groove and again angulated in the middle. The beak is incurved, and the area extremely narrow, about one-third as high as that of the ventral valve.

"Surface marked by from eight or ten to twenty or more subangular plications on either side of the mesial fold and sinus: the plications are not very prominent but usually well defined, the outer half of the number not reaching the beak, but terminating in the callosity along the area-margin. The plications are crossed by numerous fine lamellose striae, which become crowded together and closely imbricating towards the front of the shell, sometimes presenting several interrupted lines of growth." Hall, 1867.

Remarks: This species occurs in the shaly layers, zone C, of the Milwaukee section. The shell is of the flat, mucronate type so common in the Hamilton formation of New York. It is this form that was recently described by Grabau as var. *arkonensis*. The Milwaukee

specimens, however, do not have the groove on the dorsal fold and are about half the size, but in other respects agree very well with Thedford, Ontario material. The imbrications are strong. The length of the hinge-line of mature specimens ranges from 1½ inches to 1⅓ inches.

Collections: Public Museum, Milwaukee; H. F. Cleland; E. E. Teller.

Locality: Well preserved shells are occasionally found in the shaly layers of the Milwaukee cement quarry, Berthelet, and in the debris of the New Intake tunnel, Milwaukee. One specimen was also found at Lake Church.

Spirifer subvaricosus Hall & Whitfield

Plate XVI, figs. 6, 7, 8, 9, 10, 11

Spirifer subvaricosa Hall & Whitfield, 23rd Ann. Rept. New York State Cabinet of Natural History, 1872 (for the year 1868) p. 237, pl. II, figs. 12–15.

Description: "Shell small, seldom more than five-eighths of an inch on the hinge-line. Valves highly convex, the ventral somewhat gibbous, with an incurved cardinal area of moderate height, divided by a triangular foramen which is higher than wide; cardinal angles slightly rounded, plications subangular, eight to ten on each side of the ventral valve, with one moderately strong in the bottom of the sinus not always extending to the apex; on the dorsal valve the mesial fold consists of two strong equal plications with a deep angular groove between. Surface marked by somewhat strong, rugose, zig-zag lines of growth which are sharply bent backward as they cross the plications." Hall, 1868.

Remarks: The Milwaukee specimens of this species are very similar to those described from Waterloo, Iowa, the only marked difference being in the hight of the beak of the dorsal valve above the cardinal area, which is somewhat more prominent in the Iowa specimens.

The specimens found in the shaly layers, zone C, of the Milwaukee cement quarry are beautifully preserved. Specimens from zones A and B are larger and approach the closely related species *D. consobrina.* It is probable that the specimen figured by Whitfield in Vol. IV, Geology of Wisconsin and which he refers doubtfully to *Spiriferina zigzac (Delthyris consobrina)* is a large specimen of *S. subvaricosus.*

A few alate specimens (Plate XVI, fig. 6) which agree with the figures of *S. mucronatus posterus* Hall are included in this species because they are evidently not a permanent variety.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Locality: Milwaukee cement quarry, Berthelet, Wisconsin.

Spirifer sp. nov.

Plate XIV, figs. 13, 14

Description: The only specimens of this species thus far collected are in a fragmentary condition. The sinus is marked with from four to six strong rounded plications. The muscular scars in the specimens examined are small. This Spirifer is apparently new but until better material is at hand it seems best not to attempt a description. It differs from *S. divaricatus,* which is the most closely related Middle Devonic species, in having about half as many plications in the sinus. Some forms of *S. disjunctus* of the Chemung bear a strong resemblance.

Collections: H. F. Cleland and C. E. Monroe.

Locality: Lake Church and Dreuckers.

Genus **Reticularia** McCoy.

Reticularia fimbriata (Conrad)

Plate XVII, figs. 1, 2

Spirifer fimbriatus Hall, Geol. Survey Iowa Vol. I, Part II, 1858, p. 505, pl. 4, fig. 5.

Spirifer fimbriata Hall, Pal. New York, Vol. IV, 1867, p. 214, pl. 33, figs. 1–21.

Reticularia fimbriata, Kindle 25th Ann. Report Dept. Geol. etc. of Indiana, 1900, p. 651, pl. VII, fig. 11.

See Schuchert, U. S. G. S., Bull. 87, for more complete bibliography.

Description: "Shell transversely subelliptical, gibbous; hinge-line less than the width of the shell; cardinal extremities rounded. Ventral valve gibbous in the upper half, regularly curving to the front and sides; sinus well defined, usually shallow and rounded, sometimes deep and angular, and much produced in front; beak small and incurved over the area, which is high and concave and extending about half the entire width of the shell: foramen often limited by a sharp elevated border, which appears to be a projection of the dental plates.

"Dorsal valve gibbous, regularly convex on the sides, a little flattened at the cardinal extremities; mesial fold abruptly elevated in the lower part, often but little elevated or scarcely defined in the upper part; beak small, slightly arched over the sublinear area, which is somewhat concave.

"Surface marked by from three or four to eight or nine low, rounded,

often obscure plications on each side: these are crossed by imbricating lamellose striae, which are sometimes wide or distant, and often crowded. The concentric striae are studded with elongated nodes or tubercles, which are thus arranged in parallel bands, more or less contiguous, according to the distance of the concentric striae.

"The elongate tubercles may perhaps more properly be regarded as interrupted radiating striae, which, in the perfect condition of the shell, have doubtless extended in slender spines or setae." Hall, 1867.

Remarks: The Lake Church specimens are all in the form of casts. The surface markings can be made out with some degree of satisfaction on certain casts of the exterior. The shells average about 2 to 2½ cm. in width and about 2 cm. in length. A large specimen has a width of nearly 4 cm.

Collections: Public Museum, Milwaukee, and H. F. Cleland.

Locality: This species has been found in the Lake Church quarry, at Dreuckers, and a single specimen in the Milwaukee cement quarry.

Family ATHYRIDAE Phillips.

Genus **Athyris** McCoy.

Athyris fultonensis (Swallow)

Plate XIV, figs. 1, 2, 3, 4

Athyris vittata Hall, Pal. N. Y. Vol. IV, 1867, p. 289, pl. 46, figs. 1–4.
Athyris fultonensis Kindle, 25th Ann. Rept. Dept. Geol. etc., Indiana, 1900, p. 597.

Description: "Shell ovate-subquadrate, gibbous, with the mesial fold and sinus distinct; front conspicuously sinuate; hinge-line short; cardinal extremities rounded.

"Ventral valve gibbous above, more convex than the dorsal; umbo prominent; the beak incurved and truncated in the plane of the longitudinal axis by a round foramen, curving very abruptly to the cardinal and cardino-lateral margins; the center marked by a well-defined mesial sinus, which is continued nearly or quite to the beak, and becoming much deeper and subangularly margined towards the front. Dorsal valve a little less gibbous than the ventral, sides regularly curving; the middle of the upper part distinctly prominent, and developed below in a strong mesial fold which is abruptly elevated in front.

"Surface marked by regularly imbricating lamellose lines of growth, which, on the better preserved surfaces, are finely crenulate on their edges, and the intermediate spaces striate." Hall, 1867.

Remarks: The only athyrids found in the Milwaukee Devonic are of this species; the common New York *Athyris spiriferoides* not being

represented in the fauna. The species is also reported from Iowa, Missouri, Indiana, Michigan and Manitoba.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Locality: Abundant above the hard layer, zone B, and occasionally found below in the Milwaukee cement quarry, Berthelet. The specimens in the shaly layers preserve the shell; those below are in the form of casts. Not uncommon at Lake Church.

Order NEOTREMATA Beecher.

Family TREMATIDÆ Schuchert.

Genus **Lingulodiscina** Whitfield.

Lingulodiscina marginalis (Whitfield)

Plate XII, figs. 11, 12, 13

Discina marginalis Whitfield, Geol. Survey, Wisconsin, Vol. IV, 1882, p. 325, pl. 25, fig. 11; Ann. Rept. Geol. Survey, Wisconsin, 1880, p. 70.

Orbiculoidea marginalis Hall and Clarke, Pal. New York, Vol. VIII, pt 1, 1892, p. 127, pl. 4F, fig. 17.

Description: "Shell small, rather below the medium size, [to large, one specimen having a length of 27 mm.], discoid, and very nearly circular. Upper valve very depressed convex [due to pressure, but normally is quite convex] gradually rising from the front margin to the apex, which is situated quite near the margin, but not terminal. The outline of the border of the valve is very slightly narrowed as it approaches this part. Lower valve flat, a very little less in diameter than the upper one, and the apex situated more than one-third of the width of the valve from the anterior margin; between which and the apex there is a slit or foramen of medium size, apparently not extending entirely to the margin. Surface of the upper valve marked by irregular, concentric lines of growth, which have a slightly lamellose character. That of the lower valve has been marked by quite regular, elevated lines or ridges, parallel to the margin, and placed at regularly increasing distances from each other." Whitfield, 1882.

Remarks: Professor Charles Schuchert, to whom these specimens were submitted, says: "The excellent material now at hand of this species show it to be a well developed species of the genus Lingulodiscina. The brachial valve is readily distinguished from associated species of Orbiculoidea by its submarginal low and broad umbo and the irregular fine growth lines, while the pedicle valve differs in hav-

ing sharp, strongly elevated and widely separated concentric lines. This is one of the largest species of Lingulodiscina."

It is possible that two species are included in this species; one being larger, more convex and more elliptical in outline than the other.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Locality: *L. marginalis* is found throughout the Milwaukee cement quarry section and was also collected from the debris of the Intake tunnel, Milwaukee.

Family DISCINIDAE Gray.

Genus **Orbiculoidea** d'Orbigny.

Orbiculoidea telleri nov.

Plate XII, figs. 9, 10

Equals *Orbiculoidea lodiensis media* Teller and Monroe, Jour. of Geol. Vol. VII, No. 3, 1899.

Description: Shell broadly elliptical or nearly circular. Brachial valve subconical; the anterior side less convex than the posterior which is rather abrupt. Apex subcentral, about 1/3 the length of the shell from the posterior margin; marked by fine, fairly regular concentric lines of growth. Ventral valve unknown.

Remarks: This species differs from others of this genus in the Wisconsin Devonic in the absence of radial striae and the more shining shell surface. It has some resemblance to *O. lodiensis* but is clearly not this species on account of the finer and more regular concentric growth lines and especially in having a far more convex brachial valve.

Named in honor of Mr. E. E. Teller whose thorough knowledge of this fauna and excellent collection of Wisconsin fossils has added much to the knowledge of the palaeontology of that State.

Collections: E. E. Teller; H. F. Cleland; Public Museum, Milwaukee.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Orbiculoidea wardi nov.

Plate XII, figs. 14, 15, 16

Description: Shells of medium size, outline variable; normally transversely subcircular or elliptical in form. Brachial valve broadly convex with the apex situated between the center and the posterior margin of the valve; the apex of the brachial valve being usually about one fourth and sometimes more than one fourth the length of the shell from the posterior margin. The average length of a specimen is about

10 mm. The surface of the brachial valve of well preserved specimens is seen with the microscope to be ornamented with very fine, radiating striae.

Remarks: This variety resembles both *Orbiculoidea lodiensis* Hall and *Orbiculoidea lodiensis media* Hall but has well marked differences. The brachial valve is more convex and robust and the concentric lines much finer, never having the regularly disposed stronger lines of *O. lodiensis*. It seems to be still more closely related to the unsatisfactorily defined *O. seneca*, which is stated to be a more highly elevated form otherwise closely related to the above mentioned species and variety. Among specimens of *O. seneca* from Canandaigua Lake, N. Y., in the Schuchert collections are specimens with and without the radial lines. This species is quite variable; the variability being especially noticeable in the position of the apex, and the outline of the margin. The distinguishing feature of this species, the surface markings, is well shown in the enlargement (x 10) of the exterior of a brachial valve (fig. 15).

Named in honor of Mr. H. L. Ward, curator of the Public Museum, Milwaukee.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Locality: Although never abundant this species is found occasionally throughout the Milwaukee cement quarry section and was also collected by C. E. Monroe from the debris of the New Intake tunnel, Milwaukee.

Family CRANIIDAE King.

Genus **Craniella** Oehlert.

Craniella hamiltoniae (Hall)

Plate XII, figs. 7, 8

Crania hamiltoniae Hall, Pal. New York, Vol. IV, 1867, p. 27, pl. 3, figs. 17–23.

For more complete bibliography see Schuchert, U. S. G. S., Bull. 87.

Description: "Shell broadly oval or subcircular. Dorsal valve subconical; apex subcentral or excentric, pointed in well-preserved specimens, often worn or decorticated. Exterior surface of dorsal valve marked by concentric lamellose striae. Ventral or lower valve marked by four strong impressions of the adductor muscles, which are variable in form: the posterior ones are distant; the anterior ones approximate, diverging above and assuming a somewhat cordiform appearance, the pit for the protractor muscles occupying the space between. Vascular

impressions strongly digitate." Hall, 1867. Both the exterior and casts of the interior have been collected.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Locality: Upper shaly layers, zone C, in the Milwaukee cement quarry, Berthelet, Wis.

Order PROTREMATA Beecher.

Family STROPHOMENIDAE King.

Genus **Stropheodonta** Hall.

Stropheodonta cf. *costata* Owen

Plate XIV, figs. 5, 6

Strophodonta (?) costata Owen, Geol. Sur. Wis., Iowa and Minn., 1852, p. 585, pl. 3A, fig. 5.

Description: "Shell minute hardly three-eights of an inch in diameter; regularly semicircular; eleven prominent ribs like those of a modern pecten; ventral valve nearly flat; dorsal slightly convex." Owen, 1852.

Remarks: Two rather poorly preserved specimens found at Lake Church have been referred to this species with some hesitancy. They have sixteen or more plications but in other particulars agree with Owen's figure and description. Length of one specimen 8 mm.

Collection: H. F. Cleland.

Locality: Lake Church, Wis.

Stropheodonta halli nov.

Plate XIV, figs. 7, 8, 9, 10

Strophodonta demissa Hall, Geol. Survey Iowa, Vol. I, pt 2, 1858, p. 495, pl. 3, figs. 5a, b, c, d (not e, f, g, h, i, k); Whitfield, Geol. Wisconsin, Vol. IV, 1882, p. 327, pl. 25, fig. 18.

Description: "Shell semielliptical, usually wider than high; hingeline usually equalling or greater than the width of the shell below, the extremities often prolonged into mucronate tips, and sometimes the margins are contracted below, giving a subauriculate character to the shell. Ventral valve very regularly convex, sometimes gibbous or ventricose: area well defined, strongly striated vertically, the inner margin crenulate. Dorsal valve regularly concave, and following the curvature of the opposite valve: area sublinear, common to both valves; inner edges strongly crenulate.

"Surface marked by strong subangular striae, which are several

times dichotomized before reaching the base of the shell, and varying considerably in number and strength in different individuals. Fine concentric striae mark the entire surface of well-preserved specimens, and, under a lens, the entire surface is punctate." Hall, 1858.

Remarks: Hall clearly recognized marked differences between his Iowa *S. demissa* and his New York *S. demissa.* He points out that the New York shell is usually "stronger, and more convex on the ventral valve, while the dorsal valve is often nearly flat in its upper half, and bent upward toward the margin; the area is likewise broader, being nearly double the width; the cardinal extremities less salient, and the striae more subdivided and finer in the middle and lower parts of the shell." In addition to these differences the shells are more transverse, the plications sharper, stronger and fewer.

Named in honor of Professor James Hall, late state Geologist of New York who described this species as S. demissa but pointed out the differences between the eastern and western form in his Iowa Report.

Collections: Milwaukee Museum; E. E. Teller; and H. F. Cleland.

Localities: Milwaukee cement quarry, Humboldt street bridge, Milwaukee; Lake Church, Wisconsin. This species is especially abundant in Teller's layer "3" and "8" of the Milwaukee cement quarry. Well preserved specimens also occur in the upper shaly layers, zone C.

Stropheodonta halli var. *musculosa* var. nov.

Plate XIV, figs. 11, 12

Description: Shells of about the size of the New York *Stropheodonta inaequistriata* averaging 16 mm. in width, have much stronger ribs in the casts of the exterior of the pedicle valves and the crenulations of the area are seen to extend the entire width of the shell instead of "from one-half to two-thirds the length from the beak to the extremities." The muscular impressions are very much larger than in *S. inaequistriata,* resembling in this particular *S. halli* and *S. demissa.* As a whole the relationship is closer to *S. halli* than other described species.

Collection: H. F. Cleland.

Locality: Lake Church, Wis.

Stropheodonta perplana (Conrad)

Plate XVIII, figs. 1, 2, 3, 4

Strophodonta fragilis Hall, Geol. Sur. Iowa, Vol. I, pt II, 1858, p. 496, pl. 3, fig. 6a, b, c.

Strophodonta perplana Hall, Pal. New York, Vol. IV, 1867, pp. 92, 98, pl. 11, 12, 17 and 19.

Description: "Shell semielliptical; the length varying from two-thirds to three-fourths the width, which is from half an inch to two inches; slightly concave-convex, and often nearly flat. * * * Ventral valve very little convex, the greatest convexity above the middle of its length. * * * Dorsal valve gently concave, and often nearly flat. * * *

"Surface covered by fine subequal striae, those of the ventral valves being the finer, extremely sharp and often gently undulating, increasing both by bifurcation and intercalation, and crossed by fine, even concentric striae. * * * The interior of the ventral valve is marked by large flabelliform divaricator muscular impressions, extending more than half the length of the shell; narrow above, with sides nearly straight, curving below and deeply divided in front, each division showing four or five lobes. * * *

"In general the shell is readily recognized by its nearly flat form and fine nearly equal striae." Hall, 1867.

Remarks: In certain layers of the lower half of the Milwaukee quarry section Stropheodontas are very abundant, the dark color of the casts of the shells standing out in strong contrast to the light gray of the rock. Of these layers E. E. Teller* says: "Number three [three feet above the base of the section] * * * contains almost innumerable specimens of the genus Stropheodonta." * * * The Stropheodontas are always in the form of impressions of either the exterior or interior of single valves and are so numerous that it may properly be called the lower Stropheodonta layer. * * * The organic remains in number nine [11 feet 3 inches above the base of the section] are "almost a counterpart of number three; * * * fossils of but few other forms [other than Stropheodontas] are found in it."

Collections: Public Museum, Milwaukee; H. F. Cleland; E. E. Teller.

Locality: Abundant in some of the lower layers in the Milwaukee cement quarrry and found more or less commonly throughout the Wisconsin Middle Devonic.

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* Bull. Wisconsin Nat. His. Soc. Vol. 1, No. 1, pp. 50, 51.

Genus **Pholidostrophia** Hall and Clarke.

Pholidostrophia iowensis (Owen)

Plate XVIII, figs. 5, 6, 7

Strophodonta lepida Hall, Geol. Sur. Iowa, Vol. I, 1858, p. 493, pl. 3, figs. 3a, b, c.

Strophodonta nacrea Hall, Pal. New York, Vol. IV, 1867, p. 104, pl. 18, fig. 1 a–h.

For complete bibliography see Schuchert, U. S. G. S., Bull. 87.

Description: "Shell small, semielliptical, having a brilliant nacreous lustre: hinge-line crenulated, equalling or a little less than the greatest width of the shell below, and sometimes terminating in more or less distinct angles. Dorsal valve concave. Ventral valve sometimes regularly convex, flattened at the margins, often depressed-convex in the umbonal region and abruptly arched towards the front: beak very small and depressed: area very narrow, linear, without foramen. The area of the dorsal valve is often nearly as wide as that of the ventral valve.

"Surface apparently smooth, but under a lense showing very faint concentric lines of growth, with sometimes obscure traces of radiating lines. . . . The interior of the shell, excepting the muscular impressions, is studded with prominent scattered granules or papillae. The crenulations on the hinge-line are rather distant, but conspicuous." Hall, 1867.

Remarks: The specimens in the Wisconsin Devonic seldom, if ever, preserve the nacreous lustre which is so characteristic of the New York specimens and which suggested Hall's name *S. nacrea.*

This is not an uncommon species in either the Milwaukee or Lake Church quarries. In the Lake Church quarries it is associated with *Stropheodonta halli var. musculosa* where both occur in the form of casts. The casts of the exterior can usually be readily distinguished since the one is striated and the other is not. The individual crenulations differ in the casts: those of the *Stropheodonta halli* var. *musculosa* extend almost across the area while those of *Pholidostrophia iowensis* have the appearance of holes made by thrusting a pin into stiff clay.

Collections: Public Museum, Milwaukee; H. F. Cleland; E. E. Teller.

Localities: Milwaukee cement quarry, Berthelet; Lake Church, Wis. It is especially abundant in the calcerous shales, zone C, of the upper portion of the Milwaukee quarry.

Genus **Schuchertella** Girty.

Schuchertella chemungensis arctistriata (Hall)

Plate XVI, fig. 15

Streptorhynchus chemungensis var. *arctistriata* Hall, Pal. New York, Vol. IV, 1867, p. 71, pl. 9, figs. 1–12.

Schuchertella chemungensis Girty, Proceedings U. S. National Museum, Vol. 27, 1904.

For more complete bibliography see Schuchert U. S. G. S., Bull. 87, p. 296.

Description: "Shell semicircular or semielliptical, frequently unsymmetrical, the proportions of length and breadth varying in different individuals: hinge-line straight, nearly or quite equal to or greater than the greatest width of the shell; sides nearly rectangular to the hinge-line, or curving inwards. Ventral valve more or less convex towards the umbo and sometimes in the middle, curving downwards or flattened towards the front and sides of the shell: beak often distorted; area vertical or inclined forwards or backwards, usually unequal on the two sides of the foramen, which is closed by a strong convex deltidial plate. Dorsal valve depressed convex, sometimes nearly flat and sometimes very convex, with a narrow linear area: socket-plates strong, and supporting the cardinal process, which is double and has sometimes a faint ridge between the two divisions, which are themselves very short. Surface marked by sharp close radiating crenulated striae, which increase mainly by interstitial additions." Hall, 1867.

Collections: Public Museum, Milwaukee; H. F. Cleland; E. E. Teller.

Locality: Found occasionally throughout the Milwaukee cement quarry section, Berthelet, Wis.

Family PRODUCTIDAE Gray.

Genus **Chonetes** Fisher.

Chonetes schucherti nov.

Plate XVIII, figs. 11, 12, 13

Description: Shell transverse, semioval, hinge-line often not quite equalling the greatest width of the shell, cardinal angles rarely a little salient. Ventral valve moderately flat.

Surface marked by fine, sharp, subequal striae, of which seldom more than forty can be counted near the margin. The cardinal margin of the pedicle valve is furnished with five spines on either side.

As compared with *Chonetes scitulus* Hall, which it most closely resembles, the shell is smaller and flatter and has about forty plications instead of about sixty as in that species and a smaller number of cardinal spines.

Named in honor of Professor Charles Schuchert of Yale University.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Locality: Throughout the Milwaukee section.

Chonetes vicinus ? (Castelnau)

Plate XVIII, figs. 8, 9, 10

Chonetes deflecta Hall, Pal. New York, Vol. IV, 1867, p. 126, pl. 21, figs. 7, 8.

Description: "Shell semielliptical; length and width as four to five or eight to nine, but rarely proportionally wider. Ventral valve extremely gibbous, regularly arched, the greatest elevation being about the middle of the length; abruptly depressed towards the cardinal angles, which are flattened, with the extremities deflected to the ventral side. The umbo is a little elevated above the cardinal margin, and the minute apex (in perfect specimens) projects a little over the area.

"Dorsal valve deeply concave, but not equalling the convexity of the ventral valve.

"Area of the ventral valve narrow, with the exterior margin declining in a gentle curve to the extremities: the triangular foramen is partially closed by a pseudo-deltidium, and the aperture occupied by the cardinal process of the opposite valve. Dorsal area more than half as wide as the ventral, and marked in the middle by a wide triangular callosity.

"Surface of the ventral valve marked by from twenty-six to thirty or thirty-four subangular or sometimes rounded striae, which are often irregularly increased by bifurcation or intercalation towards the margin. The surface is finely pustulose in the middle, a little more closely pustulose along the deflected line, and nearly or quite smooth towards the margins." Hall, 1867.

Remarks: Since the fossils which have been referred to this species all occur in the form of casts in which the surface markings are not well preserved they have been placed in this species with some hesitation. The shells are larger than those of *Chonetes scitulus* and *C. schucherti;* the striae are comparatively finer and the median ridge is broad and angular.

Collection: H. F. Cleland.

Locality: Lake Church, Wisconsin.

Genus **Productella** Hall.

Productella spinulicosta Hall

Plate XVIII, figs. 14, 15, 16

Productella spinulicosta Hall, Pal. New York, Vol. IV, 1867, p. 160, pl. 23, fig. 6–8, 25–34.

For more complete bibliography see Schuchert, U. S. G. S., Bull. 87.

Description: "Shell broad, semielliptical or somewhat orbicular; hinge-line generally a little less than the greatest width of the shell.

"Ventral valve varying in shells of different size, from moderately to extremely gibbous in the middle, with the beak strongly incurved.

"Dorsal valve moderately concave in its upper part, and becoming more concave or arcuate towards the front.

"Surface marked by fine strong concentric striae, which are sometimes crowded and wrinkled on the body of the shell. There are several rows of interrupted ridges or spine-bases, which in entire specimens support slender spines. The ears are strongly wrinkled, and support a row of four or five spines just below the hinge-line." Hall, 1867.

Remarks: The specimens of this species collected at Lake Church vary from 30 mm. to less than 16 mm. in width. They differ very slightly from the typical New York specimens.

Collections: H. F. Cleland; E. E. Teller; Public Museum, Milwaukee.

Localities: Abundant at Lake Church. Rare in the shaly layers, zone C, of the Milwaukee cement quarry.

Family ORTHIDAE Woodward.

Genus **Schizophoria** King.

Schizophoria striatula (Schlotheim)

Plate XIX, figs. 1, 2, 3, 4, 5, 6

Orthis impressa Whitfield, Geol. Wisconsin, Vol. IV, 1882, p. 326, pl. 25, figs. 13–15.

Orthis impressa Hall, Pal. New York, Vol. IV, 1867, p. 60, pl. 8, figs. 11–19.

Orthis iowensis Hall, Geol. Survey Iowa, Vol. I, pt II, 1858, p. 488, pl. 2, fig. 4.

For more complete bibliography see Schuchert U. S. G. S., Bull. 87, 1897, p. 375.

Description: "Shell rotund. Dorsal valve very gibbous, wider than long, sinuate in front: hinge-line about two-thirds the width of the shell. Ventral valve moderately convex at the sides, somewhat flattened on the umbo, with a broad undefined sinus which becomes deeper towards the front, the margin of the shell being sometimes abruptly incurved: area of moderate height, a little incurved at the beak.

"The surface is very finely and evenly striated, and the texture of the shell is minutely punctate.

"The cast of the dorsal valve shows a strong, somewhat quadrilobate muscular impression, limited by strong and widely diverging socket-plates, with the vascular impressions somewhat narrow and extending below it to the margin of the shell. The surface of the cast preserves fine even striae. The cast of the ventral valve is broadly sinuate in the middle below, with a triangular or subovate deeply bilobed muscular impression, which is subject to considerable variation in form and proportions." Hall, 1867.

Remarks: The size varies from one fourth of an inch to two inches in length. This species is abundant in the "hard layer", zone B, of the Milwaukee section where the specimens occur only in the form of casts. In the shaly layers, zone C, of the upper portion of the Milwaukee cement quarries specimens with both valves preserved are sometimes found. Whitfield, in speaking of the fossils of the Milwaukee quarry says, "The specimens of this species, like most of the fossils of these beds, are represented only by the internal casts and impressions of the exterior surface of the same, and usually only of separated valves."*

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Localities: Abundant in the Milwaukee cement quarry, Berthelet and at Whitefish Bay.

Family PENTAMERIDAE McCoy.

Genus **Pentamerella** Hall.

Pentamerella multicostata nov.

Plate XVIII, fig. 18

Description: Shell ventricose, sub-triangular in outline; longer than wide; arcuate in old individuals.

Pedicle valve ventricose near the beak but depressed into a broad shallow sinus near the front. Beak incurved, cardinal area broad, the

* Geol. Wis. vol. IV, 1882, p. 326.

cardinal line extending almost the width of the shell. Brachial valve much less gibbous than the pedicle; mesial fold low, defined below the middle of the valve.

Surface plicated; the plications in the cast of the interior being rounded and somewhat unequal in width; increasing by bifurcation. In one specimen there are six plications in the sinus and more than five can be seen on either side of the sinus near the front of the shell. Casts of the pedicle valves show a deep septum near the beak.

Remarks: This species differs from *P. papilionensis* Hall in the greater number and regularity of the plications and in the depth of the cardinal area; from *P. dubia* Hall in its less gibbous form, coarser plications and larger size; from *P. arata* (Conrad) in the greater regularity of its plications and general outline.

Collection: E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet, Wisconsin.

Genus **Gypidula** Hall.

Gypidula comis ? (Owen)

Plate XIX, figs. 7, 8 and 9

Pentamerus occidentalis Hall, Geol. Survey Iowa, Vol. I, pt II, 1858, p. 514, pl. 6, fig. 2.

Pentamerus galeatiformis Meek & Worthen, Geol. Survey Illinois, Vol. II, 1866, p. 325.

Gypidula occidentalis Hall, Pal. New York Vol. IV, 1867, p. 380, pl. 58a, figs. 1–8.

Gypidula comis Hall and Clarke, Pal. New York, Vol. VIII, pt II, 1894, p. 247, fig. 177; pl. 72, figs. 15–24.

Description: "Shell subovoid, gibbous, very inequivalve; hinge-line equalling three-fourths the entire width of the shell. Ventral valve arcuate, gibbous or ventricose in the upper part; beak extended, strongly incurved, obtuse; fissure large and bordered by a distinct area which is vertically striated. The spoon-shaped pit is deep, extremely extended and incurved. The middle of the valve, below the first third, elevated into a more or less distinct mesial fold which is marked by two or three plications.

"Dorsal valve gibbous above, becoming flattened below the middle, sometimes concave at the sides, and the front depressed into a deep and more or less distinctly defined sinus. A narrow area extends for about two-thirds the length of the hinge-line.

"Surface plicated below by a few rounded or subangular plica-

tions which become obsolete above; the upper part of the valve marked only by concentric striae." Hall, 1867.

Remarks: The specimens referred to this species are in the form of casts of the interior. They resemble *Gypidula comis* in size and outline but the interior characters, as far as known, differ to some extent from those described as being characteristic of that species. The plications on the front of the shell are strong in *Gypidula comis* but are not conspicuous in the casts of the interior of the specimens from Lake Church.

It seems best to refer these Lake Church Gypidulas provisionally to the above species. When specimens preserving the external marking are found there will probably be little difficulty in making a determination.

Collections: H. F. Cleland and C. E. Monroe.

Locality: Lake Church, Wisconsin.

CHAPTER VII

PELECYPODA

The pelecypods are very poorly preserved in the Wisconsin Devonic dolomites. Only in certain concretions taken from the New Intake tunnel, Milwaukee, where the shells are silicified, and a few pyritised specimens from the Milwaukee quarry is the shell substance replaced. As a consequence of this condition even the coarse surface markings are seldom well retained in the casts and the finer sculpturings are almost never shown. Moreover, the specimens are very rare and consequently little opportunity is offered for comparison. Because of their rarity, distorted condition and poor preservation it is often difficult to make definite determinations.

The total number of species and varieties is quite large, being 38, although the individuals of the class are rare in all of the exposures. The geographical distribution, as compared with other classes discussed in this paper, is unusual in that no species is reported from the western Middle Devonic formations although 11 out of 24 well marked species and varieties are known to occur in the Middle Devonic of the Eastern States. It should be remembered, however, that little is known of the Middle Devonic pelecypods west of the Mississippi River.

Class **PELECYPODA** Goldfuss.

Order PRIONODESMACEA Dall.

Family GRAMMYSSIIDAE Fischer.

Genus **Grammysia** Vern.

Grammysia nodocostata Hall

Plate XXIII, figs. 1, 2, 3

Grammysia nodocostata Hall, Pal. N. Y., Vol. V, pt 1, Lamellibranchiata II, 1885, p. 360, plates LV, LVI and LVII.

Description: "Shell varying from medium size to very large; obliquely sub-ovoid; length about one-third greater than the height; basal margin broadly curving, flattened or constricted near the middle;

posterior margin abruptly rounded below, and obliquely truncate above. Cardinal line straight, bordered by a well-defined escutcheon. Anterior end abruptly rounded below the lunule.

"Valves regularly convex below and in the posterior portion, becoming gibbous or ventricose above and in the umbonal region. Often extremely gibbous from vertical compression.

"Beaks sub-anterior, prominent and strongly incurved. Owing to pressure they often project beyond the anterior end. Umbo in its upper portion, marked by several radiating nodose ridges with intermediate sulci, which, with the exception of a single strong ridge and furrow, become obsolete before reaching the middle of the shell, while the remaining furrow and ridge extend to the base and constrict the margin. The ridge is developed in the right valve, and carries the majority of the nodose radii anterior to it. The deepest furrow is developed in the left valve, and carries the principal part of the nodose radii posterior to it. This feature makes the shell somewhat inequivalve.

"Entire surface marked by fine, crowded, concentric striae, which at somewhat regular intervals are fasciculate and elevated into strong angular ridges or undulations. In the region of the cincture these are crossed and interrupted by radiating ridges extending from the beak, and are more developed in the young shells, and become obsolete below the middle in old shells." Hall, 1885.

Remarks: Of the two specimens figured, figure 1 shows the nodose radii; in fig. 3, which is a somewhat weathered specimen, these markings are not as strongly shown. The weathered specimen resembles *G. subarcuata* rather strongly and may prove to be of that species but is probably an imperfect specimen of *G. nodicostata.*

Collections: Public Museum, Milwaukee, and private collection of E. E. Teller.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee.

Genus **Edmondia** de Kon.

Edmondia fragilis nov.

Plate XXI, figs. 1, 2, 3

Description: Shell medium, length usually somewhat greater than the hight; basal margin regularly curving and extending to the posterior margin without any abruptness and thence to the cardinal line. Cardinal line short and apparently straight. Anterior end short and regularly rounded on the margins.

Valves moderately convex.

Beaks sub-anterior; umbonal slope not defined. Test unknown but apparently thin. Surface and hinge unknown. One large specimen measures about four and one half cm. in hight.

Remarks: This species resembles *E. ellipsis* Hall from the Burlington sandstone of Iowa but differs from it in the more obtuse beaks and more oblique outline. Although the specimens of this species are always in a poor state of preservation they are not uncommon.

Collections: H. F. Cleland and E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet.

Family NUCULIDAE Adams.

Genus **Nucula** Lam.

Nucula lirata var. nov.

Plate XX, figs. 1, 2, 3

cf. *Nucula lirata* Conrad, Pal. N. W. Vol. V, pt. 1, Lamellibranchiata II, 1885, p. 316, plates XLV and XCIII.

Description: "Shell of medium size, ovate-triangular; length from one-third to one-fourth greater than the height; basal margin regularly curving, more abruptly rounded at the posterior extremity; cardinal margin slightly arcuate, gradually sloping toward the posterior. Anterior end short, sub-truncate, usually abruptly rounded.

"Valves very gibbous, ventricose in the umbonal region.

"Beaks, at the anterior third or fourth of the length of the shell, distant, elevated, rising considerably above the hinge-line. Umbo very prominent. Umbonal slope elevated and rounded, merging into the general convexity before reaching the posterior end.

"Test thick, marked by regular, strong, sub-angular concentric undulations, which are crossed by extremely fine radiating striae. In older shells the margins are marked by fine, concentric striae, the strong undulations having become obsolete." Hall, 1885.

Remarks: A specimen with two valves in contact differs from this species in a number of particulars; the most marked difference being the size and the shortness of the posterior end. Length and hight of specimen 7 mm.

Collection: H. F. Cleland.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Family LEDIDAE Adams.

Genus **Nuculites** Conrad.

Nuculites milwaukeensis nov.

Plate XX, fig. 5.

Description of *N. oblongatus:* "Shell somewhat larger than the prevailing forms belonging to this group, elongate-ovate, widest at the anterior end; length usually more than twice the height; basal margin nearly straight, sometimes gently arcuate; posterior extremity narrow and abruptly rounded. Cardinal line slightly oblique, gently arcuate; just anterior to the beaks a small portion of the hinge is bent abruptly downward, reaching to the anterior muscular scar. Anterior end short and rounded, defined in the cast by the vertical clavicle.

"Valves depressed-convex in the lower and posterior portions more convex on the anterior end and the umbonal region.

"Beaks at about the anterior fourth, appressed, not rising above the hinge-line. Umbonal slope broadly rounded and undefined, extending to the post-inferior extremity.

"Test thick in the upper part of the shell. Surface marked by very fine concentric striae of growth, which are sometimes scarcely fasciculate on the lower portion of the shell.

"Hinge furnished with numerous transverse teeth.

"There is a strong vertical clavicular ridge just anterior to the beaks which extends for more than half the height of the shell. Anterior muscular scar sub-circular, distinct, situated within the cavity of the anterior end. Posterior scar narrow-ovate, very close to the post-cardinal margin. Umbo marked by three or four strong muscular pits. Pallial line distinct, distant from the margin of the valve." Hall, 1885.

Remarks: The specimen from the New Intake tunnel, Milwaukee, upon which the species is based preserves the characters of the interior. It shows the clavicular ridge or septum to be much more strongly marked, shorter and stouter than in *N. oblongatus* and that the teeth reach nearer the posterior end of shell. *N. milwaukeensis* is also less tapering posteriorly and the basal margin is straighter than in *N. oblongatus.* The length of one well preserved specimen is 28 mm. and hight 11 mm.

Collection: Public Museum, Milwaukee.

Locality: New Intake tunnel, Milwaukee; Milwaukee cement quarry, Berthelet, Wis.

Nuculites laphami nov.

Plate XX, fig. 4

Description: Shell of medium size, length 13 mm. and hight 9 mm. in the only specimen collected. Basal margin regularly curving; being abruptly rounded into the posterior extremity and more gently rounded into the anterior; cardinal margin arcuate. Valves convex. Beaks at the anterior third and umbonal ridge apparently not conspicuous.

Hinge comparatively short. Clavicular ridge or septum thin (in the specimen at hand) and at about right angles to the posterior margin.

Remarks: A single imperfect specimen in which the clavicular septum is preserved seems to be a new species of this genus. The shape differs from that of any described species both in contour and in convexity. It differs from *N. triqueter* in the absence of a distinct angular umbonal ridge and in its less triangular shape. The surface of the valve is much worn.

Collection: H. F. Cleland.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee.

Named in honor of Increase A. Lapham, the discoverer of the Middle Devonic beds of Wisconsin.

Genus **Palaeoneilo** Hall.

Palaeoneilo brevis Hall

Plate XX, figs. 6, 7

Palaeoneilo brevis Hall, Pal. New York 1885, Vol. V, pt 1, Lamellibranchiata II, p. 342, plate L, figs. 24–33.

Description: "Shell small, ovate, or ovate-triangular; length about one-third greater than the height; basal margin gently curving, with a slight constriction toward the posterior extremity. Cardinal line arcuate. Anterior end usually short and regularly rounded.

"Valves convex below, gibbous in the middle and on the umbonal ridge.

"Beaks usually at about the anterior third or a little posterior thereto, prominent, moderately elevated above the hinge-line. Umbonal slope marked by a slight flattening of the shell, which produces a gentle constriction in the post-inferior margin. This depression is rarely margined on each side by an undefined elevation.

"Surface marked by fine, even, concentric striae; the casts exhibiting only the stronger elevations which give an irregular appearance to the concentric striae. Anterior muscular impression very strongly

marked. Posterior scar large and shallow. Hinge marked by numerous minute crenulations." Hall, 1885.

Remarks: *P. brevis* Hall is a poorly defined species which even in New York, is with difficulty distinguished from *P. constricta.* It is possible that the Milwaukee species is *P. constricta.*

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Locality: Collected from the debris of the New Intake tunnel. Occurs occasionally in the Milwaukee cement quarry, Berthelet, Wis.

Palaeoneilo constricta Conrad

Plate XX, figs. 9, 19, 20, 21 and 22

Paleoneilo constricta Hall, Pal. N. Y., vol. V, pt 1, Lameillibranchiata II, 1885, p. 333, plates XLVIII and LI.

Description: "Shell of medium size or smaller; ovate-cuneate, subnasute behind; proportions of length and breadth extremely variable, the length usually about one-third greater than the height; basal margin rounded in the middle and anterior portions, straight or slightly constricted toward the posterior end. Posterior extremity narrowed cuneate or sub-nasute, constricted below. Cardinal line abruptly declining anterior to the beak, and more gently declining to the posterior. Anterior end abruptly rounded.

"Valves convex below and posteriorly, becoming gibbous above the middle and in the umbonal region.

"Beaks at about the anterior third, prominent, rising above the hinge-line. Umbonal ridge rounded, not strongly defined, with a depression or undefined furrow below it, which extends from just posterior to the beak to the post-inferior margin.

"Surface, in well-preserved specimens, marked by fine, regular and even, thread-like striae, which frequently become obsolescent in the furrow and on the post-cardinal slope.

"Anterior and posterior muscular impressions strongly marked, and with umbonal muscular scars. Hinge marked by numerous crenulations, which are coarser toward the anterior and posterior extremities." Hall, 1885.

Remarks: This is one of the most abundant pelecypods of the Milwaukee section. The specimens occur in the form of casts in the hydraulic limestone and are usually in a crushed condition.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Locality: Milwaukee cement quarry, Berthelet; Debris of Intake tunnel, Milwaukee, Wis.

Palaeoneilo emarginata Conrad

Plate XX, figs. 10, 11, 12

Palaeoneilo emarginata Hall, Pal. New York, Vol. V, pt I, Lamellibranchiata II, 1885, p. 338, pl. L.

Description: "Shell of medium size or larger, subelliptical; length usually more than twice the height; basal margin gently curving or nearly straight from the post-inferior angle to the anterior end, where it is more abruptly rounded; posterior margin deeply sinuate. Cardinal line gently arcuate. Anterior end regularly and somewhat abruptly rounded.

"Valves regularly convex in the lower anterior half, becoming gibbous above.

"Beaks at a little less than the anterior third from the end, and except in the shorter forms, moderately prominent. Umbonal slope marked by a strong elevation or ridge, with a depression above it, which produces a marked emargination. The post-cardinal extremity, above this, is produced into a linguiform extension, which is sometimes angular, but usually abruptly rounded at the termination.

"Surface marked by strong, elevated, distant, lamellose, concentric ridges, extending the entire length of the shell, between which are very fine concentric striae. The intermediate striae become obscure or obsolete, according to the degree of weathering and nature of the matrix." Hall, 1885.

Collections: Milwaukee Museum; E. E. Teller; H. F. Cleland.

Locality: This species is not uncommon in all parts of the Milwaukee cement quarry section, being rather more abundant in the "hard layer," zone B, and zone A. Silicified specimens were collected by C. E. Monroe from the debris of the New Intake tunnel, Milwaukee, Wis. It also occurs in New York but is not reported from Indiana.

Palaeoneilo fecunda Hall

Plate XX, figs. 13, 14

Palaeoneilo fecunda Hall, Pal. N. Y., Vol. V, pt I, Lamellibranchiata II, 1885, 336, pl. XLIX.

Description: "Shell large, elongate-ovate; length nearly twice the height; basal margin broadly curving. Posterior end obtusely rounded or doubly truncate. Cardinal line arcuate. Anterior end regularly rounded.

"Valves regularly convex below, gibbous above and in the umbonal region.

"Beaks at less than the anterior third from the end, moderately elevated above the hinge-line. Umbonal slope flattened, giving a slight angularity to the shell above and below it, and an oblique truncation to the posterior extremity.

"Test thick, marked in the anterior portion by fine, regular concentric striae, some of which become elevated into sharp, lamelliform striae, with finer intermediate ones on the posterior half of the shell." Hall, 1885.

Remarks: This species is so close to *P. tenuistriata* that unless the preservation of the specimens is exceptional and they are in the same kind of rock it is very difficult to distinguish the one from the other. As a whole these specimens are referred to this species with considerable certainty.

Collections: Public Museum, Milwaukee; H. F. Cleland; E. E. Teller.

Locality: New Intake tunnel, Milwaukee, and Milwaukee cement quarry, Berthelet, Wis.

Palaeoneilo cf. *maxima* Conrad

Plate XX, figs. 17, 18

cf. *Palaeoneilo maxima* Hall, Pal. of N. Y. Vol. V, pt 1, Lamellibranchiata, II, 1885, p. 335, pl. XLVIII.

Remarks: A few specimens having some of the characters of this species have been referred with considerable certainty to this species. It should be remembered that the species in the type localities are not sharply marked off from others.

Two specimens measure 22 and 21 mm. in length and 14 mm. in hight respectively.

Collections: Public Museum, Milwaukee; H. F. Cleland; E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Palaeoneilo cf. *plana* Hall

Plate XX, figs. 15, 16

cf. *Palaeoneilo plana* Hall, Pal. N. Y. Vol. V, pt 1, Lamellibranchiata, II, 1885, p. 334, pl. XLVIII.

Remarks: A few very imperfect specimens have been provisionally referred to this species.

Collection: Public Museum, Milwaukee, Wis.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Palaeoneilo sp.

Plate XX, fig. 8

Remarks: A Palaeoneilo of unusual shape was collected from the debris of the New Intake tunnel at Milwaukee. It differs from the most closely related species in the crenulation of the posterior as is shown in the cast of the interior, and in the breadth of the posterior. The crenulated character of the posterior, if constant, will place this species in another genus. Since a single specimen was collected and that in a somewhat fragmentary condition, it does not seem advisable to do more than figure and call attention to the peculiarities of the specimen. The specimen is silicified.

Collection: Public Museum, Milwaukee.

Family PTERINEIDAE Dall.

Genus **Pterinea** Goldf.

Pterinea ? paucicostata nov.

Plate XXII, fig. 9

Description: A cast of the interior of a Pterinea-like shell which has some of the characters of *Pterinea lobata* Whiteaves but is evidently not of that species has the following characters: Shell small; left valve moderately convex, right valve unknown. Hinge-line straight. Beak sub-anterior; ear short and separated from the body of the shell by a broad, deep sulcus; wing extending about two thirds the distance to the posterior end of the shell.

The left valve is marked by three strong, sharply angular plications which are separated from one another by broad, slightly concave interspaces.

Collection: H. F. Cleland.

Locality: A single specimen was found at Lake Church.

Genus **Glyptodesma** Hall.

Glyptodesma ? sp.

Plate XXI, fig. 6

A single fragmentary specimen with the characters shown in the accompanying drawing was collected from the Lake Church quarry. The specimen is not sufficiently well preserved to permit of a definite

determination but is figured in the hope that collectors will make an effort to find other specimens of this genus.

Collection: H. F. Cleland.

Locality: Lake Church, Wis.

Genus **Liopteria** Hall.

Liopteria cf. *conradi* Hall

Plate XXI, fig. 4

cf. *Liopteria conradi* Hall, Pal. N. Y. Vol. V, pt 1, Lamellibranchiata I, 1884, p. 159, plates XX and LXXXVIII.

Description: "Shell above the medium size, sub-rhomboidal; body oblique-ovate; length a little greater than the height; anterior margin straight, nearly vertical; basal and posterior margins regularly rounded.

"Valves sub-equally convex, the left valve somewhat more convex than the right.

"Hinge-line straight, longer than the length of the valve, greatly extended posteriorly.

"Beaks acute, directed forward, prominent, situated near the anterior end of the shell. Umbonal region gibbous (in well-preserved shells), moderately convex below, subtending an acute angle.

"Ear short, separated from the valve by a rounded depression or sulcus, marked by a shallow, elongate byssal sinus; extremity rounded. Wing triangular, much extended; margin concave; extremity acuminate.

"Test, as indicated by casts or partially exfoliated specimens, marked by fine, closely arranged, concentric lines of growth, which at irregular intervals are crowded and raised into rounded or sub-angular fascicles, giving the surface a decidedly undulated aspect. The striae become more crowded upon the cardinal expansions, especially upon the ear." Hall, 1884.

Remarks: Several specimens of *Liopteria* were collected but none retain the surface markings or hinge characters sufficiently well to permit of a detailed description. It is probable that they should be included in the above species but, since the various species of Liopteria are very similar, until more perfect material is at hand no definite determination can be made.

Collections: Public Museum, Milwaukee; H. F. Cleland; E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Liopteria cf. *rafinesquii* Hall

Plate XXI, fig. 5

cf. *Liopteria rafinesquii* Hall, Pal. N. Y. Vol. V, pt 1, Lamellibranchiata, I, 1884, p. 161, plates XV, XX, and LXXXVIII.

A single imperfect cast of the interior of a specimen which appears to be closely related to this species was collected from the Milwaukee quarry. The characters are not sufficiently well preserved to permit a definite determination and the specimen is figured to call the attention of collectors to this genus.

Collection: H. F. Cleland.

Family AMBONYCHIIDAE Miller.

Genus **Mytilarca** Hall.

Mytilarca oviformis ? Conrad.

Plate XXII, figs. 1, 2

Mytilarca oviformis Hall, Pal. New York, Vol. V, pt 1, Lamellibranchiata 1, 1884, p. 255, plates XXXI and LXXXVII.

Description: "Shell large; body ovate, erect, wide posteriorly and acute above; length about one-fifth greater than the height; ventral margin for nearly half the length of the shell nearly direct, thence gently curving into the posterior extremity which is broadly rounded; dorsal margin very gently curved.

"Valves equal, regularly convex in the posterior part, becoming gibbous in the umbonal region.

"Hinge-line straight, less than the height of the shell. Beaks prominent, anterior acute, and incurved, rising above the cardinal line.

"Ventral side truncate with a small fold for the passage of the byssus. Dorsal side sub-alate.

"Test thick, marked by fine, close striae of growth which at intervals are fasciculate and raised into lamellose elevations and very much crowded and elevated on the ventral side of the shell." Hall, 1884.

Remarks: The larger Mytilarcas of the Milwaukee section differ little from the New York specimens of this species.

Collections: Public Museum, Milwaukee; E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Mytilarca trigonale nov.

Plate XXII, figs. 4, 5, 6

Description: Shell medium; body semi-ovate; length to hight in casts of the interior of two specimens 23 mm. and 14 mm., and 19 mm. and 11 mm. respectively; ventral margin nearly straight, thence rounding abruptly into the basal margin, then gradually rounding into the gently curving dorsal margin.

Valves equal; from regularly to depressed convex. Ventral umbonal slope very angular in the casts. Beaks prominent, acute, very slightly curved. The shell appears to have been thick. Surface unknown.

The casts of this species resemble *M. carinata* from the Chemung group of New York but differ from it in the ventral margin and in the curvature of the dorsal margin.

Collections: C. E. Monroe and H. F. Cleland.

Locality: Lake Church quarry, Lake Church, Wisconsin.

Mytilarca sp.

Plate XXII, fig. 3

A single specimen of a *Mytilarca* in which the valves are somewhat distorted seems to be new but until more and better material is at hand it does not seem best to describe it.

Collection: Public Museum, Milwaukee.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Family CONOCARDIIDAE Newmayr.

Genus **Conocardium** Bronn.

Conocardium ornatum nov.

Plate XXI, figs. 9, 10

cf. *Conocardium cuneus* Hall, Pal. N. Y. Vol. V, pt 1, Lamellibranchiata, II, 1885, p. 409, pl. LXVII, LXVIII and XCIV.

Description of *C. cuneus*: "Shell large, angularly sub-ovate, or trigonal in outline; length less than twice the hight; basal margin gently curving from the posterior-interior extremity to the anterior end. Posterior extremity abruptly truncate, produced into a tubular expansion along the cardinal line. Cardinal line straight, margins inflected toward the anterior end. Anterior end more or less rapidly attenuate, with the margins gaping before reaching the extremity. Valves gibbous. Beaks sub-central, vertical, prominent and closely incurved over the hinge-line. Umbonal slope angular, usually strongly

defined, extending to the post-inferior extremity. Post-cardinal slope flat or concave." Hall, 1885.

Remarks: The specimen from Milwaukee differs from the above species in the ornamentation of the shell. Near the anterior margin the radiating plications are narrow and the wide interspaces are ornamented with sharp concentric lines. The posterior slope is ornamented by curving radii, the interspaces of which are crossed by sharp concentric lines which are close together.

This is an extremely rare species in the Milwaukee beds and always occurs in a crushed condition.

Collection: E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Conocardium ohioensis ? Meek

Plate XXI, figs. 7, 8

Conocardium ohioense Hall, Pal. N. Y. Vol. V, pt. 1, Lamellibranchiata II, 1885, p. 411, pl. LXVIII.

Description: "Shell small, ovate, sub-trigonal, ventricose behind the middle of its length; length one-third greater than the height. Posterior end prominent, produced in the middle and sloping abruptly to the post-cardinal angle. Anterior end abruptly contracted in front of the middle and prolonged, nasute, with the extremity narrowly rounded.

"The body of the shell is marked by about six strong radiating plications on the ventricose portion of the valve, and on each side by more numerous and smaller plications. The interspaces between the ribs are marked by lamellose concentric striae." Hall, 1885.

A somewhat distorted specimen measures 11 mm. in hight and 15 mm. in length.

Collections: C. E. Monroe and H. F. Cleland.

Locality: Lake Church quarry where the specimens are all in the form of casts.

Family PTERIIDAE Meek.

Genus **Actinopteria** Hall.

Actinopteria boydi Conrad

Plate XXII, figs. 7, 8

Actinopteria boydi Hall, Pal. N. Y. Vol. V, pt 1, Lamellibranchiata I, 1884, p. 113, plates XIX and LXXXIV.

Description: "Shell of medium size, rhomboidal; body ovate, varying in proportions, the longitudinal axis at an angle with the hinge-

line of from 45 degrees to 60 degrees; length varying from nearly equal to one-fourth greater than the height; margins regularly rounded below, straight and nearly vertical for a short distance in front; post basal side extended.

"Valves convex, the right valve a little less convex than the left.

"Hinge-line straight from the anterior side of the beak to the posterior extremity.

"Beak anterior, acute, prominent, inclined forward, rising above the hinge in the left valve. Umbonal region prominent, subtending an acute angle.

"Ear short, oblique, limited by a deep but not sharply defined sulcus. Wing large, triangular, not distinctly separated from the body of the shell; margin concave; extremity acute. In the right valve the ear is somewhat more extended, the sulcus not strong, but the byssal sinus is marked; the wing is proportionally larger and usually more acute at the extremity.

"Test thick; the left valve, in well-preserved specimens, is marked by numerous strong, simple, sharp rays, which are continuous from the umbo to the margin, with rarely intercalated finer rays; crossed by regular, sharp, elevated, concentric lamellae which (in good specimens) are produced into subtubular, spiniform extensions upon the rays. Lines of growth are seen between the lamellae. On the wing the rays are more subdued while the concentric lamellae are strong. The ear is marked only by the crowded concentric striae. On the right valve the radii are obsolete on the body and well-marked on the wing, and the lamellose expansions are conspicuous. In some casts they appear as undulating elevated lamellae." Hall, 1884.

Remarks: The specimens which have been included in this species are fragmentary but show fairly well the characteristic surface markings and shape. This species is abundant in New York but comparatively rare in Wisconsin.

Collections: E. E. Teller; H. F. Cleland; Public Museum, Milwaukee.

Locality: Found in the shaly layers of the Milwaukee cement quarry section, Humboldt street bridge, Milwaukee.

Family CARDINIIDAE Zittel.

Genus **Nyassa** Hall.

Nyassa elongata nov.

Plate XXII, figs. 10, 11, 12

cf. *Nyassa arguta* Hall, Pal. New York, Vol. V, pt 1, Lamellibranchiata, II, 1885, p. 354, plate LIII.

Description: Sheli of medium size, elongate; length 32 mm., hight 18 mm., basal margin abruptly rounded on the anterior end, giving the anterior a truncated appearance; the posterior margin curves from the basal margin with a gentle curve to the cardinal line. Cardinal line gently arcuate.

Beaks sub-anterior, small, closely appressed, rising but little above the hinge-line.

Umbonal ridge prominent, rounded or sub-angular, extending almost to the post-inferior extremity.

Surface unknown. Anterior muscular impressions strong.

Remarks: This species has very much the same outline as *N. arguta* but differs from it in the extension of the basal anterior margin which, instead of being gently, is abruptly rounded and extended giving a truncated appearance to the anterior. The basal margin is straight or even slightly concave from the anterior muscular scar to the umbonal ridge. A rare species in the Milwaukee section.

Collection: Public Museum, Milwaukee.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Family TRIGONIIDAE Lamarck.

Genus **Schizodus** King.

Schizodus cf. *appressus* Conrad

Plate XXIV, fig. 8

cf. *Schizodus appressus* Hall, Pal. N. Y. Vol. V, pt 1, Lamellibranchiata II, 1885, p. 449, plate LXXV.

Description: The cast of the interior of a specimen in which the imprint of the lateral teeth and the muscular scars are well shown was collected in the Lake Church quarry. The outline of the anterior of the shell is preserved but the posterior is broken away. A comparison with the described species shows that the Lake Church specimens

are probably new but the material is too fragmentary to make an accurate description possible.

Collection: H. F. Cleland.

Locality: Lake Church, Wis.

Family PECTINIDAE Lamarck.

Genus **Pterinopecten** Hall.

Pterinopecten telleri nov.

Plate XXV, figs. 1, 2

Description: The shell is large, slightly oblique, length somewhat greater than the hight. Convexity of the valves apparently nearly the same. The only specimen of the right valve examined is more convex than the left but in this specimen this character may be due to compression. Hinge-line straight, somewhat shorter than the length of the shell.

Beaks obtuse, low, anterior to the middle of the hinge-line. Umbonal region almost flat. Ears almost flat. Posterior wing large and not clearly marked off from the body of the valve. Anterior ear separated from the body of the shell by a well defined sulcus.

Surface of both valves marked by strong, rounded ribs with strong concentric elevated lines which give a cancellated appearance with flat interspaces. This character extends to the wings where, however, they are closer together.

Rèmarks: This species differs from *Pterinopecten vertumnus* in the wider interspaces and few but stronger ribs. The outline of the shell is somewhat different.

A few specimens which have been identified as *Pterinopecten vertumnus* and *Lyriopecten* cf. *interradiatus* Hall evidently belong to a new species of *Pterinopecten*. The reason for the confusion in identification is due to the fragmentary condition of the material.

Collections: E. E. Teller; Public Museum, Milwaukee; H. F. Cleland.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Family MODIOLOPSIDAE Fischer.

Genus **Modiomorpha** Hall.

Modiomorpha concentrica Conrad

Plate XXIV, figs. 6, 7

Modiomorpha concentrica Conrad, Pal. N. Y. Vol. V, pt 1, Lamellibranchiata II, 1885, p. 275, plates XXXIV, XXXV and XXXVI.

Modiomorpha concentrica Kindle, Devonian fossils and Stratigraphy of Indiana, 1900, p. 680, plate 14.

Description: "Shell of medium size, ovate, extremely variable in its proportions; length less than twice the height; basal margin often nearly straight, usually a little concave on the anterior third; posterior margin abruptly rounded below and more gently curving above; cardinal margin oblique in the prevailing forms, moderately arcuate, often nearly straight, sub-alate in many specimens. Anterior end produced beyond the beaks, abruptly rounded, sometimes nasute, limited by a broad depression extending from the beak to about the anterior third of the basal margin.

"Valves moderately convex, gibbous along the umbonal slope; the point of greatest convexity is about the anterior third of the length of the shell.

"Hinge-line extending half, or sometimes more than half, the length of the shell.

"Beaks sub-anterior, small, sharply angular, appressed, directed forward. Umbonal region a prominent, sub-angular elevation, extending obliquely from the beak toward the post-basal margin, usually dying out about the middle of the length of the shell.

"Test comparatively thick, strongly ornamented by regular concentric, rounded or sub-angular striae, which become lamellose and coalescing on the anterior end of the valves, where they are less prominent." Hall, 1885.

Remarks: The Milwaukee specimens of this species differ little from those described from New York and Indiana. This species is rather more common than other species of pelecypods.

Collections: Public Museum, Milwaukee; H. F. Cleland; E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Modiomorpha obliqua nov.

Plate XXIV, fig. 4

Description: Shell larger than medium size, variable in its proportions; length to breadth of two specimens as 45 mm. and 32 mm., and 76 mm. and 50 mm. respectively; basal margin nearly straight; posterior margin abruptly rounded below and nearly straight above where it is abruptly rounded to the cardinal margin. Cardinal margin oblique and nearly straight. Anterior end produced beyond the beaks, abruptly rounded, the upper margin being nearly on a line with the cardinal margin.

Valves moderately convex, the point of greatest convexity being about midway between the anterior and posterior and nearer the basal than the cardinal margin. Hinge-line more than half the length of the shell.

Beaks situated about one-third the length of the shell from the anterior margin. The exterior of the shell is concentrically striated with irregular lines of growth.

Remarks: The species of the genus *Modiomorpha* are so poorly defined and are so variable that it is, in many cases, difficult to say to which species a specimen belongs. The most conspicuous difference between these Milwaukee Modiomorphas and those from New York is the obliquity of the hinge-line and the upper margin of the anterior lobe.

Collections: E. E. Teller and Public Museum, Milwaukee.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wis.

Modiomorpha mytiloides Conrad

Plate XXIII, fig. 4

Modiomorpha mytiloides Hall, Pal. of New York, Vol. V, pt 1, Lamellibranchiata II, 1885, p. 277, plates XXXVII and XXXVIII.

Description: "Shell larger than medium size, rhomboid-ovate, oblique; length less than twice the height; basal margin nearly straight, or very slightly concave anterior to the middle, curving to the anterior and posterior extremities; posterior margin abruptly curving below and more gently recurving toward the cardinal line; cardinal margin arcuate. Anterior end narrow, extended, abruptly curved on the margin; somewhat defined by the sinus which extends from anterior to the beak to the middle of the shell. * * *". Hall, 1885.

Remarks: In his description of *M. macilenta* Hall makes the following statement: "The typical forms here recorded under the specific

designation of *M. mytiloides, M. alta,* and *M. macilenta,* are easily distinguishable; but in the study of large collections we find so many intermediate forms that it becomes difficult, if not impracticable, to arrange them under these several designations." In the Milwaukee collections the Modiomorphas which are included in the above species in this paper have been variously identified from Hall's figures as *M. alta, M. affinis,* and *M. mytiloides.* In fact there is some warrant for assigning almost every specimen of this genus collected in the Milwaukee quarry to a different species. But any attempt to break it up into a number of species results in great confusion.

Locality: Milwaukee quarry, Humboldt street bridge, Milwaukee, Wis.

Modiomorpha schucherti nov.

Plate XXIV, figs. 1, 2, 3

Description: Shell medium, two specimens being 4 cm. in length and 3 cm. in hight; highest at the posterior termination of the hinge-line. Valves rather strongly convex, contour regularly arcuate. Anterior end produced somewhat beyond the beak.

Hinge-line straight, oblique, extending for more than half the length of the shell.

Beaks rounded, directed forward. Umbonal slope poorly defined, the shell being gently arcuate both from the anterior to the posterior and from the beak to the margin. Muscular impressions unknown.

Remarks: This shell resembles *M. alta* but is more regularly rounded on the anterior and lacks the well defined umbonal ridge. *M. tumida* Whiteaves differs from it in the presence of an angular alation.

Three specimens are figured: 1 and 2 of right valves and figure 3 of a left valve.

Named in honor of Professor Chas. Schuchert of Yale University.

Collections: Public Museum, Milwaukee; H. F. Cleland; E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Modiomorpha clarkei nov.

Plate XXIV, fig. 5

Description: Shell above medium size, subrhomboidal; length about $6\frac{1}{2}$ cm. and hight $4\frac{1}{2}$ cm. in one specimen. Basal margin nearly straight anteriorly until almost directly beneath the umbo where it curves sharply, continuing in a gentle curve to the post-cardinal margin. Beak situated about midway between the anterior and posterior extremities.

Valves convex, being most gibbous near the middle along a line extending almost at right angles to the hinge-line but somewhat anteriorly from the beaks to the basal margin. Hinge-line nearly straight, extending more than one half the length of the shell. Beaks obscure; umbonal region not sharply defined.

Test marked by irregular concentric growth lines which are stronger at the basal margin.

Remarks: This well-marked species differs from all described Modiomorphas except a specimen figured as *M. alta* in Pal. N. Y. Vol. V, pt 1, plate LXXX, fig. 7, but it is certainly not of this species. The outline is very unusual, suggesting a different genus but it seems safe to include it with the Modiomorphas. It is a rare fossil in the Wisconsin deposits.

Named in honor of Dr. J. M. Clarke, Director of New York Geological Survey.

Collection: E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Order ANOMALODESMACEA Dall.

Family PHOLADELLIDAE Miller.

Genus **Cimitaria** Hall.

Cimitaria recurva Conrad

Plate XXV, fig. 10

Cimitaria recurva Hall, Pal. N. Y. Vol. V, pt 1, Lamellibranchiata II, 1885, p. 467, pl. LXXVII.

Description: "Shell large, falcate; length nearly three times the height. Basal margin broadly curving with a slight sinuosity toward the anterior end. Posterior extremity broadly rounded or sub-truncate. Cardinal line long, concave. Anterior end short, broadly rounded, obliquely truncated above by the lunule. Escutcheon large. Lunule long and abruptly limited.

"Valves depressed-convex in the basal and posterior portions, becoming gibbous above in the umbonal region.

"Beaks sub-anterior, prominent, appressed and closely incurved. Umbonal slope obtusely angular, curving downward and becoming obsolescent before reaching the post-inferior extremity. Post-cardinal slope broad, flattened or slightly concave. Cincture an undefined flattening or depression, extending from the beak obliquely backward to the base, and producing a slight sinuosity in the margin.

"Surface marked by fine concentric striae, which are irregularly

fasciculate and are raised into strong undulations on the anterior portion of the shell. In well-preserved specimens the surface is also marked by fine pustulose striae. In addition to this the post cardinal slope is sometimes marked by distant radii." Hall, 1885.

Remarks: There are certain differences between the Wisconsin specimens and those from New York, but they do not seem to be of specific rank. The shells are more recurved, the umbonal ridge is more angular and the anterior is somewhat less rounded than in the New York specimens. One shell is more than 6 cm. in length.

Collections: H. F. Cleland; E. E. Teller; Public Museum, Milwaukee.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Order TELEODESMACEA Dall.

Family PLEUROPHORIDAE Dall.

Genus **Cypricardinia** Hall.

Cypricardinia cf. *indenta* Conrad

Plate XXVI, fig. 3

cf. *Cypricardinia indenta* Conrad, Pal. N. Y. Vol. V, pt 1, Lamellibranchiata II, 1885, p. 485, plates LXXIX and XCVI.

Remarks: A single specimen of this genus has been referred to this species provisionally. The specimen is not sufficiently well preserved to warrant a definite determination.

Collection: H. F. Cleland.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Family LUCINIDAE Fleming.

Genus **Paracyclas** Hall.

Paracyclas elliptica Hall

Plate XXV, figs. 3, 4, 5

Paracyclas elliptica Hall, Pal. N. Y., Vol. V, pt 1, Lamellibranchiata II, 1885, p. 440, plates LXXII and XCV.

Description: "Shell large, sub-circular or broadly sub-elliptical (subject to great variation in form from compression); length and height about equal. Pallial margin regularly curving from the extremities of the hinge. Cardinal line short, more than one-third the length of the shell, slightly arcuate.

"Valves regular convex, somewhat regularly gibbous in the middle.

"Beaks a little anterior to the middle, small, appressed and closely

incurved, rising but little above the hinge-line. Umbonal slope defined above by a depression extending from the beaks to about the middle of the posterior extremity, distinctly limiting the post-cardinal slope of the valves.

"Test thin. Surface marked by fine concentric striae, which are aggregated into fascicles at irregular distances.

"Ligamental groove narrow and elongate. Posterior muscular impression just within the post-cardinal margin and below the ligamental groove. Pallial line parallel with the basal margin, marked in the cast by a row of elongate nodes, which are the terminations of low ridges from above. Interpallial area pustulose on the cast." Hall, 1885.

The specimens of this species from the New York Onondaga are larger than those from the Middle Devonic of Wisconsin but are otherwise the same.

Remarks: One specimen from the Lake Church quarry measured 26 mm. in length and 24 mm. in hight; two imperfect specimens measured, the one 30 mm. in hight, and the other 30 mm. in length. Fine casts of the interior and exterior are occasionally found at Lake Church.

Collection: H. F. Cleland.

Locality: Lake Church quarry, Lake Church, Wis.

Paracyclas lirata var.

Plate XXV, figs. 6, 7

Description: Shell small, irregularly elliptical; length about the same as the hight being 8 mm. Cardinal line less than half the length of the shell. Valves moderately convex. Beaks slightly anterior to the centre, small and rising but little above the hinge-line. Surface marked by strong, subangular concentric ridges.

Remarks: The specimens referred to this species are usually less than half the size of *Paracylas lirata* which they most closely resemble and are less circular in outline.

Collections: Public Museum, Milwaukee; H. F. Cleland.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee.

Paracyclas ohioensis tenuistriata var. nov.

Plate XXV, fig. 9

cf. *P. ohioensis* Kindle, Devonian Fossils and Stratigraphy of Indiana, 1900, p. 675, pl. XV. figs. 1, 1a, 1b.

Description: Related to *P. ohioensis* but differing from it in the sharper, finer and more regular concentric undulations, and in the shallower but well defined sulcus.

Collection: H. F. Cleland.

Locality: A rare fossil in the Lake Church section, Lake Church, Wisconsin.

Paracyclas sp.

Plate XXV, fig. 8

Description: A single specimen of the left (?) valve of a *Paracylas* is more gibbous than is usual with species of this genus. The outline is sub-circular, being rather more irregular than in *P. tenuis* which it most closely resembles.

Collection: Public Museum, Milwaukee.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Genus **Goniophora** Phillips.

Goniophora obtusiloba nov.

Plate XXV, fig. 11

Description: Shell of medium size for the genus, length about twice the hight. Basal margin convex in general outline but somewhat concave near the middle, beyond which it curves rather abruptly into the anterior margin. Posterior margin obliquely truncate. Cardinal margin nearly straight. Anterior end short and rounded. An oblique sinus extends from the beak to the base, anterior to the middle.

Valves convex below the umbonal ridge. Beaks anterior, small, closely incurved. Umbonal ridge angular and prominent, apparently extending to the post-basal extremity.

The shell is ornamented with concentric lines of growth, which are irregularly spaced. The specimen figured has a length of about 35 mm.

This species differs from other described species in the bluntness of the anterior lobe. Only a very few poorly preserved specimens were collected.

Collection: E. E. Teller.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wis.

Genus **Megambonia** Hall.

Megambonia wisconsinensis nov.

Plate XXVI, figs. 1, 2

Description: Shell large; higher than long; basal margin apparently regularly rounded; curve of the anterior greater than that of the posterior and probably auriculate. Right valve regularly and moderately convex near the posterior margin but becoming gibbous as the umbo is approached. Beak sub-anterior. Test unknown. The specimen figured has a length of 7 cm. and a breadth, when restored, of about 5 cm.

It is interesting to find this rare genus in this locality. A single fragmentary specimen was collected.

Collection: E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet, Wis.

CHAPTER VIII

GASTROPODA

The gastropods of the Milwaukee cement quarry and at Whitefish bay are very rare, while in the quarry of the Lake Shore Stone Co. near Lake Church, and at Dreuckers they are rather abundant in certain layers. The commonest forms in the last two sections are *Bellerophon pelops* and *Trochonema monroei*. For a list of the species with their relative abundance, and geographical and vertical distribution see page 18.

Class **GASTROPODA.**

Order ASPIDOBRANCHIA Schweigger.

Family PLEUROTOMARIIDAE d'Orbigny.

Genus **Pleurotomaria** Defrance.

Pleurotomaria sp.

A few fragmentary and distorted specimens from the Milwaukee cement quarry have some of the characters of this genus but it did not seem wise to attempt an identification with the imperfect material at hand.

Genus **Porcellia** Leveillé

Porcellia ? kindlei nov.

Plate XXVII, fig. 1

Description: Shell large, one nearly complete specimen measuring 4 cm. in diameter; concave on both (?) sides. Umbilicus wide and open. Number of volutions about four. Each volution is ornamented on its dorso-lateral margins with two rows of rather large tubercles. Cross section of volutions ovate.

Surface beautifully cancellated by stronger transverse lines crossed by weaker longitudinal lines which produce a regular granulose appearance.

Remarks: This is one of the rarest and most beautiful specimens

in the Wisconsin Devonic. It resembles *Porcellia nodosa* Hall of the Illinois Kinderhook group but differs from it in that the tubercles are situated nearer the outer portion of the volutions.

The specimen figured was found in the bottom of the quarry among other loose material which had fallen from the walls above. It probably came from some layer below the "hard layer."

Named in honor of Dr. E. M. Kindle of the U. S. Geological Survey.

Collections: E. E. Teller, the late Mr. Green and H. F. Cleland.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Genus **Murchisonia** d'Arch. and Vern.

Murchisonia dowlingii ? Whiteaves

Plate XXVII, fig. 2

Murchisonia dowlingii Whiteaves, Cont. Canadian Pal. 1892, Vol. I, pt 4, p. 316, pl. 41, fig. 8.

Description: "Shell elongated, turreted, very slender and many whorled. Volutions thirteen or more, the first three or four rounded or indistinctly angulated, the remainder strongly angulated and distinctly bicarinated considerably below their midlength, the two prominent spiral keels being placed close together and separated by a narrow but rather deep groove, and the centre of the basal or anterior side of the upper keel encircled by an impressed line: sides of the volutions obliquely flattened and somewhat concave both above and below the two spiral keels, but narrowing much more abruptly inward below them; suture deeply and angularly excavated, its centre occupied by a very fine but deeply impressed line or minute spiral groove.

"Surface nearly smooth, marked only with very faint but close set incremental striae, which curve very gently backward on the upper or apical side, and rather more strongly forward on the lower side of the two spiral keels, which form the outer boundaries of the slit band: crescents very indistinctly defined, but apparently as closely disposed as the incremental striae." Whiteaves, 1892.

Remarks: The species to which these specimens are referred were first collected and described from the shores of Lake Winnipegosis, Canada. The fragmentary condition of the specimen from Lake Church makes our determination provisional. As will be seen from the illustration the specimen is incomplete and does not preserve the surface markings.

Collection: H. F. Cleland.

Locality: Lake Church, Wis.

Family BELLEROPHONTIDAE M'Coy.

Genus **Bellerophon** Montf.

Bellerophon pelops Hall

Plate XXVIII, figs. 12

Bellerophon pelops Hall, Pal. New York, Vol. V, pt. 2, 1879, p. 95, plate XXII, figs. 7–13 and pl. XXVI, fig. 1.

Description: "Shell subglobose. Body-volution ventricose and expanded at the aperture; umbilicus closed by a callus of the lip; outer lip with a moderate sinus in front and broadly rounded on each side, thickened and twisted at the umbilicus, with usually a thin callosity spreading over the columellar side of the aperture. Aperture transverse, broadly subreniform.

"Surface marked by a slender dorsal band, which appears either as a single elevation or with sharply carinate margins; the entire surface ornamented by fine subregular striae, which, rising from the umbilical region, curve gently forward, and then more directly transverse over the body of the shell, bending slightly backward as they approach the dorsal carina, in crossing which they make a gentle retral curve; the striae are usually stronger on the dorsal side, and fainter in the umbilical region." Hall, 1879.

Remarks: The specimens from the Lake Church section occur as casts of the interior and exterior and do not well preserve the finer marking.

Collections: Public Museum, Milwaukee, for complete specimens and E. E. Teller and H. F. Cleland for casts.

Locality: Silicified specimens were collected from the debris of the New Intake tunnel, Milwaukee. In the Lake Church quarry and at Dreuckers the specimens are abundant as casts of the exterior and interior.

Genus **Ptomatis** Clarke.

Bellerophon (*Ptomatis*) *patulus* Hall

Plate XXVIII, fig. 13

Bellerophon patulus Hall, Pal. New York, Vol. V, pt 2, 1879, p. 100, pl. XXII and XXIV.

B. patulus Kindle, Devonian Fossils and Stratigraphy of Indiana, 1900, p. 692, plate XXI.

For more complete bibliography see Hall.

Description: "Shell subglobose, ventricose; umbilicus small, closed before reaching the centre. Volutions rounded, the last one abruptly

and widely dilated, giving a broad subcircular aperture, the width greater than the dorso-ventral diameter. * * *

"Surface, on the expanded part of the outer volution, marked by fine, close, concentric striae, which are sometimes crowded in fascicles, giving an undulating surface; the posterior prominent part of the volution is marked on the back, and partially on the sides, by strong, even, arching costae, which are more abruptly and sometimes subangularly curved on the dorsal line. These costae sometimes continue for half the length of the volution anteriorly, gradually becoming obsolete on the middle and sides, and are never seen upon the broad expansion of the shell. The spaces between these costae are marked by fine, close, concentric striae, and, in well-preserved specimens, extremely fine revolving striae are sometimes visible. The costae become finer or obsolete as they approach the umbilicus, and the surface is marked only by the fine striae of growth.

"This shell can usually be readily distinguished by its widely expanded outer volution, the broad, shallow sinuosity in the anterior margin of the lip, and the absence of all markings on this part of the shell except striae of growth." Hall, 1879.

Remarks: Two silicified specimens of this species were collected from the New Intake tunnel, Milwaukee and several casts from the Milwaukee cement quarry. They preserve the surface marking of the species but the margin of the lip is unknown.

Kindle reports this species from Indiana and Hall from New York.

Collections: Public Museum, Milwaukee; E. E. Teller.

Locality: New Intake tunnel and Humboldt street bridge, Milwaukee.

Family EUOMPHALIDAE de Kon.

Genus **Euomphalus** Sow.

Euomphalus sp.

Plate XXVII, figs. 9, 10

Description: A few specimens of a large gastropod of which two are figured seem to be of an undescribed species but since the surface markings are not preserved it seems best not to attempt a complete description. One specimen which, when complete, must have had a diameter of 5 cm. has three or four volutions. The whorl enlarges rapidly. No surface markings are preserved and the aperture is unknown.

Collection: H. F. Cleland.

Locality: Lake Church, Wis.

Euomphalus planodiscus ? Hall

Plate XXVII, fig. 12

Euomphalus planodiscus Hall, Pal. N. Y., Vol. V, pt 2, 1879, p. 57, pl. XVI.

Description: "Shell discoid planorbicular; spire depressed, the apex being below the plane of the outer volution; lower side broadly concave; periphery rounded. Volutions about four or five, slender, barely contiguous, very gradually enlarging from the apex and regularly rounded, the adjacent sides not being perceptibly flattened; the last one near the aperture somewhat flattened above. Aperture slightly expanded, subcircular, a little transverse.

"Surface marked by fine close striae, which are sometimes crowded in regular fascicles, giving the appearance of annular ridges, which bend a little forward at the edge of the periphery." Hall, 1879.

Remarks: Two specimens from Lake Church have been referred to this species with some hesitancy. The specimens are casts of the interior and consequently do not preserve the surface markings, upon which the species is based, except in a slight degree.

Collections: C. E. Monroe; H. F. Cleland.

Locality: Lake Church, Wis.

Genus **Phanerotinus** Sowerby.

Phanerotinus exiguus ? (Kindle)

Plate XXVII, fig. 8

Euomphalus exiguus Kindle, Devonian Fossils, 25th Ann. Rept. Dep't Geol. and Nat. Res. Indiana, 1900, p. 718, pl. XXI.

Description: "Shell small, discoid, spire depressed. Volutions about four, rounded contiguous except the first and second, which are sometimes separated for a short distance by a slight space. Gradually enlarging from the apex, which is elevated a little above the plane of the outer volution. Umbilicus broad. Surface concentrically striated by very fine striae." [Not shown on the specimens from Wisconsin.] Kindle, 1900.

Remarks: Since the specimens referred to this species do not preserve the surface ornamentation the determination is somewhat in doubt. However, the shape and general characters of the specimens are as in *E. exiguus.*

Collection: E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet, Wisconsin.

Genus **Pleuronotus** Hall.

Pleuronotus sp.

Plate XXVII, fig. 11

cf. *E. tioga* Hall, Pal. New York Vol. V, pt 2, 1879, p. 56, pl. XV, figs. 9, 10, pl. XXVII, fig. 8.

A single angulated specimen from Lake Church has, in general, the characters of *E. tioga* described by Hall from the Chemung group of New York but is about half the diameter. The type specimen of *E. tioga* is a somewhat worn cast of the interior in which it is difficult to distinguish the important features. The Wisconsin specimen is probably not of this species but is closely related.

Collection: H. F. Cleland.

Locality: Lake Church, Wis.

Family TURBINIDAE Adams.

Genus **Cyclonema** Hall.

Cyclonema ? subglobosa nov.

Plate XXVIII, figs. 7, 8, 9, 10

Description: Shell turbinate. Volutions four or five; evenly convex; gradually expanding to the body whorl which is ventricose.

The surface of a silicified specimen from the New Intake Tunnel (fig. 7) is marked by strong, regular, revolving pustulose striae. This pustulose character may, however, be a cancellation produced by the crossing of fine concentric striae which are not preserved in the interspaces.

Remarks: This species has been identified as *Machrocheilus hamiltoniae* Hall but differs from it in the more globose form of the interior and its surface markings. The difficulty in making a specific, and in many cases a generic, determination is because the specimens occur in the form of casts. The smooth subglobose casts of the interior which have been identified as the above may prove to be another species.

Collections: H. F. Cleland; E. E. Teller; Public Museum, Milwaukee.

Locality: Milwaukee cement quarry; New Intake tunnel, Milwaukee, Lake Church, Wis.

Family TROCHONEMATIDAE Zittel.

Genus **Trochonema** Salter.

Trochonema monroei nov.

Plate XXVIII, figs. 11, 14, 15, 16

Description: Shell sub-turbinate; hight of spire to width of base in a small specimen about as 11 mm. is to 14 mm. Other species have almost twice these dimensions. Volutions four to six, usually five; apex minute and rapidly expanding to the body-whorl, which is somewhat ventricose. Aperture sub-circular and smooth.

Surface marked by strong elevated lines or carinae, of which there are five on the lower and two on the whorl next above. The carinae on the lower side of the body whorl are much closer together than those on the upper side. The carinae on the upper portion of the whorl are ornamented by strong pointed elevations. Casts of the interior are smooth.

Collections: C. E. Monroe and H. F. Cleland.

Locality: A large number of specimens of casts of the interior were collected at Lake Church, Wis.

Order CTENOBRANCHIATA Schweigg.

Family PYRAMIDELLIDAE Gray.

Genus **Aclisina** De Kon.

Loxonema (Aclisina) cancellata nov.

Plate XXVII, figs. 3, 4

Description: Shell turreted, spire rapidly and regularly ascending. Volutions ten or eleven, each one slightly convex. Aperture narrowed and attenuate at the base.

Surface marked by numerous, fine, spiral revolving striae, which are stronger in the lower than upper half. These are crossed by numerous fine lines which bend back at the middle of each whorl. The effect of these two series of lines is to give a cancellated appearance to the exterior. Suture band, or upper edge of the volution, overlapping the next preceding and constricted just below the margin. The specimens occur as casts of the exterior.

This species differs from other Loxonemas of the Middle Devonic in the cancellated surface markings.

Collection: H. F. Cleland.

Locality: Lake Church, Wis.

Genus **Loxonema** Phil.

Loxonema hamiltoniae Hall

Plate XXVII, figs. 5, 6

Loxonema hamiltoniae Hall, 15th Rep. N. Y. State Cab. Nat. Hist. 1862, p. 53, pl. 4, fig. 8.

Pal. New York, Vol. V, pt 2, 1879, p. 45, pl. XIII, figs. 15, 17.

Description: "Shell elongate, subulate. Volutions moderately convex, about thirteen in the largest specimens known, very gradually increasing in size from the minute apex, the last one ventricose. Aperture ovate, narrowing below; columella extended.

"Surface marked by longitudinal sharp, curving striae, which bend gently backward from the suture, and forward towards the base of the volution, having the greatest curve near the middle, those of the last volution curving abruptly backward to the columellar lip. Striae separated by distinctly defined grooves, which are a little wider than the ridges; the striae increasing in distance as the shell grows older." Hall, 1879.

Remarks: There is some variation in the strength of the longitudinal striae of the Wisconsin specimens, but otherwise the specimens are typical. Silicified specimens and casts of the exterior have been collected.

Collections: E. E. Teller; H. F. Cleland; Public Museum, Milwaukee.

Locality: New Intake tunnel; Milwaukee cement quarry, Berthelet; Lake Church, Wis.

Superfamily TAENIOGLOSSA Bouvier.

Family CAPULIDAE Cuvier.

Genus **Platyceras** Conrad.

Platyceras bertheletensis nov.

Plate XXVIII, figs. 1, 2

Description: Shell of medium size, incurved at the apex, expanding rapidly to the aperture. Surface comparatively smooth except near the aperture where the shell is strongly undulated.

The surface is crossed by fine concentric growth lines which bend back gently to a narrow keel which becomes indistinct toward the apex.

Remarks: This species differs from *Platyceras bucculentum* Hall in the more open coil and from *P. carinatum* Hall in the absence of the dorsal ridge.

This is a rare fossil but some of the specimens collected are well preserved. Zone C, of the Milwaukee quarry yielded the best specimens.

Collection: E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Platyceras bertheletensis unsymmetricum var. nov.

Plate XXVIII, fig. 3

A specimen from the Teller collection differs from *P. bertheletensis* in its greater lack of symmetry, the whorl being almost flat on one side.

Collection: E. E. Teller.

Locality: Milwaukee cement quarry.

Platyceras hornefferi nov.

Plate XXVIII, fig. 4, 5, 6

Description: Shell medium for the genus; somewhat irregularly arcuate from the base to the apex.

Apex blunt and not in contact with the rapidly spreading body whorl, the shell making but one volution. The dorsum angular from the apex to within about one third the distance of the aperture, thence the carination disappears giving place to a number of small crenulations. Aperture not clearly shown; the lip irregularly but clearly crenulated by narrow folds.

Surface marked by undulating lines of growth which become straighter as the apex is approached.

Remarks: The species of this genus are extremely variable and for this reason it is with some hesitancy that these shells were placed in a new species but they differ so markedly from described species that it seemed necessary to do so.

Collections: Milwaukee Museum; E. E. Teller; H. F. Cleland.

Locality: Upper shaly layers, zone C, Milwaukee cement quarry, Berthelet, Wis.

Class **SCAPHOPODA** BRONN.

Order OPISTOBRANCHIA Milne-Edwards.

Sub-Order CONULARIDA M. and G.

Family TORELLELLIDAE Holm.

Genus **Coleolus** Hall.

Coleolus ? tenuis nov.

Plate XXVI, fig. 11

Description: A number of specimens which appear to be of the genus Coleolus were collected at Lake Church. The diameter of the larger end of a cast of the interior—not the aperture—is 7 mm.; from this point the shell tapers gently to a point, so that in a fragmentary specimen 24 mm. in length the larger end is 5 mm. and the smaller 2 mm. in diameter. The total length of a large specimen is at least 10 cm.

The cast of the interior is smooth. On the cast of the exterior of one specimen faint longitudinal lines are seen but it is possible that these lines are not structural. Apex and aperture unknown. One specimen curves slightly, a character which may be due to pressure.

Collections: C. E. Monroe; H. F. Cleland.

Locality: Lake Church, Dreukers, Wis.

Family CONULARIIDAE Walcott.

Genus **Conularia** Mill.

Conularia congregata milwaukeensis var. nov.

Plate XXVI, figs. 4, 5, 6, 7

cf. *Conularia congregata* Hall, Pal. N. Y. Vol. V, pt 2, 1879, p. 214, plates XXXIV and XXXIV A.

Description: Form regularly pyramidal with sides gently sloping from the apex. Transverse section unknown. Faces of the pyramid apparently equal and without a distinct groove or depression along the center. Angles marked by a narrow, distinctly rounded furrow at which the striae end. Aperture unknown.

Surface marked by abruptly elevated, transverse striae which are regularly and closely tuberculated along their crests and which are interrupted at the angles (figure 7). Usually these striae are continued on the adjacent face of the pyramid but occasionally one will end at the angle with no corresponding stria on the adjacent face. The striae become much crowded toward the aperture. Interspaces in well preserved specimens are longitudinally striated.

Remarks: This species resembles *C. congregata* but differs from it in that the striae are interrupted at the angles at least near the apex. It differs from *C. continens* in the absence of the interlocking striae in the groove of the angle.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Locality: Milwaukee cement quarry, Berthelet, Wisconsin.

Family HYOLITHIDAE Nich.

Genus **Hyolithes** Eichwald.

Hyolithes alatus ? Whiteaves

Plate XXVI, figs. 9, 10

Hyolithes alatus Whiteaves, Contributions to Canadian Palaeontology, Vol. I, part 4, 1892, p. 342, pl. 46, figs. 2, 3, 4.

Description: "Shell large, attaining to a length of a little more than four inches, nearly straight, except when abnormally distorted, which it often is, narrowly elongated and increasing very slowly in thickness; sides broadly alate at their base, the 'dorsal' margin being produced on each side into a broad thin laminar expansion. 'Dorsal' side much flatter than the 'ventral', slightly convex along the median line and broadly but shallowly concave on each side: ventral side strongly convex but angulated and obtusely subcarinate along the median line: outline of transverse section triangular, with the latero-basal angles produced on each side into a narrow projecting spur, the base of the triangle, with its two spurs, being more than twice as broad as the triangle is high, and each of its sides faintly convex. Shape of the aperture not clearly ascertainable, though on the dorsal side there is a broad and rather deep sinus, which is nearly flat at the bottom, in the middle of the lip, and a projecting lobe, which is broadly rounded on its inner margin and narrowly rounded or sub-angular externally, on each side.

"The only surface markings that are preserved in any of the specimens are a few lines of growth on the dorsal side parallel to the outer lip. Operculum unknown." Whiteaves, 1892.

Remarks: The specimen figured was sent to Professor J. F. Whiteaves for comparison with his type specimens. He replied as follows: "The state of preservation of the Wisconsin fossil is so imperfect that I should not care to offer a very decided opinion as to whether it is referable to *Hyolithes alatus* or not. But, I am also free to confess, that I can not see any tangible difference between the specimen you sent, and three authentic and typical examples of *H. alatus* in our Museum." [Letter to the author dated Jan. 9, 1908.]

The aperture and apex are wanting in the specimens at hand.
Collection: H. F. Cleland. Collected by C. E. Monroe.
Locality: Lake Church, Wisconsin.

Hyolithes aclis ? Hall

Plate XXVI, fig. 8

Hyolithes aclis Hall, Illustrations of Devonian Fossils, 1876, pl. 27; Pal. New York Vol. V, pt 2, 1879, p. 197, pls. XXXII and XXXII A.

Description: "Form an elongate triangular pyramid, gradually and regularly tapering to an acute extremity. Transverse section somewhat semi-elliptical or subtriangular, a little convex on the ventral side, about twice as wide as high; the lateral margins obtusely angular, sometimes attenuate from compression. Ventral face gently convex, and slightly curving in a longitudinal direction; anterior portion extended in a subspatulate expansion. Dorsal face highly convex transversely, and obtusely angular along the middle; very slightly concave longitudinally. Aperture oblique, the margin extended on the ventral side; on the dorsal side the peristome is not fully determined, but is apparently nearly straight on the sides, with a sinus at the angle. Operculum in general form subelliptical, the body of which is moderately convex; the ventral margin (or that corresponding to what may be termed the ventral side of the shell) is regularly curving. The umbo is situated about three-fourths of the width from the base, and extending thence on each side, almost rectangularly to the transverse axis, is a distinct fold which gradually expands toward the margins, and below which is a corresponding groove or channel. Above this fold is a narrow border or flange, which turns upward at a considerable angle (varying in two specimens from ten to more than thirty degrees), and in the centre of which is an abrupt angular depression. Shell thin, and usually very imperfectly preserved." Hall, 1879.

Remarks: The few specimens of this species which have been collected do not show the characters well. The transverse section, the aperture, the surface markings and operculum are unknown.

It should be remembered that the above species has few strongly marked characters and is consequently liable to be confused with almost any small smooth *Hyolithes* which is poorly preserved.

Collection: Public Museum, Milwaukee.

Locality: New Intake tunnel, Milwaukee; Milwaukee cement quarry, Berthelet, Wis.

CHAPTER IX

CEPHALOPODA

The cephalopod fauna of the Wisconsin Devonic is remarkable for the form of some of its species as well as for the abundance of individuals.

The specimens are crushed to such an extent by pressure applied at various angles with reference to the vertical axis, that a hasty study would probably result in their separation into a large number of species and perhaps genera. In order that these distorted forms might be clearly understood, and to reduce as much as possible the liability to error in their determination, restorations in clay and later in plaster were made from careful measurements of actual specimens. In these restorations no attempt was made to restore the initial stages, since in but two specimens was that portion of the shell preserved. In *Gomphoceras calvini* Cleland, the lower one and one quarter inches of the restoration is hypothetical, but in *G. wisconsinense* Cleland, practically the whole specimen is known. The transverse section was made circular in the restorations of all the species. In the case of *G. wisconsinense* this was doubtless the true shape, but it is possible that in *G. fusiforme* Whitfield, the cross-section was elliptical.

The rim of the aperture of *G. wisconsinense, G. calvini,* and *G. fusiforme* is pretty well known. It is difficult in all cases to determine the position, if any, of the hyponomic sinus.

It should be remembered that the restorations in this paper are in every case of the interior. If a restoration were made of the exterior, account must necessarily be taken of the thickening of that portion of the shell forming the chamber of habitation. In none of our specimens is this thickening indicated, but it has been shown by Dr. R. Ruedemann* that in certain Ordovicic cephalopods "the slight constriction of the living chamber [shown in the cast of the interior] is largely due to a thickening of the shell in apertural direction, evidently a gerontic feature." It is possible that the exteriors of the upper por-

* Cephalopoda of the Champlain Basin, N. Y. State Mus. Bul. 90, 1906, p. 503, figure 57.

tion of the shells of *G. wisconsinense* and *G. calvini* were much less concave than the interior, or were even convex.

The impossibility of determining the position of the siphuncle in certain species compels the use of the broader classification of the older literature.

Class **CEPHALOPODA.**

Order NAUTILOIDEA.

Family ORTHOCERATIDAE.

Genus **Orthoceras** Breyn.

Orthoceras clarkei nov.

Plate XLII, figs. 2, 2A

Description: Shell straight and regularly enlarging, the angle of the mature portion being about 8 degrees. Transverse section circular. Chamber of habitation unknown. The air chambers have a depth of 3 mm. where the diameter of the shell is 9 mm. and a depth of 2 mm. where the diameter is 7 mm. In the specimen figured the air chambers are seen to begin at the apex.

Septa smooth, thin, slightly concave. Siphuncle small, central or sub-central. Test apparently very thin, the surface of which in the mature shell being ornamented with fine transverse lines.

The character of the initial stages are well shown in this specimen and illustrate the features described below. Although the upper portion of the specimen is lacking, with the exception of the protoconch, the whole of the initial stages are preserved. The orthocone may be said to extend to a point 7 or 8 mm. distant from the apex. It increases in diameter rapidly at first and then more slowly, the angle of the orthocone being roughly about 35 degrees, that of the mature shell about 8 degrees.

The surface sculpturings, which are especially worthy of notice, are the longitudinal ribs of the orthocone which extend from the apex for 7 or 8 mm. where they become faint and give place to the fine transverse ornamentation of the mature shell. The cicatrix is very irregular in outline.

Named in honor of Dr. J. M. Clarke, Director of the New York Geological Survey who has added much to our knowledge of the initial stages of the cephalopods.

Collection: E. E. Teller.

Locality: Debris of the New Intake tunnel, Milwaukee.

Orthoceras cf. *bebryx* Hall

Plate XLIII, figs. 1, 2

cf. *Orthoceras bebryx* Hall, Pal. N. Y. Vol. V, pt 2, 1879, p. 275, plates XXXVIII, XXXIX, LXXXIII, LXXXIV.

Description: "Shell robust, straight, regularly enlarging from the apex. Transverse section, allowing for the degree of compression, sub-circular. Apical angle eight to ten degrees. * * * Air-chambers regular, increasing in depth from the apex, and varying in different individuals from six to ten mm. * * *" Hall, 1879.

A large incomplete specimen in the collection of the Public Museum, Milwaukee, measures 35 cm. in length. Siphuncle central. The lack of surface markings and the poor preservation of the siphuncle make the determination doubtful.

Collections: E. E. Teller; Public Museum, Milwaukee.

Locality: Milwaukee cement quarry, Berthelet, Wisconsin.

Orthoceras sp. undet

Plate XLII, figs. 3, 3A

Description: A specimen with a greater apical angle than other specimens examined from the Milwaukee Devonic has not been included in a described species. It is probably a specimen of some species closely allied to *O. bebryx* Hall but does not appear to be of that species.

The air chambers have a depth of about 3½ mm. Siphuncle central. Cross-section either circular or sub-circular.

Collection: H. F. Cleland.

Locality: Zone B of the Milwaukee cement quarry, Berthelet, Wis.

Genus **Gomphoceras** Sowerby.

Gomphoceras wisconsinense Cleland

Plates XXIX, XXX, XXXI

Gomphoceras wisconsinense Cleland, Jour. Geol. Vol. XV, 1907, p. 461, figs. 1, 2, 3.

Description: Shell very large, straight, extremely gibbous. Longitudinal section like a pointed amphora. The shell rapidly enlarges to a point about midway between the apex and the aperture, becoming ventricose; thence it more gradually narrows to near the aperture where it flanges out.

Chamber of habitation large, about one third the total length of the shell, gradually enlarging from within a short distance of the last

septum to near the aperture where it flanges out. In all specimens the chamber is concave near the aperture but not in the same degree. No other specimen examined shows this character so strongly developed as that shown in Plate XXIX.

Air chambers more than 20, increasing in frequency toward the apex and varying in width (in one specimen) from 5 mm. near the chamber of habitation to a maximum of about 16 mm. where the diameter of the shell is greatest. Siphuncle marginal. In one specimen with a diameter of about 9.5 cm. the siphuncle has a diameter of about 11 mm.

Surface unknown.

One specimen of medium size which is crushed laterally measures about 22 cm. in length and 15 cm. in its greatest diameter, the actual diameter of a circle being about 10.5 cm.; the largest specimen examined has a diameter of about 12 cm.

This specimen most resembles *G. mitra* Hall from the Upper Helderberg limestone of Lexington, Indiana, but differs from it in essential points.

Gomphoceras hyatti Whitfield, of the "Upper Helderberg group" of Ohio bears some resemblance to *G. wisconsinense* but differs in the apical angle and in the chamber of habitation. It is possible that *G. hyatti* is an ancestral form.

Remarks: Specimens of this cephalopod occur rarely in the Milwaukee cement quarry. They are called "horses hoofs" by the quarrymen because of a fancied resemblance to these objects. The fossils of *G. wisconsinense* are usually very much distorted. This was probably due to the thinness of the shell and to its peculiar shape which caused a whirling motion as the dead animal sank through the waters to the soft bottom of calcareous mud, where it rested in the position it had in the water immediately before striking the bottom. As a result of this whirling motion, it is seldom that two individuals struck the bottom at precisely the same angle. The effect, whether due to impact or to the weight of the superimposed sediments, was a distortion in different planes resulting in a great variety of fossil forms. It is possible that these cephalopods never left the bottom during life but were brought to the surface during putrifaction.

Collections: E. E. Teller; Public Museum, Milwaukee.

Location: Milwaukee cement quarry, Berthelet, Wis.

Gomphoceras whitfieldi Cleland

Plates XXXIX, XL

Gomphoceras whitfieldi Cleland, Jour. Geol. Vol. XV, p. 464, figs. 9, 10, 1907.

Description: Shell medium, sub-triangular in a longitudinal section. Transverse section elliptical or circular. Conch rapidly and regularly enlarging from the apex to the point of greatest transverse section, thence contracting more gradually to the aperture. Apical angle about 25 degrees in a crushed specimen.

The chamber of habitation apparently varies in length from 3.5 cm. to more than 6 cm. depending upon the maturity of the animal. Aperture oval or sub-circular. Air chambers regular, varying little in depth from the chamber of habitation to near the apex. Siphuncle marginal. Surface unknown.

Length of two incomplete specimens 13 and 14 cm. respectively; greatest diameter of a crushed specimen about 9 cm.

This species differs from *G. calvini* in its more acute apical angle and symmetrical form; from *G. brevipositicum* and *G. fusiforme* in its greater size and more obtuse apical angle.

Collections: H. F. Cleland; E. E. Teller; Public Museum, Milwaukee.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Gomphoceras calvini Cleland

Plate XXXIV, fig. 1; Plates XXXV, XXXVI, XXXVII

Gomphoceras calvini Cleland, Jour. Geol. Vol. XV, 1907, p. 465, figs. 4, 5, 6, 7.

Description: Shell large, fusiform. Transverse section elliptical or circular. Tube regularly enlarging from near the apex to the greatest transverse diameter which is posterior to the chamber of habitation, at the third or fourth septum; thence contracting to the aperture, but hanging to one side in old age.

Chamber of habitation large. Air-chambers irregular, varying in depth within 9 cm. of the chamber of habitation, from 5 to 10 mm. Hyponomic sinus shallow and apparently on the concave side. Siphuncle is a crushed specimen 7 mm. from the periphery on the concave side.

Surface unknown. Internal mold frequently covered with parasitic bryozoa.

In none of the specimens which are referred to this species is the

apex retained. This species somewhat resembles *G. fischeri* Hall of the New York Marcellus, but differs from it in the arrangement of septa. It also resembles *G. plena* Hall.*

The restoration of this species was difficult because of the poor preservation of the fossils. The apical angle and the rim of the aperture are somewhat in doubt, but are probably correctly shown. It did not seem best with the material at hand to attempt a restoration of the initial stages, but it is probably as shown in Plate XXXV, fig. 1. It is possible that the transverse section was broadly elliptical. Because of the unsymmetrical form the specimens are usually crushed in the same plane.

Collections: E. E. Teller; H. F. Cleland; Public Museum, Milwaukee.

Locality: Milwaukee cement quarry, Berthelet, Wis. This species occurs commonly in the "hard layer," zone B.

Gomphoceras sp. undet

Plate XXXVIII

Gomphoceras sp. Cleland, Jour. Geol. Vol. XV, 1907, p. 468, fig. 8.

Description: A somewhat crushed specimen of a large Gomphoceras differs from other Milwaukee cephalopods in that it is subfusiform and has a large chamber of habitation which contracts slightly toward the aperture. Septa 3 or 4 mm. apart near the chamber of habitation, but 9 to 10 mm. apart 6.5 cm. from the chamber. Transverse section subcircular or circular. The greatest diameter appears to be at about the tenth septum. This specimen may prove to be a variety of *G. wisconsinense* Cleland.

Collection: H. F. Cleland.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Gomphoceras brevipositicum Whitfield

Plate XLI, figs. 4, 5

Gomphoceras brevipositicum Whitfield, Geology of Wisconsin, Vol. IV, (1873–79), published 1882, p. 339, Plate XXVI, fig. 15.

Gomphoceras brevipositicum Cleland, Journal Geol. Vol. XV, 1907, p. 467, fig. 13.

Description: "Shell rather below medium size, very rapidly expanding from below upward, the rate of increase more rapid toward

* Paleontology of New York, 1888. Supplement to Vol. V, Part 2, plate 121 A.

the base of the outer chamber than in the earliest stages of growth, and again decreasing in the same rate to near the middle of the chamber, and gently contracted above to the aperture. The rate of increase in the type specimen in a length of two inches below the point of greatest diameter, is from a little less than five-eighths of an inch to one inch and seven-eighths; septa moderate, those preserved being about one-eighth of an inch apart; siphuncle lateral in the specimen; aperture sharply sinuate on one side, at a distance of one-fourth of the circle from the position of the siphuncle. No evidence of the lobed contraction of the aperture, as in the Silurian examples of the genus, exists.'' Whitfield 1882. The siphuncle is on the dorsal side.

It is possible that *G. fusiforme* Whitfield and *G. brevipositicum* Whitfield are of the same species, the difference in the chamber of habitation being due to age. The shells are almost identical in size, in the depth of the air chambers, and as to the margin of the aperture.

Collections: Public Museum Milwaukee; E. E. Teller; H. F. Cleland, etc.

Locality: Milwaukee cement quarry, Berthelet, Wis; ''Whitefish bay, near Milwaukee.''

Gomphoceras fusiforme Whitfield

Plate XLI, figs. 1, 2, 3, Plate XXXIV, fig. 2

Gomphoceras ? fusiforme Whitfield, Geology of Wisconsin, Vol. IV, (1873–79), published 1882, p. 338, plate XXVI, fig. 16.

Gomphoceras fusiforme Cleland, Jour. Geol. Vol. XV, p. 467, 1907.

Description: ''Shell rather below a medium size, very moderately expanding from below upward to near the middle of the outer chamber, as seen on the type specimen, above which it again decreases to the aperture somewhat more abruptly than below. Section circular, or very nearly so, the slight flattening of the specimen being probably due to compression. Septa not distinctly defined in the specimen, but apparently about one-sixteenth to one-twelfth of an inch apart, and but slightly concave.'' [Septa 5 mm. apart at the chamber of habitation, and 3 mm. apart 3 cm. from the chamber. Siphuncle marginal.] Whitfield 1882.

This species resembles *G. tumidum* Hall of the Chemung shales of New York.

It is possible that this is an old-age form of *G. brevipositicum* Whitfield. For discussion on this point see description of that species.

Collections: Public Museum, Milwaukee; H. F. Cleland; E. E. Teller, etc.

Locality: Milwaukee cement quarry, Berthelet, Wis., especially abundant in the "hard layer", zone B; Whitefish bay near Milwaukee.

Gomphoceras sp. undet.

Plate XLII, fig. 1

Description: The characters peculiar to this specimen are the acuteness of the apical angle of the initial stage for a distance of 4 or 5 cm. and the rapid enlargement of the conch from that distance, toward the aperture. The angle of the initial stage is about 28 degrees but that of the body of the shell is large. In the only specimen found the apex is pyritized.

Collection: H. F. Cleland.

Locality: Milwaukee cement quarry, Berthelet, Wis.

Genus **Gyroceras** de Kon.

Gyroceras eryx Hall

Plate XXXIII

Gyroceras eryx Hall, Pal. N. Y., Vol. V, pt 2, 1879, p. 386, plates LVIII and CIII.

Gyroceras eryx Cleland, Jour. Geol. Vol. XV, 1907, p. 469, fig. 14.

Description: Shell large, regularly coiled, forming a very open spiral, making about one and one half volutions. Regularly enlarging from near the apex to the chamber of habitation. Circular or subcircular in transverse section. Apex unknown. Greatest diameter of the coil 17 cm.

Chamber of habitation comparatively short, and in one specimen appears to be contracted toward the aperture. Aperture not clearly shown, but apparently has a shallow hyponomic sinus on the convex side.

Septa numerous, regular with straight transverse sutures which near the chamber of habitation are 9 mm. apart on the convex side, and 5 mm. apart on the inner side.

Siphuncle small, situated about one third the diameter of the shell from the lower side.

What appear to be surface markings are preserved on the inner mold of one specimen (Plate XXXIII) and show fine growth lines swinging backward and crossing the septa at an angle of about ten degrees. Fine, irregular, longitudinal lines which appear to be vestiges of color markings are also shown.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Locality: Milwaukee cement quarry, Berthelet, Wisconsin.

Gyroceras sp.

An incomplete specimen of a large individual in which a portion of the chamber of habitation and two air chambers are preserved is in the Teller collection. The circumference of the volution is 22 cm. The specimen when complete must have had a diameter of at least a foot. The siphuncle is about 1 cm. from the inside of the volution.

Collection: E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet, Wisconsin.

Gyroceras sp.

Plate XXXII

Description: A specimen with a very slight curvature and which enlarges much more rapidly than the common Milwaukee species, *G. eryx* Hall, has air chambers of about the same depth. This may prove to be a new species but with the material at hand it seems best to attempt no description.

Collection: E. E. Teller.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Genus **Goniatites** De Haan.

Goniatites sp. undet.

Plate XLII, fig. 4

Description: A single crushed specimen which is little more than a shadow is a small discoid Goniatite in which no trace of the sutures can be seen. The greatest diameter of the specimen is 5 cm.

Collection: E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet, Wisconsin.

CHAPTER X

CRUSTACEA

The Middle Devonic formation in Wisconsin has yielded very few crustacean remains, the most abundant being the wide-spread trilobite, *Phacops rana* Green from the shaly layers of the Milwaukee quarry. Portions of two specimens of *Echinocaris punctata* Hall and one fragmentary specimen of *Tropidocaris* sp. were collected by Mr. E. E. Teller. The four species of Ostracoda illustrated and described below were identified by R. S. Bassler from material sent to him for examination.

Class **CRUSTACEA.**

Sub-Class **TRILOBITA**

Order OPISTHOPARIA Beecher.

Family PROËTIDAE Barrande.

Genus **Proëtus** Steininger.

Proëtus rowi Green

Plate XLIV, figs. 1

Proëtus rowi Hall, Pal. N. Y., Vol. VII, 1888, p. 119, plates XXI and XXIII.

Description: Body ovate or elongate-elliptical in outline. Cephalon semicircular to semielliptical in outline. Border broad and flat.

Glabella simple; length one third greater than the width. Usually no trace of lateral furrows are preserved.

Eyes prominent, large, lunate, not elevated above the surface of the glabella. Cheeks relatively narrow. Thorax composed of ten segments. Pygidium subcircular or subelliptical in outline. Surface ornamented with faint obsolete pustules and granulations.

Collections: E. E. Teller; Public Museum, Milwaukee; H. F. Cleland.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee.

Proëtus crassimarginatus ? Hall

Remarks: It is possible that certain of the pygidia in the collections from Milwaukee and Lake Church are of this species.

Order PROPARIA Beecher.

Family PHACOPIDAE Salter.

Genus **Phacops** Emmrich.

Phacops rana Green

Plate XLIV, fig. 2

Phacops rana Meek and Worthen, Geol. Survey Illinois, Vol. III, 1868, p. 447, pl. 11, 1a-e.

Phacops rana Hall and Clarke, Pal. New York Vol. VII, 1888, p. 19. pl. VII, figs. 1–11; pl. VIII, figs. 1–18, pl. VIII A, figs. 21–33.

Phacops rana Kindle, 25th Ann. Rept. Dept. Geol. etc. Indiana, 1900, p. 744, pl. 31, figs. 1, 1a, 1b.

For more complete bibliography see Hall and Clarke p. 19.

Remarks: This well known trilobite occurs throughout the Milwaukee section but is never abundant. As is usually the case with Devonic trilobites it is seldom that a specimen is complete, the cephalon, pygidium and thorax being generally separated. Occasionally a rolled specimen is found.

Collections: Public Museum, Milwaukee; E. E. Teller; H. F. Cleland.

Locality: Milwaukee cement quarry, Berthelet, Wis.; Whitefish bay; Lake Church.

Sub-Class **EUCRUSTACEA** Kingsley.

Sub-Order OSTRACODA Latreille.

Family BEYRICHIIDAE Jones.

Genus **Bollia** Jones and Holl.

Bollia ungula Jones

Plate XLIV, fig. 5

Bollia ungula (Claypole MSS.), Jones, Amer. Geol., IV, 1889, p. 338, figs. 10–13.

Bollia ungula Ulrich, Journal Cincinnati Society Natural History, Vol. XIII, 1891, p. 188, pl. 144, figs. 6a, b.

Description: Size varying in length "from 1 to 2½ mm." It

differs from *Bollia lata* Hall in its larger size and in the greater thinness of the central ridge at its curve. The exterior is probably smooth.

Collection: United States National Museum.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee.

Genus **Barychilina** Ulrich.

Barychilina walcotti (Jones)

Plate XLIV, figs. 7, 8

Primitia ? walcotti, Quart. Journ. Geol. Soc. London, Vol. XLVI, 1890, p. 543, text figure 1.

Kirkbya (?) *walcotti* Jones, Geol. Surv. Canada, Cont. Micro. Pal. 1891, p. 96, pl. 11, figs. 12a, b.

Barychilina walcotti Ulrich, Journ. Cincinnati Soc. Nat. Hist. Vol. XIII, 1891, p. 199 (generic reference).

Barychilina walcotti Whiteaves, Geol. Surv. Canada, Cont. Canadian Pal., Vol. I, Pt V, 1898, p. 409 (locality occurrence).

Description: "Length .95 mm.; height .47 mm. An oblique Primitia? * * * * with a central pit, and elegantly ornamented with narrow curved ridges and furrows (of about equal width). These are nearly straight, and somewhat inosculating on the dorsal, tortuous and interrupted on the ventral region. Small pits occur here and there along the furrows, as if marking obsolete meshes." Jones, 1890.

Collection: National Museum, Washington, D. C.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee.

Genus **Kirkbya** Jones.

Kirkbya subquadrata Ulrich

Kirkbya subquadrata Ulrich, Journal Cincinnati Society Natural History, Vol. XIII, 1891, p. 192, pl. 15, figs. 1a, 1b, 1c.

Description: "Size: Length, 0.87 mm.; height, posterior, 0.62 mm., anterior, 0.57 mm.; thickness of one valve, 0.18 mm."

"Valves compressed, subquadrate, ends subequal, the anterior the narrowest and most curved; back slightly concave, ventral edge straightened, dorsal angles blunt, antero- and postero-ventral regions abruptly recurved. Free margins with a sharply elevated ridge, enclosing the reticulated body of the valve. A sharply defined, large umbilical pit just in front of the center of the reticulated area. Point of greatest convexity a little behind the pit." Ulrich, 1891. An imperfect specimen which may prove to be of this species was found.

Locality: Shaly layers, zone C, of the Milwaukee quarry, Humboldt street bridge.

Collection: United States National Museum, Washington.

Genus **Ulrichia** Jones.

Ulrichia conradi Jones

Plate XLIV, fig. 6

Ulrichia conradi Jones, Quart. Jour. Geol. Soc. London, Vol. XLVI, 1890, p. 544, text figure 2.

Ulrichia conradi Jones, Geol. Surv. Canada, Cont. Micro-Pal., pt III, 1891, p. 95, pl. 11, fig. 13.

Ulrichia conradi Whiteaves, Geol. Surv. Canada, Cont. Can. Pal. Vol. I, pt V, 1898, p. 409 (locality occurrence).

Description: "This small bituberculate and punctate valve is near *P. morgani*, but is more oblong, margined with a distinct raised rim, and has two tubercles obliquely peaked, and nearly equal in size." Jones, 1890.

Collection: National Museum, Washington, D. C.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee.

Superorder MALACOSTRACA Latreille.

Order PHYLLOCARIDA Packard.

Family ECHINOCARIDAE Clarke.

Genus **Echinocaris** Whitfield.

Echinocaris punctata Hall

Plate XLIV, figs. 3 and 4

Echinocaris punctata Hall, Pal. New York, Vol. VII, 1888, p. 166, plates XXVII, XXVIII, XXIX.

Description: "Each valve obliquely sub-ovate, widest posteriorly. Surface gently and irregularly convex, most elevated in the postero-lateral region. Length to greatest width as 1.5:1. [In the Milwaukee specimen as 3:5 and in the New York specimens examined, as 3:4.] Hinge-line short, somewhat longer than one-half the length of the carapace, slightly thickened and elevated, and upon the posterior half bearing three or four low tubercles. The anterior margins of each valve are slightly reëntrant at the dorsal line, curving thence abruptly and rounding to the ventral edge in a constantly widening arc to the postero-lateral extremity; thence forward the margin is sharply

curved for a short distance and slopes to the hinge in a nearly straight line. The posterior reëntrant angle thus formed between the valves is broad and deep. The entire margin is normally somewhat thickened and elevated into a sharp ridge. In well preserved examples, the posterior margin bears a few low tubercles, which, in old individuals, are elongated into stout spinules.

"Surface of the carapace over the cephalic region covered with low faint pustules, which become more conspicuous upon the thoracic region." Hall, 1888.

The abdominal somites of the specimen figured (fig. 4) differ from those of New York *E. punctata* in certain particulars and may be of a new but closely related species. The caudal spines of the New York specimens are broader and shorter than those of the Milwaukee specimen, one caudal spine of which measures 34 mm. in length. The somites are longer than in any New York specimen examined, the longest somite being 10 mm. in width and 12 mm. in length. There is a strong central spine at the posterior portion of the segments and apparently two others at the sides. In *E. punctata* these spines are small.

Collection: E. E. Teller.

Locality: Milwaukee cement quarry, Berthelet.

Genus **Tropidocaris** Beecher.

Tropidocaris sp.

Plate XLIV, fig. 9

Description: A single specimen of a crushed individual in which the two valves overlap obscuring the hinge-line, appears to be of this genus. The valves are about 5 cm. in length. Two strong carinae extend to within 13.5 mm. of the anterior and, if extended, would form an angle of 23 degrees with each other. The optic node is inside the inner carina and about 10 mm. from the anterior border.

Remarks: The specimen from Milwaukee differs from those of New York in its greater size, in the greater length in proportion to the width, and in the carinae which, in the Milwaukee specimen, is much straighter. The abdominal somites are longer than in any New York specimens examined, the longest somite being 10 mm. in width and 12 mm. in length. One caudal spine measured 34 mm. in length.

Collecton: The only specimen collected is figured. E. E. Teller.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee.

CHAPTER XI

PISCES (FISHES)

The most striking of the Devonic fossils of Milwaukee are the fish remains which consist of thick plates, spines, jaws and scales representing at least eighteen species. The best specimens thus far collected are to be found in the private collection of E. E. Teller of Milwaukee and the excellent collection donated by C. E. Monroe to the Public Museum Milwaukee.

It was the fish remains that gave to that versatile naturalist, Increase A. Lapham, the clue to the age of the rocks. It is rather remarkable that this should have been the case since fish fossils, though conspicuous when present, are among the rarest of the Devonic organic remains. The number of species represented in the Wisconsin Devonic (see list of species, page 20), is, however, large as compared with that of other States.

The descriptions of species given below are taken largely from the writings of Dr. C. R. Eastman and the late Professor T. S. Newberry.

Sub-Class **ELASMOBRANCHII** (Sharks and Rays).

Order ICHTHYOTOMI.

Family CLADODONTIDAE.

Genus **Cladodus** Agassiz.

Cladodus monroei Eastman

Plate XLVII, fig. 3

Cladodus monroei Eastman, Jour. Geol. vol. 8, 1900, page 36, text fig. 2. N. Y. State Museum Memoir 10, 1907, p. 62, plate 1, fig. 5.

"The type of this species is a small, imperfectly preserved tooth found by Mr. Charles E. Monroe in the Hamilton limestone of Milwaukee, Wis. The median cone is robust, very thick at the base, and indistinctly striated. The external denticles are also stout in proportion to the size of the principal cone, but the three intermediate denticles of either side are excessively small. The total hight of the median

cone probably amounted to less than 1.5 cm, and the width across the base 2.5 cm.'' Eastman, 1907.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wis.

Sub-Class **HOLOCEPHALI.**

Order CHIMAEROIDEI.

Family PTYCTODONTIDAE.

Genus **Rhynchodus** Newberry.

Rhynchodus excavatus Newb.

Plate XLVII, fig. 4

R. excavatus Newberry, Geol. Survey Wisconsin, vol. 2, 1877, p. 397.
Newberry, Mon. 16, p. 50, Pl. 29, fig. 1—1a, 1889.
Rhynchodus excavatus Eastman, N. Y. State Museum Memoir 10, 1907, p. 68.

Description: ''Tooth small; size when entire perhaps two an a half inches long by one and a quarter deep; the crown alone preserved. Of this the external surface is marked vertically with vermicular furrows; superior margin sinuous, terminating anteriorly in a prominent point; the superior surface irregularly excavated and roughened, showing two elevations or tubercles, one on the middle of the exterior margin and one near the anterior extremity. The inner surface of the tooth shows a prominent ridge running up to the anterior point.'' Newberry, 1889.

''The total length of the dental plates rarely exceeds 5 cm. and there is close similarity between those of the upper and lower jaws, excepting that the symphysial margin of the lower is produced into a long and slender descending spine, and the cutting edge of the upper is somewhat less arched or ''excavated'' than in the lower dental plates. As shown by marks of wear, the tips of the lower dental plates closed outside and slightly behind those of the upper, in the same manner as in *Ptyctodus.*'' Eastman 1907.

Locality: Brown Deer, Wisconsin.

Rhynchodus sp.

Plate XLVII, fig. 6

Description: ''Detached plates of the form shown are thin and scale-like in appearance, and displaying a uniform configuration, are an invarible accompaniment of Ptyctodont dentition in the Hamilton limestone of Wisconsin and Cedar Valley limestone of Iowa,

being especially abundant in Bremer and Black Hawk counties in the latter State. Long suspected to be of Chimaeroid nature, owing partly to their resemblance to certain dermal ossifications of *Myriacanthus,** evidence is now at hand which renders their association with Rhynchodus extremely plausible, and the chances are that the species is *R. excavatus* Newb. Easily recognizable as external dermal structures, the most likely position that can be theoretically assigned them pending the discovery of parts preserved *in situ,* is in the shoulder region, lying free in the integument, and manifestly without connection with any internally situated elements such as the pectoral arch.

"Considerable similarity is to be noticed between these definitely characterized dermal plates from the Hamilton, here associated with *Rhynchodus,* and the segmented spiniferous plates from the Onondaga and 'Corniferous' limestone of the Ohioan region described as *Acanthaspis armata;* and there is reason to believe that both varieties of plates are homologous with certain tuberculated structures found in natural association with a foreign species of *Rhynchodus,* † but of which Jaekel has constructed his so-called 'Shoulder-girdle of Rhamphodus.' Under no possibility, however, can any of these plates be conceived of as endoskeletal elements, hence the statement would appear to be justified that Jaekel's attempted restoration of a pectoral girdle for this genus is without foundation of fact. It has, indeed, been characterized by English and American students as a purely mythical creation. On the other hand, from a distributional standpoint, it is interesting to note that Rhynchodus dental plates in the Mesodevonic of both the Ohioan and Dakotan (Iowa) provinces, and also in the Upper Devonic of Wildungen in Germany, are accompanied by dermal ossifications of distinctive pattern and evidently homologous nature." Eastman. Letter dated Jan. 28, 1908.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wis.

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* Amer. Nat. (1898), 32, p. 556.

† *R. major* Eastm. with which the terms *R. emigratus* v. Huene and *Rhamphodus tristrodon* Jaekel are synonymous.

Genus **Ptyctodus** Pander.

Ptyctodus calceolus N. & W.

Plate XLVIII, figs. 1–17

Ptyctodus calceolus Eastman, Am. Nat. vol. 32, p. 476, figs. 1–17, 1898; N. Y. State Museum Memoir 10, 1907, p. 71.

Description: "Dental plates compressed into a thin cutting edge shortly behind the symphysis, but widening gradually, becoming more or less outwardly curved, and the oral surface occupied for nearly its entire width by the tritoral area, the inner margin of which is more strongly curved than the other. Laminar structure of the tritors indicated superficially by fine punctae arranged in parallel rows running obliquely across the functional surface. The compressed edge in advance of the tritor in the lower dental plate slopes rapidly upward and terminates in a strong anterior beak. Upper dental plates similar to the lower, except that the symphysial border is rounded and not produced into a beak." Eastman, 1907.

Locality: Milwaukee quarry, Humboldt street bridge, Wisconsin. It is also found in the Middle Devonic of Iowa, Illinois, Missouri and Manitoba.

Ptyctodus compressus Eastman

Plate XLVIII, figs. 18–27

Ptyctodus compressus Eastman, Am. Nat. vol. 32, p. 479, fig. 18–27, 1898.

Ptyctodus compressus Eastman, N. Y. State Museum Memoir 10, 1907, p. 72.

Description: "The tritors in this species are relatively longer and narrower than in the preceding, and the oval margin in advance of the triturating surface is developed into a long, sharp cutting edge. In all other species this trenchant margin is shorter than the tritorial area but in the present form it is invariably longer, sometimes exceeding the length of the tritor by one fourth. The dental plates are as a rule less curved than those of *P. calceolus*, and the symphysial beak less produced." Eastman, 1907.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin. It also occurs in the State Quarry beds in Iowa.

Ptyctodus ferox Eastman

Plate XLIX, fig. 35–40.

Ptyctodus ferox Eastman, Am. Nat. vol. 32, p. 480, 483, figs. 35–40, p. 552, 1898.

P. ferox Eastman N. Y. State Museum Memoir 10, 1907, p. 72.

Description: "Dental plates unusually large and massive, attaining a total length of about 14 cm, and exhibiting but slight lateral curvature. Lower dental plate with a stout symphysial beak, the front margin projecting downward into a long spiniform process, evidently for strengthening the symphysial union. Anterior margin of upper dental plate uniformly rounded, not produced into a beak or spiniform process, and showing on the outer face marks of contact with the opposing dentition. Inner surface of both upper and lower dental plates with a roughened triangular symphysial facet. * * * The dental plates of *P. ferox* are accompanied not only by dermal spines, but by tuberculated dermal plates not unlike those associated with Myriacanthus." Eastman, 1907.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Genus **Palaeomylus** Sm. Woodw.

Palaeomylus greeni (Newberry)

Plate L

Rhynchodus greenei Newberry, Mon. U. S. Geol. Sur. vol. XVI, 1889, p. 51.

Palaeomylus greenei Eastman, Am. Naturalist, vol. 32, p. 546, fig. 48, 1898.

Description: "Teeth large and massive, six inches in length, one inch in thickness at the anterior border; elliptical or semi-circular in outline, the anterior angle produced into a strong triangular point; posterior to this a triturating flattened surface extends to or beyond the middle of the superior margin. This surface is broadest anteriorly, where it is three-quarters of an inch in width, and bears two obtuse rounded tubercles. The sides are smooth and polished, terminating below in sharp somewhat waved edges.

"The teeth of this species resemble those of *Rhynchodus frangens*, from the Devonian rocks of Ohio, but are narrower vertically, and are longer and much thicker at the anterior border." Newberry, 1889.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wis.

ICHTHYODORULITES (Fossil Fin Spines of Sharks, Chimaeroids, etc.)

Genus **Acantholepis** Newberry.

Acantholepsis fragilis Newberry.

Plate XLV, fig. 3

Acantholepis pustulosus Newberry, U. S. Geol. Sur. Mon. XVI, 1889, p. 34, plate 31, fig. 5.

Acantholepis fragilis Eastman, N. Y. State Museum Memoir 10, 1907, p. 79, pl. 3, fig. 1.

Description: "Cranial or body scutes having a somewhat spatulate form, and attaining in some cases a length of seven or eight inches and a breadth of two inches. These scutes were set contiguous to each other, forming a defense to the body or head; the more elongated ones becoming curved spines, similar in general character to those of Acanthaspis, but differing in this, that they are not united by sutures with flat bones, or plates, but are the extremities of such plates drawn out into spines, which must have projected from the general surface. The broader plates are quite thin, and seem to have been applied to flat or arched surfaces, while those which form spines have their remote extremities narrowed and thickened till they become prominent and effective defensive organs. In some instances the plates are triangular in outline, and seem to have been thin cones of bone or enamel, supported by cartilaginous centers. As the latter are decomposed, the sides which were once widely separated, were brought together or crushed in like broken shells.

"The external surface of these plates is tuberculated in a variety of ways. In some instances the tubercles are large, scattered, smooth and rounded, and resemble pustules. In other cases they are irregular and crowded; while ocasionally they are in rows, the interstices between them being beautifully chased and ornamented. Along the margins of the spinous extremities of the plates the tubercules are elongated until they become conical denticles." Newberry, 1889.

Locality: Some fragmentary specimens from the Milwaukee cement quarry, Humboldt street bridge, Milwaukee have been referred to this species.

Genus **Phlyctaenacanthus** Eastman.

Description: "Arcuate spines of large size, with flat lateral surfaces, very broad at the base and gradually tapering to an acute point. Ornamentation and other characters as in Acantholepis, except that the ex-

serted portion is certainly unsegmented. Inserted portion triangularly expanded, thin walled and hollow, recalling the conditions in the corresponding portion of Stethacanthus." Eastman, 1907.

Phlyctaenacanthus telleri Eastman

Plates LI and LII, fig. 1

Phlyctaenacanthus telleri C. R. Eastman, Am. Nat. vol. 32, p. 551, text fig. 49.

P. telleri Teller, Bull. Wis. Soc. Nat. His., vol. 4, No. 4, 1906, pp. 162–7, pls. 1–5.

P. telleri Eastman, N. Y. State Museum Memoir 10, 1907, p. 80.

Description: "The spines assigned to this species are scarcely distinguishable from those of Acantholepis, their form, structure and ornamentation being practically identical. The exserted portion, however, has been definitely ascertained to consist of but a single piece, and the inserted portion (unknown in Acantholepis) appears to have been embedded in the soft parts in similar fashion as in Stethacanthus. Admitting these remains to be fin spines, it would certainly seem that a like interpretation should be applied to Acantholepis." Eastman, 1907.

Collection: E. E. Teller.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wis.

Genus **Heteracanthus** Newberry.

Heteracanthus politus Newberry

Plate XLVII, figs. 1 and 2.

Heteracanthus politus Newberry, U S. Geol. Sur. Mon., 1889, vol. 16, p. 16, pl. 21, figs. 4, 5.

Gamphacanthus politus Miller, North Am. Geol. & Pal., 1892, p. 715.

Heteracanthus politus C. R. Eastman, Am. Nat. vol. 32, p. 552, 1898.

Heteracanthus politus Eastman, N. Y. State Museum Memoir 10, 1907, p. 82.

Description: "Spines attaining a total length of about 20 cm, very broad at the base, and with Ctenacanthus-like ornamentation. The longitudinal ridges, which are rather numerous and closely apposed, become perfectly smooth when worn, their presence being indicated only by the fine and deep intercostal grooves—the so called 'sinuous or denticulate longitudinal sutures' of Newberry. More or less variation in size and number of the costae is to be observed amongst different

examples. The basal portion seems to be regularly expanded, without forming an asymmetrical "shoulder" as in Physonemus, Stethacanthus, etc.

"Bilaterally symmetrical as these spines undoubtedly are, their position must have been in the median line of the body, and not, as suggested by Newberry and others, along the anterior margin of the pectoral fins." Eastman, 1907.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wis. It also occurs in Iowa and New York.

Heteracanthus uddeni Lindahl

Heteracanthus uddeni Lindahl, Cinn. Soc. Nat. Hist. Jour., vol. 19, p. 95, pl. 6, 1897.

Heteracanthus uddeni Eastman, Am. Nat., vol. 32, p. 557, 1898.

Heteracanthus uddeni Eastman, N. Y. State Museum Memoir 10, 1907, p. 83.

Description: "Spines of moderate size having the distal portion essentially as in the preceding species, but the basal portion curving forward so as to form a rounded anterior projection or "shoulder," somewhat similar to that in Stethacanthus. The longitudinal costae are finer and more closely crowded than in the type species, and exhibit a sigmoidal curvature toward the base." Eastman, 1907.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin. This species also occurs in Iowa in the Middle Devonic beds.

Genus **Machaeracanthus** Newberry.

Machaeracanthus longaevus ? Eastman

Remarks: Dr. C. R. Eastman in discussing certain fish fragments from the Milwaukee cement quarry says, "A few doubtful fragments, suggestive either of this species or *M. sulcatus* Newberry have been obtained from the Hamilton of Wisconsin."

Sub-Class **DIPNEUSTI.**

Order ARTHRODIRA.

Family COCCOSTEIDAE.

Genus **Dinichthys** Newberry.

Dinichthys pustulosus Eastman

Plate XLV, figs. 1 and 2, Plate XVI

Dinichthys pustulosus Eastman, Mus. Comp. Zool. Bul. vol. 31, p. 38, pl. 3, fig. 4, 1897.

Dinichthys pustulosus Eastman, Am. Nat., vol. 32, p. 748, text fig. 1, 2, 1898.

Dinichthys pustulosus Eastman, Jour. Geol., vol. 8, p. 32, text fig. 1, 1900.

Dinichthys pustulosus St. John, Am. Nat., vol. 36, p. 657, text figs. 1, 2, 1902.

Dinichthys pustulosus Hussakof, Am. Mus. Nat. Hist. Mem. vol. 9, p. 142, text fig. 22D, 1906.

Dinichthys pustulosus Eastman, N. Y. State Museum Memoir 10, 1907, p. 130, pls. 2, 5 and 12.

Description: "A primitive species somewhat smaller than *D. terrelli*, generally of about the size of *D. intermedius*, and distinguished from both by its fine tuberculation, wavy suture lines, and more Coc-

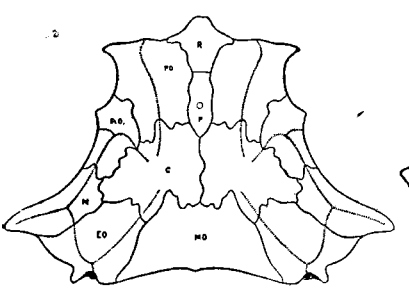

Fig. 4.—*Dinichthys pustulosus* Eastm. Middle Devonic; Iowa, Restoration of the head shield, dorsal aspect. Reduced. *C* = central; *EO* = external occipital; *M* = marginal; *MO* = median occipital; *P* = pineal; *PO* = preorbital; *PtO* = postorbital; *R* = rostral, sometimes identified as nasal or mesethmoid. Sensory canals represented by double dotted lines. (After Eastman.)

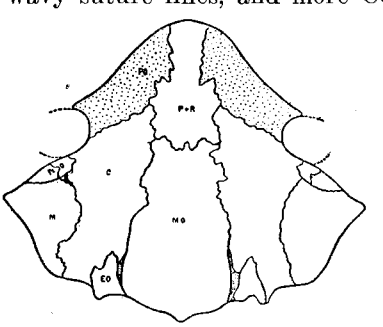

Fig. 5.—*Ncoceratodus forsteri* (Krefft) Dorsal aspect of cranial roof, drawn as if flattened out to same extent as in Dinichthys. Cartilaginous portions dotted, and dermal plates lettered to correspond with those of Arthodires. The undivided, anterior median plate is commonly termed mesethmoid. Reduced. (After Eastman.)

costeus-like aspect. Lower dental plates with a simple trenchant margin, behind which there is an abrupt downward slope beset with rudimentary denticles. Shear teeth with convex functional margin, simply trenchant, and without posterior denticles so far as known. Vomerine

teeth resembling those of *D. intermedius.* Visceral surface of occipital region without prominent ridges, the posterior pit of the median occipital scarcely divided. Pineal plate apparently in contact with the centrals, and with inconspicuous foramen." Eastman, 1907.

There are some fine specimens of this species in the Milwaukee Public Museum.

Remarks: This is one of the most abundant species of fish in the Wisconsin Middle Devonic. It also occurs in beds of the same age in Iowa and Illinois, and has been collected from the Devonic beds of Kentucky and New York.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Dinichthys tuberculatus Newberry

Dinichthys tuberculatus Newberry, U. S. Geol. Sur. Mon., vol. 16, p. 98, pl. 32, fig. 3, 1889.

Dinichthys tuberculatus C. R. Eastman, Mus. Comp. Zool. Bul., vol. 31, p. 38, 1897.

Dinichthys tuberculatus Eastman, N. Y. State Museum Memoir 10, p. 137, 1907.

Description: "An imperfectly definable species, known only by detached plates which are remarkable for their relatively great thickness, and coarsely tuberculate style of ornamentation. The known portions of the abdominal armor indicate a species rather less than one half the size of *D. intermedius.* In the present state of our knowledge, there are no reasons other than difference in geological horizon to prevent assigning to this species certain heavy and coarsely tuberculated Dinichthyid plates found in the Middle and Upper Devonic of Wisconsin and Iowa; neither is it possible, except for difference in geological age, to recognize a distinction between the plates known under this name and the so-called *D. precursor* Newberry, from the Corniferous limestone of Ohio." Eastman, 1907.

Locality: Fossils thought to belong to this species have been collected from the Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Genus **Titanichthys** Newberry.

Titanichthys sp.

Titanichthys sp. Eastman, Am. Nat., vol. 32, p. 556, 1898.

Titanichthys Eastman, N. Y. State Museum Memoir 10, 1907, p. 140.

Description: "Plates of head and trunk resembling those of *Dinichthys,* but relatively thinner, and more laterally expanded. Pineal

plate elliptical, broader than long, in contact with the centrals, and pierced by one or two foramina, the latter sometimes capped by a small bony operculum. Lower dental plates long and slender, without denticulations, grooved in the anterior portion of the oral margin as if for a horny sheath, and somewhat turned upwards at the symphysis. Outer (free) portion of clavicular developed as a stout arm, rounded or semicylindrical in cross-section.

"The remarkable fishes comprised by this genus represent the ultimate stage of specialization attained by *Dinichthyids*. Unable to maintain an existence except under peculiarly favorable conditions—their gigantic size, unwieldy organization and weak dentition presupposing an estuarine habitat and abundant food supply—they survived for a relatively short period, and within a limited area. Their remains are confined, so far as known, to the Upper Devonic of Ohio. Forerunners of the genus, however, make their appearance as early as the Ulsterian, and fragmentary plates very suggestive of *Titanichthys* occur in the Hamilton limestone of Milwaukee, Wis." Eastman, 1907.

Locality: Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wis.

Genus **Oestophorus**

Oestophorus (Sphenophorus) sp.

Sphenophorus N. S. Eastman, Am. Nat., vol. 32, p. 556, 1898.

Sphenophorus (Oestophorus) sp. Eastman. N. Y. State Museum Memoir 10, 1907, p. 157.

Remarks: Certain elliptical plates having a closely similar style of ornamentation to *Sphenophorus lilleyi* Newberry are known from the Middle Devonic beds in the Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Sub-Class **TELEOSTOMI.**

Order CROSSOPTERYGII.

Family ONYCHODONTIDAE.

Genus **Onychodus** Newberry.

Plate XLVII, fig. 5

Onychodus cf. *sigmoides* Eastman, N. Y. State Museum Memoir 10, 1907, p. 169, Plate I, fig. 3.

Remarks: "A few detached presymphysial teeth comparable in a general way to this species are also known from the Hamilton of Mil-

waukee, Wis., . . . others, with less pronounced sigmoidal curvature, are present in the Middle Devonic of the Eifel district." Eastman, 1907.

These specimens were collected from the rocks of the Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wis.

CHAPTER XII.

PLANTAE

The plant remains in the Wisconsin Devonic are, as far as the known exposures show, very rare. Two specimens in the Public Museum collected by C. E. Monroe, are, however, well preserved for rocks of this age. These specimens were described by Professor D. P. Penhallow of McGill University in the Bulletin of the Wisconsin Natural History Society in April, 1908. The descriptions are given below.

Genus **Nematophycus**

Nematophycus milwaukeensis Penhallow.

Plate LII, fig. 2

Nematophycus milwaukeensis ,Penhallow, Bull. Wis. Soc. Nat. His. vol. 6, no. 1, 1908, page 8, plate I.

Description. "The specimen [figured] measures 68 cm. in extreme length. It has been broken into three fragments, but when in place these show a continuous stem. The upper end has a width of 5.5 cm. and a maximum thickness of 1.7 cm. These dimensions are maintained for a distance of 41 cm. when the stem expands, at first gradually and them somewhat rapidly, into a rather large base 12 cm. broad and 3.8 cm. thick. These dimensions, however, probably do not represent the real base of the plant, since there is no evidence of a root system or of holdfasts. There is no evidence of branching at any part of the stem, although on the central fragment, on the side opposite that shown on the photograph, there is an apparent knot suggestive of a protecting organ of some sort. On closer examination, however, it is seen that this feature is completely covered by a prominent layer of coal derived from the carbonization of the superficial parts of the stem. Whatever its character may be, it is, therefore, closely related to the interior structure and not to the surface parts.

"The specimen shows several transverse joints. These are in no sense structural, but have been caused by displacement in the matrix and were subsequently filled with silica. Such joints are well known features of *Nematophycus*. Apart from them, there is no evidence of nodes, from which it may be concluded that the stem was of a very simple character such as may be met with in the stipes of the Laminariae.

"The interior of the specimen has been entirely occupied by silica which has so completely replaced all structure that no evidence of the nature of the plant from that source could be obtained. The only basis from which information could be secured, was found in the general form of the specimen and the occurrence of a very prominent layer of coal which originally extended over the entire surface, but which, owing to its friable character, has been very largely removed. The side of the specimen shown in the photograph, indicates the almost complete removal of this layer, but on the opposite side it covers nearly half the specimen. The coaly layer has a maximum thickness of 2 mm., and gives abundant evidence of the former presence of plant structure.

"In endeavoring to determine the possible nature of the plant represented, it may be recalled that there are only two genera of plants from so low a horizon, with which it may be compared—*Cordaites and Nematophycus.*

"With respect to the former, although at least four species are known to the Middle Devonian, there are none which may be directly compared with the present specimen, either in external appearance, or in mode of preservation, and it is permissible to exclude the genus from further consideration, without hesitation.

"*Nematophycus crassus* is known to the Hamilton group of New York. So far as the general mode of preservation may be taken as evidence, that presented by the Berthelet specimen is in exact accord with what is commonly found. Furthermore, the condition in which the plant is found, indicates clearly, that it was soft in texture and very susceptible to decay which had progressed extensively before infiltration.

"The absence of hapteres and other portions of the anchorage system, can not be adduced as evidence opposed to the view that this may have been a large alga, since such an objection would be equally valid as applied to Cordaites. All the evidence points with directness and force, to the idea that the plant is a species of *Nematophycus,* but which of the known species it is impossible to determine in the absence of the internal structure.

"So far as known, *N. crassus* is the only species found in the Hamilton group, and it must have had a very extensive distribution in Middle Devonian time. It is, therefore, in a high degree probable that the New York specimens and those from Milwaukee represent the same species. It would seem better, however, to indicate the latter by a distinctive name derived from the locality, until such time as further and more complete material may enable us to determine its relation to known species in a more thorough and satisfactory manner. I therefore call it *Nematophycus milwaukeensis.*" Penhallow, 1908.

Genus **Fucus**

Fucus bertheletensis Penhallow

Plate LIII

Fucus bertheletensis Penhallow, Bull. Wis. Soc. Nat. His., vol. 6, no. 1, 1908, page 11, plate II.

Description: [The specimen studied] "presents the form of several strap-shaped organs lying in parallel positions, and representing probably, the subdivisions of one plant." * * * [This] "plant is represented by a series of 16 linear members projected in a parallel manner. In three separate places it may be seen that the members subdivide by a regular dichotomy, and the conclusion is justified that such dichotomy is characteristic of the plant as a whole.

"The plant has been carbonized, but instead of a very thin filmy layer of carbon as would be obtained from plants of the type of *Zostera,* the deposit is somewhat bulky, and, indeed, represents the entire structure. The organs are obviously thicker in the middle where there is evidence of a structure comparable with a midrib as presented by the medullary region of many of the Phaeophyceae. Individually, the various members are linear, 4–7 mm. broad and distinctly dichotomous, the largest fragments showing simple branches 18 cm. in length.

"From these facts it is evident that the plant must have been possessed of rather thick and bulky parts, the structure of which was not only susceptible of somewhat ready decay, but which was entirely carbonized. Like *Nematophycus,* it was evidently of an aquatic habit. All of these considerations point with some force to a comparison with rockweeds, the essential feature of which it possesses in a large degree, although no fruit has been observed.

"The genus *Fucus* is not on record for so low a horizon, but there is no valid reason why it should not be found in the Middle Devonian, as well as the Laminarieæ. I designate it as *Fucus bertheletensis.*" Penhallow, 1908.

EXPLANATION OF PLATES.

PLATE I.

CORALS.

Aulacophyllum cf. *convergens* Hall.

Page 27.

Fig. 1. A much worn specimen from the Milwaukee section. Teller Collection.

Heliophyllum cf. *corniculum* M–E.

Page 29.

Fig. 2. An unusually perfect specimen for the Wisconsin Devonic of this species. The surface has parasitic growths of Aulopora.

Acervularia davidsoni E and H.

Page 30.

Figs. 3, 4. Gutta percha casts of the interior of the calices of two specimens from Lake Church. Figure 3 shows a specimen with coarse and figure 4 a specimen with fine septa.

Heliophyllum halli E and H.

Page 28.

Fig. 5. A gutta percha cast of the interior of a calice from the Lake Church section. This is the only form in which this species occurs at Lake Church.

Ceratopora rugosa nov.

Page 36.

Fig. 6. An unusually perfect specimen, for this genus, from the Milwaukee section.

Ceratopora jacksoni ? Grabau.

Page 36.

Fig. 7. A single specimen with two corallites parasitic on Atrypa reticularis. Enlarged one and one half diameters. Teller Collection.

Favosites alpenensis ? Winchell.

Page 31.

Fig. 8. A single specimen from the Teller collection which preserves some of the characters of the species.

Ceratopora agglomerata Grabau var.

Page 35.

Fig. 9. A specimen with the characters of this Lower Carboniferous species.

Favosites radiatus ? Rominger.

Page 31.

Fig. 10. The cast of the interior of a specimen that appears to be of this species.

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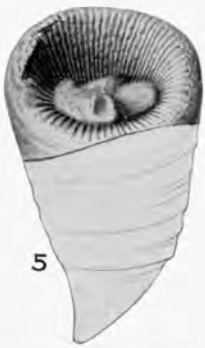

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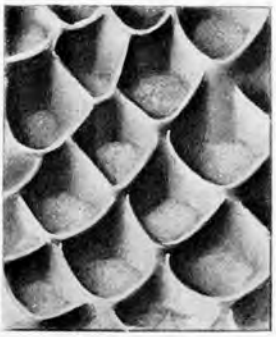

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PLATE II.

CORALS.

Alveolites ? monroei nov.

Page 33.

Fig. 1. The only specimen yet found in the Wisconsin Devonic of this species. The colony surrounds what appears to be a much crushed cephalopod.

Fig. 2. An enlargement to four diameters of a portion of the above.

Aulopora annectans Clarke.

Page 33.

Fig. 3. A specimen parasitic upon *Stropheodonta perplana.*

Aulopora serpens Goldf.

Page 34.

Fig. 4. A specimen parasitic on *Stropheodonta halli.*

Striatopora iowensis (Owen).

Page 32.

Fig. 5. An imperfect specimen showing the diameter and some of the characters of the species.

Ceratopora sp. nov.

Page 36.

Fig. 6. A cast of the exterior of a specimen from the Lake Church section.

Ceratopora flabellata Greene.

Page 34.

Fig. 7. A specimen showing the orifices and branching characteristic of the species. A valve of *Spirifer subvaricosus* rests upon the specimen.

PLATE III.

CRINOIDS AND BLASTOIDS.

Pentremitidea milwaukeensis Weller.

Page 43.

Fig. 1. A crushed specimen of this species. Public Museum, Milwaukee.

Nucleocrinus obovatus Barris

Page 43.

Fig. 2. A nearly perfect specimen showing the shape and surface ornamentation. Collected by C. E. Monroe. Public Museum, Milwaukee.

Pentremitidea filosa Whiteaves.

Page 44.

Fig. 3. A well-preserved specimen showing the characters of the species. Collected by C. E. Monroe. Now in the Public Museum, Milwaukee.

Melocrinus nodosus Hall

Page 38.

Fig. 4. A specimen in which an arm is preserved. Teller Collection.

Melocrinus nodosus var. *spinosus* Weller.

Page 39.

Fig. 5. A specimen with the spines broken but otherwise well-preserved. Collection of E. E. Teller.

Melocrinus subglobosus Weller.

Page 39.

Figs. 6 and 7. Lateral and top views of different specimens. **Fig.** 7 shows the position of the arm bases. Teller collection.

Melocrinus milwaukeensis var. *rotundatus* Weller.

Page 41.

Fig. 8. A specimen showing the spines and the position of the arm bases. Teller collection.

Melocrinus milwaukeensis Weller.

Page 40.

Fig. 9. A specimen in which a joint of the stem is attached. The position of the arm bases is also shown. Teller collection.

Melocrinus pentangularis nov.

Page 41.

Fig. 10. A specimen showing the characteristic pentangular shape of the body. Teller collection.

Taxocrinus interscapularis Hall.

Page 42.

Fig. 11. A well preserved specimen from the Teller collection.

Taxocrinus interscapularis ? Hall.

Page 42.

Fig. 12. A small specimen from the Teller collection which may be new.

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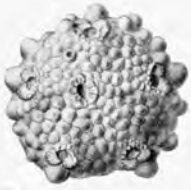

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PLATE IV.

VERMES AND COLEOLUS.

Arabellites crescentum nov.

Page 45.

Fig. 1. A nearly complete individual (enlarged x 20) from the shaly layers (zone C) of the Milwaukee quarry.

Cornulites sp.

Page 46.

Fig. 2. A specimen enlarged (x 2). This specimen is attached to a specimen of *Spirifer subvaricosus.*

Spirorbis omphalodes Whiteaves.

Page 46.

Fig. 3. A specimen, natural size, on *Schizophoria striatula.*

Fig. 3A. One individual from the above enlarged (x 5). Teller Collection.

Autodetus apicatus nov.

Page 47.

Fig. 4. Two specimens (natural size) on *Spirifer euryteines var. milwaukeensis.*

Fig. 4A. One of the above enlarged (x 5).

Tentaculites bellulus Hall.

Page 47.

Figs. 5, 6, 7, 8. To show the variations and occurrence of this species.

Coleolus sp.

Fig. 9. A silicified specimen from the Teller Collection.

PLATE V.

BRYOZOA.

Figures 3, 4, 8, 10, and 12 of this plate are copied from Ulrich and Bassler (Smithsonian Misc. Coll., Quart. Issue, XLV, 1904).

Heteronema monroei, new species.
Page 51.

Fig. 1. Several of the creeping threads, x 9, imperfectly preserved.
Fig. 2. Several more complete threads, x 9.
Both specimens are attached to fragments of *Cystodictya hamiltonensis*.
Devonic, Milwaukee, Wisconsin.

Rhopalonaria tenuis Ulrich and Bassler.
Page 53.

Fig. 3. The excavated mold of a normally developed colony, x 9.
Fig. 4. Mold of another colony, x 9, in which the zoœcia are crowded on account of the frequent crossing of the branches.
Devonic (Traverse), Alpena, Michigan.

Vinella devonica, new species.
Page 51.

Fig. 5. A nucleus with the usual number of radiating tubular stolons, x 9.
Fig. 6. Two nuclei, with connecting stolons, x 9.
Fig. 7. A nucleus with numerous radiating stolons, x 9.
The originals of figures 5 to 7 are attached to brachiopods.
Devonic, Milwaukee, Wisconsin.

Allonema fusiforme (Nicholson and Etheridge, Jr.).
Page 52.

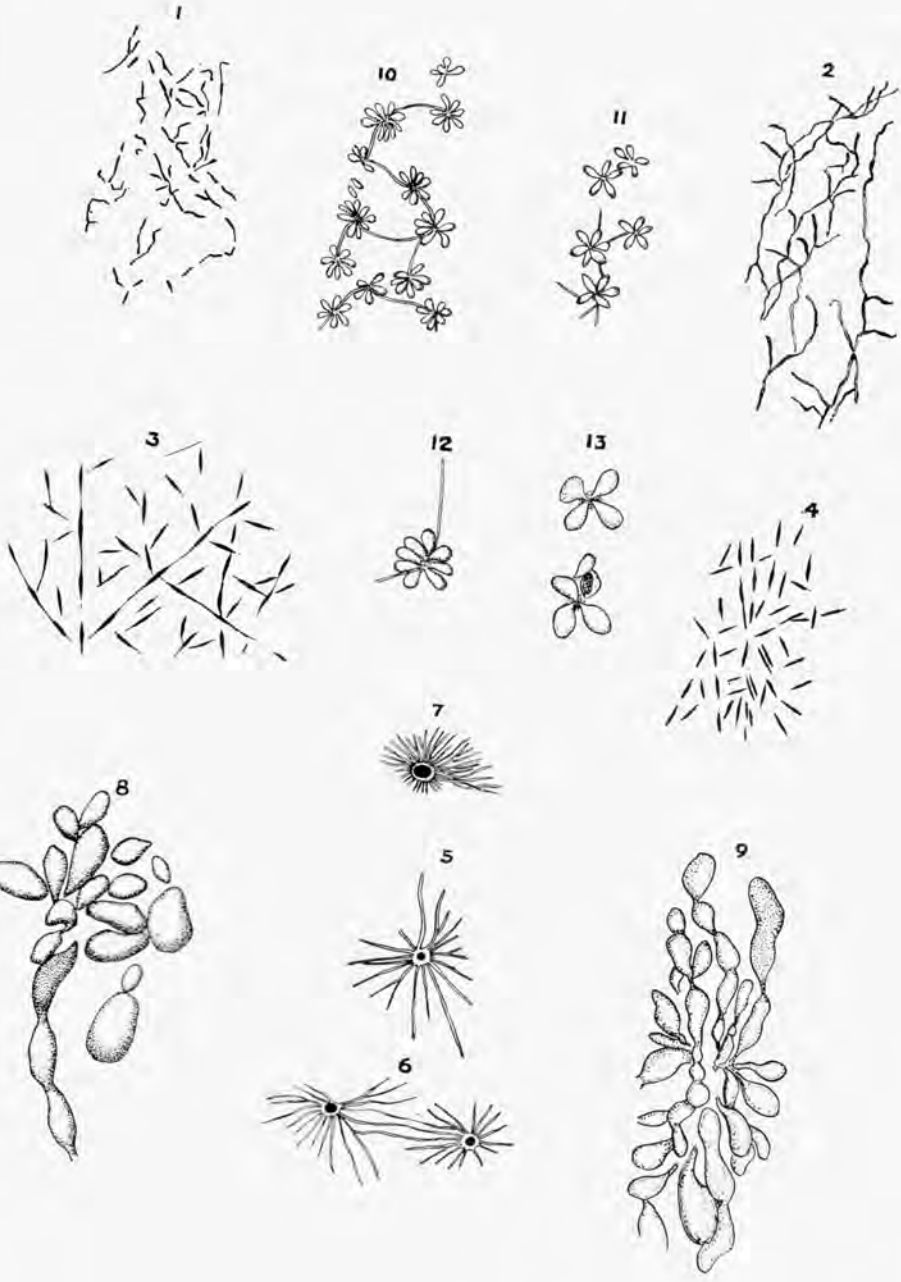
Fig. 8. Part of a colony, x 9, growing upon the poriferous side of a *Polypora*.
Devonic (Traverse), Alpena, Michigan.
Fig. 9. A small but nearly complete colony, x 9, attached to *Cystodictya hamiltonensis*. In both figures 9 and 10 only one vesicle is drawn to show the punctæ of the surface.
Devonic, Milwaukee, Wisconsin.

Ascodictyon floreale Ulrich and Bassler.
Page 53.

Fig. 10. Portion of a colony with numerous clusters, x 9, growing upon a *Stropheodonta*.
Devonic (Traverse), near Alpena, Michigan.
Fig. 11. A small colony, x 9, attached to *Cystodictya hamiltonensis*.
Devonic, Milwaukee, Wisconsin.

Ascodictyon stellatum (Nicholson and Etheridge, Jr.).
Page 54.

Fig. 12. A cluster, x 9, exhibiting the usual number of vesicles.
Devonic (Hamilton), Eighteen Mile Creek, New York.
Fig. 13. Two clusters with fewer vesicles than usual, x 9.
Devonic (Hamilton), York, New York.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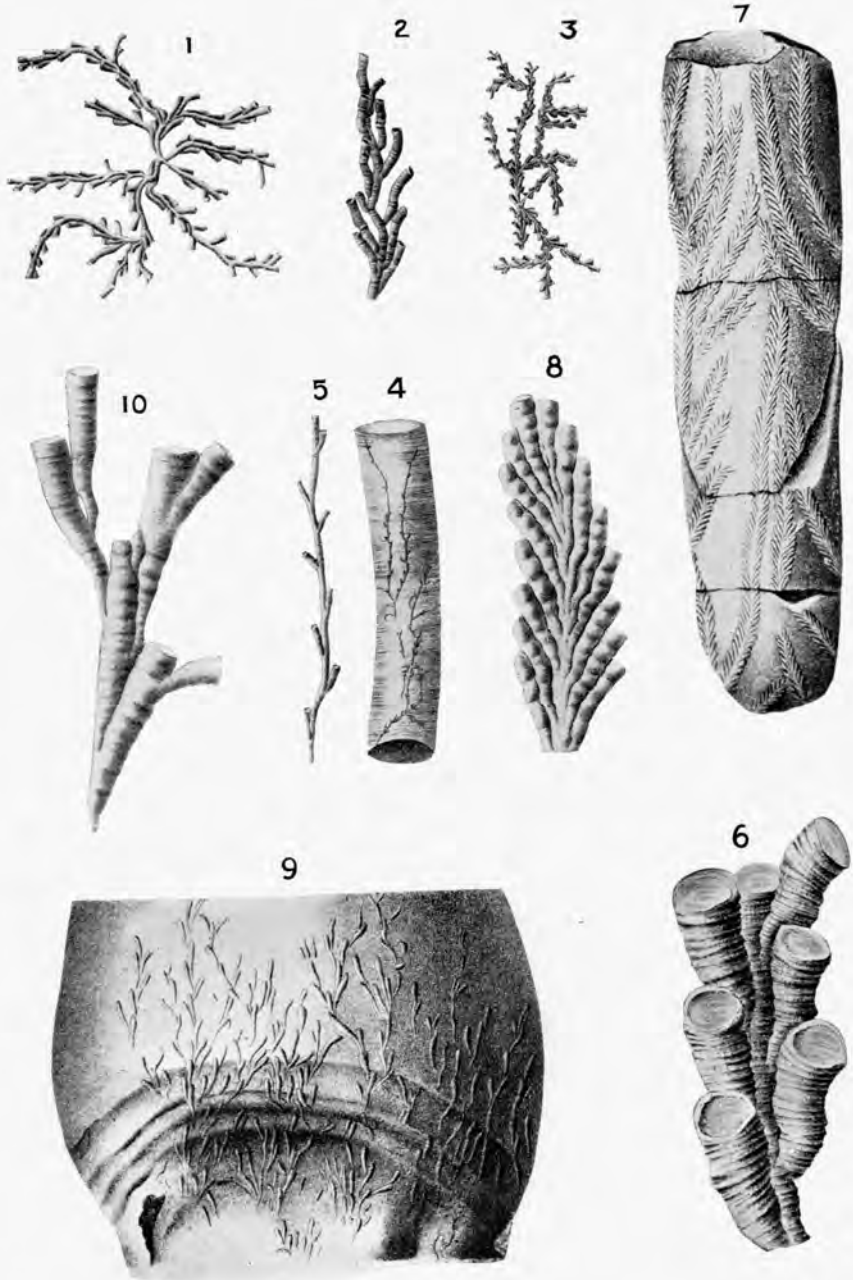
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PLATE VI.

BRYOZOA.

All the figures on this plate have been copied from Hall and Simpson. (Nat. Hist. New York, Pal., VI, 1887).

Hederella filiformis (Billings)

Page 55.

Fig. 1. A frond, x 1.5, showing the usual characters.

Fig. 2. Portion of a colony, x 4, exhibiting strongly annulated cell tubes.

Fig. 3. A colony, about natural size.

Devonic (Hamilton), York, New York.

Hederella cirrhosa Hall.

Page 57.

Fig. 4. A frond slightly less than natural size.

Fig. 5. A portion of fig. 4, x 4, showing the tubes and method of growth more distinctly.

Devonic (Hamilton), West Bloomfield, New York.

Hederella magna Hall.

Page 55.

Fig. 6. A portion of a frond, x 6, showing the form, mode of growth, and surface characters of the cell tube.

Devonic (Hamilton), York, New York.

Reptaria stolonifera Rolle.

Page 57.

Fig. 7. A typical specimen, natural size, encrusting an *Orthoceras*.

Fig. 8. An enlargement from figure 7, x 6.

Devonic (Hamilton), Cazenovia, New York.

Hernodia humifusa Hall.

Page 58.

Fig. 9. A colony, slightly reduced, encrusting a *Gomphoceras*.

Fig. 10. An enlargement of a portion of figure 9.

Devonic (Hamilton), Cazenovia, New York.

PLATE VII.

BRYOZOA.

Figures 1 to 6 are after Nicholson and Foord (Ann. and Mag. Nat. Hist. (5), XVI, 1885), and figures 7 to 12 are copied from Ulrich (Geol. Surv. Illinois, VIII, 1890).

Fistulipora utriculus Rominger.

Page 59.

Fig. 1. Tangential section, enlarged, showing the conspicuous lunarium and general arrangement of zoœcia and mesopores.

Fig. 2. Portion of figure 1, still further enlarged.

Fig. 3. Vertical section, enlarged.

Fig. 4. Surface of zoarium, greatly enlarged.

Figs. 5 and 6. Two zoaria, natural size.

Devonic (Hamilton), Thedford, Ontario.

Fistulipora monticulata Ulrich.

Page 59.

Fig. 7. A tuberculated example, natural size, showing mode of growth.

Fig. 8. Surface of same, x 12.

Figs. 9 and 10. Tangential and vertical sections, x 18, exhibiting the internal structure.

Devonic, Buffalo, Iowa.

Cyclotrypa collina (Ulrich).

(See also Plate XI, figs. 4, 5.)

Page 60.

Figs. 11 and 12. Vertical and tangential sections, x 18.

Devonic, Buffalo, Iowa.

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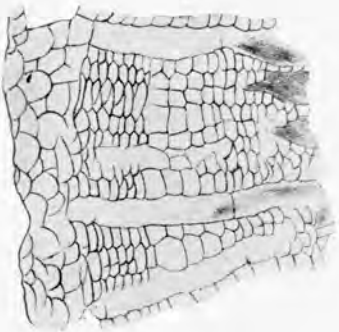

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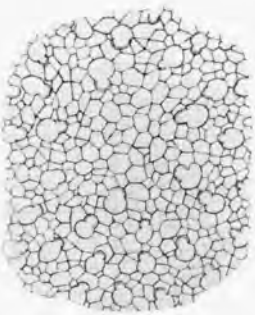

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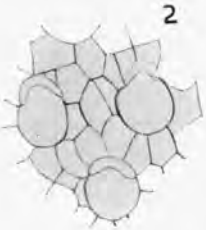

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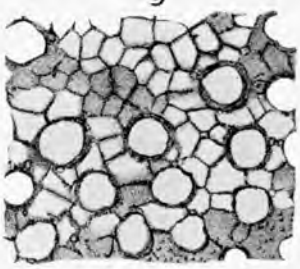

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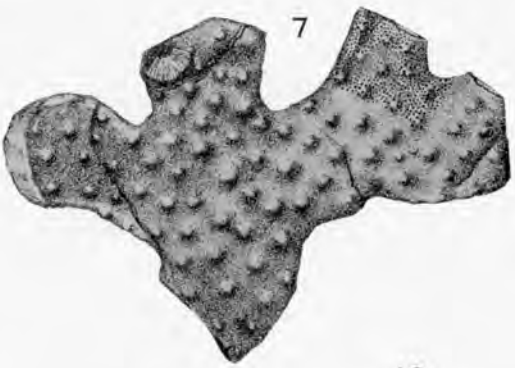

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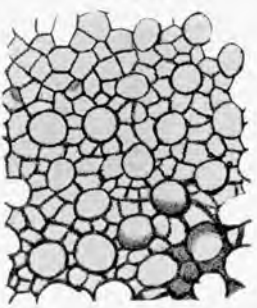

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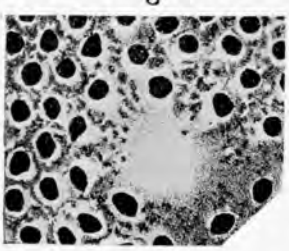

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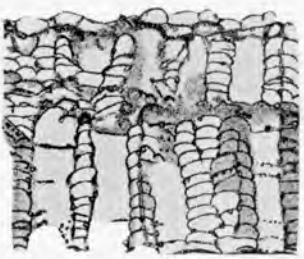

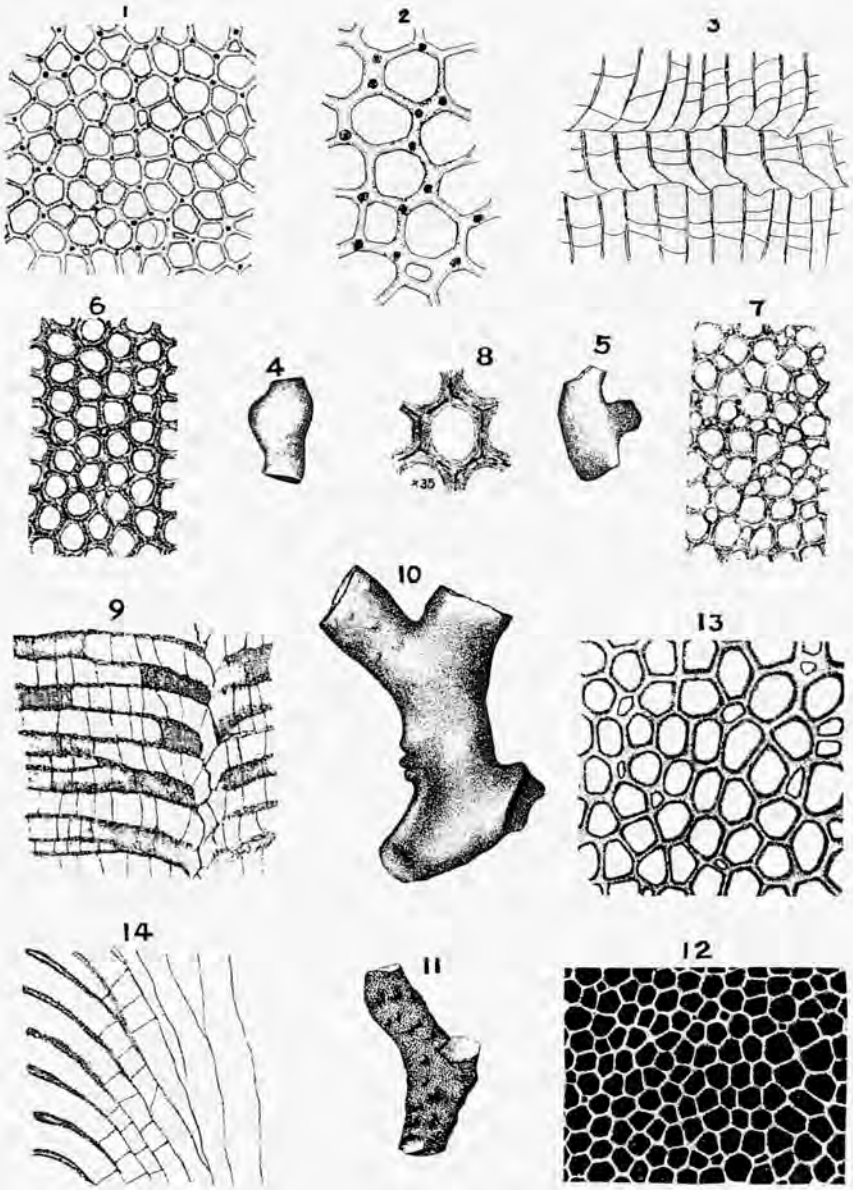
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PLATE VIII

BRYOZOA.

Figures 4 to 14 of this plate are copied from Ulrich (Geol. Surv. Illinois, VIII, 1890).

Orbignyella tenera, new species.

(See also Plate XI, fig. 3.)

Page 61.

Figs. 1 and 2. Tangential sections, x 20 and x 35 respectively, illustrating the minute structure.

Fig. 3. Vertical section, x 20, passing through two complete layers of zoœcia and a portion of a third layer.

Devonic (Traverse), Petosky, Michigan.

Petalotrypa compressa Ulrich.

Page 63.

Figs. 4 and 5. Two examples, natural size.

Figs. 6 and 7. Tangential sections, x 18, showing few and numerous mesopores, respectively.

Fig. 8. A zoœcium of fig. 6, x 35, showing the minute structure of the walls.

Fig. 9. Vertical section, x 18, complete only on the left side.

Devonic, Rock Island, Illinois.

Eridotrypa appressa (Ulrich).

Page 62.

Figs. 10 and 11. Fragments of two zoœcia, natural size.

Fig. 12. Surface of zoarium, x 12, showing the polygonal zoœcia and thin walls.

Figs. 13 and 14. Tangential and vertical sections, x 18.

Devonic, Rock Island, Illinois.

PLATE IX.

BRYOZOA.

Fistulipora romingeri Nicholson and Foord.

Page 60.

Fig. 1. Tangential section, x 20, showing the comparatively large lunarium and mesopores and round zoœcia.

Fig. 2. Vertical section, x 20, through the mature region. These thin sections were prepared from Rominger's type specimen of *Fistulipora crassa.*

Devonic (Hamilton), Thedford, Ontario.

Lioclema minutissimum (Nicholson).

Page 62.

Figs. 3 and 4. Surface of different portions of the same zoarium, x 12, showing variation in the number of mesopores.

(After Hall and Simpson, Nat. Hist. New York, Pal. VI).

Devonic (Hamilton), West Hamburg, New York.

Figs. 5 and 6. Tangential section, x 20, and several zoœcia and mesopores of the same, x 40.

Fig. 7. A vertical section, x 20, passing through portions of two layers of zoœcia.

Devonic, Buffalo, Iowa.

Orbignyella monticula (White).

(See also Plate XI, figs. 1, 2.)

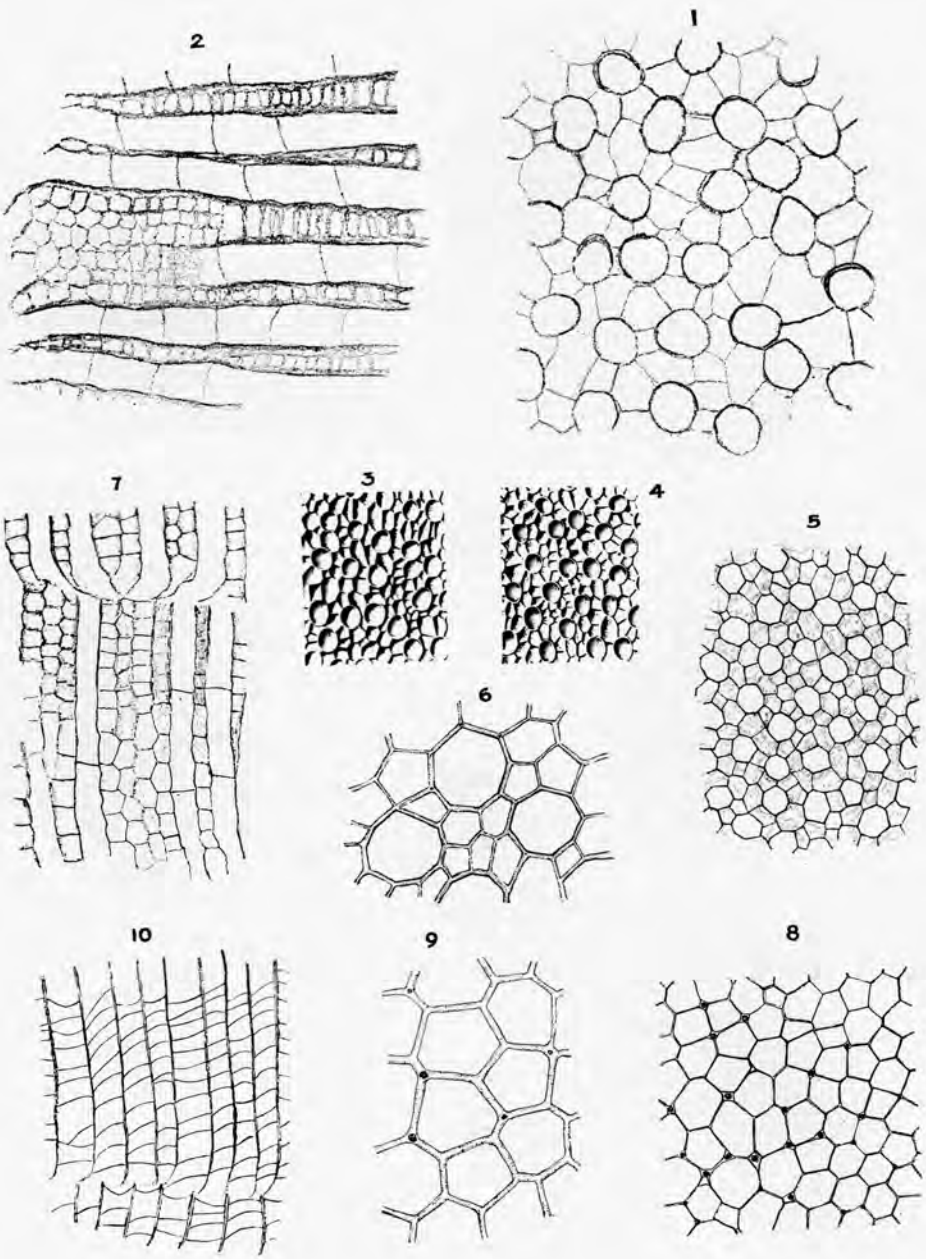
Page 61.

Fig. 8. Tangential section, x 20, prepared from the type specimen of *Monticulipora monticula* White.

Fig. 9. A portion of the same, x 35.

Fig. 10. Vertical section, x 20, prepared from the same specimen, passing through one layer of zoœcia and a portion of another. The rather numerous, curved diaphragms is the most characteristic feature shown in such sections.

Devonic, Iowa City, Iowa.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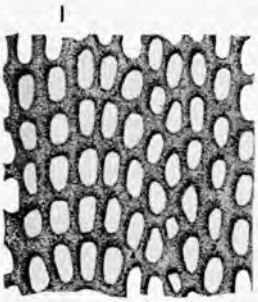
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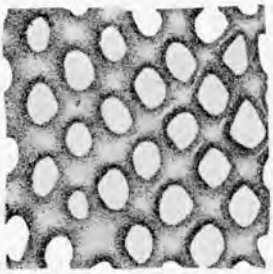
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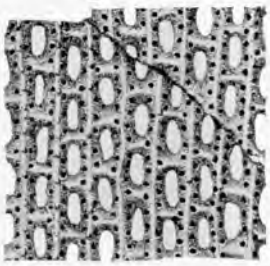
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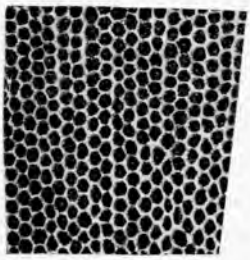
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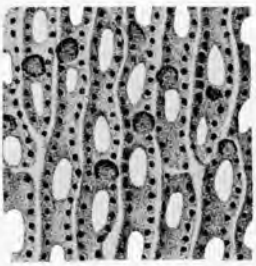
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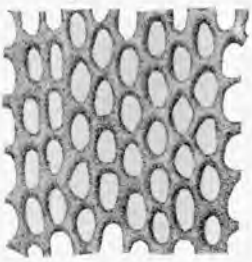
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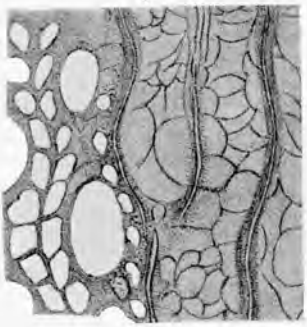
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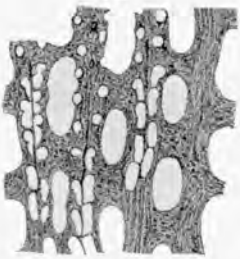
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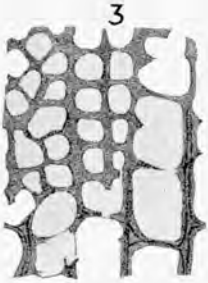
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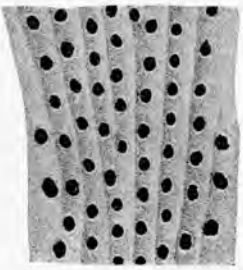
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PLATE X.

BRYOZOA.

All the figures on this plate are copied from Ulrich (Geol. Surv. Illinois, VIII, 1890).

Hemitrypa tenera Ulrich.

Page 66.

Fig. 1. View of the reverse side of a zoarium, x 9.

Fig. 2. A portion of the superficial network, x 9.

Fig. 3. Horizontal section, x 18, showing the principal bars of the superficial network on the right side and the secondary bars and scalæ on the left.

Fig. 4. Horizontal section of the branches, x 18.

Devonic, Davenport, Iowa.

Semicoscinium rhombicum Ulrich.

Page 65.

Fig. 5. Portion of the non-celluliferous side of a typical example, x 9.

Fig. 6. The celluliferous or reverse face of a zoarium, x 9. The flexuous branches, thin keel and large pores on the dissipiments are characteristic of the species.

Fig. 7. Horizontal section through the branches of an old example, x 18. The region between the cell apertures and the tips of the keels is occupied by irregular vesicles, as indicated in the half of the figure to the right.

Devonic, Buffalo, Iowa.

Fenestella vera Ulrich.

Page 64.

Figs. 8 and 9. The celluliferous and non-celluliferous faces respectively, x 9, of this neat species.

Fig. 10. Section, x 18, passing obliquely through a branch so as to show the minute structure at different levels.

Devonic, Buffalo, Iowa.

Cystodictya hamiltonensis Ulrich.

(See also Plate XI, fig. 8.)

Page 67.

Fig. 11. Fragments of a zoarium, natural size, of this abundant species.

Fig. 12. Surface of a branch, x 9.

Devonic, Buffalo, Iowa.

PLATE XI.

BRYOZOA.

Orbignyella monticula (White).
(See also Plate IX, fig. 8 to 10).
Page 61.

Figs. 1 and 2. Top and side views, natural size, of the type specimen of *Monticulipora monticula* White, showing the petasiform method of growth characteristic of the species.
Devonic, Iowa City, Iowa.

Orbigynella tenera, new species.
(See also Plate VIII, figs. 1 to 3).
Page 61.

Fig. 3. A zoarium of this species, natural size, encrusting a crinoid column.
Devonic, Milwaukee, Wisconsin.

Cyclotrypa collina (Ulrich).
(See also Plate VII, figs. 11, 12.)
Page 60.

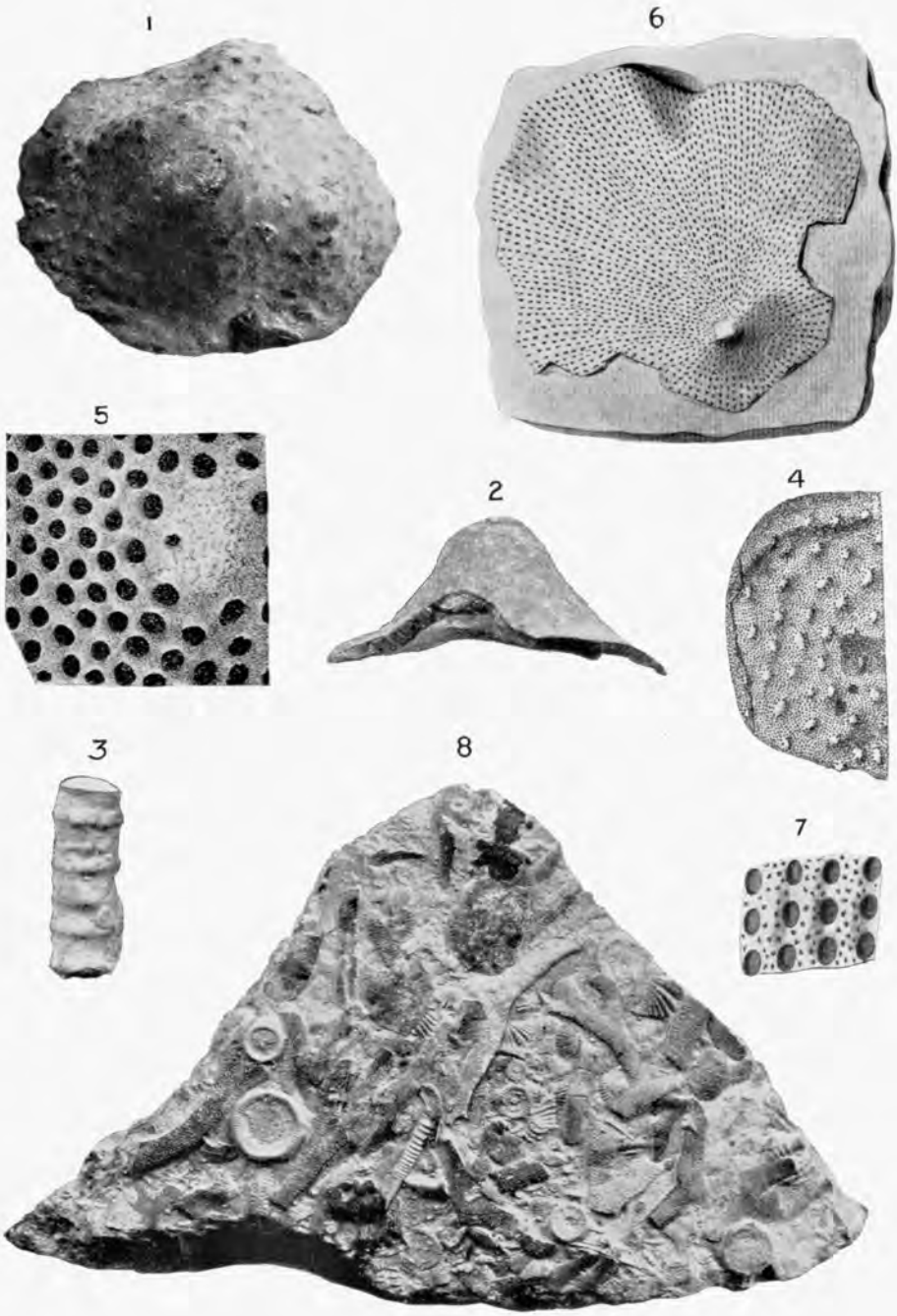
Fig. 4. About half of a subcircular zoarium, natural size.
Fig. 5. Surface of same, x 12, showing the thin interspaces and faintly elevated lunarium.
Devonic, Buffalo, Iowa.

Reteporina hamiltonensis (Prout).
Page 65.

Fig. 6. A zoarium, natural size (after Prout).
Fig. 7. Portion of celluliferous face, enlarged (after Prout).
Devonic, Buffalo, Iowa.

Cystodictya hamiltonensis Ulrich.
(See also Plate X, figs. 11, 12).
Page 67.

Fig. 8. A thin limestone slab, natural size, with the surface showing numerous fragments of this species.
Devonic, Milwaukee, Wisconsin.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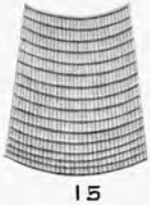
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PLATE XII.

BRACHIOPODS.

Lingula cf. *delia* Hall.

Page 70.

Fig. 1. A specimen from the Teller collection showing one almost complete valve and the apex of the opposite valve.

Fig. 2. A fragmentary specimen which is probably of the same species. The restoration of the outline is probably incorrectly drawn.

Lingula milwaukeensis nov.

Page 69.

Figs. 3 and 4. Specimens, enlarged two diameters, that still retain the color bands of the living shell. In the Public Museum, Milwaukee. (For color markings on other species see Fig. 5 of this plate and Figs. 8 and 9, Plate XIII.)

Lingula sp. undet.

Page 70.

Fig. 5. A specimen in which some traces of the color bands are preserved. Public Museum, Milwaukee.

Glossina truncata nov.

Page 68.

Fig. 6. A nearly complete ventral valve from the Teller collection.

Craniella hamiltoniae Hall.

Page 86.

Fig. 7. The exterior of a specimen attached to *Atrypa reticularis*. Teller collection.

Fig. 8. A cast of the interior of a specimen which is probably of this species, in which strong muscular impressions are shown. Public Museum, Milwaukee.

Orbiculoidea telleri nov.

Page 85.

Figs. 9 and 10. Typical specimens showing the surface markings and the variations in size. Public Museum, Milwaukee.

Lingulodiscina marginalis (Whitfield).

Page 84.

Fig. 11. A pedicle valve of the size and characters described by Whitfield.

Figs. 12 and 13. Brachial and profile views of a slightly crushed large specimen. Public Museum, Milwaukee.

Orbiculoidea wardi nov.

Page 85.

Fig. 14. A typical exterior of a brachial valve.

Fig. 15. An enlargement (x 10) showing the most marked characteristic of the species—the radiating striae.

Fig. 16. A cast of the interior of a brachial valve. These specimens are all from the Public Museum, Milwaukee.

PLATE XIII.

BRACHIOPODS.

Liorhynchus greeni nov.

Page 71.

Figs. 1 and 2. Natural casts of the interior of a brachial and of a pedicle valve. Teller collection.

Camarotoechia contracta saxatalis Hall.

Page 70.

Figs. 3, 4 and 5. Brachial profile and pedicle valves of a nearly perfect specimen from the shaly layers (zone C). Public Museum, Milwaukee.

Camarotoechia scitulus nov.

Page 71.

Figs. 6 and 7. Brachial and pedicle valves of natural casts of the interior of exceptionally well-preserved specimens. Teller collection.

Cranaena iowensis (Calvin).

Page 72.

Figs. 8 and 9. Brachial and pedicle valves showing the remarkably well preserved color bands. (For other examples of color markings see Plate XII, figs. 3, 4, 5.

Figs. 10 and 11. Pedicle and profile views of a specimen of the larger and more gibbous variety. Both specimens were collected by Mr. C. E. Monroe. Public Museum, Milwaukee.

Atrypa reticularis (Linnaeus).

Page 74.

Fig. 12. A brachial valve of the fine ribbed type from the Lake Church section. The fine ribbed Atrypas are characteristic of this section.

Fig. 13. A pedicle valve of the coarse ribbed type from the Milwaukee section.

Atrypa hystrix Hall.

Page 73.

Fig. 14. A natural cast of the interior of a brachial valve.

Fig. 15. A gutta percha cast of the exterior of a brachial valve. Figs. 14 and 15 are small for this species but occur commonly in the Lake Church section.

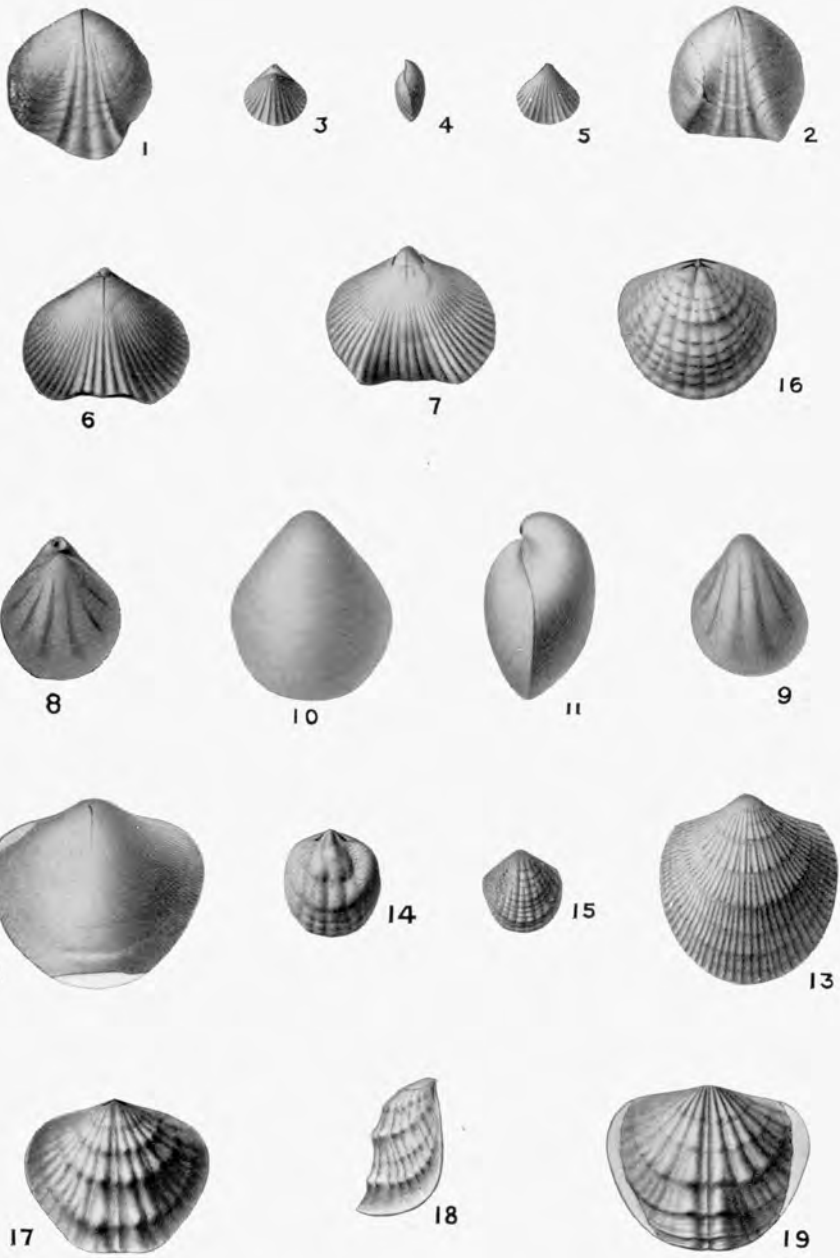
Fig. 16. A specimen of the normal size and characters from the Milwaukee section.

Atrypa sinuata nov.

Page 75.

Figs. 17 and 18. Brachial and profile views of a natural cast of the interior of a well preserved specimen.

Fig. 19. A gutta percha cast of the exterior of a brachial valve.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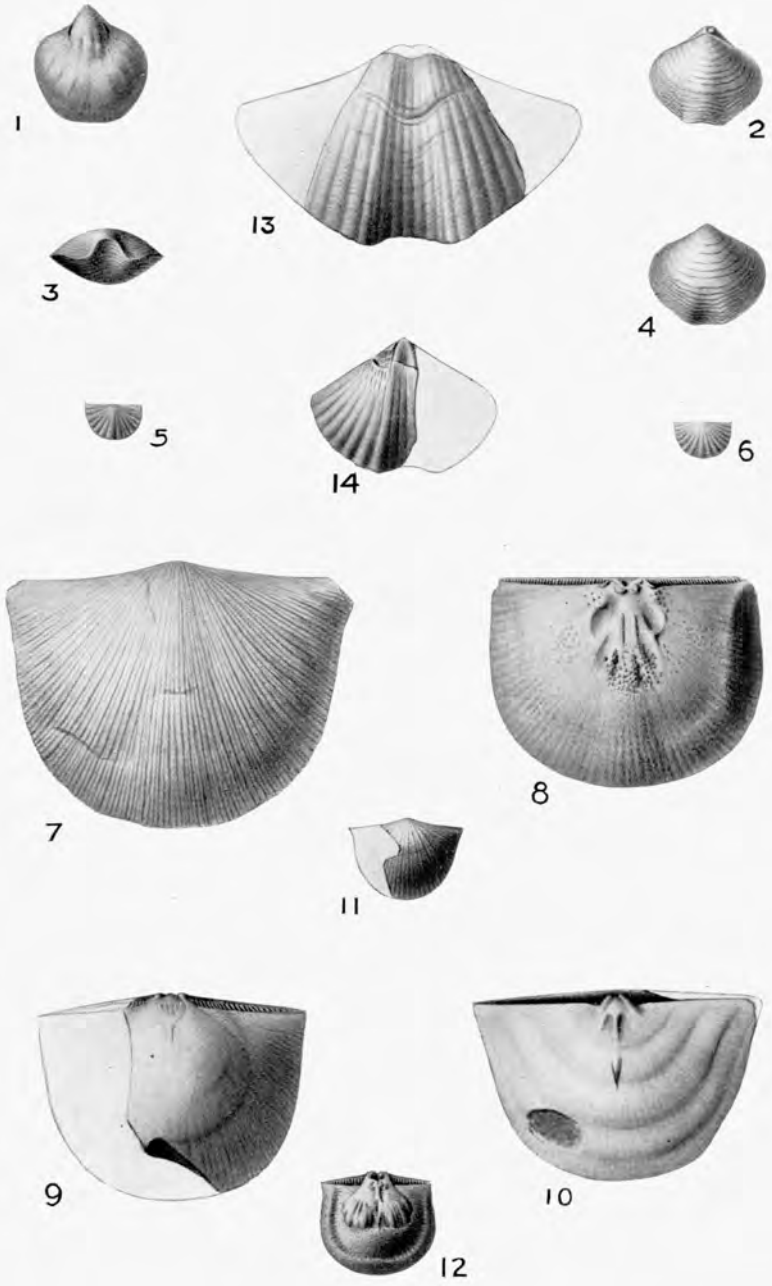
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PLATE XIV.

BRACHIOPODS.

Athyris fultonensis (Swallow).

Page 83.

Fig. 1. A natural cast of the interior of a pedicle valve from the Lake Church section.

Figs. 2, 3 and 4. Brachial, front and pedicle views of a well preserved specimen from the shaly layers (zone C) of the Milwaukee section.

Stropheodonta cf. *costata* Owen.

Page 87.

Figs. 5 and 6. Specimens apparently of this poorly defined species from the Lake Church section.

Stropheodonta halli nov.

Page 87.

Fig. 7. A pedicle valve preserving the surface markings. In the Teller collection.

Fig. 8. The interior of a brachial valve in which the muscular impressions are preserved. Public Museum, Milwaukee.

Figs. 9 and 10. Natural casts of the interior of a pedicle valve in which the crenulations of the hinge-margin are shown. The specimen, fig. 9, is from Lake Church, the others from Milwaukee.

Stropheodonta halli musculosa var. nov.

Page 88.

Figs. 11, 12. A gutta percha cast of the exterior of a pedicle valve and a natural cast of the interior of a pedicle valve showing the strong muscular impression and the crenulations of the hinge-line. Both specimens are from the Lake Church section.

Spirifer sp.

Page 82.

Fig. 13. A large specimen of a pedicle valve in which the important feature, the ribs in the sinus, is shown.

Fig. 14. A smaller specimen showing the outline of the shell. Both specimens were collected at Lake Church.

PLATE XV.

BRACHIOPODS.

Spirifer euryteines var. *milwaukeensis* var. nov.
Page 77.

Fig. 1. Exterior of a brachial valve in which, unfortunately, the characteristic well-marked groove in the fold does not appear.

Fig. 2. Cast of the interior of a brachial valve in which the groove is shown on the fold.

Fig. 3. Exterior of a pedicle valve.

Fig. 4. A profile view of a natural cast of the interior of the two valves in their natural position.

Fig. 5. A portion of the surface of Fig. 3 (enlarged two diameters) showing the characteristic fine longitudinal striations of the species.

Fig. 6. A natural cast of the interior of a pedicle valve.

All the specimens figured are from the Milwaukee section.

Cyrtina hamiltonensis Hall.
Page 75.

Figs. 7, 8, 9 and 10. Profile, cardinal, brachial and pedicle views of specimens from the shaly layers, (zone C) of the Milwaukee section.

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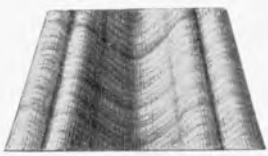

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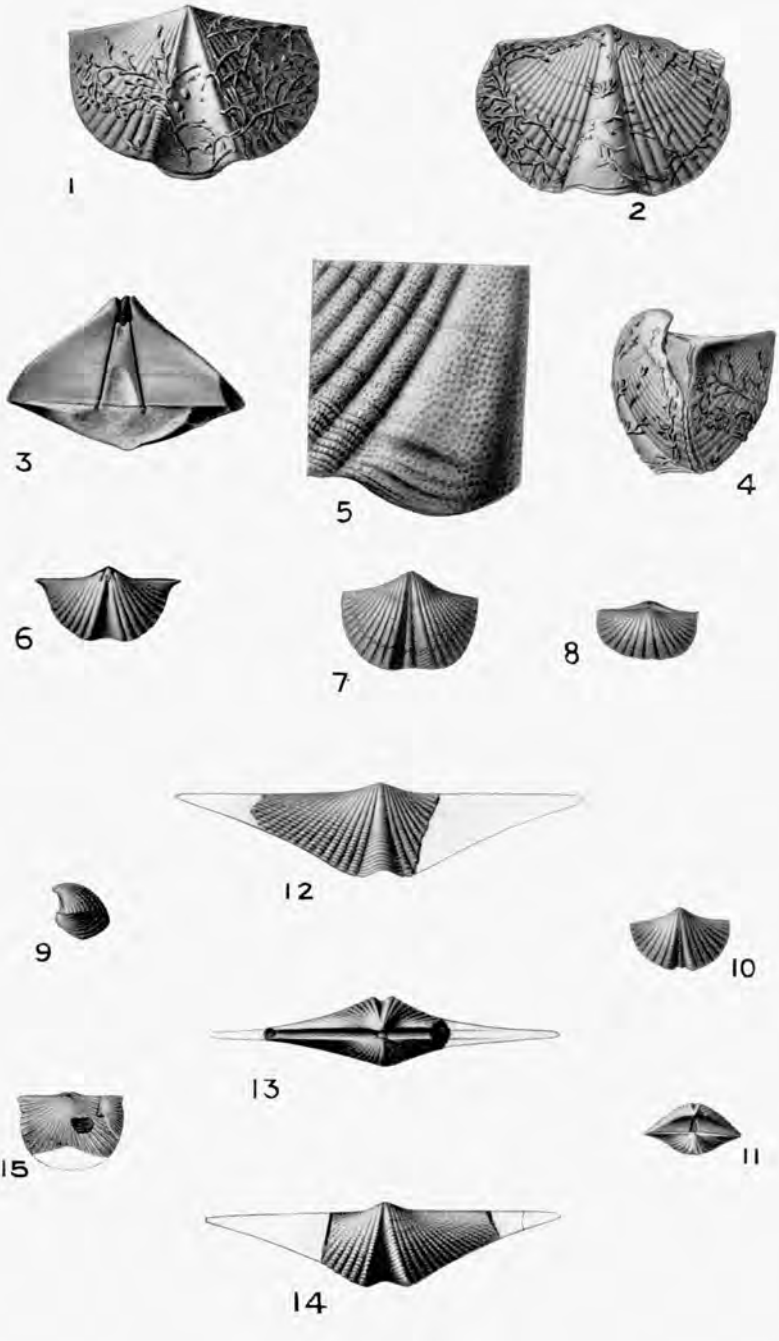
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PLATE XVI.

BRACHIOPODS.

Spirifer asper Hall.

Page 76.

Figs. 1, 2 and 4. Pedicle, brachial and profile views of a specimen which is encrusted with a bryozoan. Collected from the debris of the Intake Tunnel, Milwaukee, by Mr. C. E. Monroe.

Fig. 5. A portion of the exterior of another specimen (enlarged three diameters) which shows the characteristic granular ornamentation of the species.

Fig. 3. A cardinal view of a cast of the interior. From the Milwaukee section.

Spirifer subvaricosus H & W.

Page 81.

Fig. 6. Pedicle valve of a natural cast of an unusually alate individual.

Figs. 7 and 10. Pedicle valves showing variation in size and surface ornamentation.

Figs. 8, 9 and 11. Brachial, profile and cardinal views.

All specimens of this species here figured are from the Milwaukee section.

Spirifer mucronatus Conrad.

Page 80.

Figs. 12, 13 and 14. Brachial, cardinal and pedicle views showing the common form of this species in the Milwaukee section.

Schuchertella chemungensis arctistriata Hall.

Page 91.

Fig. 15. A specimen showing the characteristic markings and form of the species.

PLATE XVII.

BRACHIOPODS.

Reticularia fimbriata (Conrad).
Page 82.

Figs. 1 and 2. Cardinal and pedicle views of the cast of the interior of the same individual. From the Lake Church section.

Spirifer iowensis Owen.
Page 79.

Figs. 3 and 5. Pedicle and brachial valves of the cast of the interior of the common type.

Fig. 4. A cardinal view of an unusually large, distorted specimen. In the Public Museum, Milwaukee.

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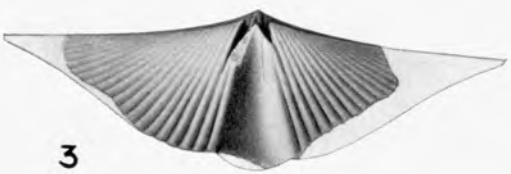

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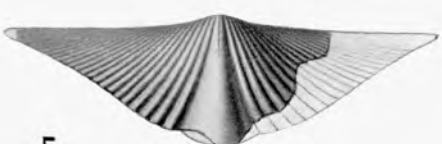

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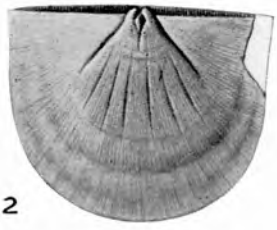
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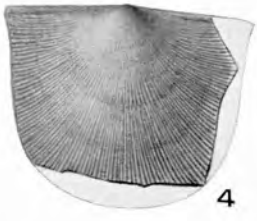
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PLATE XVIII.

BRACHIOPODS.

Stropheodonta perplana (Conrad).

Page 89.

Fig. 1. A very small pedicle valve.

Fig. 2. A natural cast of the interior of a pedicle valve showing the crenulations of the hinge-margin and the strong muscular impressions.

Fig. 3. An enlargement (ten diameters) of the striae of a specimen (figure 4) showing the peculiar surface markings of the species.

Fig. 4. The pedicle valve of a specimen of average size.

Pholidostrophia iowensis Owen.

Page 90.

Fig. 5. A natural cast of the interior of a pedicle valve showing the peculiar ornamentation of the hinge-margin and the muscular impressions.

Fig. 6. The interior of a brachial valve showing the hinge margin, cardinal process and muscular impressions.

Fig. 7. A gutta percha cast of the exterior of a pedicle valve. The shell is smooth with strong concentric lines and not striated as shown in the figure. Figs. 5 and 6 from the Milwaukee section, fig. 7 from Lake Church.

Chonetes vicinus ? (Castelnau).

Page 92.

Fig. 8. A natural cast of the interior of a pedicle valve.

Fig. 9. A natural cast of the interior of a pedicle valve in which the cast of the cardinal area is also shown.

Fig. 10. The exterior of a pedicle valve. All specimens figured are from Lake Church.

Chonetes schucherti nov.

Page 91.

Fig. 11. An enlargement (x 4) of the cardinal area showing the spine bases and the deltidium.

Figs. 12 and 13. Pedicle and brachial valves. The specimens figured are from the Milwaukee section and were collected from the shaly layers (zone C).

Productella spinulicosta Hall.

Page 93.

Figs. 14, 15. Two views of a pedicle valve of a specimen from Lake Church.

Fig. 16. A natural cast of the exterior of a brachial valve.

Pentamerella sp.

Fig. 17. A cast of the interior of a pedicle valve from the Milwaukee section. Teller collection.

Pentamerella multicostata nov.

Page 94.

Fig. 18. A cast of the interior of a pedicle valve. Teller collection.

PLATE XIX.

BRACHIOPODS.

Schizophoria striatula (Schlotheim).

Page 93.

Figs. 1, 2 and 3. Pedicle, brachial and profile views of the exterior of the same individual.

Figs. 4, 5 and 6. Pedicle, brachial and profile views of a cast of the interior of the same individual.

Gypidula cf. *comis* (Owen).

Page 95.

Figs. 7 and 8. A pedicle valve and a cardinal view of the same specimen.

Fig. 9. A brachial valve of this (?) species.

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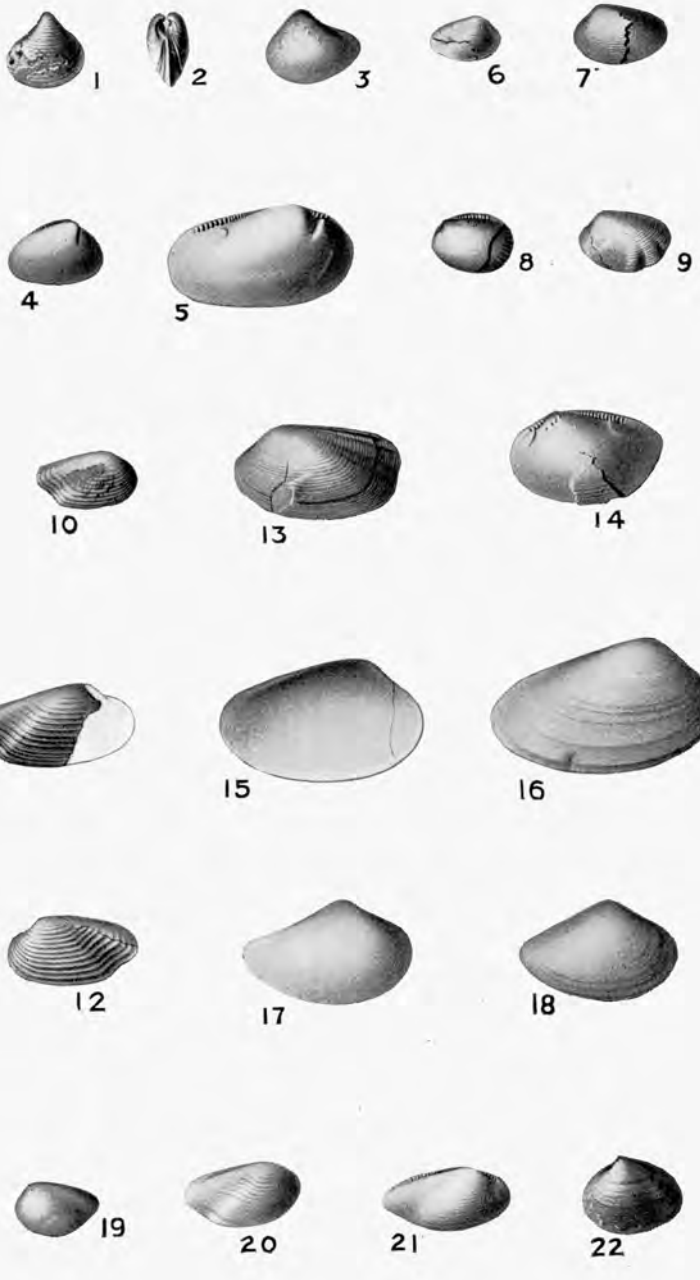
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PLATE XX.

PELECYPODS.

Nucula lirata var. nov.
Page 99.

Fig. 1. A right valve of a pyritized specimen in which both valves are preserved. From the Milwaukee quarry.

Fig. 2. An anterior view of the specimen illustrated in figure 1.

Fig. 3. A left valve of a weathered specimen which appears to be of the same species.

Nuculites laphami nov.
Page 101.

Fig. 4. A right valve of a much weathered specimen.

Nuculites milwaukeensis nov.
Page 100.

Fig. 5. The cast of the interior of a silicified specimen of a right valve from the New Intake tunnel, Milwaukee. Collected by Mr. C. E. Monroe and now in the Public Museum, Milwaukee.

Palaeoneilo brevis Hall.
Page 101.

Figs. 6 and 7. Right and left valves of specimens from the Milwaukee quarry.

Palaeoneilo sp.
Page 105.

Fig. 8. A specimen collected from the debris of the New Intake tunnel, Milwaukee, by Mr. C. E. Monroe showing a crenulation of the interior of the posterior of the valve.

Palaeoneilo constricta ? Conrad.
Page 102.

Fig. 9. An unusual shell in which the left valve has three folds on the posterior portion.

Palaeoneilo emarginata Conrad.
Page 103.

Figs. 10 and 11. Right valves of two specimens of this species.

Fig. 12. A left valve.

Palaeoneilo fecunda Hall.
Page 103.

Figs. 13 and 14. Specimens of right valves of silicified specimens showing the exterior and cast of the interior. Public Museum, Milwaukee.

Palaeoneilo cf. plana Hall.

Page 104.

Fig. 15. The interior of a left valve.

Fig. 16. The exterior of a right valve.

Palaeoneilo cf. maxima Conrad.

Page 104.

Figs. 17 and 18. Right valves of rather poor specimens which are probably of this species.

Palaeoneilo constricta Conrad.

Page 102.

Figs. 19, 20 and 21. One left and two right valves of typical specimens.

Palaeoneilo cf. constricta Conrad.

Page 102.

Fig. 22. A specimen of unusual shape which may be of this species.

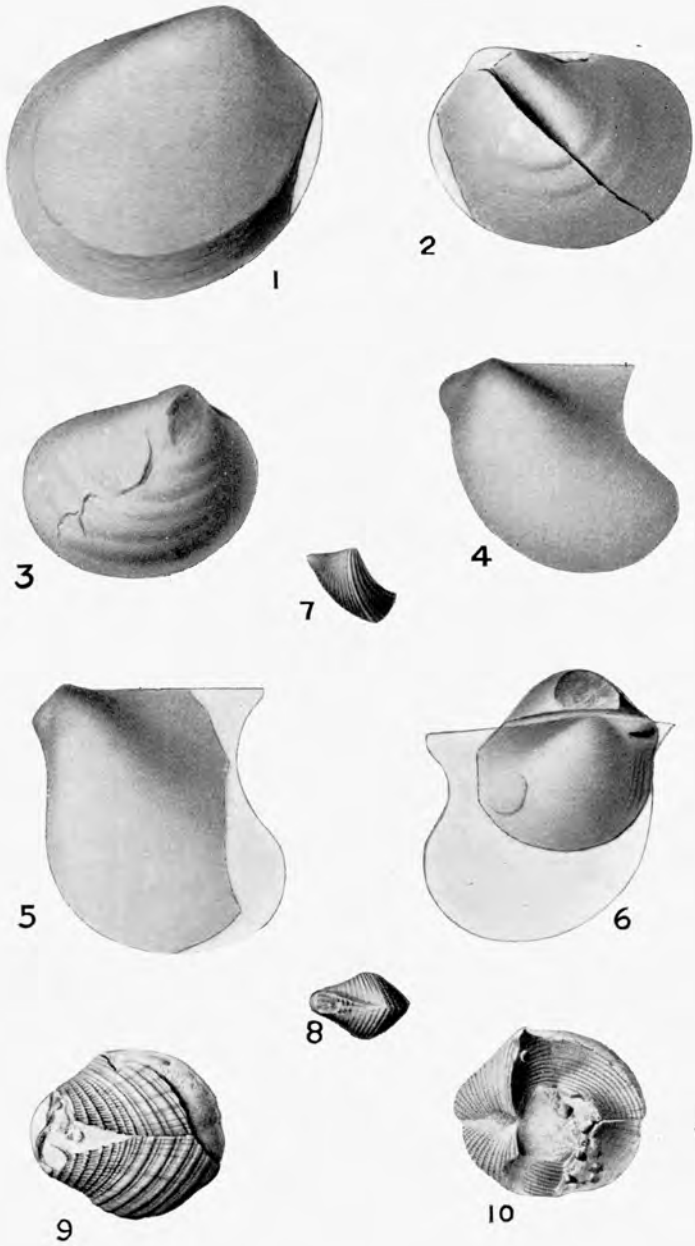
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PLATE XXI.

PELECYPODS.

Edmondia fragilis nov.

Page 98.

Figs. 1, 2 and 3. Right, left and right valves in which the shell is not preserved. Fig. 1 from the Teller collection.

Liopteria cf. *conradi* Hall.

Page 106.

Fig. 4. A much weathered specimen of a left valve which appears to be of this species. Somewhat restored.

Liopteria cf. *rafinesquii* Hall.

Page 107.

Fig. 5. A weathered specimen of a left valve which is probably of this species.

Glyptodesma ? sp.

Page 105.

Fig. 6. A fragmentary specimen of two valves. The restoration is in doubt.

Conocardium ohioensis ? Meek.

Page 109.

Fig. 7. The left valve of a specimen from Lake Church.

Fig. 8. A ventral view of a specimen showing the opening and the denticulated margin.

Conocardium ornatum nov.

Page 108.

Figs. 9 and 10. Ventral and posterior views of a specimen from the Teller collection. Milwaukee section.

PLATE XXII.

PELECYPODS.

Mytilarca oviformis ? Conrad.

Page 107.

Figs. 1 and 2. Left and right valves of specimens from the Milwaukee section.

Mytilarca sp.

Page 108.

Fig. 3. A right valve of a specimen which may be new. Public Museum, Milwaukee.

Mytilarca trigonale nov.

Page 108.

Fig. 4. A posterior view of specimen, figure 6.

Fig. 5. A cast of the interior of a left valve from Lake Church.

Fig. 6. The cast of the interior of a right valve from Lake Church.

Actinopteria boydi Hall.

Page 109.

Figs. 7 and 8. Left valves showing variation in size. The variation in the surface markings is due to the degree of preservation. Fig. 7 is a gutta percha cast.

Pterinea ? paucicostata nov.

Page 105.

Fig. 9. The cast of the interior of a left valve, somewhat restored.

Nyassa elongata nov.

Page 111.

Figs. 10 and 12. Views of left and right valves of casts of the interior.

Fig. 11. A cardinal view of a cast of the interior. Figs. 10, 11 and 12 are of one individual. Public Museum, Milwaukee.


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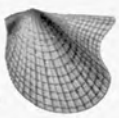
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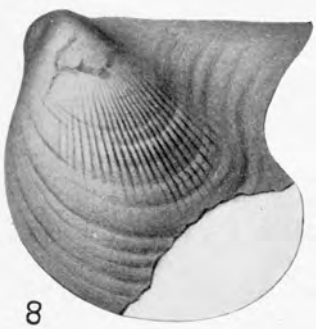
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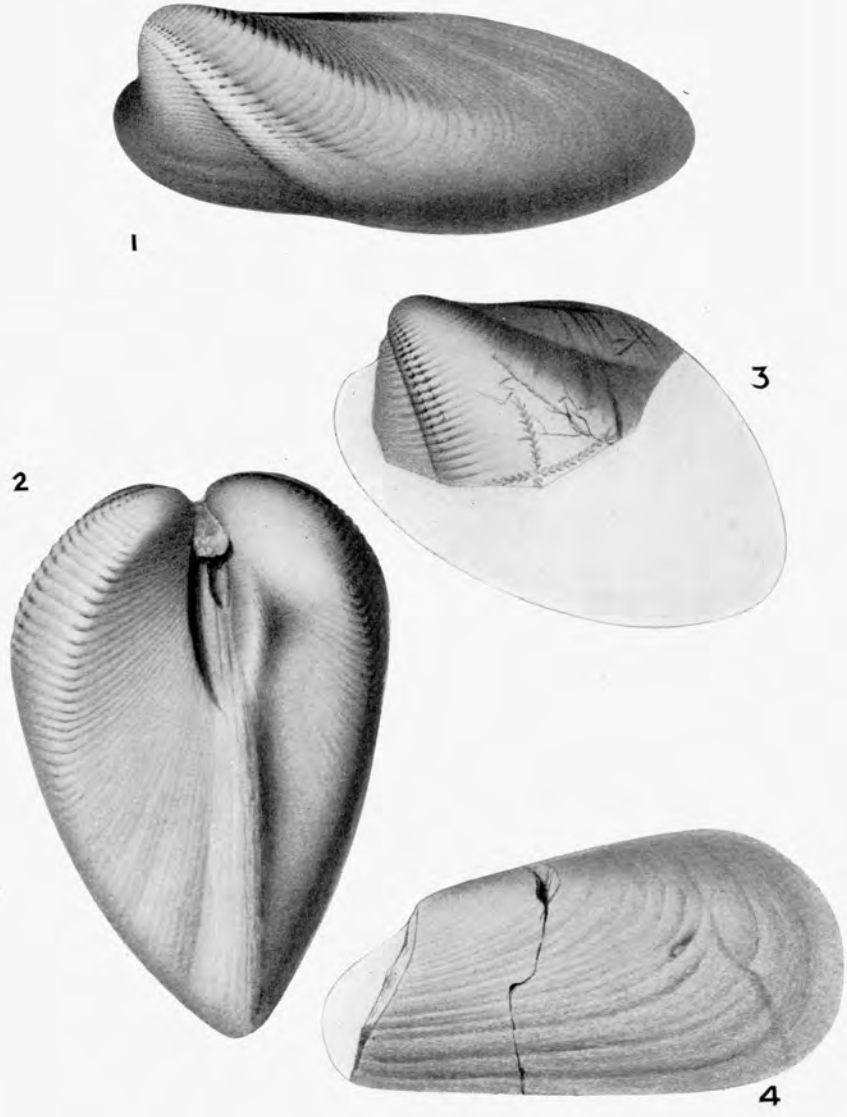
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PLATE XXIII.

PELECYPODS.

Grammysia nodocostata Hall.

Page 97.

Fig. 1. A left valve of a distorted specimen.

Fig. 2. A posterior view of the same specimen showing both valves in position.

Fig. 3. A partly restored left valve of a worn specimen.

Modiomorpha mytiloides Conrad.

Page 114.

Fig. 4. A left valve of a somewhat distorted specimen from the Teller collection.

PLATE XXIV.

PELECYPODS.

Modiomorpha schucherti nov.
Page 115.

Figs. 1 and 2. Right valves of worn specimens.

Fig. 3. A left valve showing the variation in form. All are from the Milwaukee section.

Modiomorpha obliqua nov.
Page 114.

Fig. 4. A left valve of a good specimen from the Teller collection.

Modiomorpha clarkei nov.
Page 115.

Fig. 5. A left valve of a typical specimen from the Teller collection.

Modiomorpha concentrica Conrad.
Page 113.

Figs. 6 and 7. Left and right valves showing the well marked characters of the species.

Schizodus cf. *appressus* Conrad.
Page 111.

Fig. 8. A natural cast of the interior of a right valve partly restored.

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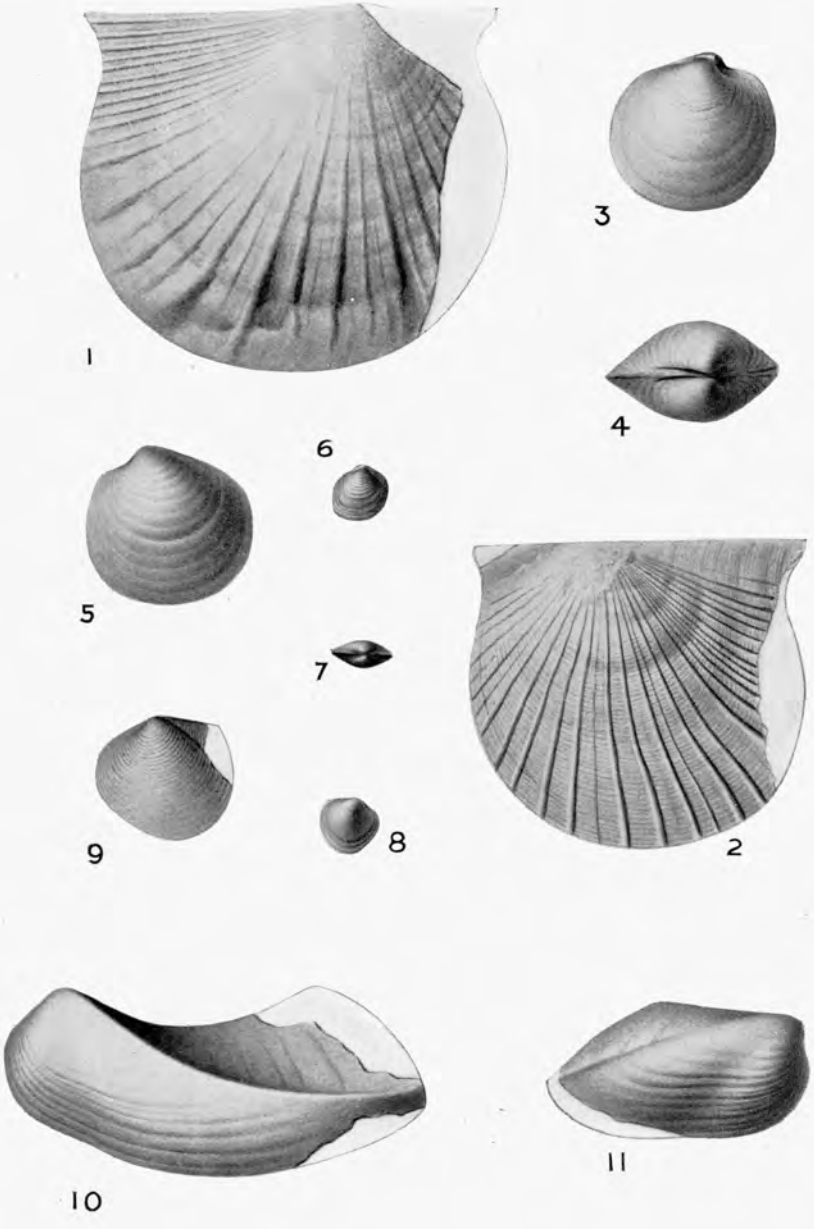
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PLATE XXV.

PELECYPODS.

Pterinopecten telleri nov.
Page 112.

Fig. 1. A right valve somewhat restored.
Fig. 2. A well preserved left valve of a specimen from the Teller collection.

Paracyclas elliptica Hall.
Page 117.

Figs. 3, 4 and 5. Right, cardinal and left views of the cast of the interior of a well preserved specimen. From Lake Church.

Paracyclas lirata var.
Page 118.

Figs. 6, 7. Right and cardinal views of a complete but somewhat distorted specimen.

Paracyclas sp.
Page 119.

Fig. 8. A left valve which shows some unusual characters.

Paracyclas ohioensis var. *tenuistriata* var. nov.
Page 119.

Fig. 9. A left valve slightly restored.

Cimitaria recurva Conrad.
Page 116.

Fig. 10. A left valve of a specimen partly restored.

Goniophora obtusiloba nov.
Page 119.

Fig. 11. A right valve of a nearly complete specimen.

PLATE XXVI.

PELECYPODS AND PTEROPODS.

Megambonia wisconsinensis nov.

Page 120.

Fig. 1. A right valve of a weathered specimen from the Teller collection.

Fig. 2. A cardinal view of the same individual.

Cypricardinia cf. *indenta* Conrad.

Page 117.

Fig. 3. A left valve of a weathered specimen.

Conularia congregata var. *milwaukeensis* var. nov.

Page 130.

Figs. 4, 5 and 6. Somewhat distorted specimens showing the exterior characters and the outline. Figs. 4 and 6 are from the collection of the Public Museum, Milwaukee.

Fig. 7. An enlargement (x 10) of a portion of the exterior.

Hyolithes aclis ? Hall.

Page 132.

Fig. 8. A fragmentary specimen which is probably of this species.

Hyolithes alatus ? Whiteaves.

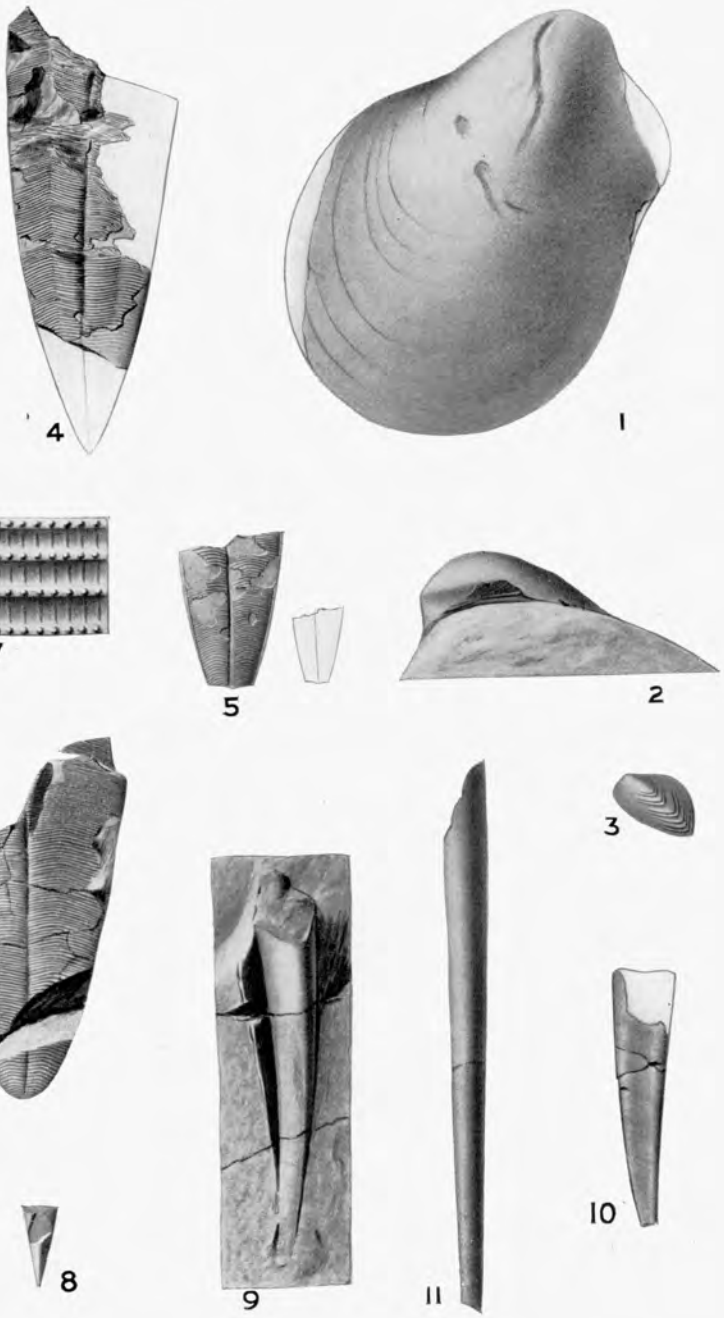
Page 131.

Figs. 9 and 10. Specimens showing the cast of the interior of the specimens. Collected by Mr. C. E. Monroe from the Lake Church section.

Coleolus ? *tenuis* nov.

Page 130.

Fig. 11. A specimen in which little but the form is preserved. Collected by Mr. C. E. Monroe from the Lake Church section.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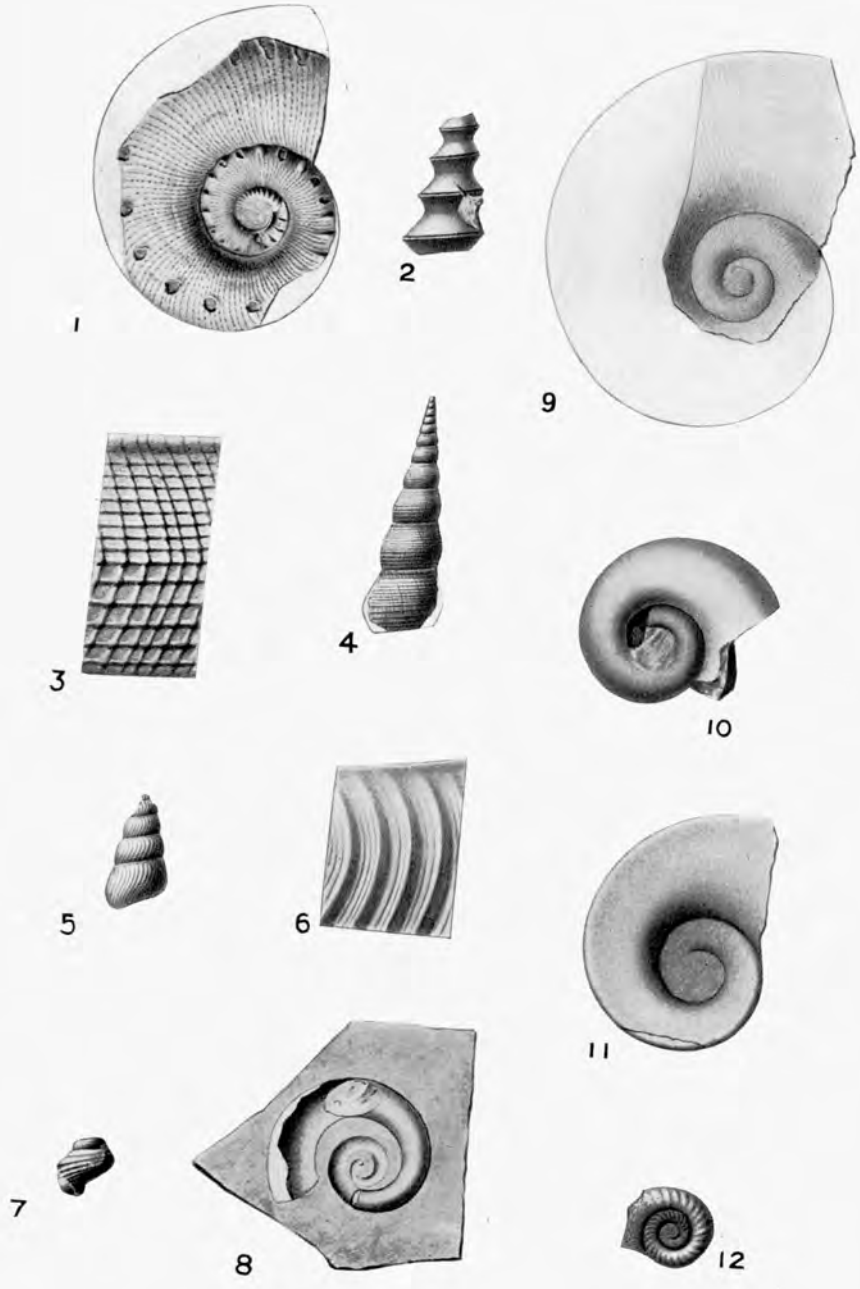
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PLATE XXVII.

GASTROPODS.

Porcellia ? *kindlei* nov.

Page 121.

Fig. 1. A gutta percha cast showing the ornamentation and other characters of this species. Milwaukee quarry.

Murchisonia cf. *dowlingii* Whiteaves.

Page 122.

Fig. 2. A fragmentary specimen that may be of this species. Lake Church quarry.

Loxonema cancellata nov.

Page 127.

Fig. 3. A portion of the surface of a specimen (fig. 4) enlarged seven diameters.

Fig. 4. A specimen showing the characters of the species exceptionally well.

Loxonema hamiltoniae Hall.

Page 128.

Figs. 5 and 6. A fragmentary specimen and an enlargement (x 7) of a specimen which retains the external characters of the species.

Cyclonema ? sp.

Fig. 7. A fragmentary specimen from the New Intake Tunnel collected by C. E. Monroe. Public Museum, Milwaukee.

Phanerotinus cf. *exiguus* Kindle.

Page 125.

Fig. 8. A specimen from Lake Church that is probably of this species.

Euomphalus sp.

Page 124.

Fig. 9. A gutta percha cast of a large specimen from Lake Church.

Euomphalus sp.

Page 124.

Fig. 10. A natural cast of a specimen from Lake Church.

Pleuronotus sp.

Page 126.

Fig. 11. The cast of the interior of a specimen in which the periphery is angular.

Euomphalus planodiscus ? Hall.

Page 125.

Fig. 12. A gutta percha cast of a specimen from Lake Church.

PLATE XXVIII.

GASTROPODS.

Platyceras bertheletensis nov.
Page 128.

Figs. 1, 2. Dorsal and lateral views of the same specimen. Teller collection.

Platyceras bertheletensis var. *unsymmetricum* nov.
Page 129.

Fig. 3. A dorsal view of a specimen showing the lack of symmetry produced by the flattening of the right side.

Platyceras hornefferi nov.
Page 129.

Figs. 4, 5. Two views of the same individual to show the position of the beak, the surface ornamentation and the crenulations of the margin. Public Museum, Milwaukee.

Fig. 6. The right side of a valve in which the plications are more numerous than in the specimen, fig. 5. Teller collection.

Cyclonema ? subglobosa nov.
Page 126.

Fig. 7. A slightly crushed, silicified specimen from the debris of the New Intake tunnel, Milwaukee, in which the surface characters are preserved. Public Museum, Milwaukee.

Figs. 8, 9. Natural casts of the interior of specimens from Lake Church that appear to be of this species.

Fig. 10. A pyritized specimen from the Milwaukee quarry which is probably of the same specier.

Bellerophon pelops Hall.
Page 123.

Fig. 12. A silicified specimen in which the characters of the shell are well shown. Collected by C. E. Monroe from the debris of the New Intake tunnel, Milwaukee. Public Museum, Milwaukee.

Bellerophon (Ptomatis) patulus Hall.
Page 123.

Fig. 13. A silicified specimen which shows the characters of the species. Public Museum, Milwaukee.

Trochonema monroei nov.
Page 127.

Fig. 11. A specimen which is probably of this species.

Figs. 14, 16. Gutta percha casts of the exterior.

Fig. 15. A natural cast of the interior.


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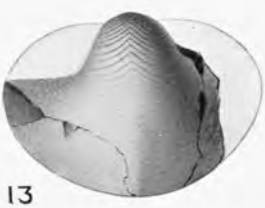
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PLATE XXIX.

CEPHALOPODS.

Gomphoceras wisconsinense Cleland.

See Plates XXX, XXXI.

Page 135.

Lateral view of a crushed but exceptionally well-preserved specimen of *Gomphoceras wisconsinense* Cleland. The slight enlargement of the chamber of habitation a short distance above the last air chamber is more strongly developed in other specimens. The measurements from which the model (Plate XXX) was constructed were largely from this specimen. The original is from Milwaukee and is now in the Public Museum, Milwaukee. x 5/6.

PLATE XXX.

CEPHALOPODS.

Gomphoceras wisconsinense Cleland.

See Plates XXIX, XXXI.

Page 135.

A restoration in plaster of *Gomphoceras wisconsinense*. The shape of the apex is somewhat in doubt. x ⅔. The initial stage is not shown.

PLATE XXXI.

CEPHALOPODS.

Gomphoceras wisconsinense Cleland.

See Plates XXIX, XXX.

Page 135.

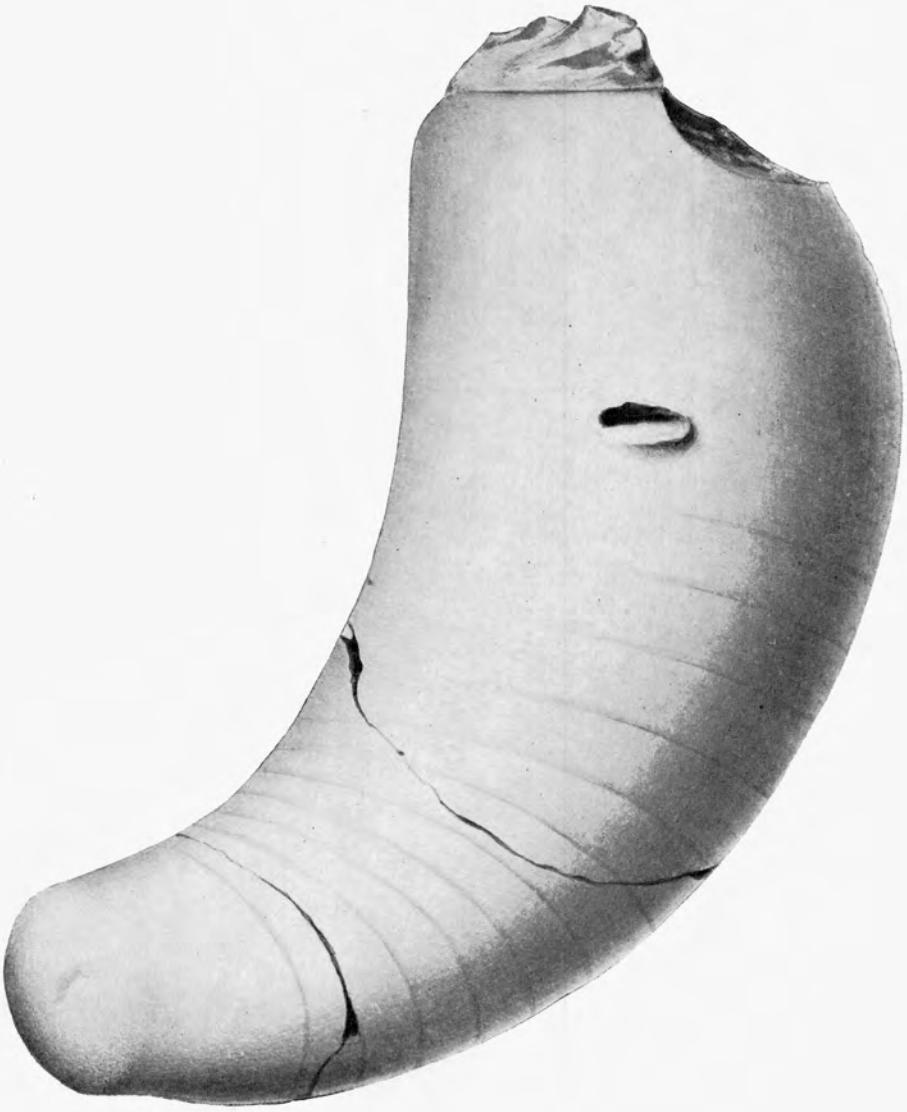
Exterior view of a crushed specimen with a parasitic growth. The dark band near the upper portion of the specimen is composed of pyrite or marcasite and is present on practically all the specimens examined. Its significance is not understood. The original is in the Public Museum, Milwaukee. x $\frac{11}{17}$.

PLATE XXXII.

CEPHALOPODS.

Gyroceras sp.
Page 141.

A specimen with less curvature and which enlarges more rapidly than *Gyroceras eryx* Hall. The specimen is crushed to some extent.



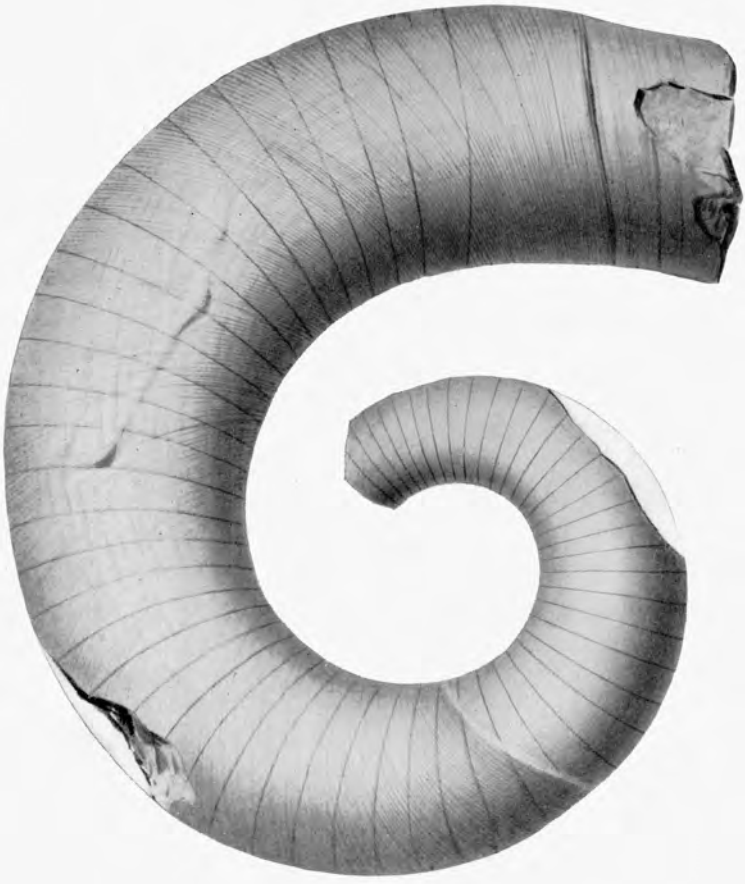


PLATE XXXIII.

CEPHALOPODS.

Gyroceras eryx Hall.

Page 140.

An exterior view of a remarkably well-preserved specimen of ***Gyroceras eryx*** in which what appear to be traces of both transverse and longitudinal color markings are preserved. The original is in the Public Museum, Milwaukee. x $\frac{9}{13}$.

PLATE XXXIV.

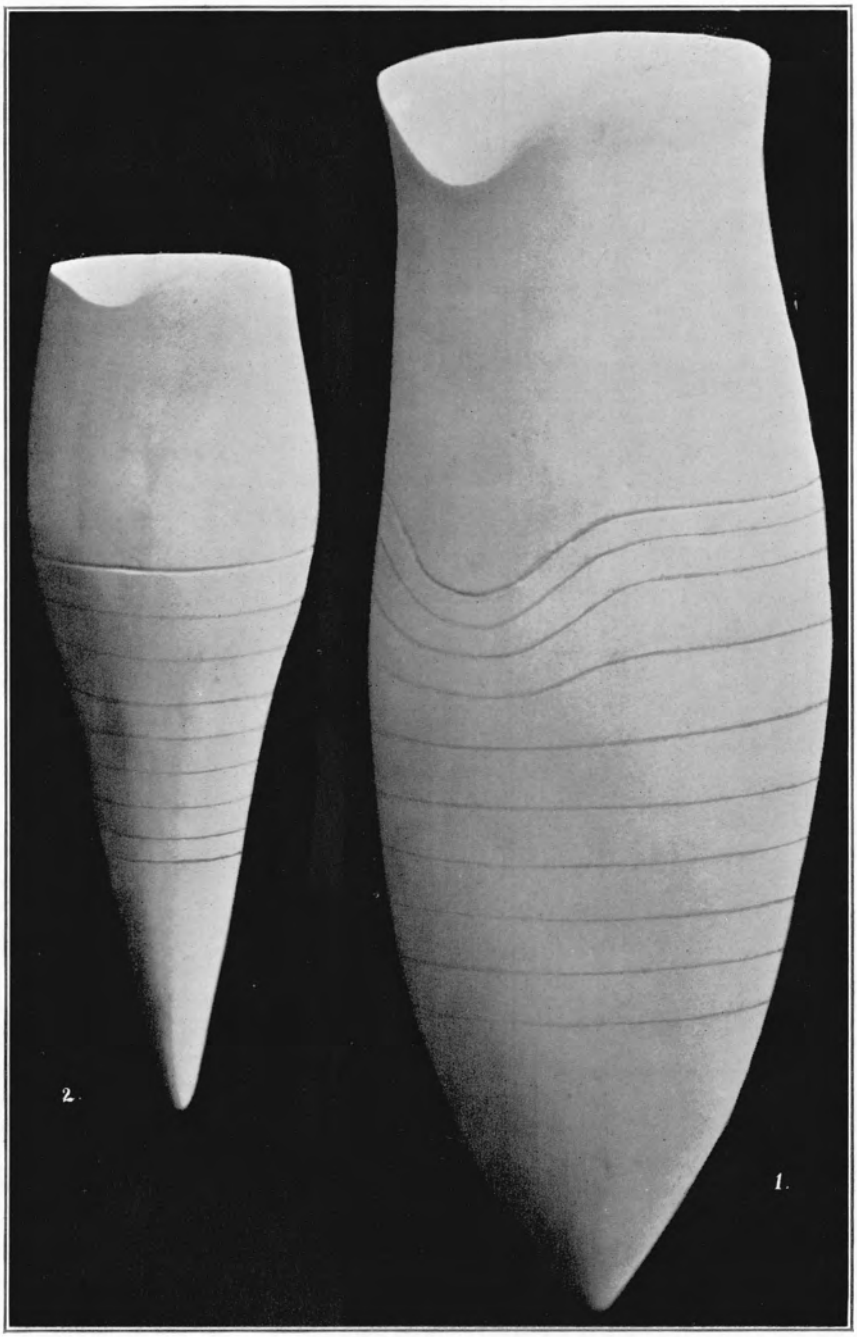
CEPHALOPODS.

Gomphoceras calvini Cleland.
See Plates XXXV, XXXVI, XXXVII.
Page 137.

Fig. 1. A restoration of this species. The initial stages are not shown.

Gomphoceras fusiforme Whitfield.
See Plate XLI.
Page 139.

Fig. 2. A restoration in which the apex and a portion of the aperture are somewhat in doubt. The initial stages are probable as shown in Plate XLII, fig. 1.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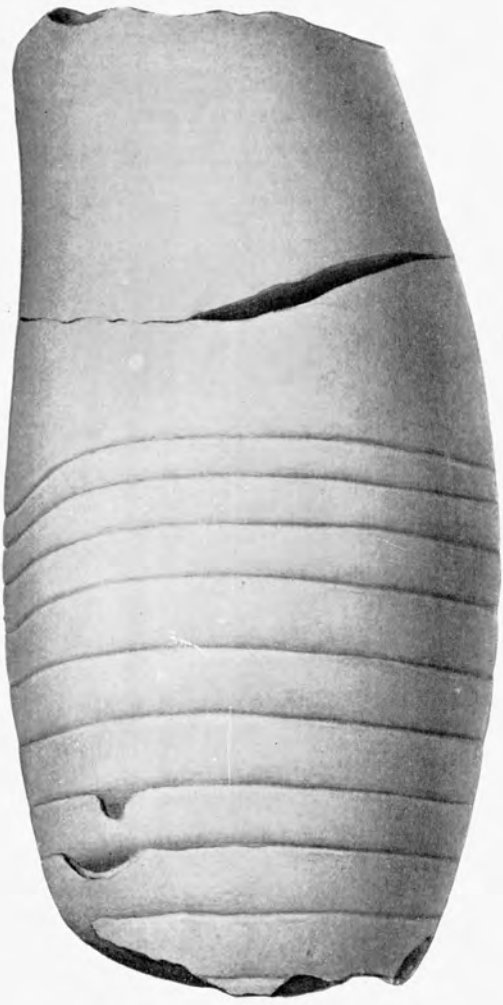


PLATE XXXV.

CEPHALOPODS.

Gomphoceras calvini Cleland.

See Plates XXXIV, XXXVI, XXXVII.
Page 137.

A view of the most perfect specimen examined which shows the unsymmetrical shape of the upper portion due to the leaning to one side of the upper air chambers and the chamber of habitation. The original is in the Williams College Museum.

PLATE XXXVI.

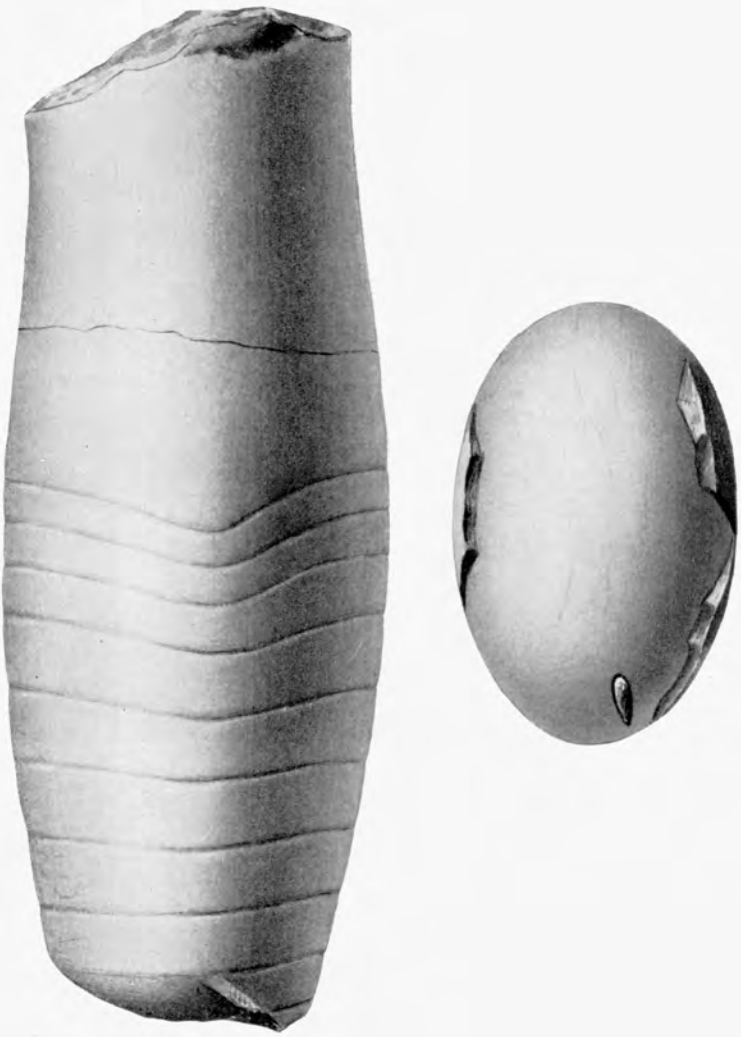
CEPHALOPODS.

Gomphoceras calvini Cleland.

See Plates XXXIV, XXXV, XXXVII.
Page 137.

Fig. 1. Exterior view of the concave side of the specimen figured on Plate XXXV.

Fig. 2. Transverse view of figure 1 showing the septum and the position of the siphuncle.



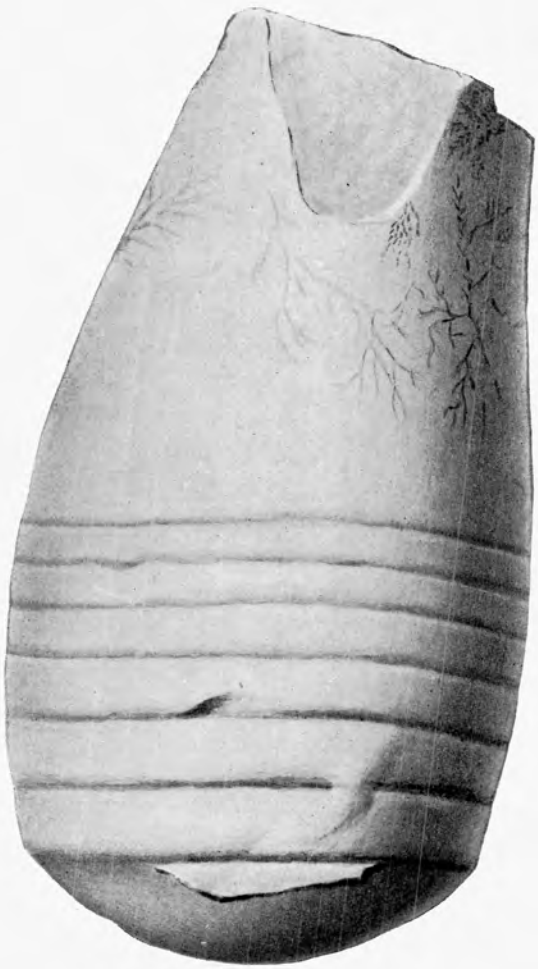


PLATE XXXVII.

CEPHALOPODS.

Gomphoceras calvini Cleland.

See Plates XXXIV, XXXV, XXXVI.
Page 137.

A view of a large specimen of this species in which the unsymmetrical shape is well shown. In the Williams College Collection.

PLATE XXXVIII.

CEPHALOPODS.

Gomphoceras sp. undet.
Page 138.

A specimen of a Gomphoceras that appears to be new but in which the characters are not sufficiently well preserved for specific identification. The original is in the Williams College Collection.

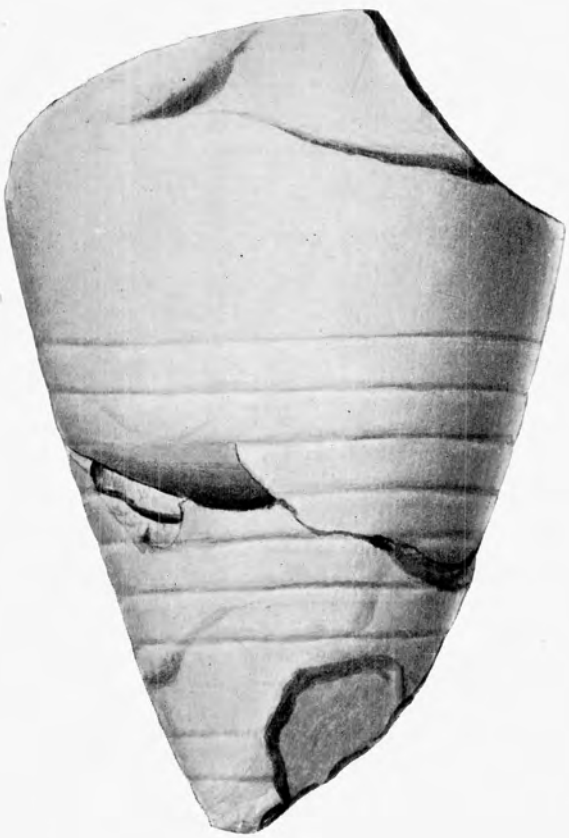


PLATE XXXIX.

CEPHALOPODS.

Gomphoceras whitfieldi Cleland.

See Plate XL.
Page 137.

A view of a crushed specimen of this species in which the regular air chambers are shown. Compare the chamber of habitation shown in this specimen with that shown in Plate XL. In the Williams College Collection.

PLATE XL.

CEPHALOPODS.

Gomphoceras whitfieldi Cleland.

See Plate XXXIX.
Page 137.

A view of the best specimen examined. The chamber of habitation is longer than in other specimens. This may be due to more perfect preservation or it may be an old age condition. From the collection of Mr. E. E. Teller, Milwaukee, Wisconsin.

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PLATE XLI.

CEPHALOPODS.

Gomphoceras fusiforme Whitfield.
See Plate XXXIV, fig. 2.
Page 139.

Fig. 1. A specimen showing a portion of the chamber of habitation and a large number of the air chambers. The specimen is more crushed toward the apex than in the upper portion of the conch. From the Public Museum, Milwaukee.

Fig. 2. A transverse view showing the position of the siphuncle of the crushed specimen illustrated in figure 3.

Fig. 3. A crushed specimen of *G. fusiforme* in which only the chamber of habitation and one air chamber is preserved. See also figure 2.

Gomphoceras brevipositicum Whitfield.
Page 138.

Figs. 4 and 5. Two specimens of *Gomphoceras brevipositicum* Whitfield showing the chamber of habitation and two air chambers. From the Williams College Collection.

PLATE XLII.

CEPHALOPODS.

Gomphoceras sp. undet.

Page 140.

Fig. 1. A specimen of Gomphoceras in which what appears to be the orthocone is preserved in pyrite or marcasite.

Orthoceras clarkei nov.

Page 134.

Fig. 2. The specimen, natural size, showing the form and general appearance of the shell. Teller collection.

Fig. 2A. An enlargement (x 2) of the apical angle showing the surface ornamentation of the orthocone.

Orthoceras sp. undet.

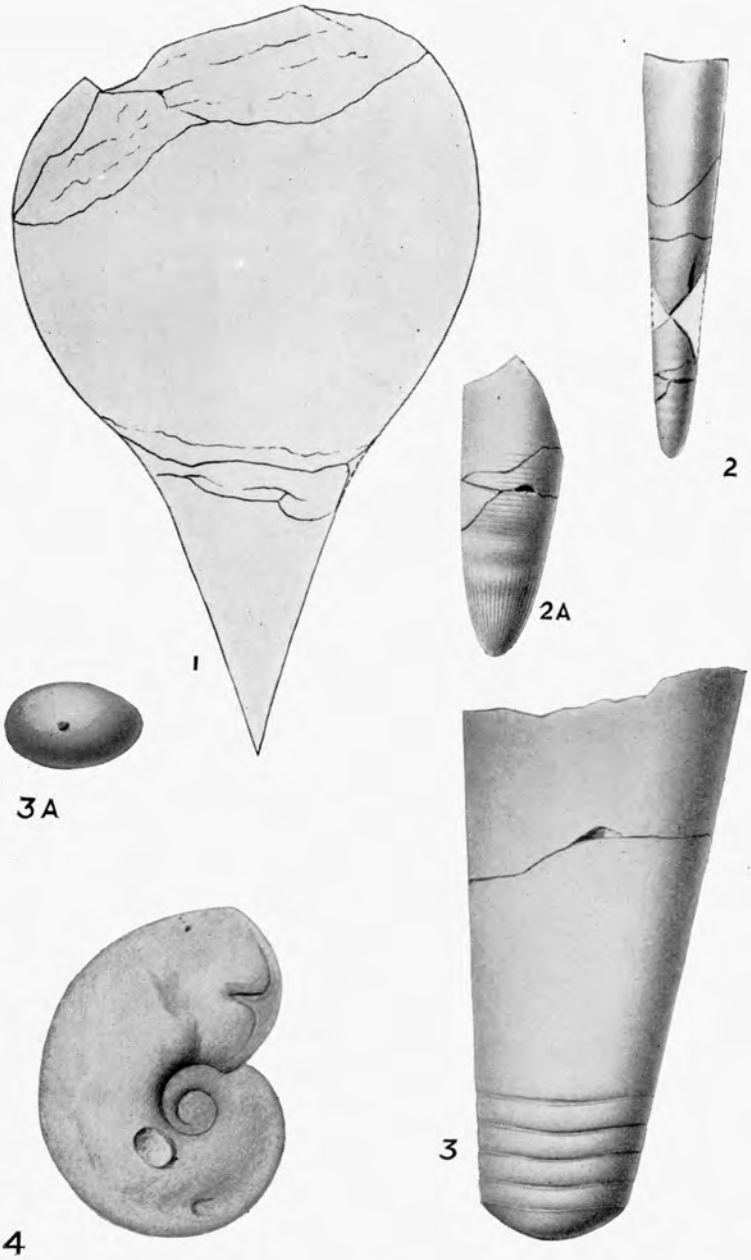
Page 135.

Figs. 3, 3A. Lateral and transverse views of a slightly crushed specimen.

Goniatites sp. undet.

Page 141.

Fig. 4. The figure is at fault in showing a convexity. The specimen is perfectly flat.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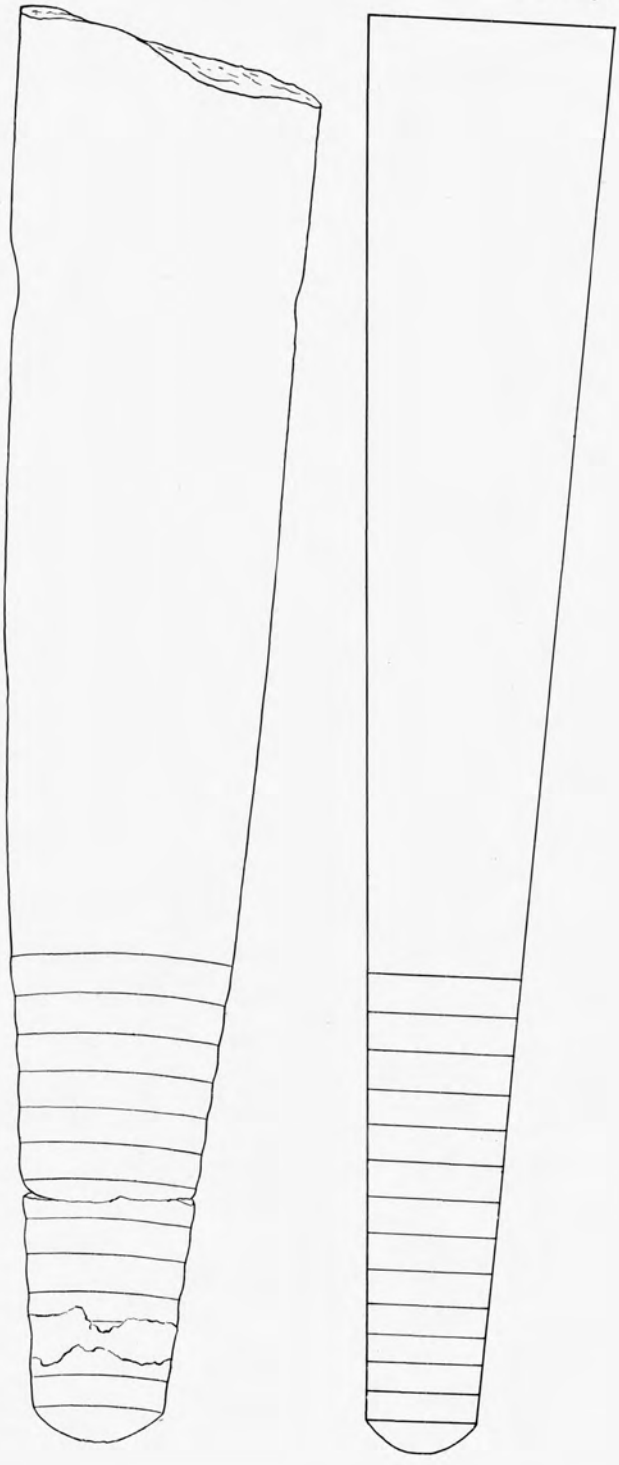

PLATE XLIII.

CEPHALOPODS.

Orthoceras cf. *bebryx* Hall.

Page 135.

Figs. 1 and 2. Outline drawings showing the specimen in a crushed condition and also a restoration. x ½.

PLATE XLIV.

CRUSTACEA.

Proëtus rowi Green.

Page 142.

Fig. 1. A nearly complete but somewhat distorted specimen in which the characters of the species are well shown. Collected by E. E. Teller.

Phacops rana Green.

Page 143.

Fig. 2. A cephalon of one individual and a thorax and pygidium of a somewhat smaller individual of this widespread species. Collection E. E. Teller.

Echinocaris punctata Hall.

Page 145.

Fig. 3. The cephalon of the only specimen collected showing the surface ornamentation.

Fig. 4. Another specimen of the same or closely related species showing portions of four abdominal somites, the two upper dorsal, the remainder ventral, the telson and three caudal spines. Collection E. E. Teller.

Bollia ungula Jones.

Page 143.

Fig. 5. An enlargement (x 10) of a specimen from the Falls of the Ohio. The figure is from Journ. Cin. Soc. Nat. His. XIII, 1891, p. 14, fig. 6.

Ulrichia conradi Jones.

Page 145.

Fig. 6. An enlargement (x 30) of a specimen from Thedford, Ontario. The figure is from Geol. Sur. Canada, Cont. Micro. Pal., pt III, 1891, pl. 11, figs. 13.

Barychilina walcotti (Jones).

Page 144.

Fig. 7. An enlargement (x 30) of a specimen from Thedford, Canada.

Fig. 8. An enlargement (x 60) of a portion of the same specimen. Both figures are from Geol. Surv. Canada, Cont. Micro. Pal., pt III, 1891, pl. 11, figs. 12a and 12b.

Tropidocaris sp.

Page 146.

Fig. 9. A crushed specimen in which one valve overlaps the other which appears to be a new species. Teller Collection.

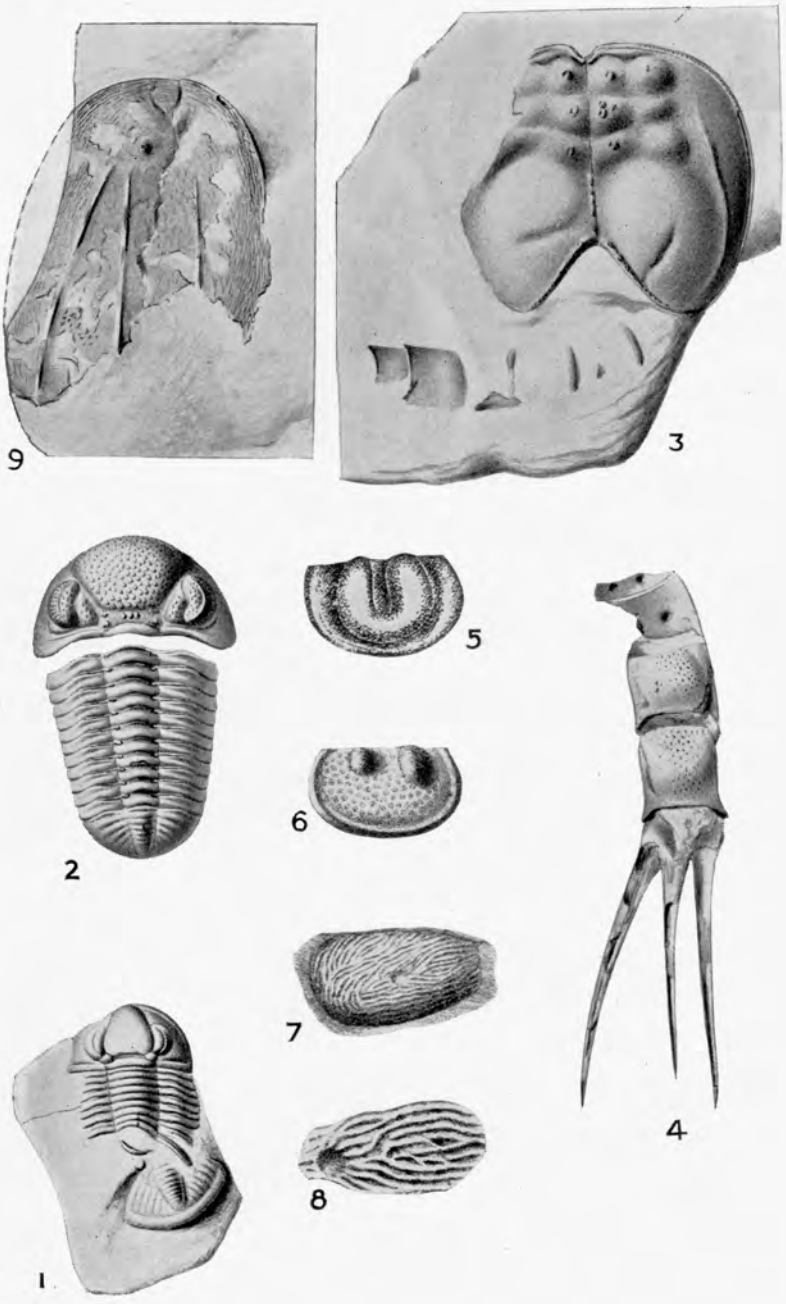
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PLATE XLV.

FISHES.

Dinichthys pustulosus Eastman

See Plate XLVI

Page 155.

Fig. 1. External aspect of left mandibular ramus. x ½. After Eastman. Milwaukee quarry, Humboldt street bridge, Milwaukee, Wis.

Fig. 2. Left posterior palato-pterygoid dental plate, or "shear tooth." Natural size. After Eastman. Milwaukee quarry, Humboldt street bridge, Milwaukee, Wis.

Acantholepis fragilis Newb.

Page 152.

Fig. 3. Two lateral scutes in natural position, showing outer surface, natural size. Corniferous limestone, Sandusky, Ohio. After Newberry.

PLATE XLVI.

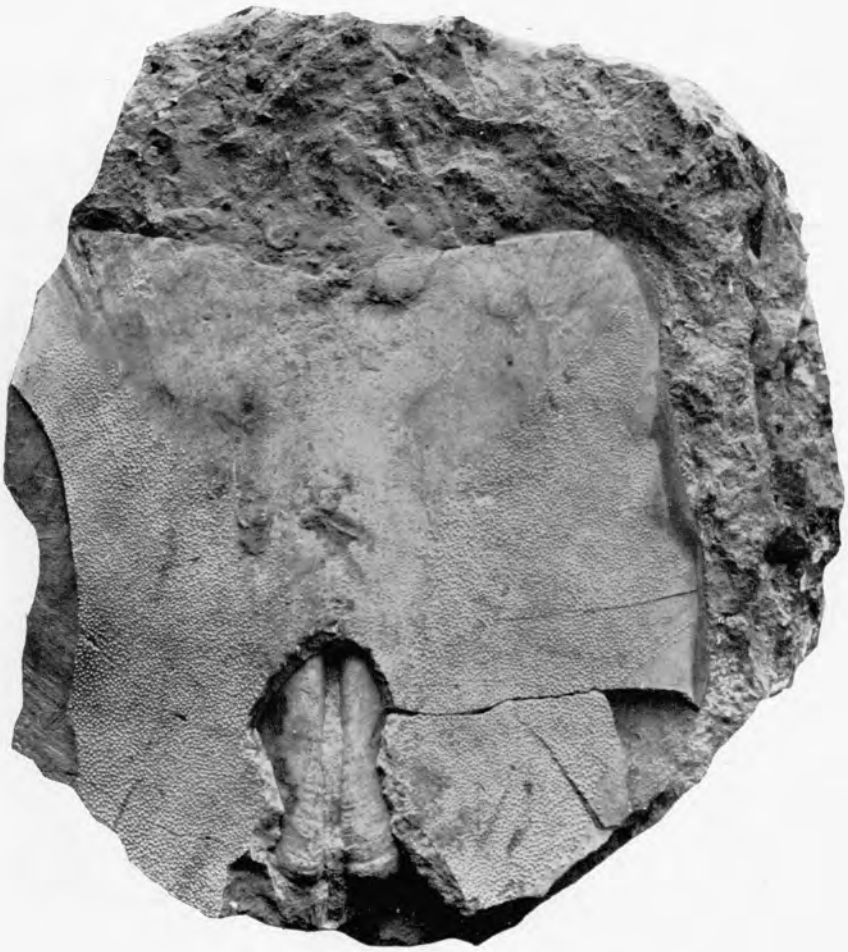
FISHES.

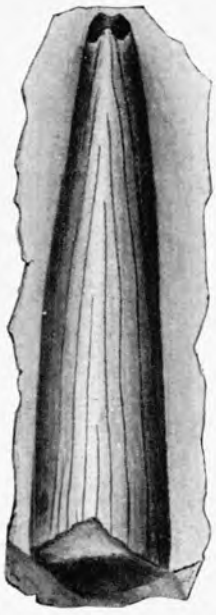
Dinichthys pustulosus Eastman

(See also Plate XLV)

Page 155.

Medial plate, reduced to 2/5 natural size. Hamilton limestone, Rock Island, Ill. After Eastman.





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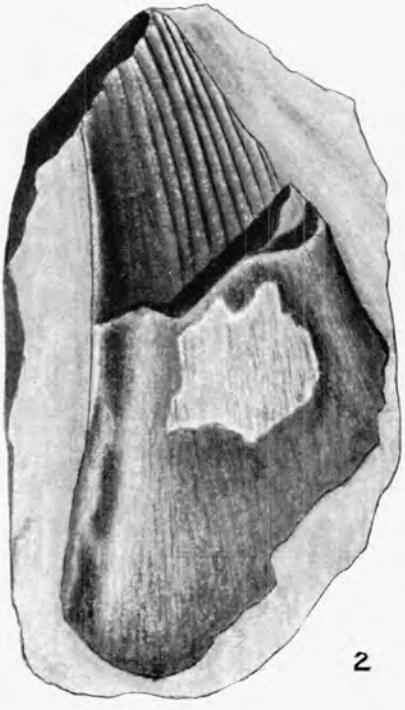

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PLATE XLVII.

FISHES.

Heteracanthus politus Newb.

Page 153.

Figs. 1, 2. Summit and base of spine, natural size. After Newberry. Milwaukee quarry, Humboldt street bridge, Milwaukee, Wis.

Cladodus monroei Eastman

Page 147.

Fig. 3. Detached tooth, coronal apex and portion of the root broken away. x 2. After Eastman. Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wis.

Rhynchodus excavatus Newb.

Page 148.

Fig. 4. Left lower tooth, natural size. After Newberry. Hamilton group, Brown Deer, Wis.

Onychodus sp. undet.

Page 157.

Fig. 5. Imperfect slightly arcuate tooth showing central cavity. x 2. After Eastman. Milwaukee quarry, Humboldt street bridge, Milwaukee, Wis.

Rhynchodus sp.

Page 148.

Fig. 6. Detached scalelike plate evidently external in position, and regarded as a dermal calcification of *Rhynchodus*. Natural size. Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wis.

PLATE XLVIII.

FISHES.

This plate is introduced through the courtesy of the American Naturalist.

Ptyctodus calceolus N. and W.
Page 150.

Figs. 1–17. Dental plates of the above species. After Eastman.

Ptyctodus compressus Eastman
Page 150.

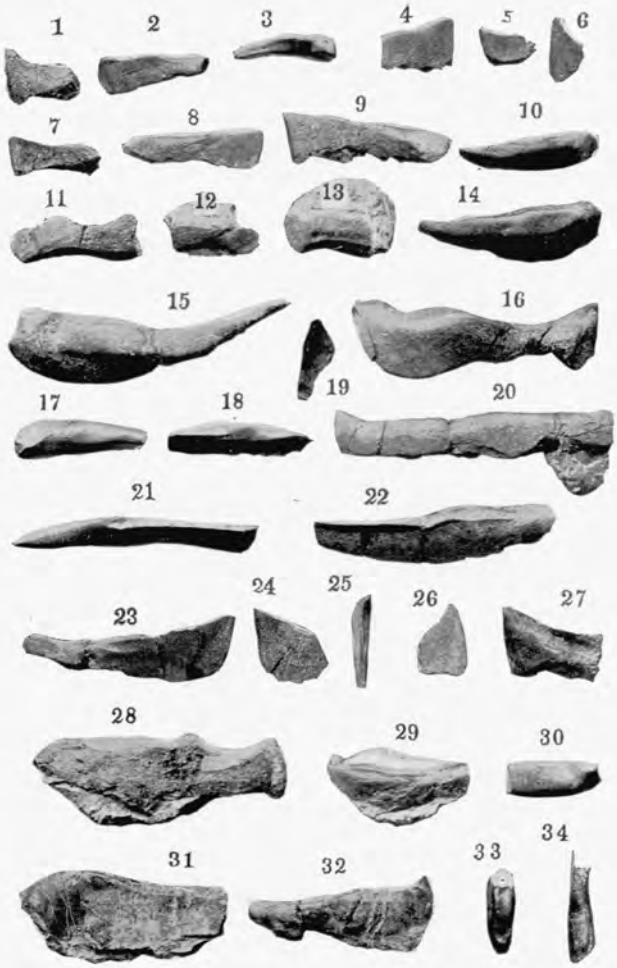
Figs. 18–27. Somewhat fragmentary specimens from the Milwaukee cement quarry. After Eastman.

Ptyctodus molaris Eastman

Figs. 28–30. These figures are introduced for comparison.

Ptyctodus panderi Eastman

Figs. 31–34. These figures are introduced for comparison.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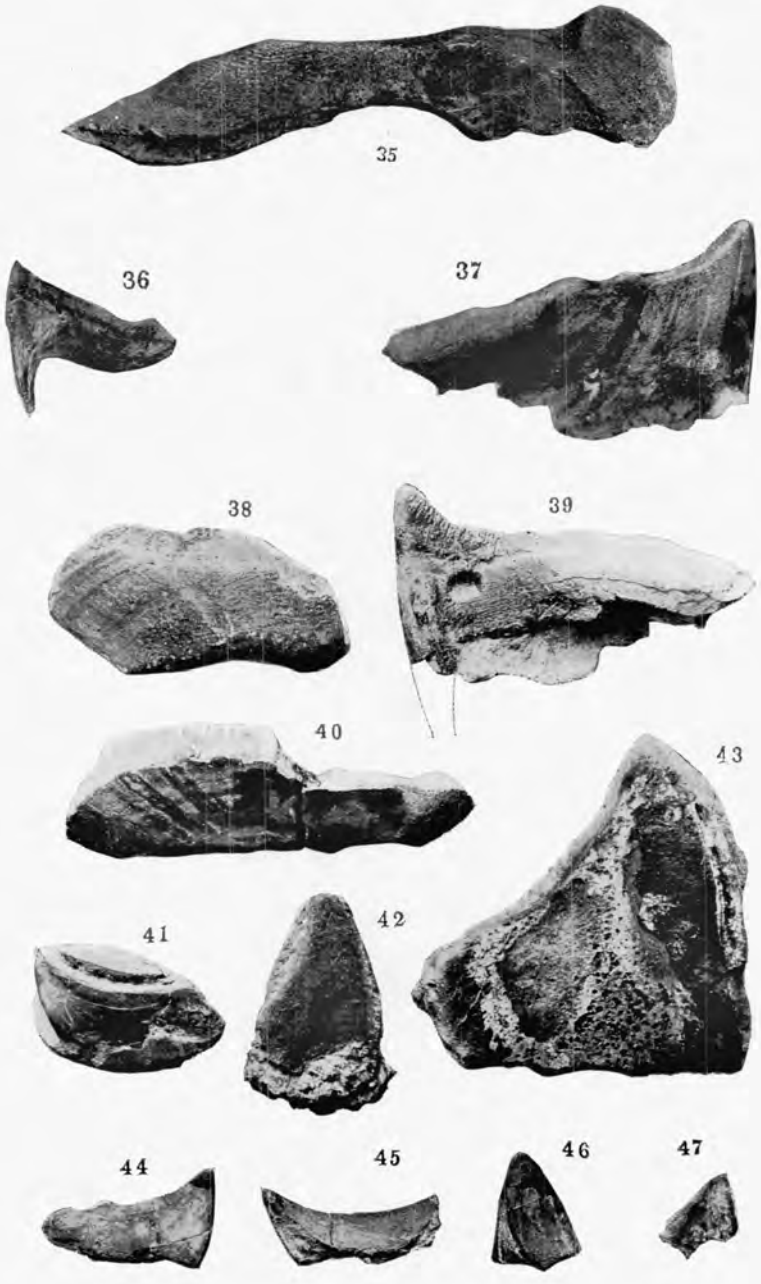
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PLATE XLIX.

FISHES.

The figures in this plate are reproduced through the courtesy of the American Naturalist.

Ptyctodus ferox Eastman

Page 151.

Fig. 35. A left upper dental plate. After Eastman. Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Figs. 36–40. Other specimens of the above from the Milwaukee cement quarry. Collected by Messrs. Teller and Monroe.

Figs. 41, 44–47 are of *Rhynchodus rostratus* Eastman.

Fig. 42 is of *Rhynchodus major* Eastman.

Fig. 43 is of *Ptyctodus predator* Eastman.

Figures 41–47 are introduced for comparison.

PLATE L.

FISHES.

Palaeomylus greenei Newberry

Page 151.

A group of four naturally associated dental plates. Teeth of the lower jaw at top, and teeth of the upper jaw at the bottom of the figure. Those belonging to the left side of the mouth are on the left, and those belonging to the right side are on the right of the figure. x ⅔. After Eastman. From the Milwaukee cement quarry.

PLATE LI.

FISHES.

This plate was loaned by the Editor of the Bulletins of the Wisconsin Natural History Society.

Phlyctaenacanthus telleri Eastman

Page 153.

The left side of a specimen that shows the inserted portion of the two rays, and a portion of the spine below the angle, also a tooth of *Palaeomylus greenei*. Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

PLATE LII.

FISHES AND PLANTS.

The figures on this plate were loaned by the Editor of the Bulletins of the Wisconsin Natural History Society.

Phlyctaenacanthus telleri Eastman

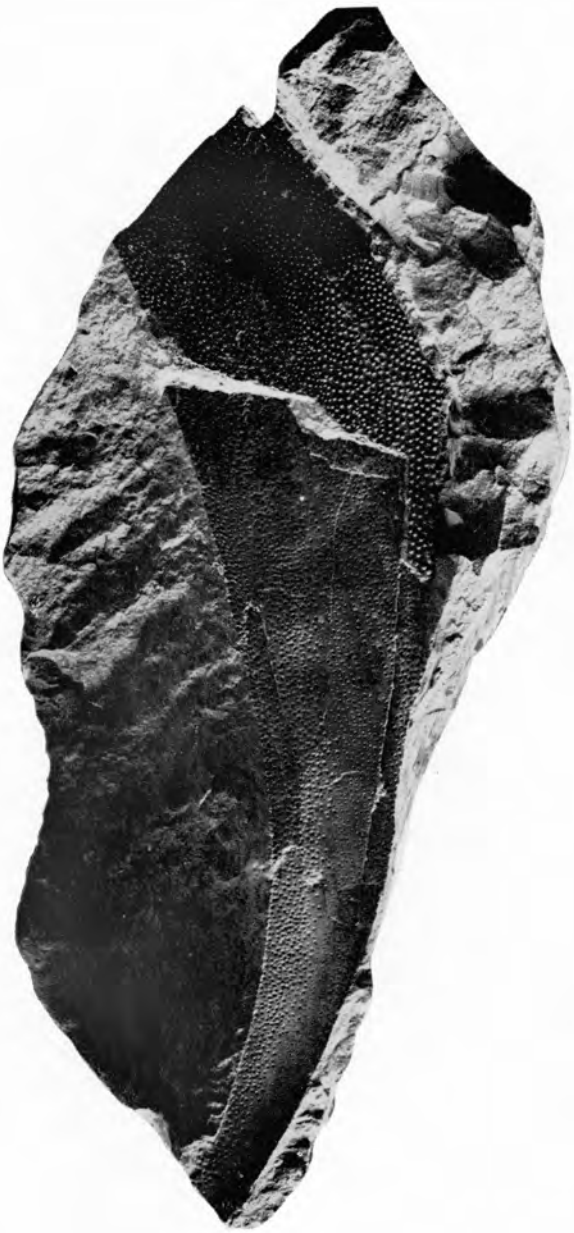
Page 153.

Fig. 1. Specimen showing the angle of the anterior surface and that portion of the spine above the angle. After Teller. Milwaukee cement quarry, Humboldt street bridge, Milwaukee, Wisconsin.

Nematophycus milwaukeensis Penhallow

Page 158.

Fig. 2. This is the type of the species and is the only good specimen seen. Reduced. Collected by C. E. Monroe from the Milwaukee cement quarry; now in the Public Museum, Milwaukee.



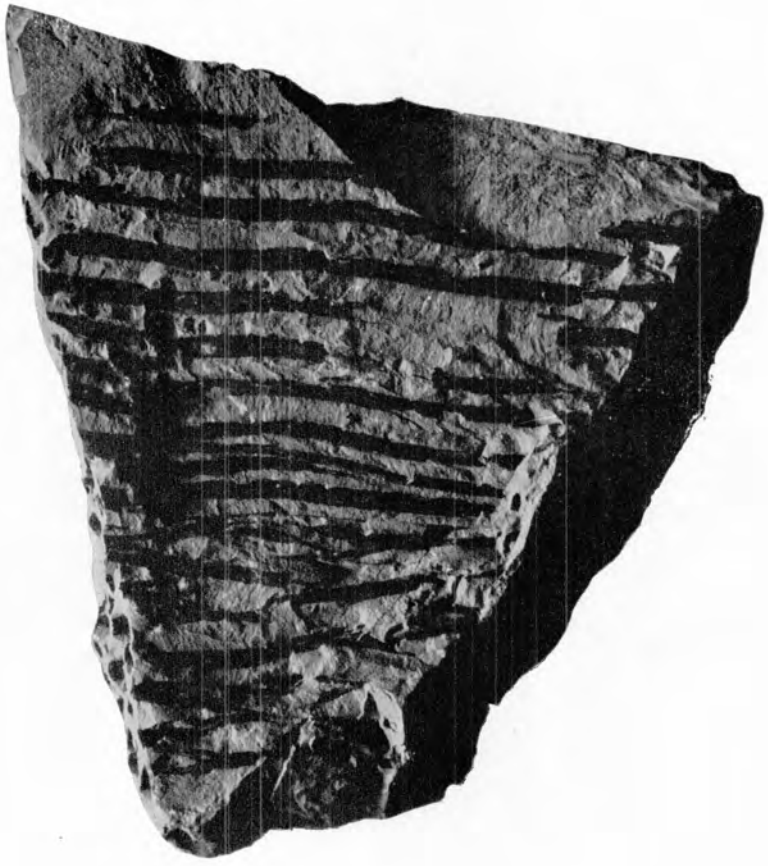


PLATE LIII.

PLANTS.

This plate was loaned by the Editor of the Bulletins of the Wisconsin Natural History Society.

Fucus bertheletensis Penhallow

Page 160.

A well preserved specimen from the Milwaukee cement quarry, Humboldt street bridge, Milwaukee. Collected by C. E. Monroe and now in the Public Museum, Milwaukee. Reduced.

INDEX

*The more important references are in heavy type.